SECTION 203
FINAL INTEGRATED FEASIBILITY REPORT
AND
ENVIRONMENTAL IMPACT STATEMENT
FOR THE
HOUMA NAVIGATION CANAL DEEPENING PROJECT
TERREBONNE PARISH, LOUISIANA

Submitted to

U.S. Army Corps of Engineers
New Orleans District
New Orleans, Louisiana

Submitted by

LOUISIANA DEPARTMENT OF
TRANSPORTATION & DEVELOPMENT
Baton Rouge, Louisiana

Prepared by

Baton Rouge, Louisiana

September 2017

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7400 Leake Avenue
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LOUISIANA DEPARTMENT OF TRANSPORTATION & DEVELOPMENT

P.O. Box 94245
Baton Rouge, Louisiana 70804
225.379.3035

Prepared by

8282 Goodwood Boulevard
Baton Rouge, Louisiana
225.612.3000

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EXECUTIVE SUMMARY

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SECTION 203
FINAL INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL IMPACT STATEMENT FOR THE HOUMA NAVIGATION CANAL DEEPENING PROJECT TERREBONNE PARISH, LOUISIANA

Description of Report: The Louisiana Department of Transportation and Development (LADOTD) has prepared this Integrated Feasibility Report/Environmental Impact Statement (IFR/EIS) for the Houma Navigation Canal (HNC) Deepening Project. The report and EIS describe the formulation and evaluation of plans considered to address navigation needs of the Houma Navigation Canal; economic and environmental conditions and potential effects of the alternative plans; environmental mitigation; and project costs and implementation information.

Purpose and Need: Houma, Louisiana, is a large center for shipyard work for the offshore marine sector for the construction of new vessels and for regular repairs of licensed vessels. A deeper waterway is needed to reduce future waterborne transportation costs and allow the efficient passage of large oil and gas sector barges, new vessels built at the Houma shipyards, and vessels working in the Gulf of Mexico (Gulf).

History, Authority, Prior Studies: Local interests constructed the HNC in 1962 and the River and Harbor Act of 23 October 1962 provided Federal maintenance. Authority was granted on August 23, 1973, in accordance with Section 5 of the River and Harbor Act of March 4, 1915, to increase the HNC project dimensions of the Cat Island Pass Reach to −18 feet Mean Low Gulf (MLG) depth and a 300-foot bottom width; the pass was deepened in July 1974. The Inland and Terrebonne Bay Reaches are currently authorized to a depth of −15 feet MLG and a bottom width of 150 feet.

By letter to the Assistant Secretary of the Army for Civil Works, dated January 10, 2012, the LADOTD recommended initiating this IFR/EIS under the authority granted by Section 203 of the 1986 WRDA (PL 99-662).

The Morganza to the Gulf Project was authorized for construction by Section 1001 (24)(A) of WRDA 2007 to provide storm surge risk reduction for coastal communities in Lafourche and Terrebonne Parishes. The HNC lock complex, which will be located within the channel just below Mile 20.0, is a key component of the Morganza to the Gulf Project, the Increase Atchafalaya Flow to East Terrebonne Project, and this deepening project. The State of Louisiana through the CPRA is constructing the lock complex (TE-113) for flood control, salinity control, freshwater distribution, and navigation.

Alternative Plans: Port of Terrebonne shippers are already using nonstructural measures when necessary, including light loading vessels, taking additional trips, diverting deeper draft vessels to deeper ports, rerouting along a longer detour route, and navigation aids including additional tugs and/or dry docks. Nonstructural measures will not address the study objectives by improving navigation and the continued bank erosion along the HNC cannot be reduced by nonstructural means.

Structural measures were designed to make the HNC a more efficient navigation channel and to address bank erosion and wetland loss. These measures include: channel deepening, foreshore protection, and placement measures. The No-Action Plan would be continued maintenance dredging of the existing 15-foot channel. Combinations of the two depths, foreshore protection and rock retention dikes, and three lower reach placement options were used to formulate six deepening alternatives for additional evaluation. All deepening alternatives would construct foreshore protection to reduce bank erosion and rock retention dikes, where necessary, between adjacent disposal areas and the channel, in locations along both banks on the Inland Reach.

The two channel depths and three lower reach disposal options created six deepening alternatives to be evaluated in detail to select a Tentatively Recommended Plan (TRP). The six deepening alternatives (plus the No-Action Alternative) are:

- Alternative-0–No-Action–Continued maintenance of 15-foot channel
- Alternative 1A–18-foot Channel (Lower reaches adjacent disposal)
- Alternative 1B–18-foot Channel (Lower reaches BU Earthen Containment)
- Alternative 1C–18-foot Channel (Lower reaches BU Rock Containment)
- Alternative 2A–20-foot Channel (Lower reaches Adjacent Disposal) (TRP)
- Alternative 2B–20-foot Channel (Lower reaches BU Earthen Containment)
- Alternative 2C–20-foot Channel (Lower reaches BU Rock Containment)

The LADOTD, Terrebonne Parish Consolidated Government (TPCG), and the Terrebonne Port Commission (TPC) have expressed a willingness to be the non-Federal sponsors for this project and have requested that only alternatives up to –20 feet are evaluated due to current financial limitations. Plan 2A is designated as the TRP for implementation because it is a National Economic Development (NED) Plan; it creates marsh or provides BU for environmental restoration and enhancement; and it is supported by the non-Federal sponsors.

Benefits, Costs, and Implementation of the Recommended Plan: Deepening the HNC channel to −20 feet NAVD88 would achieve transportation cost savings from more efficient transportation compared to the currently authorized channel depth of -15 feet. The TRP would also provide benefits by allowing fabrication industries along the HNC to be competitive in responding to contract solicitations calling for fully integrated offshore platforms. The rock foreshore protection and retention dikes would help prevent further bank erosion and would also serve to provide containment and protection for dredged material disposal areas along certain portions of the channel. The disposal plan provides for beneficial use of dredged material by placing material in locations and quantities with earthen containment structures to restore wetland habitats.

For all deepening alternatives, beneficial use of dredged material would be utilized within the inland reach (Mile 36.3 to Mile 11.0). Alternatives 1B, 1C, 2B, and 2C would utilize beneficial use of dredged material within the Terrebonne Bay and Cat Island Pass reaches (Mile 11.0 to Mile -3.7). Alternatives 1A and 2A would utilize disposal of dredged material via single point discharge to the west of the channel.

The NED plan and the TRP: Based on an evaluation of alternative plan economic costs and benefits, the NED plan includes a 20-foot deep channel with shoreline protection and rock retention along portions of the Inland Reach. This is the depth at which net benefits (benefits minus costs) are greatest. Alternative 2A, with the least costly disposal option, provides the highest return per dollar spent with a benefit cost ratio of 4.96 without fabrication benefits and 5.30 with fabrication benefits.

Coordination with Agencies and the Public: To ensure that the public and Federal, tribal, state, and local agencies were kept informed about progress on technical analyses and policy issues, public meetings were held.

Areas of Controversy: User groups and agencies have commented on existing bank erosion problems in the Inland Reach, and how the proposed deepening may affect this issue. Due to the problems with bank erosion, this project will construct foreshore protection and retention dikes in the Inland Reach. In addition, this project will beneficially use dredged material in disposal areas to create marsh habitat within the Inland Reach. Disposal within the Terrebonne Bay and Cat Island Pass reaches would be unconfined.

Environmental Impacts Analysis: The TRP would have limited or no direct long-term impact on the hydrology along the HNC, with the exception of possible changes in salinity in the channel and connected water bodies. The impact from the construction of rock dikes, earthen dikes, rock foreshore protection, and rock retention structures associated with the proposed alternative would have direct and indirect surface water runoff impacts to the adjacent water bodies. Specifically, the construction activities would probably introduce non point source discharges, such as suspended sediments. However, the beneficial use of dredged material for restoration and preservation of the wetland areas would provide water quality benefits that would far outweigh these adverse impacts.

With the TRP, there would be a direct impact on the ecology of the benthos in the project area. The canal would be deepened for approximately 41 miles. This length works out to be just short of 1,000 acres of disturbance. With the placement of excavated dredge material in the designated disposal sites within the upland reach, open water bottom would be converted to marsh. Approximately 14.7 miles of foreshore dikes and rock retention dikes would be built or refurbished with this project.

The TRP could have a positive indirect impact on aquatic resources, by the creation of marsh. Increasing nutrients and sediments in the estuarine area would enhance the growth of marsh vegetation and slow the rate of land loss. Increased plant growth would result in greater production of organic detritus that is essential for a high rate of fisheries production. The deepening of the channel would cause an increase in salinity intrusion; however, this would be mitigated by the operation of the HNC lock. Oyster reefs that exist in any placement areas would be buried. There is one oyster lease in the placement sites.

The TRP would have a positive impact on Essential Fish Habitat (EFH) due to the creation of wetlands.

The TRP could have a positive indirect impact on wildlife and T&E species, through the creation of marsh, which could provide foraging areas for some birds and mammals. In the long-term, there could be an impact to T&E Species as their habitat and prey's habitat loss rates stabilize.

With implementation of the TRP there would be minor short-term impacts to air quality that would result from the construction phase of the HNC deepening. The TRP would have only short-term, and minor, direct impacts on noise during construction.

Mitigation: The appropriate application of mitigation is to formulate an alternative that first avoids adverse impacts, then minimizes adverse impacts, and lastly, compensates for unavoidable impacts. During the planning process, this methodology was followed where practicable. This helped avoid adverse impacts to some wetlands. To minimize adverse impacts, dredged material placed within the shallow open water areas would be placed to an initial elevation conducive to the development of long-term wetlands.

Compensatory mitigation would be necessary for the value of the wetland habitat lost and for impacted oyster leases. Impacts to bottomland hardwood would be purchased from a mitigation bank. Impacts to fresh marsh would be mitigated through the creation of freshwater marsh habitat in some of the Inland Reach disposal areas.

Regional and Local Economic Effects: Deepening the channel to 20 feet would increase vessel utilization 38 percent over the No-Action Alternative while maintaining the same annual growth rate as the No-Action Alternative. The 20-foot channel would also allow for greater utilization of existing facilities and obviate the need to continue to maintain satellite facilities on deeper channels.

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1.0 INTRODUCTION

The Houma Navigation Canal (HNC) is a Federally maintained waterway that connects the Gulf Intracoastal Waterway (GIWW) in Houma with the Gulf of Mexico (Gulf) (Figures 1-1 and 1-2). The HNC is located in south-central Terrebonne Parish, approximately 50 miles southwest of New Orleans. The project area is within the Barataria-Terrebonne National Estuary, one of the most expansive and productive estuaries in the United States (U.S.).

The Louisiana Department of Transportation and Development (LADOTD) has prepared this Draft Integrated Feasibility Report/Environmental Impact Statement (IFR/EIS) for the HNC Deepening Project. Houma Louisiana is a large center for shipyard work for the offshore marine sector. The shipyard work consists of the construction of new vessels and the regular repairs of licensed vessels. A deeper waterway is needed to reduce future waterborne transportation costs and allow the efficient passage of large oil and gas sector barges, new vessels built at the Houma shipyards, and vessels working in the Gulf.

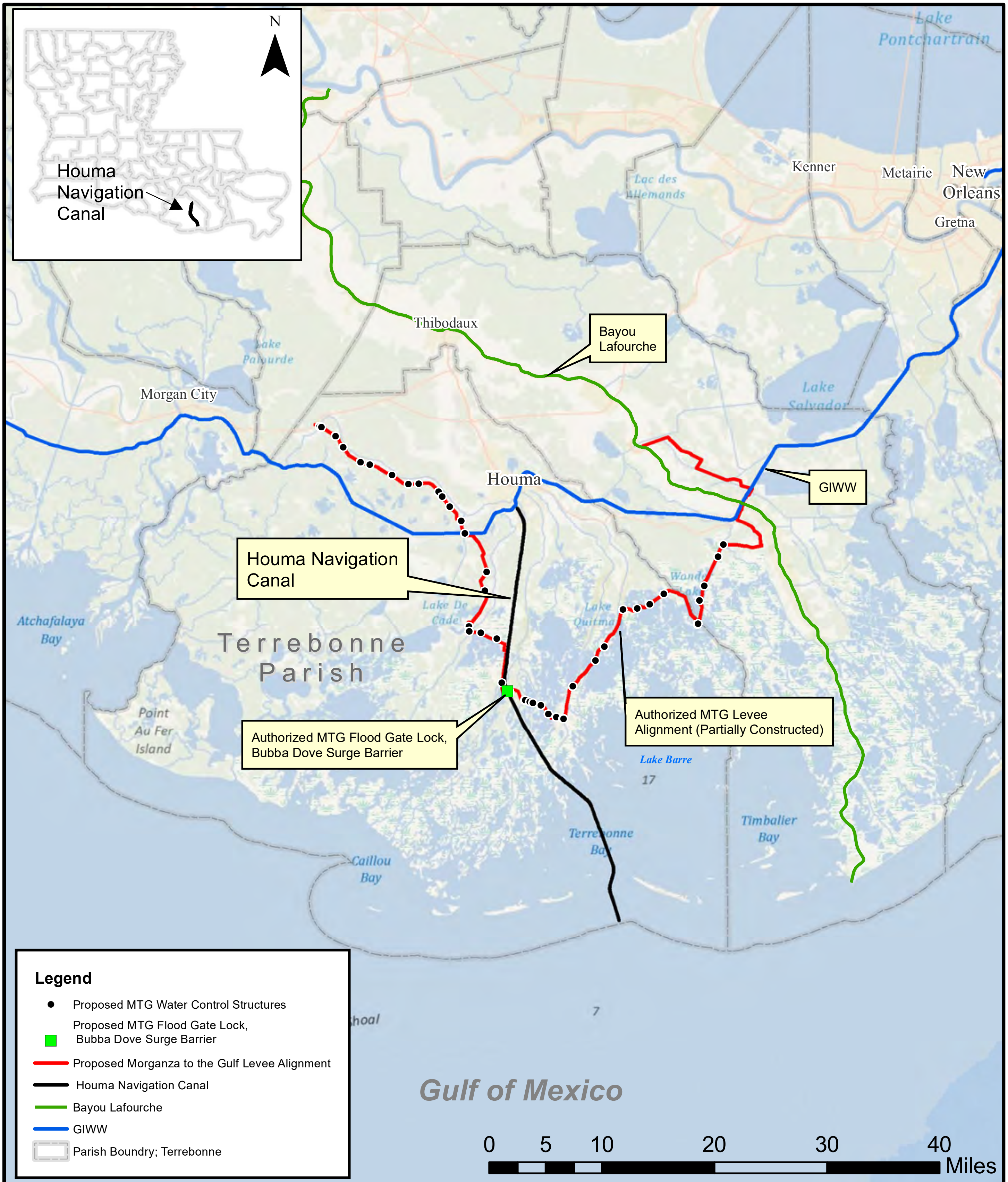
1.1 Study Authority

<u>Rivers and Harbors Act of 1962</u>

Local interests completed construction of the HNC in 1962. The entire length of the channel (from the GIWW in Houma to Mile −3.5, the approximate 18-foot Gulf contour) was initially constructed to −15 feet deep MLG and a 150-foot bottom width. The Rivers and Harbors Act of 23 October 1962 provided authority for Federal maintenance of the HNC. Authority was granted on August 23, 1973, in accordance with Section 5 of the Rivers and Harbors Act of March 4, 1915, to increase the HNC project dimensions of the Cat Island Pass Reach (from Miles 0.0 to −3.5) to −18 feet Mean Low Gulf (MLG) depth and a 300-foot bottom width. The Cat Island Pass Reach deepening and widening was completed in July 1974. The Inland and Terrebonne Bay Reaches are currently authorized to a depth of −15 feet MLG and a bottom width of 150 feet. HNC reaches are shown in Figure 1-2.

<u>Energy and Water Development Appropriations Bill, 2013, Senate Report 103-291</u>

The Energy and Water Development Appropriations Act of 1995 [Public Law (PL) 103-316] authorized the Morganza, Louisiana, to the Gulf of Mexico (Morganza to the Gulf) feasibility

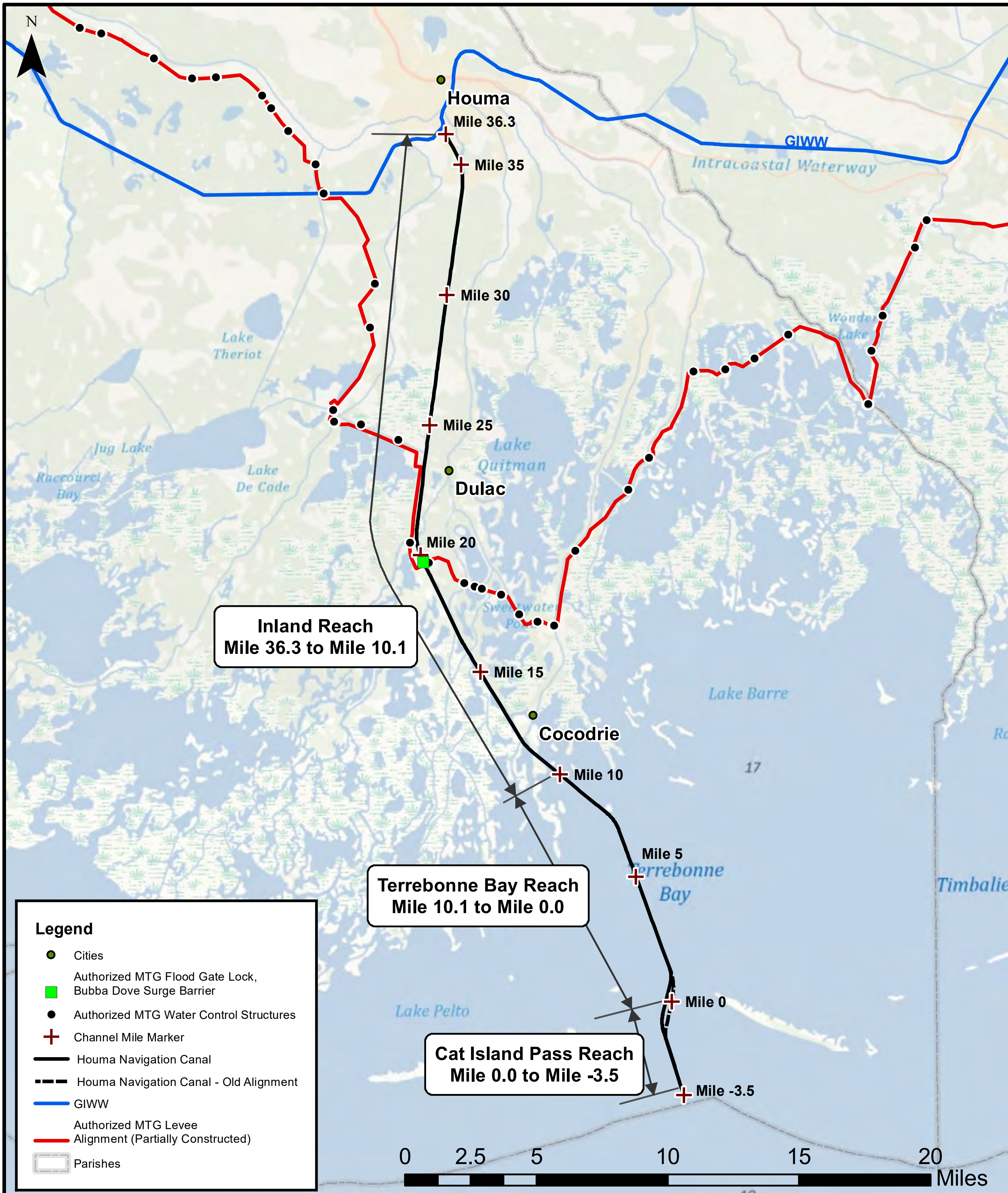


VICINITY MAP

Houma Navigation Canal Deepening

ERSI Ocean Map

Figure 1-1	
Date: October 2012	
Scale: 1:750,000	
Source: ESRI/GEC	
Map ID: 278500218-3026	



HNC REACHES

Houma Navigation Canal Deepening

ERSI Ocean Map

GEC

Figure 1-2	
Date: September 2012	
Scale: 1:325,000	
Source: ESRI/GEC	
Map ID: 278500218-3026	

study. The U.S. Army Corps of Engineers (USACE) was directed to give particular attention to the interrelationships of the various ongoing studies in the area, and consider improvements to the HNC in the Energy and Water Development Appropriations Bill, 2013, Senate Report 103-291:

> *The Committee is aware that the Corps of Engineers is proceeding with several studies and projects that impact the coastal area of Louisiana, including the Morganza, La. to the Gulf of Mexico feasibility study, the Lower Atchafalaya Basin reevaluation study, and several projects being pursued under the Coastal Wetlands Planning, Protection, and Restoration Act. The Committee is concerned that these studies and projects are proceeding concurrently, yet independently, and requests that the Corps gives particular attention to the interrelationship of these studies and projects during the planning and construction process, along with special emphasis on the imperative and direct involvement of the various local interests during the process. The Committee also directs that the Morganza, La. to the Gulf of Mexico study includes consideration of improvement at and/or within the Houma Navigation Canal.*

Section 425 of WRDA 1996

Section 425 of the Water Resources Development Act (WRDA) of 1996 (PL 104-303) required the USACE to develop a study of the HNC lock as an independent feature of the Morganza to the Gulf of Mexico Hurricane and Storm Damage Risk Reduction Project.

Energy and Water Development Appropriations Act of 1998

The HNC lock study was completed in 1997. Congress authorized the USACE to initiate detailed design of the HNC multipurpose lock in the Energy and Water Development Appropriations Act of 1998 (PL 105-62). During the Preconstruction, Engineering, and Design (PED) phase of the HNC lock design, the navigation industry expressed concerns about designing the HNC lock to accommodate future traffic and growth on the HNC. Any changes in the authorized depth of the HNC would affect the HNC lock sill elevation. In response to this request, the New Orleans District of the USACE (CEMVN) completed a preliminary evaluation of deepening the channel in March 2001. This evaluation determined that further Federal participation was warranted based on the National Economic Development (NED) benefits derived from channel deepening. A General Reevaluation Study was undertaken based on those findings. An In-Progress Review meeting in May 2009 with CEMVN and Headquarters USACE (HQUSACE) determined the Houma Navigation Canal Improvement Study would proceed as a Feasibility Study rather than a General Reevaluation Study.

Section 203 of WRDA 1986

By letter to the Assistant Secretary of the Army for Civil Works (ASA(CW)), dated January 10, 2012, the LADOTD recommended initiating this IFR/EIS under the authority granted by Section 203 of the 1986 WRDA (PL 99-662), which states:

Sec. 2231. Studies of projects by non-Federal interests

(a) Submission to Secretary

A non-Federal interest may on its own undertake a feasibility study of a proposed harbor or inland harbor project and submit it to the Secretary. To assist non-Federal interests, the Secretary shall, as soon as practicable, promulgate guidelines for studies of harbors or inland harbors to provide sufficient information for the formulation of studies.

(b) Review by Secretary

The Secretary shall review each study submitted under subsection (a) of this section for the purpose of determining whether or not such study and the process under which such study was developed comply with Federal laws and regulations applicable to feasibility studies of navigation projects for harbors or inland harbors.

(c) Submission to Congress

Not later than 180 days after receiving any study submitted under subsection (a) of this section, the Secretary shall transmit to the Congress, in writing, the results of such review and any recommendations the Secretary may have concerning the project described in such plan and design.

(d) Credit and reimbursement

If a project for which a study has been submitted under subsection (a) of this section is authorized by any provision of Federal law enacted after the date of such submission, the Secretary shall credit toward the non-Federal share of the cost of construction of such project an amount equal to the portion of the cost of developing such study that would be the responsibility of the United States if such study were developed by the Secretary.

General Authorities Relating To Beneficial Uses of Dredged Material

Engineering Regulation (ER) 1105-2-100, p. E-72 states that management plan studies should include an assessment of potential beneficial uses of dredged material for meeting navigation and non-navigation objectives. When beneficial use is included as part of the base plan, it shall be treated as a general navigation O&M component.

Section 204 of WRDA 1992

Section 204 of the WRDA of 1992, as amended by the WRDA of 2007, provides programmatic authority for the selection of a placement method that provides beneficial use when it is not the least-cost method of placement. In this situation, where the non-federal sponsor is willing, cost sharing would be applied to the incremental cost above the least-cost method of dredged material disposal consistent with engineering and environmental criteria. The environmental, economic, and social benefits, monetary and non-monetary, must justify the costs, and the project must not result in environmental degradation. These provisions would be covered under the Continuing Authorities Program (CAP) and would be limited to $5 million.

Section 206 of WRDA 1996

Section 206 of the WRDA of 1996 authorizes the Secretary of the Army to carry out aquatic ecosystem restoration projects that will improve the quality of the environment, are in the public interest, and are cost effective. Individual projects are limited to $5 million in federal cost. Non-federal interests must contribute 35 percent of the cost of construction and 100 percent of the cost of operation, maintenance, replacement, and rehabilitation. The program has an annual program limit of $25 million. This program received initial funding of $6 million in fiscal year 1998.

Section 207 of WRDA 1996

Policy Guidance Letter No. 56, Section 207 of the WRDA of 1996, states that the USACE may select a disposal method that is not the least cost (NED) option. The Secretary must determine that the incremental costs of the selected disposal method are *reasonable* in relation to *environmental benefits* to be realized non-Federal Interests pay 25 percent of the incremental cost in excess of the least cost (NED) disposal option.

Section 1135 of WRDA 1986

Section 1135 of the WRDA of 1986, as amended, gives the USACE the authority to make modifications to the structures and operations of water resources projects constructed by the USACE to improve the quality of the environment. The primary goal of these projects is ecosystem restoration with an emphasis on projects benefiting fish and wildlife. To qualify under this program, projects must be justified; that is, both monetary and non-monetary benefits resulting from constructing the project must justify the cost of the project. The project must also be consistent with the authorized purposes of the project being modified, environmentally acceptable, and complete within itself. Each separate project is limited to a total cost of not more than $5 million, including studies, plans and specifications, and construction.

1.2 Purpose of Action and Scope

1.2.1 Purpose of Action

The LADOTD has developed this Section 203 study to determine the feasibility of deepening the existing HNC Federal project and to identify the NED plan. The NED plan has the greatest net economic benefits consistent with protection of the Nation's environment. This feasibility study has been developed together with an EIS as required by the National Environmental Policy Act of 1969 (NEPA).

An analysis of the deepening of the HNC was originally conducted in 2006 and updated in 2016. The updated report, *Economic Benefits of Houma Navigation Canal Deepening* (Appendix D), reanalyzes the NED benefits of deepening the HNC. The 2016 update incorporates the prior reports, including the results of a time series of market interviews and assessments conducted in relation to traditional NED benefits analyses of waterway improvements and fabrication benefits related to the deepwater oil and gas sector. The report complies with guidance provided by Section 6009 of the Emergency Supplemental Appropriations Act for Defense, the Global War on Terror, and Tsunami Relief, 2005 (PL 109-13) dated May 11, 2005, which states:

> *SEC. 6009. OFFSHORE OIL AND GAS FABRICATION PORTS.*
> *In determining the economic justification for navigation projects involving offshore oil and gas fabrication ports, the Secretary of the Army, acting through the Chief of Engineers, is directed to measure and include in the National Economic Development calculation the value of future energy exploration and production fabrication contracts and transportation cost savings that would result from larger navigation channels.*

The analysis of deepening alternatives has been limited to a maximum channel elevation of −20 feet North American Vertical Datum of 1988 (NAVD88). The non-Federal project cost share increases from 20 to 35 percent for Federal navigation projects deeper than −20 feet elevation. In accordance with USACE Engineering Regulation (ER) 1105-2-100, Planning Guidance, dated April 22, 2000, if the non-Federal sponsor identifies a constraint to maximum physical project size or a financial constraint due to limited resources, and if net benefits are increasing as the constraint is reached, the requirement to formulate larger scale plans in an effort to identify the NED plan is suspended. However, the constrained plan may be recommended.

1.2.2 Scoping

A scoping meeting was held on May 21, 2003 and a Notice of Intent by the CEMVN to prepare this EIS was published in the Federal Register on May 23, 2003. Additional public briefings were held in 2002 and 2003 and monthly status meetings were held. Scoping comments considered relevant to the proposed action and appropriate for detailed evaluation included: lock should be built and operated first; bank stabilization; saltwater intrusion; wetland loss; 20-foot depth; drinking water; importance of canal on local economy; socioeconomic; flooding; hurricane protection; maintenance of channel; indirect, secondary, and cumulative effects; wake-induced erosion; and beneficial use of material to create marsh. These issues are discussed and evaluated in this integrated report. Additional details regarding the scoping meeting and the results are discussed in further detail in Section 6.0 and Appendix J of this report.

1.3 Federal Objective

To approve a plan under Section 203, the plan must satisfy a federal objective. The Federal objective is based on the Water Resources Council's *Economic and Environmental Principles and Guidelines for Water Related Land Resources Implementation Studies*. This guidance requires that Federal and Federally assisted water and related land resources planning must contribute to NED consistent with protecting the nation's environment, in accordance with national environmental statutes, applicable executive orders, and other Federal planning requirements. The objectives and requirements of applicable laws and executive orders are considered throughout the planning process in order to meet the Federal objective.

1.4 Study Participants and Coordination

1.4.1 Study Sponsors

The Federal sponsor for the HNC deepening project is the USACE–CEMVN. Local sponsors include the LADOTD, the Terrebonne Parish Consolidated Government (TPCG), and the Terrebonne Port Commission (TPC). The LADOTD and CEMVN entered a Memorandum of Agreement (MOA) on December 16, 2013, whereby the LADOTD would conduct the study, and the CEMVN would assist in policy review and Agency Technical Review (ATR).

1.4.2 Agency Coordination

An interagency habitat evaluation team (HET) was formed on November 15, 1995, for the Morganza to the Gulf Project. This HET was also engaged in the planning process of the HNC Deepening project. This team selected the proposed disposal sites identified in this report. The HET included members from the U.S. Environmental Protection Agency (EPA), National Oceanic and Atmospheric Administration's-National Marine Fisheries Service (NOAA-NMFS), U.S. Fish and Wildlife Service (USFWS), National Resource Conservation Service (NRCS), Louisiana Department of Natural Resources-Coastal Management Division (LADNR-CMD), Louisiana Coastal Protection and Restoration Authority (CPRA), Louisiana Department of Wildlife and Fisheries (LDWF), LADOTD, Terrebonne Levee and Conservation District (TLCD), TPC, and CEMVN. The USFWS conducted Wetland Value Assessments (WVAs) for the evaluation of the alternatives and prepared the Fish and Wildlife Coordination Act Report. Comments were solicited from the U.S. Coast Guard (USCG) regarding navigation concerns. The Louisiana Department of Environmental Quality (LDEQ) provided coordination for the Water Quality Certification.

1.5 Planning Process and Report Organization

1.5.1 Planning Process

The HNC Deepening Project IFR/EIS follows the USACE six-step planning process specified in the USACE *Planning Guidance Notebook* (ER 1105-2-100, dated 22 April 2000) (USACE 2000). The planning process identifies and responds to problems and opportunities associated with the Federal objective and specifies state and local concerns. These steps include:

- Specify water resources problems and opportunities;
- Inventory, forecast, and analyze the water and related land resource conditions within the study area;
- Formulate alternative plans which address the identified problems and take advantage of the opportunities;

- Evaluate the effect of alternative plans;
- Compare alternative plans; and
- Select the tentatively recommended plan (TRP).

New navigation projects include the deepening or widening of existing Federal navigation channels and the creation of new Federal channels. Planning for major navigation improvements is conducted under authority in the *Principles and Guidelines* (P&G) adopted by the Water Resources Council and signed by the President in 1983. The P&G consist of two parts: The Economic and Environmental Principles for Water and Related Land Resources Implementation Studies and The Economic and Environmental Guidelines for Water and Related Land Resources Implementation Studies. These P&G provide the framework for USACE water resources planning studies. Within this framework, the USACE seeks to balance economic development and environmental needs as it addresses water resources problems. The P&G requires that the plan recommended for Federal action should be the alternative plan with the greatest net economic benefit consistent with protecting the Nation's environment (the NED plan), unless the Secretary of the Army grants an exception to this rule.

New navigation projects provide an opportunity for the beneficial use of dredged material. The USACE *Planning Guidance Notebook* that implements the P&G identifies national ecosystem restoration as one of the objectives to consider in planning new navigation projects. This guidance provides the basis for considering beneficial uses of dredged material in the planning effort for this project.

Planning for the HNC deepening has been a dynamic process resulting in multiple iterations of the six-step planning process. The study has been refined through these iterations, and has resulted in a TRP for Federal action that is consistent with the P&G and ER 1105-2-100. A final recommended plan will be included in the final IFR/EIS.

1.5.2 Report Organization

The report is organized similarly to a USACE IFR/EIS, in order to facilitate review and processing by the ASA-CW. As stated in ER 1165-2-209, Studies of Harbor or Inland Harbor Projects by Non-Federal Interests:

> *The traditional study process is for the U.S. Army Corps of Engineers to carry out a water resources development feasibility study using, in addition to the cost share provided by the non-Federal interests, funding provided by the Congress. The premise of Section 203 is that certain non-Federal interests may be capable of producing a feasibility study of a proposed water resources development project without involvement of the Corps of Engineers. Section 203 provides that a non-Federal interest can submit a completed feasibility study to the Secretary of the Army for review to determine if the study, and the process under which the study was developed, each comply with Federal laws and regulations applicable to feasibility studies of water resources development projects. Section 203 provides that within 180 days of receipt of the non-Federal feasibility study, the Secretary shall submit to*

the Committee on Environment and Public Works of the Senate and the Committee on Transportation and Infrastructure of the House of Representatives a report that includes the results of the Secretary's review of whether the feasibility study and the process under which the study was developed comply with Federal law and regulations; a determination of whether the project is feasible; any recommendations concerning the plan or design of the project; and any conditions that the Secretary may require for construction of the project.

Once the non-Federal interest submits the Section 203 feasibility study to the Assistant Secretary of the Army (Civil Works) (ASA(CW)), the ASA(CW) will review the study to determine whether it complies with Federal laws and regulations applicable to Corps of Engineers water resources development feasibility studies and to enable the ASA(CW) to make appropriate recommendations on the study to the Congress. In order to comply with Federal laws and regulations applicable to feasibility studies of water resources development projects, the Section 203 feasibility study must contain the information described in Appendix B.

Appendix B of ER1165-2-209 states:

Within 15 days of receipt of a Section 203 feasibility study and subject to determination that the basic requirements of a feasibility study are met, including compliance with relevant Federal laws and regulations, OWPR will dispatch letters transmitting information regarding the project proposal, draft environmental compliance documents (Environmental Assessment (EA) or Environmental Impact Statement (EIS)), and related documents to State and Federal agencies for comment, and to designated addressees for information. The notice shall request that comments shall be submitted to OWPR within 30 days. Any draft or final EIS will be filed with EPA.

The report is organized as follows, with NEPA-specific sections noted with an asterisk:

Chapter 1–Introduction*
Chapter 2–Prior Studies, Reports and Existing Projects
Chapter 3–Need for and Objective of Actions*
Chapter 4–Affected Environment*
Chapter 5–Formulation and Evaluation of Alternative Plans*
Chapter 6–Environmental Consequences*
Chapter 7–Public Involvement
Chapter 8–Coordination and Compliance
Chapter 9–Conclusions and Determinations
Chapter 10–List of Preparers*
Chapter 11–Index*

2.0 NEED FOR AND OBJECTIVE OF ACTIONS

This section includes reviewing the study area conditions and problems, needs, and opportunities to establish specific planning objectives and constraints that provide the focus in developing alternative plans.

2.1 Need for Action

At present, the depth of the channel causes marine interests to use less efficient methods to service the offshore oil and gas facilities located in the Gulf of Mexico. These inefficiencies manifest themselves as light loading and/or use of more remote harbors with deeper channels. Deepening the channel would eliminate these inefficiencies.

Many and varied businesses are located along the approximately 41 miles of the HNC south of LA Hwy 661. The navigation needs of many of these firms are not being fully met by the existing dimensions of the channel. Most of the current traffic on the canal is composed of motorized boats used for support of the offshore oil and gas industry, including support vessels, tug/tow boats, as well as local area commercial fishing vessels. Almost all of the remaining tonnage on the HNC is composed of petroleum barges and barges carrying gravel. Over a 3-year period from 1996 through 1998, vessel traffic declined an average of 7.5 percent annually. However, offshore oil and gas activity grew during this same period. This trend implies that activity on the HNC will stabilize and remain there well into the future if no changes are made to the channel because inefficiencies in navigation manifest themselves as light loading and/or use of more remote harbors with deeper channels.

2.2 Problems and Opportunities

Existing navigation problems and opportunities for the HNC were identified through coordination with Federal and state agencies, waterway users and other stakeholders, and the non-Federal sponsor. These problems and opportunities primarily relate to the limited depth of the HNC Federal channel which is causing marine interests to use less efficient methods such as light loading, rerouting, and/or use of alternate ports. There are also opportunities to use dredged material to restore surrounding wetlands, which have been lost or degraded due to erosion, subsidence, saltwater, and other factors. The following problem and opportunity statements describe these inefficiencies and opportunities:

- The current Federal channel depth is insufficient and there are opportunities to improve navigation in the channel;
- The insufficient channel depth results in waterway users light-loading larger vessels, using smaller vessels, rerouting larger vessels to deeper ports, and detouring along longer routes to avoid the HNC, and there are opportunities to reduce transportation costs;
- Bank erosion occurs along the Inland Reach of the channel and there are opportunities to reduce shoaling and reduce maintenance dredging in the Federal channel; and

- Bank erosion and wetland loss occurs in the area and there are opportunities to reduce erosion and create wetlands in the area.

2.3 Planning Objectives

Study planning objectives are more specific in terms of expected or desired outputs than the Federal objective, which is a National goal. The planning objectives established for this study were used to guide the formulation of a TRP in accordance with the federal objectives. The specific objectives reflect a review of the study authorization purpose, desires of the local sponsor, views of interested publics, examination of existing and future study area conditions, and review of the problems, needs, and opportunities. These objectives guided alternative plan development.

The study objectives are:

- Provide increased efficiency for navigation on the HNC;
- Preserve and enhance opportunities to maintain the fabrication industry in the study area;
- Reduce economic and environmental losses caused by bank erosion; and
- Preserve, restore, and enhance ecosystem wetland resources.

2.4 Planning Constraints

This study was conducted within the constraints of the P&G adopted by the Water Resources Council and signed by the President in 1983, and by applicable Department of the Army regulations and other documents, which provide guidance pertaining to the implementation of these principles and guidelines. In addition, all phases of the study adhered to local and Federal laws and regulations.

Legislative and executive authorities have specified the range of impacts to be assessed and have set forth the planning constraints and criteria that must be applied when evaluating alternative plans. Plans must be developed with regard to the benefits and costs, both tangible and intangible, as well as associated effects on the ecological, social, and economic well-being of the region. Federal participation in developments should also ensure that any plan is complete in itself, efficient and safe, economically feasible, environmentally acceptable, and consistent and acceptable in accordance with local, regional, and state plans and policies.

Evaluation of concerns expressed during agency coordination and scoping, analysis of lessons learned from previous projects, and historical information led to the following planning constraints:

- Maximum channel depth considered would be −20 feet
- Channel would follow existing alignment
- Project would not be implemented until the HNC Lock is constructed and operational

The proposed authorized channel depth for plan formulation would be constrained to −20 feet. The LADOTD, TPCG, and TPC have expressed a willingness to be the non-Federal sponsors for this project and have requested that only alternatives up to –20 feet are evaluated due to current financial limitations. For Federal navigation projects deeper than −20 feet elevation, the non-Federal project cost share increases from 20 to 35 percent. Paragraph 3-2b(10) of ER 1105-2-100, Categorical Exemption to the NED Plan, allows a non-Federal sponsor to identify constraints on channel depths to be analyzed during a study. This is permissible provided that the constrained depth has greater net benefits than plans with less depth and there are sufficient alternatives to ensure net benefits do not maximize at a scale smaller than the constrained depth. The development of alternatives was also limited to the existing channel alignment. No changes to the existing channel alignment were considered or proposed.

The local sponsors prefer to wait for construction and operation of the HNC Lock prior to the deepening. Construction of the HNC lock was assessed for NEPA compliance in the 2013 Final Post Authorization Change Report and Revised Programmatic Environmental Impact Statement (MTG PAC/RPEIS) (USACE 2013). Although the MTG PAC/RPEIS is programmatic in nature, several features of the final alternatives had sufficiently detailed designs to be fully assessed for NEPA compliance, and do not require additional NEPA documentation. These features, termed "Constructible Features," included, but were not limited to, the HNC Lock Complex.

The HNC Lock Complex assessed in the MTG PAC/RPEIS consisted of a 110-foot by 800-foot lock, an adjacent 250 foot-wide sector gate, and a dam closure. The complex would tie into adjacent earthen levees to reduce the risk of storm surge traveling up the HNC. Vessel traffic would pass through the sector gate portion of the structure for the majority of conditions. However, when the sector gates are closed, the lock would be used. The HNC Lock would include implementation of a sponsor-funded additional work item to construct the lock sill at −23 feet NAVD88, instead of −18 feet, to accommodate a −20 foot channel depth instead of −15 feet MLG. This would alleviate the necessity of reconstructing the lock should this proposed deepening project be authorized and funded. The CPRA would assume all incremental costs and incremental Operations, Maintenance, Replacement, Repair, and Rehabilitation (OMRR&R) of the sponsor-funded additional work item above the Federal Plan costs. As stated in the MTG PAC report (page 95), "…the New Orleans District has included the -23 ft NAVD88 sill elevation as part of the 1% AEP post-authorization plan [the Recommended Plan] as a sponsor funded additional work item. Significant coordination with the resource agencies has been undertaken on both the 1% AEP alternative and the sponsor funded additional work item. No issues have been raised at this stage in the planning process that would preclude implementation of either project."

The primary purpose of the HNC lock and floodgate structure assessed in the MTG PAC/RPEIS was for storm surge control. Secondary purposes assessed included prevention of saltwater intrusion from impacting drinking water quality at the Houma Water Treatment Plant, and protection of marsh areas inside the system along the HNC channel by reducing salt water intrusion. The lock would be built as a feature of the hurricane, storm damage risk reduction project in order to address impacts to navigation as a result of the operation of these features for project purposes. The lock operation plan has two triggers based on the two purposes. First, maintaining a safe water elevation in the channel for storm control and navigation, and second, controlling chloride levels at the Houma Treatment Plant and controlling salinity to protect environmental habits upstream of the structure. The MTG PAC/RPEIS is incorporated into this HNC Deepening Feasibility Report/EIS by reference.

After the HNC lock complex is constructed as part of the MTG project, the lock could also be operated for ecosystem restoration purposes, such as distribution of freshwater. Proposed operational changes for ecosystem restoration purposes, and associated impacts, are documented in the Louisiana Coastal Area (LCA) Program's Final Integrated Feasibility Study and EIS for the Convey Atchafalaya River Water to Northern Terrebonne Marshes and Multipurpose Operation of Houma Navigation Lock (USACE, 2010). For the multipurpose operation to occur, the LCA project would need an OMRR&R plan that considers operation of the lock beyond the current authorization of the Morganza to the Gulf project. By letters dated August 20, 2012 and October 16, 2012 the State formally notified USACE of the State's path forward for the LCA program. The HNC Lock Complex that provides for inland waterway transportation is a Federal responsibility for OMRR&R. A supplemental NEPA document would be needed under the LCA program once a detailed operation plan is developed.

3.0 PRIOR STUDIES, REPORTS, AND EXISTING PROJECTS

Several existing and authorized water resource projects and studies are located within the HNC project area, including navigation, hurricane and storm damage risk reduction, and ecosystem restoration projects. These projects are summarized below.

3.1 Navigation Projects

Gulf Intracoastal Waterway (GIWW) Navigation Project - The GIWW is the portion of the Intracoastal Waterway along the U.S. Gulf Coast. The GIWW is a navigable inland waterway extending approximately 1,050 miles from Carrabelle, Florida, to Brownsville, Texas. The GIWW extends across the project area in Louisiana from Bayou Lafourche at Larose, through Houma, to the Atchafalaya River. The waterway is important for commerce and supports a variety of other public purposes, including flood control, waterside commercial development, and water-based recreational activities. The waterway provides a channel with a controlling depth of 12 feet, and is designed primarily for barge transportation. The GIWW was authorized by the Rivers and Harbors Act of July 24, 1946, and prior Rivers and Harbors Acts. Construction was completed in 1949.

Houma Navigation Canal Additional Disposal Areas and Maintenance – Since 1984, additional placement areas and maintenance changes have been examined in other Environmental Assessments, including:

1. EA #44–Advance Maintenance & Allowable Overdepth (FONSI signed July 18, 1984);
2. EA #128–Marsh Restoration Disposal Area A (FONSI signed November 27, 1990);
3. EA #264–Bay Chaland Disposal Site Enlargement (FONSI signed October 7, 1997);
4. EA #265–Cat Island Pass Realignment (FONSI signed November 26, 1997);
5. EA #127A–Wine Island (FONSI signed August 20, 2001); and
6. Continued Maintenance of the Houma Navigation Canal, Louisiana Project

Falgout Canal Marsh Management Project - The 1995 LADNR Foreshore Protection Project constructed a rock dike along the west bank of the HNC from Miles 25.3 to 24.2. A narrow ridge of high bank separates the HNC from marsh at this location. Miles 25.1 to 24.2 of this reach would require flotation dredging for barge access.

HNC ODMDS Designation and Cancellation of Designation – The EPA is responsible for designating and managing ocean dumping sites under the Marine Protection, Research and Sanctuaries Act. Designated ocean disposal sites are selected to minimize the risk of potentially adverse impacts of the disposed material on human health and the marine environment. The USACE either conducts or issues permits associated with all of the underwater dredging in the United States. Ocean disposal of dredged material requires use of an EPA designated ocean dredged material disposal site (ODMDS) to the greatest extent feasible. EPA's ocean dumping regulations provide the criteria and procedures for the designation and management of ODMDSs.

The HNC ODMDS is located west and parallel to the Cat Island Pass section of the HNC. The ODMDS is 2.08 square nautical miles in area, roughly rectangular in shape, and has depths ranging from 6 to 30 ft. Disposal in the ODMDS is limited to dredged material from the vicinity of Cat Island Pass. EPA designated it an interim ODMDS in 1977 and final designation of the ODMDS was completed on August 14, 1989. The site was used for disposal of dredged material from Cat Island Pass since 1964. In 1995, two shoals located within the boundaries of the ODMDS were designated as Section 404 (Clean Water Act) disposal areas for the purpose of beneficially using dredged material. It is anticipated that sediment from the shoals is transported naturally to barrier islands west of the shoals. However, this 404 designation did not reduce the area of the ODMDS. Effective September 5, 2014, the EPA cancelled the designation of the ODMDS because the site had not been used for more than 20 years and the USACE proposes to continue to use the Single Point Discharge areas (SPDs).

Houma Navigation Canal, Cat Island Pass - The HNC Cat Island Pass study was conducted under the authority of Section 204 of WRDA 1992. This study investigated alternatives to disposing of material dredged from the HNC bar channel (in the Cat Island Pass Reach) in the ODMDS. Alternatives included disposal of material at Wine Island or East Island; or disposing of the material at locations where littoral drift would carry the material to sites where land would be created.

Houma Navigation Canal Additional Disposal Areas between Miles 11.0 and 0.0, Terrebonne Parish - The Additional Disposal Areas between Miles 11.0 and 0.0 Project proposed to beneficially use shoal material removed during routine maintenance of the HNC to create approximately 625 acres of barrier island habitat at three shallow open water sites. Rock retention dikes would be placed on the southeast side of each disposal area. The Finding of No Significant Impact (FONSI) was signed on September 29, 2000 for Environmental Assessment (EA) #312–Terrebonne Bay. The Bay Chaland site was the only area developed.

Deepening of the Short Cut Canal, Louisiana - The Short Cut Canal links the Port of Terrebonne with the HNC. This deepening study is authorized by Section 107 of the Rivers and Harbors Act of 1960, as amended. This dredging project would facilitate navigation through the Short Cut Canal and benefit marine commerce for the Port of Terrebonne. The project would deepen the existing 4- to 10-foot deep portion of the Short Cut Canal. The proposed alternatives would dredge the 0.5-mile long existing channel bottom to 16- or 18-foot deep by 400-feet wide. Dredged material would be deposited on the adjacent earthen dredged material embankments. A FONSI was signed on May 24, 2006; however, the project was never constructed.

Houma Navigation Canal Additional Disposal Areas, Terrebonne Parish, Louisiana - The HNC Additional Disposal Areas project designated four disposal areas between Miles 28.0 and 18.0 along the west side of the channel near Theriot, Louisiana. These areas were designated for beneficial use placement of material removed during routine HNC maintenance dredging. A FONSI was signed on July 25, 2008.

Houma Navigation Canal, Miles 12 to 31.4, CAP Section 1135 - The HNC Miles 12 to 31.4 CAP Program Section 1135 project would stabilize the bank using a rock dike along 3.4 miles from Miles 25.3 to 28 on the west bank (to Falgout Canal), and along the east bank of the channel from HNC Miles 27.6 to 27.7 and Miles 23.7 to 24.3, approximately 5 miles south of Houma, Louisiana. The HNC shoreline in this reach is severely eroded due to tidal action and wave action caused by vessels navigating the channel. The rock dike would be placed off the bankline in conjunction with maintenance dredging to allow marsh creation and reinforce the existing shoreline and provide additional protection to the Falgout Canal Marsh Management Area (FCMMA). The FCMMA, a mitigation area managed by the TPCG, consists of approximately 13,355 acres of pristine cypress-tupelo swamp. This study was conducted under the authority of Section 204 of WRDA 1992. This feasibility study was completed and FONSI was signed on September 15, 2008.

Houma Navigation Canal Channel Realignment Cat Island Pass, Terrebonne Parish - The HNC Cat Island Pass channel realignment project realigned an HNC segment from Miles 1.0 to −1.5 to reduce shoaling due to the gradual westward migration of Timbalier Island. The HNC was realigned approximately 1,000 feet to the west. The realigned segment exceeded the authorized channel depth and required no dredging. The width or depth of the navigation channel was not changed. The FONSI was signed on June 12, 2009 for EA #423–Channel Realignment Cat Island Pass.

Houma Navigation Canal Additional Disposal Areas between Miles 11.0 and 8.0, Terrebonne Parish - The Additional Disposal Areas between Miles 11.0 and 8.0 Project designated two subsided and eroded marsh areas, located between HNC Miles 11.0 and 8.0 on both sides of the channel, as beneficial use disposal areas for the placement of material removed during routine HNC maintenance dredging. The dredged material slurry would be discharged into shallow open water areas to an initial height not to exceed approximately +3.0 feet NAVD88 for wetland development, with an anticipated target elevation following dewatering and compaction of about +1.5 to +1.0 feet NAVD88. The dredged material slurry would be allowed to overflow existing emergent marsh vegetation, but would not be allowed to exceed a height of about one foot above the existing marsh elevation. Retention dikes and/or closures would be constructed, as necessary, to prevent the flow of dredged material from re-entering the HNC and adjacent waterways. The FONSI was signed on February 3, 2009 for EA #412–Terrebonne Bay Additional Disposal Areas.

3.2 Hurricane and Storm Damage Risk Reduction Projects (HSDRRS)

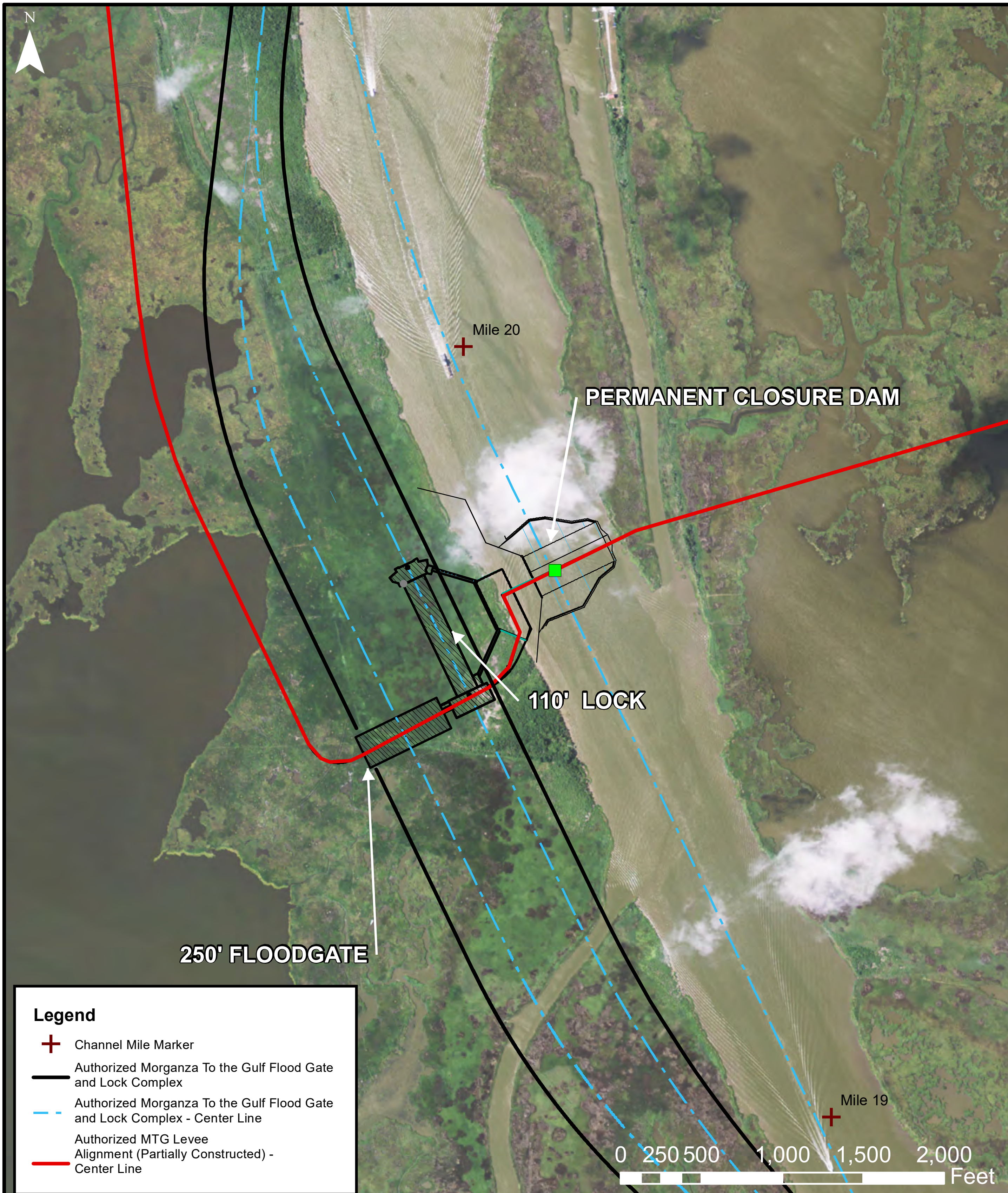
Larose to Golden Meadow, Louisiana, Hurricane Risk Reduction Project - The Larose to Golden Meadow Project is a proposed ring levee system to provide hurricane and storm damage risk reduction to roughly 25,000 people living along both sides of Bayou Lafourche, about 50 miles southwest of New Orleans in Lafourche Parish. The 43-mile levee system extends from Larose to a point two miles south of Golden Meadow, Louisiana. The eastern endpoint of the proposed MTG levee would tie into the Larose to Golden Meadow levee system. The Larose to Golden Meadow project was originally intended to provide the 1-percent annual exceedance probability (AEP) level of risk reduction; however, it is currently undergoing a PAC analysis. The PAC Study will identify and evaluate modifications needed to ensure that completion of project features, designed and constructed before the development of the post-Katrina Hurricane and Storm Damage Risk Reduction System (HSDRRS) design guidelines, are in compliance with these new guidelines. In addition to the PAC Study, remedial measures and construction of a portion of the original project that was never completed are ongoing.

Morganza to the Gulf of Mexico, Louisiana Project - The MTG Project was authorized for construction by Section 1001 (24)(A) of WRDA 2007 to provide storm surge risk reduction for coastal communities in Lafourche and Terrebonne Parishes. The MTG Federal Plan would construct 98 miles of levees, 23 environmental water control structures, and 22 navigable structures, including the HNC floodgate and lock complex (Figure 3-1).

The authorized MTG project estimates were based on pre-Hurricane Katrina standards and costs. As a result of post-Katrina changes in design standards, the authorized project elevations are less than necessary to provide a current (post-Katrina) one percent design level. A Post Authorization Change Report and Revised Programmatic Environmental Impact Statement (PAC/RPEIS) were developed to re-validate the Federal interest in the project. The MTG PAC/RPEIS report updated project designs, costs, and benefits resulting from revised levee standards after Hurricane Katrina. The Record of Decision (ROD) for the PAC/RPEIS was signed on December 9, 2013 and the PAC project is included in the WRDA 2013 and was passed by the House of Representatives on May 15, 2013.

Concurrent with the development of the MTG PAC/RPEIS, the navigation industry and the three non-Federal sponsors of this HNC study [LADOTD, TPCG, and TPC] have expressed concerns about designing the HNC floodgate and lock complex in order to accommodate future traffic and growth on the HNC. Any changes in the authorized depth of the HNC would affect the HNC lock sill elevation. For that reason, the MTG PAC/RPEIS included the implementation of a sponsor-funded additional work item to construct the lock sill at −23 feet NAVD88, instead of −18 feet, to accommodate a −20 foot channel depth of instead of −15 feet MLG. This would alleviate the necessity of reconstructing the lock should this project be authorized and funded. To avoid precluding the future deepening of the HNC, the CPRA requested that the USACE proceed with the MTG PAC including the −23 foot NAVD88 sill as an additional sponsor-funded work item. The CPRA would assume all incremental costs and incremental OMRR&R of the sponsor-funded additional work item above the Federal Plan costs.

Since 2008, the TLCD, in cooperation with Terrebonne Parish Government, Lafourche Parish Government and the State of Louisiana, are proceeding with design and construction of the first lift of levee segments, floodgates and the HNC lock along the MTG Hurricane Protection Project alignment. One of the floodgates, the HNC Bubba Dove surge barrier south of Dulac, was completed in 2013.



Authorized Morganza To the Gulf Flood Gate and Lock Complex

Houma Navigation Canal Deepening

ERSI Basemap - Bing Map Hybrid

GEC

Figure 3-1

Date: August 2012

Scale:1:10,000

Source: ESRI/GEC

Map ID: 278500218-3026

Bubba Dove Surge Barrier – The Bubba Dove floodgate is located in the existing HNC channel along the MTG Hurricane Protection Project alignment and was designed to provide interim protection until the lock is constructed. The floodgate is 42-feet high (including 13-foot flood walls), 273-feet long, and 60-feet wide and will remain open most of the time. The floodgate will be swung shut and filled with water to sink it in place during flooding or major storms.

HNC Lock Project (TE-113) - The HNC lock complex is a key component of the MTG Project, the Increase Atchafalaya Flow to East Terrebonne Project, and this deepening project. The State of Louisiana through the CPRA is planning to construct the lock complex (TE-113) for flood control, salinity control, freshwater distribution, and navigation. The floodgate and lock complex would be located south of Dulac and would consist of a 110-foot by 800-foot lock, an adjacent 250 foot-wide sector gate, and a dam closure tying into adjacent earthen levees to reduce the risk of storm surge traveling up the HNC. The structure will stay closed except for navigation purposes. This deepening study assumes the HNC Lock is in place and operational as part of the future-without-project conditions.

Information related to the design and operation of the HNC Lock is found in the Morganza to the Gulf Final Post Authorized Change Report and Revised Progromattic EIS and Record of Decision signed 9 December, 2013. The document is hereby incorporated into the IFR/EIS by reference:

http://www.mvn.usace.army.mil/Portals/56/docs/PD/Projects/MTG/FinalRevisedProgrammaticEISMtoG.pdf

https://www.researchgate.net/profile/Robert_Martinson/publication/269112620_Record_of_Decision_-_Morganza_to_the_Gulf_of_Mexico_LA_HSDR_-_9_Dec_13/links/5481fd2f0cf2f5dd63a83165.pdf

3.3 Coastal Restoration Projects

The Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA) - CWPPRA 1990 was the first Federal statutory mandate to restore Louisiana's coastal wetlands. The CWPPRA Task Force is composed of five Federal agencies: USACE, EPA, USFWS, NOAA-NMFS, and NRCS, and the State of Louisiana. Many CWPPRA restoration projects are within, or adjacent to, the HNC project area. These projects may affect the hydrology or habitats in the project area. These CWPPRA projects are within, or adjacent to, the study area:

- Brady Canal Hydrologic Restoration
- Central Terrebonne Freshwater Enhancement
- GIWW Bank Restoration of Critical Areas in Terrebonne
- Lost Lake Marsh Creation and Hydrologic Restoration
- Madison Bay Marsh Creation and Terracing
- North Lake Mechant Landbridge Restoration

- Penchant Basin Natural Resources Plan, Increment 1
- South Lake De Cade Freshwater Introduction
- Terrebonne Bay Marsh Creation - Nourishment Project
- West Lake Boudreaux Shoreline Protection and Marsh Creation

Morganza to the Gulf, Louisiana Houma Navigation Canal Lock Salinity Intrusion Study - The 1999 CEMVN Houma Navigation Canal Lock Salinity Intrusion Study concluded that salinity intrusion along the HNC occurs almost annually. These salinities cause chloride levels in the GIWW at the Houma Water Treatment Plant (HWTP) to exceed the EPA criteria of 250 parts per million (ppm). Elevated HWTP chloride levels occur primarily during the fall and are believed to be due to the effects of Lower Atchafalaya River flows on the Barataria/Terrebonne Estuary. If the lock is constructed with a floodgate in Bayou Grand Caillou, the effects of the lock would depend on the operation of the floodgate. However, if the floodgate is left open when the lock is operated, and the progression of salinity up the HNC is not monitored, there may still be a substantial number of days of elevated chloride levels at the HWTP.

Coastal Impact Assistance Program (CIAP) - The Energy Policy Act of 2005 established the Coastal Impact Assistance Program (CIAP), which authorizes funds for environmental conservation, protection, restoration, or mitigation purposes to be distributed to Outer Continental Shelf oil and gas producing states. The following CIAP projects are within or adjacent to the study area:

> **<u>Falgout Canal Freshwater Enhancement Project</u>** - Terrebonne Parish and the State of Louisiana dedicated CIAP funding to the Falgout Canal Freshwater Enhancement Project. The project is located in the marshes adjacent to Falgout Canal between Bayou du Large and the HNC. This project would include construction of an inlet structure at a site on the HNC north of Falgout Canal, modeling of the basin, and channel improvements, as necessary, to improve efficiency of freshwater flow within the basin area. In addition, existing structures along Falgout Canal would be improved or replaced to facilitate operation and maintenance and to accommodate the possible placement of shoreline protection along unprotected areas of the HNC. If there is sufficient funding, this project could be expanded to facilitate movement of fresh water, nutrients, and sediment to the hydrologic unit south of Falgout Canal. Project benefits include freshwater flow enhancements to approximately 5,000 acres of marsh. This project is designed to restore project area salinities to levels favorable for fresh and intermediate marshes. As of this report, modeling has been completed and funding is now in place for design and construction.
>
> This project is located along the proposed footprint of the MTG Project, Reach E, where culverts are also being proposed for environmental benefits. Terrebonne Parish and CEMVN are coordinating between the two projects.

Louisiana Coastal Area (LCA) Plan

Title VII of WRDA 2007 authorized the Louisiana Coastal Area (LCA) plan to support coastal restoration projects in Louisiana. These LCA projects are within, or adjacent to, the study area:

Convey Atchafalaya River Water to Northern Terrebonne Marshes and Multipurpose Operation of Houma Navigation Lock - The Convey Atchafalaya River Water to Northern Terrebonne Marshes and Multipurpose Operation of Houma Navigation Lock project shares much of the project area of the Morganza to the Gulf Project. The Final IFR/EIS for this project was completed in September 2010. The recommended plan would redistribute fresh water to benefit Terrebonne marshes and eliminate freshwater constrictions in the GIWW. Additional measures to restrict, increase, and control water are proposed for the three project area subunits. Dredging, bank protection, a sediment plug, and a weir would be used in the west (Bayou Penchant) area. In the central (Lake Boudreaux) area, culverts, levees, dredging, marsh terraces and berms, sediment plugs, modified operation of the future HNC lock complex, and a large sluice-gated box culvert are proposed. Culverts, dredging, gaps in canal dredged material banks, marsh berms, sediment plugs, and removal of a weir and soil plug are proposed in the east (Grand Bayou) area.

The recommended plan assumes the HNC lock complex would be constructed and operational under the Morganza to the Gulf Project and proposes to operate the lock complex to redirect fresh water from the GIWW into the surrounding wetlands through the HNC. Coordinated adaptive management between this project and the Morganza to the Gulf Project would be necessary.

Increase Atchafalaya Flow to Terrebonne (TE-110) - This CPRA project would dredge the GIWW east of the Atchafalaya River and install a bypass structure at the Bayou Boeuf Lock to increase freshwater and sediment flows from the Atchafalaya River to Terrebonne marshes. The project is modeled to maintain a minimum of 20,000 cubic feet per second (cfs) east along the GIWW towards the HNC. Another possible component of the project would be the creation of approximately 1,190 acres of marsh along the GIWW in Terrebonne Basin (through sediment dredging of the GIWW) to create new wetland habitat, restore degraded marsh, and reduce wave erosion.

Davis Pond Freshwater Diversion - The Davis Pond Freshwater Diversion project is currently being evaluated. This diversion structure on the west bank of the Mississippi River in St. Charles Parish was authorized for construction in 1986 and completed in 2002. The Davis Pond diversion could divert up to 10,650 cfs from the Mississippi River to marshes south of the river. Current benefits are almost exclusively in the Barataria Basin. However, some of the flows could extend to the eastern portion of the Terrebonne Basin via the GIWW. The resulting higher stages in the GIWW could have a minor influence on eastward flows from the GIWW to Grand Bayou.

Small Bayou Lafourche Reintroduction - The Small Bayou Lafourche Reintroduction LCA project would reintroduce flow from the Mississippi River into Bayou Lafourche.

The flow would be continuous and would increase riverine influence in the wetlands between Bayou Lafourche and Bayou Terrebonne, south of the GIWW. Several alternatives are being considered that would provide year-round flow into Bayou Lafourche, including gated culverts and a pump/siphon station in Donaldsonville. Additional features that would be required, regardless of the type of diversion structure built, include modification of existing infrastructure, bank stabilization, dredging, and channel improvements. This project could reduce saltwater intrusion in the eastern Terrebonne marshes. In addition, potential measures to improve the distribution of Bayou Lafourche reintroduction waters (e.g., the enlargement of Bayou L'Eau Bleu and/or Grand Bayou) could facilitate efforts to move Atchafalaya River water into areas of critical need.

Maintain Land Bridge between Caillou Lake and Gulf of Mexico - The Maintain Land Bridge between Caillou Lake and Gulf of Mexico LCA project would place shoreline protection along Grand Bayou du Large to maintain the land bridge between Caillou Lake (Sister Lake) and the Gulf to minimize saltwater intrusion. This shoreline protection would use rock armoring or marsh creation to plug/fill broken marsh areas on the west bank of lower Grand Bayou du Large, to prevent a new channel from breaching the bayou bank and allowing a new hydrologic connection with Caillou Lake. Gulf shoreline armoring may be required where shoreline retreat and the loss of shoreline oyster reefs have allowed increased water exchange between the Gulf and the interior water bodies (between Bay Junop and Caillou Lake). This feature would reduce marine influences in these interior areas to allow increased freshwater influence from Four League Bay to benefit marshes in the surrounding areas.

Beneficial Use of Dredged Material (BUDMAT) - The CEMVN has the largest annual channel operations and maintenance (O&M) program within the USACE, with an average of 64.0 million cubic yards (mcy) of material dredged annually. Currently, about 24 percent of the material dredged under the USACE O&M program is used beneficially within the Federal standard. The Federal standard is the least costly alternative identified by the USACE that is consistent with sound engineering practices and meets all of the Federal environmental standards established by Section 404 of the Clean Water Act of 1972 and Section 103 of the Marine Protection, Research, and Sanctuaries Act of 1972, as amended. Application of the Federal standard constitutes the base disposal plan for a navigation project. Funds from the Beneficial Use of Dredged Material (BUDMAT) Program would be used for disposal activities associated with separate, cost-shared, ecosystem restoration beneficial use projects that are above and beyond disposal activities covered under the USACE O&M maintenance dredging Federal standard.

The 2004 LCA Plan recommended authorization of $100 million in programmatic authority for the additional funding needed for beneficial use of dredged material generated by existing programs. Based on the appropriated funds and a 10-year period of implementation, beneficial use of dredged material could create 21,000 acres of wetlands. The HNC is one of nine authorized Louisiana Federal navigation channels that represent the most significant opportunities for additional beneficial use of dredged material in coastal Louisiana.

GIWW Bank Restoration of Critical Areas in Terrebonne Parish - The GIWW Bank restoration of Critical Areas in Terrebonne Parish project closed 4 large breaches (a total of 4,500 linear feet) along the south bank of the GIWW. The breach closures provided immediate benefits to the adjacent thin-mat flotant marshes by stopping water exchange. This project was initially engineered, designed, permitted, and received the necessary land rights for construction through CWPPRA. The CIAP program constructed only that portion of the project that included these most critical breaches. CIAP-funded construction was completed in 2010. The CWPPRA portions of the project are detailed below.

Small Dredge Program - The Small Dredge Program used a small dredge to hydraulically dredge borrow canals and other open water areas to restore approximately 175 acres of marsh apron along levees, cheniers, and roadways near Golden Meadow, on the west side of Bayou Lafourche. Construction was completed in 2010.

Atchafalaya River Long Distance Sediment Pipeline - The Atchafalaya River Long Distance Sediment Pipeline project would restore marsh and ridge habitat in eastern and central portions of the Terrebonne Hydrologic Basin. In the conceptual phase at the time of this report, this project would install a pipeline, booster pumps, and outlets from the Atchafalaya River near Morgan City, Louisiana, to transport sediment slurry to the marshes of the eastern and central Terrebonne Basin. Marsh restoration locations would be selected to enhance the sustainability of existing and planned levee systems. The project is designed to identify and apply appropriate design, engineering, and construction techniques to enable strategies and infrastructure to eventually become components of future large-scale, system-wide marsh and ridge restoration projects in the basin. Information gained from the Barataria Basin segment of the Mississippi River Long Distance Sediment Pipeline would be fully integrated into the design and implementation of the proposed Terrebonne Basin segment.

4.0 FORMULATION AND EVALUATION OF ALTERNATIVE PLANS

This section presents the approach and results of applying the USACE Plan Formulation Process in developing a Tentatively Recommended Plan (TRP). Under this process, various structural and non-structural management measures are considered and alternative plans are developed to achieve the planning objectives. The impacts of the alternative plans are assessed and evaluated considering National Economic Development (NED) costs and benefits, environmental impacts, regional development impacts, and social wellbeing and related impacts. The tradeoffs between the alternative plans are examined towards selecting a TRP.

To determine the TRP for this Houma Navigation Channel study, alternative plans were developed and evaluated through application of numerous, rigorous criteria in accordance with USACE Planning Guidance. This study required the development of alternatives that addressed the navigation needs of the community while protecting the environment. Alternatives were developed to take advantage of the existing channel alignment and dredged material. All reasonable alternatives were evaluated for engineering effectiveness, economic efficiency, and environmental and social acceptability. Alternatives that satisfied these criteria were studied in more detail.

4.1 Plan Formulation Rationale

This study follows the USACE six-step planning process specified in ER 1105-2-100, April 2000; the USACE Institute for Water Resources (IWR) Report 96-R-21, November 1996; and Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (P&G), March 1983. The planning process consists of the following major steps:

1. Specification of the water and related land resource problems and opportunities (relevant to the planning setting) associated with the Federal objective and specific State and local concerns (Section 2);
2. Inventory, forecast, and analysis of water and related land resource conditions within the planning area relevant to the identified problems and opportunities;
3. Formulation of alternative plans;
4. Evaluation of the effects of the alternative plans;
5. Comparison of alternative plans; and
6. Selection of a recommended plan based upon the comparison of alternative plans.

The Formulation of Alternative Plans (Step 3 above), as described in ER 1105-2-100, includes the following considerations:

1. Alternative plans are formulated to identify specific ways of achieving planning objectives within the project constraints, in order to solve the problems and realize the opportunities identified in Step 1 above;
2. Structural and nonstructural management measures are identified and management measures are combined to form alternative plans;
3. Planners will keep focus on complete plan(s) while doing individual tasks, to ensure their plans address the problems of the planning area;
4. Section 904 of the WRDA of 1986 requires USACE to address the following during the formulation and evaluation of alternative plans:

   - Enhancing NED, including benefits to particular regions that are not transfers from other regions;
   - Protecting and restoring the quality of the total environment;
   - The well-being of the people of the United States; and
   - Preservation of cultural as well as historical values.

5. Nonstructural measures must be considered in the plan formulation process as means to address problems and opportunities; and
6. Revised costs of mitigation will be included in the final cost/benefit analysis.

Integrated in plan formulation is the National Environmental Policy Act (NEPA) evaluation; reviewing a Federal action within the context of the surrounding environment. The alternatives, as they result from plan formulation, are the basis of a NEPA document.

4.2 Plan Formulation Criteria

4.2.1 Completeness

Completeness is the extent that an alternative provides and accounts for all investments and actions required to ensure the planned output is achieved. The plans provide for all the requirements for allowing for the plan to function and provide the expected outputs. Completeness also includes consideration of real estate issues, O&M, monitoring, and sponsorship factors. Adaptive management plans formulated to address project uncertainties also have to be considered.

It is noted that there are areas that the responsibility for implementing the plan are the responsibility of the local sponsor, such as some of the relocations and acquisition of real estate rights, as well as deepening the berthing areas and constructing bulkheads as necessary. In addition, the realization of transportation savings and fabrication benefits are dependent on local industries at the Port of Terrebonne that support Gulf petroleum operations.

4.2.2 Effectiveness

Effectiveness is defined as the degree to which the plan will achieve the planning objective. The plan must make a significant contribution to the problem or opportunity being addressed.

4.2.3 Efficiency

The project must be a cost-effective means of addressing the problem or opportunity. The plan outputs cannot be produced more cost-effectively by another institution or agency.

4.2.4 Acceptability

A plan must be acceptable to Federal, state, and local government in terms of applicable laws, regulations, and public policy. The project should have evidence of broad-based public support and be acceptable to the non-Federal cost sharing partner.

4.2.5 Environmental Operating Principles

One goal in fulfilling the study objectives was to formulate alternative plans that would maximize the benefits to industry and the community while seeking ways to preserve and enhance the environment. Environmental features of this project were developed under the guidelines of the USACE Environmental Operating Principles (EOPs), formalized in 2002. These principles are defined in Engineering Circular 1105-2-404 (dated May 1, 2003) entitled *Planning Civil Works Projects under the Environmental Operating Principles.*

EOPs govern all the USACE missions and interactions and are applicable to decision-making in all programs. Viewed as a whole, these principles outline a path for conducting planning studies and implementing and operating constructed projects that recognizes the important link between environmental stewardship and sustainable economic productivity.

By implementing these principles, the USACE will continue its efforts to develop the scientific, economic, and sociological measures to judge the effects of its projects on the environment and to seek better ways of achieving environmentally sustainable solutions. EOPs are consistent with NEPA; the Army Strategy for the Environment with four pillars of prevention, compliance, restoration, and conservation; and other environmental statutes and WRDA that govern USACE activities. The EOPs inform the plan formulation process and are integrated into all project management processes. Alternatives were formulated for this project to be consistent with these EOPs:

1. Strive to achieve environmental sustainability. An environment maintained in a healthy, diverse and sustainable condition is necessary to support life.

2. Recognize the interdependence of life and the physical environment. Proactively consider environmental consequences of USACE programs and act accordingly in all appropriate circumstances.
3. Seek balance and synergy among human development activities and natural systems by designing economic and environmental solutions that support and reinforce one another.
4. Continue to accept corporate responsibility and accountability under the law for activities and decisions under our control that impact human health and welfare and the continued viability of natural systems.
5. Seeks ways and means to assess and mitigate cumulative impacts to the environment; bring systems approaches to the full life cycle of our processes and work.
7. Build and share an integrated scientific, economic, and social knowledge base that supports a greater understanding of the environment and impacts of our work.
8. Respect the views of individuals and groups interested in USACE activities, listen to them actively, and learn from their perspective in the search to find innovative win-win solutions to the nation's problems that also protect and enhance the environment.

Appropriate mitigation of adverse effects would be an integral component of each alternative plan. When evaluating a plan's accomplishments in meeting the above criteria, consideration was also given to general criteria as well as four categories of technical criteria, including: engineering, economic, environmental, and institutional items:

General

- Plan must comply with applicable Federal laws and regulations;
- Plan must comply with applicable state and local laws and regulations, to the maximum extent practicable; and
- Plan must comply with USACE regulations.

Engineering

- Must represent a sound, acceptable, and safe engineering solution.

Economic

- Plan must contribute NED benefits;
- Tangible benefits of a plan must exceed economic costs;
- Each separable unit of improvement must provide benefits at least equal to costs; and
- Plan implementation may not preclude development of more economical means of accomplishing the same purpose.

Institutional

- Plan must satisfactorily address the identified needs and concerns of the public;
- Plan must be implementable with respect to financial and institutional capabilities; and
- Plan must be implementable with regard to public support.

Environmental

- Plan will fully comply with all relevant environmental laws, regulations, policies, and executive orders;
- Plan will represent an appropriate balance between economic benefits and environmental sustainability;
- Adverse impacts to the environment will be avoided. In cases where adverse impacts cannot be avoided, mitigation would be provided to minimize impacts to at least a level of insignificance; and
- Plan will be developed in a manner consistent with the USACE EOPs.

In an effort to incorporate the USACE EOPs into the plan formulation process for the HNC study, team members representing various Federal and state resource agencies were invited to actively participate and take ownership in the navigation study early in the process. Invoking the EOPs early in the study process supported NEPA compliance and promoted public acceptance of the feasibility study.

Identification of channel alignment and dredge material disposal options was accomplished with the help of various agency participants as well as stakeholders to ensure a plan with balance and synergy among human development activities and natural systems was pursued. As a result, the project delivery team recognized the interdependence of life and the physical environment and incorporated this relationship into the study process for the best possible outcome. With involvement from individuals outside of the USACE, the environmental consequences related to deepening existing navigation channels allowed what many stakeholders considered a "win-win" alternative to be identified early in the study process. Existing data was used to exclude unreasonable alternatives, thus minimizing study time and cost.

The TRP meets the majority of the sponsor and stakeholder needs while fully engaging nearly all of the EOPs to culminate in a positive environmental output. The principles are consistent with NEPA, the Army's Environmental Strategy with its four pillars of prevention, compliance, restoration and conservation, and other environmental statutes and WRDA that govern USACE activities.

4.3 Management Measures

A management measure is a feature or activity that can be implemented at a particular geographic site to address one or more planning objectives. Management measures can be combined to form plans (alternatives) and can be categorized as nonstructural or structural. Structural measures directly affect conditions needed to allow more efficient navigation along the HNC. Nonstructural measures can improve navigation efficiency without directly affecting those conditions.

4.3.1 Development of Management Measures

Before alternative plans were formulated, the first step taken was to identify potential improvements that would satisfy the goals and objectives established for the study area. From these discussions, the team developed an array of *general measures* for the study area, from which *specific measures* would be developed. The team members' depth of professional experience and first-hand management knowledge was invaluable in identifying and defining general measures. The general measures were then evaluated for their ability to produce positive benefits for eight screening criteria developed by the team. The measures that passed the evaluation process were carried forward as possibilities for inclusion into study alternatives.

4.3.2 Description of Management Measures

Nonstructural Measures - Nonstructural measures are activities available to address the planning objectives and include:

- Light loading vessels
- Additional trips
- Diverting vessels or cargo to deeper ports
- Rerouting along a detour route
- Navigation aids including additional tugs and/or dry docks

Port of Terrebonne shippers are already using nonstructural measures when necessary, including light loading vessels, taking additional trips, diverting deeper draft vessels to deeper ports, rerouting along a longer detour route, and navigation aids including additional tugs and/or dry docks (Appendix D).

Structural Measures – Structural measures available to address the planning objectives include:

- Channel deepening
- Foreshore protection/rock retention for Inland Reach
- Dredged Material placement options for Lower Reaches

Structural measures were designed to make the HNC a more efficient navigation channel and to address bank erosion and wetland loss. These measures include: channel deepening, foreshore protection, and beneficial use of dredged material. Measures considered were:

Channel Deepening -- The local sponsor had established a −20.0 foot depth constraint, as described in Section 2.4. The −18.0 foot alternative depth was identified where the economic analysis could identify net benefits in excess of the smaller scale plans, and identify increasing benefits at the −20.0 foot depth.

- Deepen to 18-foot channel, −18 feet NAVD88

- Deepen to 20-foot channel, –20 feet NAVD88

Foreshore Protection Bank Stabilization and Rock Retention for Inland Reach -- Additional measures were considered to protect Inland Reach channel banks against erosion induced from boat wakes (which may increase due to increased channel traffic), from saltwater intrusion, and from subsidence, among other factors. In locations where it was advantageous to do so, rock protection was placed at a distance from the bankline to permit disposal behind the protection for marsh creation. Other locations were identified for simple bankline stabilization.

Rock stabilization was identified as the preferred method of bank stabilization due to the significant reduction in erosion rates that occurred after rock was added to the HNC as part of the Falgout Canal Marsh Management Project in 1995 (Section 3) that added rock on the west bank of the HNC between Miles 25.3 to 24.2. In fact, the project reduced erosion rates enough that a $7 Million CAP project was authorized in September, 2008, which added rock along the west bank between Miles 28.0 and 25.3 and along the east bank from Miles 27.7 to 23.7.

Placement Options for Lower Reaches -- Beneficial use disposal areas were developed as an alternative to the Single Point discharges (SPDs) currently used for maintenance dredged adjacent disposal in the two lower reaches. Two types of beneficial use containment dikes, rock and earth, were considered for evaluation as measures. During the Value Engineering process alternative methods of dredged material containment, such as Geotubes, were considered and screened out (Appendix A – Annex IX). Additional containment measures will be considered during the PED phase of the project.

4.3.3 Measures Not Carried Forward for Further Analysis

Nonstructural management measures were eliminated from the study due to their inability to address the study objectives by improving the efficiency of HNC navigation or allowing Port of Terrebonne fabricators to be more competitive because these activities are more costly and make use of alternate ports or waterways. In addition, the continued bank erosion along the HNC cannot be reduced by nonstructural means.

4.4 Preliminary Alternative Plans

Alternative plans are singular or combinations of specific measures that collectively meet study goals and objectives within the defined study constraints. Alternative plans and their component measures were assessed relative to the objective of National Economic Development (NED).

To focus the team's efforts and guide alternative development, the PDT developed a list of strategies. These strategies were developed to produce a full range of alternative plans as required by the National Environmental Policy Act of 1969 (NEPA) and USACE regulations. The strategies were designed to be significantly different from one another and to represent the entire range of solutions from No-Action to full restoration in consideration of study goals, objectives, and constraints. From these strategies, alternatives that contained suites of general measures were developed. Specific measures were generated from the general measures.

4.4.1 Future Without Project Conditions

Navigation - Waterborne Commerce Projections - Waterborne Commerce Statistics (WCS) cargo tons for the HNC are largely related to offshore oil and gas activity, which has been increasing. Port Fourchon is regarded as a reliable indicator of the strength of the offshore oil and gas sector. The port currently serves half the platforms operating in the Gulf and is projected to serve 47 percent of pending future deepwater plans. Port Fourchon has 1,700 developed acres with state-of-the-art service facilities; the port is in the final phase of its Northern Expansion Project, which will more than double its size and further accommodates the industry's growing needs (Greater Lafourche Port Commission 2012).

MMS Projections - It has been noted that Materials Management Service (MMS) past projections of Gulf of Mexico (GOM) deepwater installations were slightly different from Infield Systems in terms of threshold depth for "deepwater."[1] Less overt differences are that MMS (and its successor, the Bureau of Ocean Energy Management [BOEM]) usually does not make long term projections of sea level deepwater oil gas production units.[2] Rather MMS (and its successor BOEM) makes deepwater GOM (>800 meters) projections for the universe of production units, which primarily reflect sub-sea level units. Adjustments based on assumptions about the proliferation of sub-sea production installations compared to sea level production installations have to be made to infer the minority proportion of production units that are sea level installations in the MMS projections.[3]

Previous assumptions about the proliferation of sub-sea production installations in the MMS forecasts of GOM deepwater (>800 m) production installations for GOM used 67 percent sub-sea units of total MMS projected GOM deepwater installations to reflect the residual of sea level production platforms.[4] Table 4-1 reflects that assumption (MMS total deepwater GOM production units are multiplied by 33 percent to arrive at forecasted sea level units) comparing MMS deepwater (>800 meters) production units (sea level) with Infield deepwater (>500 meters) sea level units. The correlations between MMS 2006 "low" and MMS 2006 "high" forecasts of GOM deepwater sea level production units and Infield 2005 and 2009 sea level GOM deepwater (>500 meters) indicate that there is a better statistical fit between MMS 2006 and Infield 2009 than MMS 2006 and Infield 2005 forecast.

[1] Infield Systems has used 500 m as the threshold depth for "deepwater". MMS/BOEM has used >800 m for "deepwater" (but has forecasted production installations for lesser depths).

[2] All references to "MMS" reflect that this agency prior to be being reorganized as BOEM supplied forecasts of GOM deepwater oil/gas production installations for use in developing fabrication benefits under previous investigations.

[3] Sea level production installations are elsewhere commonly referred to as the constituent components of "hulls" and "topsides".

[4] There is an undocumented concern that the percentage of deepwater production installations that are subsea would likely increase over time as opposed to decrease.

Table 4-1. Comparison of MMS and Infield GOM Deepwater Topsides Projections

	Infield 2005 and MMS>800 2006 Low	Infield 2009 and MMS>800 2006 Low	Infield 2005 and MMS>800 2006 High	Infield 2009 and MMS>800 2006 High
Correlation	0.756	0.937	0.809	0.956
RSQ	0.571	0.877	0.655	0.914
ST DEV	3.502	3.555	4.969	5.608

Notes: Correlation between Infield and MMS forecasts is "perfect" with a value of 1.00.
RSQ = R-squared coefficient representing the percentage of the changes in the dependent variable reflected by changes in the independent variable.
ST DEV = the standard deviation of the R-square coefficient.

Source: G.E.C., Inc.

Given the synergy between offshore oil and gas activity and the Houma-based major supply sector for equipment and parts, the local oil and gas sector-based economy and related activity is expected to continue to grow and remain at historically higher levels of activity than the recent past. Energy Information Administration Projections (EIA) in 2014 show a continuing sustained increase in GOM offshore oil production through the duration of the forecast, 2040 (Appendix D, Table 12A). The expansion of Gulf exploration and development as well as the maintenance of existing wells through 2040 would appear to have a sustainable effect on use of the HNC. Although the volume of installations of deepwater production platforms is projected to decline after 2030, production is projected to be reasonably stable through the duration of the current EIA forecast that ends in 2040.

Although there is a relationship between Gulf offshore oil and gas exploration and production (including services related to future abandonment of wells) and cargo tons on the HNC, a strict causal relationship cannot be inferred that would support a projection of cargo tons of petroleum and petroleum products and crude materials. Moreover, for this analysis, the benefiting cargo is vessel movements generally not related to cargo but rather to ancillary matters such as repairs and home port layups. Quantitative cargo projections have not been made because they would not translate into particular vessel movements other than in a very loose manner. Rather, cargo projections are discussed qualitatively in terms of the factors (deepwater oil and gas exploration/production in the Gulf) that drive continued use of the HNC for supporting infrastructure and equipment. Additional details are provided in Appendix D.

HNC Reported Vessel Trips and Drafts Trends - The WCS total annual trips and drafts (foreign and domestic vessels) reported for the HNC for the period 2003-2013 are summarized in Table 4-2. Note that beginning with year 2003, Waterborne Commerce revised the formatting of reporting the vessel trips and drafts from sequential foot by foot drafts to footage ranges. A full

Table 4-2. Houma Navigation Canal Annual Trips by Vessel Flag and Draft, 2003-2013

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Domestic											
All Drafts (ft.)	5,235	5,133	7,294	7,803	8,472	8,471	5,666	4,048	3,737	3,714	4,087
0 to 5	3,085	2,432	3,710	4,361	3,996	4,587	3,277	1,881	1,783	1,736	1,781
6 to 9	1,967	2,459	3,488	3,292	4,255	3,799	2,351	2,088	1,841	1,726	2,252
10 to 12	168	238	90	149	221	66	36	78	103	245	54
13 to 14	11	2	4	0	0	1	2	1	10	7	0
15 to 17	4	1	2	1	0	18	0	0	0	0	0
Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Foreign											
All Drafts (ft.)	246	303	87	414	866	502	308	53	60	66	180
0 to 5	18	60	14	20	57	7	8	3	5	2	22
6 to 9	135	132	29	155	497	322	201	25	25	28	65
10 to 12	68	87	33	208	198	120	63	13	16	24	69
13 to 14	9	16	5	20	62	27	1	6	9	5	18
15 to 17	16	8	6	11	52	25	35	5	4	4	6
18 to 20	0	0	0	0	0	1	0	1	1	3	0
Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
All Vessels											
All Drafts (ft.)	5,481	5,436	7,381	8,217	9,338	8,973	5,974	4,101	3,797	3,780	4,267
0 to 5	3,103	2,492	3,724	4,381	4,053	4,594	3,285	1,884	1,788	1,738	1,803
6 to 9	2,102	2,591	3,517	3,447	4,752	4,121	2,552	2,113	1,866	1,754	2,317
10 to 12	236	325	123	357	419	186	99	91	119	269	123
13 to 14	20	18	9	20	62	28	3	7	19	12	18
15 to 17	20	9	8	12	52	43	35	5	4	4	6
18 to 20	0	0	0	0	0	1	0	1	1	3	0

Source: Waterborne Commerce Statistics.

set of detailed HNC annual trips and drafts by direction and vessel is provided in Appendix D, Table A-4. Total reported trips and drafts on the HNC for the period 2003 through 2013 peaked at 9,338 trips in 2007. There are substantial fluctuations in reported vessel trips similar to cargo tonnages. There were about 5,400 trips annually in years 2003 and 2004 compared to about 9,000 trips annually in years 2007 and 2008. Total annual vessel trips compiled by the USACE have risen, reflecting increased cargo in recent years, although there is not a clear sustained trend to increased vessel trips. For example, in 2009 cargo tons declined to 0.621 million and total vessel trips declined to 5,976.

Continued concerns about the volume of commercial vessel traffic entering the HNC led the TPC to purchase data on vessel transits (Ship Tracker) from the north and south ends of the HNC. Initial data for the period January 31, 2012 to May 21, 2012, nearly four calendar months, show 628 vessel transits at the north end of the HNC and 2,029 vessel transits at the south end of the HNC. These data could be extrapolated to a full calendar year by a factor of three, not allowing for seasonal traffic fluctuations. Estimated annual vessel transits would be nearly 2,000 at the north end (628*3=1,884) and 6,000 at the south end (2029*3=6,087). The total estimated annual traffic would be nearly 8,000 vessels using the HNC from the north and south junction points with other waterways.

Similar data for the first seven months of calendar year 2015, January 1, 2015 through August 2, 2015, show 939 vessel transits at the north end of the HNC and 3,554 vessel transits at the south end of the HNC. The data for seven months could be extrapolated to a full calendar year by a factor of 1.7143 (12/7 = 1.7143). Estimated annual 2015 vessel transits would be nearly 1,600 at the north end (939*1.7143 = 1,610) and 6,000 at the south end (3,554*1.78143 = 6,093).

Total estimated HNC 2015 annual traffic would be nearly 7,600 vessels using the HNC from the north and south junction point with other waterways.

There is no trend to deeper vessels transiting the HNC; fluctuations in the deepest reported drafts seem to reflect the changes in the total volume of trips rather than shifts to deeper drafts (Table 4-2). The reported annual total number of trips for drafts more than 12 feet is relatively low. This appears to be consistent with vessel operator interviews, which indicated that they would not use the HNC for drafts of more than 12 or 13 feet because of vessel groundings and related damages associated with channel maintenance of full authorized depths. Channel survey data supplied by the TPC indicated that a section of the lower HNC near the mouth is reported to have navigable drafts in the range of 12 to 13 feet, thus supporting the contention that vessel operators are not able to use the full authorized project depth except after maintenance (Appendix D). Summaries of operator interviews are provided in lieu of specific quotes to maintain promised confidential information.

HNC Dulac Pontoon Bridge Vessel Transits – The WCS statistics reported for cargo and vessel trips and drafts represent a subset of the total population of cargo and vessels transiting the HNC. The WCS statistics are reported for commercial vessels engaged in trade between ports. Commercial vessels sailing between the HNC and the Gulf for offshore work related to oil and gas platforms, exploration, and drilling have been indicated to not report cargo trips to WCS because these vessels are not calling a specific *port* offshore. Consequently, there is a large underreported commerce related to the Gulf that is not included in the WCS statistics for cargo and vessel transits on the HNC.

A more accurate measure of the use of the HNC is reflected in the bridge tender records of openings for transiting vessels at the Dulac pontoon bridge. The estimated monthly total number bridge openings for vessels for the period 2004 through 2014 are contained in Table 4-3. Trips by month and vessel type were compiled from paper copies of daily bridge tender logs for calendar year 2005 and the month of June 2005 in Tables 4-4A and 4-4B, respectively.

Table 4-3. Houma Navigation Canal Pontoon Bridge Annual Openings, 2004-2014

Month	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
January	911	1,135	892	674	544	595	582	726	638	701	112
February	1,057	1,016	798	530	836	585	616	455	572	564	105
March	1,190	1,392	1,045	677	978	810	736	826	767	691	714
April	1,238	1,330	1,111	1,045	860	809	906	830	869	646	652
May	1,887	1,064	1,437	1,392	1,312	1,194	919	1,080	805	796	1,006
June	1,515	1,288	1,507	1,330	1,104	1,053	575	1,095	1,044	901	786
July	1,527	1,284	1,242	1,064	1,347	1,080	748	1,116	962	436	811
August	1,597	1,255	1,673	1,288	1,481	945	1,054	1,080	1,211	920	812
September	1,770	1,004	1,537	1,284	615	853	961	949	863	849	559
October	1,449	793	1,331	1,255	1,184	904	1,031	892	964	1,031	870
November	927	1,174	1,181	1,004	885	760	859	713	630	664	847
December	1,107	850	687	793	921	577	597	584	602	645	618
Total	16,175	13,585	14,441	12,336	12,067	10,165	9,584	10,346	9,927	8,844	7,892

Source: Terrebonne Parish Consolidated Government.

Table 4-4A. Houma Navigation Canal Pontoon Bridge Vessel Count, 2005

Month	Actual Count	Percentages
January	967	6.38%
February	1,009	6.65%
March	1,178	7.77%
April	1,223	8.07%
May	1,497	9.87%
June	1,574	10.38%
July	1,687	11.13%
August	1,447	9.54%
September	1,305	8.61%
October	1,134	7.48%
November	1,143	7.54%
December	999	6.59%
Total	**15,163**	**100%**

Source: Terrebonne Parish Department of Public Works.

Table 4-4B. Houma Navigation Canal Pontoon Bridge Vessel Count, June 2005

Type of Vessel	Actual Count	Percentages
Tug Boat in Tow	647	41.11%
Tug Boat (Light Boat)	244	15.50%
Offshore Supply	78	4.96%
Rig Jacket	27	1.72%
Trawl Boat	57	3.62%
Oyster Boat	8	0.51%
Lafitte Skiff	42	2.67%
Crew Boat	153	9.72%
Pleasure Boat	282	17.92%
Other	36	2.29%
Total	**1,574**	**100%**

Source: Terrebonne Parish Department of Public Works.

The annual bridge data of vessel transits in Table 4-3 indicate that there are about twice the number of commercial vessels passing through the bridge than are reported by the total WCS trips and drafts for 2005. Slightly more than half of the total HNC bridge transits are related to tug movements. Other vessels related to the offshore oil and gas sector such as offshore supply and rig jackets are not very prominent (Appendix D).

Offshore Supply Vessel Trends - The length overall (Loa) size distributions of platform supply vessels for the world fleet and the Gulf fleet are presented in Table 4-5. The world fleet is reportedly 1,718 vessels, and the Gulf fleet is reportedly 526 vessels. A smaller fleet, in terms of size and number of vessels, is operated in Mexico by several U.S. firms. These vessels are not included in Table 4-5, but are typically returned to the U.S. for major repairs and maintenance.

The Loa size distributions for the world and Gulf fleets are similar; nearly 30 percent of both fleets are >200 feet Loa vessels. Most of the world and Gulf fleets consist of comparatively small vessels (<200 feet Loa). In the Gulf, smaller vessels (<200 feet Loa) will be replaced with wider and deeper hulls with increased cargo capacity. Note that the cargo carrying capacity of the wider (beam) and deeper (draft) larger (Loa) vessel hulls are greater than proportional changes in Loa.

Table 4-5. Platform Supply Vessel Characteristics: Loa and Age

Length Overall (Feet)	World Fleet Count	World Fleet Avg Age (Yrs)	World Fleet Percent	GOM Count	GOM Fleet Avg Age (Yrs)	GOM Percent
Zero or Blank	6	0	0.35%	4	0	0.76%
Less Than 140	333	27	19.38%	68	23	12.93%
Between 140 and 159.99	193	24	11.23%	70	13	13.31%
Between 160 and 179.99	332	28	19.32%	124	25	23.57%
Between 180 and 199.99	312	23	18.16%	99	21	18.82%
Between 200 and 219.99	168	13	9.78%	78	7	14.83%
Between 220 and 239.99	136	11	7.92%	32	11	6.08%
Between 240 and 259.99	89	6	5.18%	26	8	4.94%
Between 260 and 279.99	84	7	4.89%	23	3	4.37%
Greater than 279.99	65	10	3.78%	2	21	0.38%
TOTAL	**1,718**		**100%**	**526**		**100%**

Note: GOM=Gulf of Mexico.

Source: Lloyd's Fairplay Register.

The draught and breadth statistics for the world fleet, by Loa category, are shown in Table 4-6. Vessels above 200 feet Loa are deeper and wider. There is a greater increase in width than depth (draught). Vessels more than 180 feet Loa, some of the larger platform supply vessels, cannot use the HNC unless they are light loaded (if at all). The larger platform supply vessels built in Houma have to be towed out on the HNC in a *light* condition, carrying minimum fuel and supplies and preferably not under the vessel's own power to minimize sailing drafts. Fully fitted out vessels cannot return to Houma on the HNC because of draft constraints. The emerging trend in the platform supply fleet to shift to larger vessels (>200 feet Loa) cannot be sustained by the HNC under the without-project conditions (Table 4-6) (Appendix D).

Vessel Fleet Costs - The constrained depth of the HNC has increased costs for several categories of actual or potential users: (1) diversions of HNC draft-constrained vessels navigating to Houma or other ports by longer routes (rerouting); (2) use of smaller, shallower tugs for interior movements of offshore barges (tug assistance) or other vessels because large ocean tugs cannot navigate the HNC directly to Houma; and (3) other draft-related issues that constrain efficient vessel use such as smaller and/or light loaded vessels, substitutions of truck trips related to oilfield supplies in place of barges, and diversions to other ports. These trends are expected to continue under the future-without-project scenario. A quantitative analysis of these costs is provided in Appendix D.

Table 4-6. Platform Supply Vessel Characteristics: Loa and Draught

Length Overall (Feet)	Draught Comparison		Breadth Comparison	
	World Fleet Count	World Fleet Average Draught	World Fleet Count	World Fleet Average Breadth
Zero or Blank	201	0	9	0
Less Than 140	224	8.9	332	28.2
Between 140 and 159.99	167	10.4	193	35.8
Between 160 and 179.99	320	11.7	332	38.4
Between 180 and 199.99	309	13.0	312	40.7
Between 200 and 219.99	157	15.6	168	47.9
Between 220 and 239.99	126	17.2	136	50.3
Between 240 and 259.99	86	18.8	89	54.1
Between 260 and 279.99	68	19.5	82	59.1
Greater than 279.99	60	20.3	65	65.0
TOTAL	**1,718**		**1,718**	

Source: Lloyd's Fairplay Register.

Population and Industry Trends - The population of Terrebonne Parish was 111,860 people in 2010 (U.S. Census Bureau 2010). The population is expected to increase to approximately 125,210 by 2030 (Louisiana.gov 2009). By 2030, the segment of the population that is 65 years and older is projected to grow by 51 percent. No other population cohort is projected to exhibit similar growth (HTRPC 2012).

Population growth is projected to spur increased residential and commercial development, which has historically occurred along higher land elevations, such as bayou ridges. This land use pattern is expected to continue over the next 20 years (HTRPC 2012). The exact location of the population growth would be influenced by factors including land availability, flood protection, and improvements to the transportation network.

The Houma area workforce has a collection of materials handling skill sets that support offshore Gulf oil and gas industries through ship building, repair, and the provision of offshore supply equipment and materials. Because of its labor supply skill sets, geography, and proximity to traditional industry supply chains domiciled at New Orleans and Fourchon, the Houma area is regarded as a central location for the provision of offshore oil and gas equipment and services.

Many commercial activities currently operating on the HNC are likely to continue in the future, particularly activities supporting shallow water Gulf platforms. Vessels will continue to be limited by the −15-foot channel depth, which, as discussed in Section 2.2 (Problems and Opportunities), causes transportation delays, rerouting, and lightloading, increasing the transportation costs.

Physical Conditions – The major physical changes anticipated in the study area under future without project conditions are related to the construction of the Federal MTG HSDRRS Project (Morganza to the Gulf Final Programmatic Environmental Impact Statement, USACE, 2002). The project was authorized for construction by WRDA 2007 and is intended to provide storm surge risk reduction for coastal communities in Lafourche and Terrebonne Parishes. The project would include the construction of 98 miles of levees, 23 environmental water control structures, and 22 navigable structures, including the HNC floodgate and lock complex. The floodgate and lock complex would be located south of Dulac and would consist of a 110-foot by 800-foot lock, an adjacent 250 foot-wide sector gate, and a dam closure tying into adjacent earthen levees to reduce the risk of storm surge traveling up the HNC. Information on the design and proposed operation of the lock complex is found in the Final MTG EIS (USACE, 2013). The major impact of the MTG project is the loss of wetlands within the project right of way. Mitigation for wetland impacts would be implemented through the restoration of eroded and subsided wetlands in the project area. The project would complement state and Federal coastal restoration projects in the area by reducing the risk of coastal erosion due to storm surges.

Environmental Resources – There has been no appreciable deltaic development in the Terrebonne Basin for the past 500 years. According to a 2010 analysis, the land-loss rate in the study area between 1985 and 2008 was approximately 2,500 acres per year (approximately 0.3 percent per year), which equates to nearly 60,000 acres lost over that time period. The rate was determined by analyzing imagery from 1985 to 2008 to determine the percent coverage of land and water for each year that imagery was available. These data points were then used to determine land-loss trend lines for the study area. Projecting that loss rate over the next 75 years, approximately 200,000 additional acres are expected to be lost. Losses would be greater if the rate of sea level rise increases above the historic rate (USACE 2010). Bank erosion is also expected to continue along the HNC, impacting wetlands and other habitats.

A number of ongoing restoration efforts are expected to continue and new efforts introduced to restore subsiding marsh habitat in the project area. Dredged material generated from regular maintenance dredging of the HNC has been used beneficially to restore degraded marsh habitat in the project area. This practice is expected to continue under the future without project scenario. Local, state, and Federal restoration programs, such as LCA and CWPPRA, are expected to continue to play a strong role in restoring eroded marsh habitat in the project area. Finally, the LCA program anticipates developing a final operational plan when the HNC lock complex is constructed. The plan would maximize potential environmental benefits, by minimizing saltwater intrusion through the HNC during storm surges and optimizing flow distribution to enable freshwater from the GIWW escaping down the HNC to be redirected into the surrounding wetlands. A preliminary operational plan is found in the Morganza to the Gulf Final Programmatic EIS (USACE, 2013).

Cultural and Historic Resources - Subsidence and erosion are ongoing processes throughout the project area. Under future without project conditions, site erosion processes and subsidence are projected to continue and adversely affect cultural and historic resources in the project area.

4.4.2 Alternatives Considered in Preliminary Analysis

The No-Action Plan would be continued maintenance dredging of the existing 15-foot channel. In addition to the No-Action Plan, deepening the HNC was the only other structural option considered to address the problems, needs, and opportunities relative to navigation. Two depths were considered in developing alternative plans.

Combinations of the two depths, foreshore protection and rock retention dikes, and three lower reach placement options were used to formulate six deepening alternatives for additional evaluation (Table 4-7). All alternatives, excluding the No-Action Plan, would construct foreshore protection to reduce bank erosion and rock retention dikes, where necessary, between adjacent disposal areas and the channel, in locations along both banks on the Inland Reach.

Table 4-7. Seven Alternatives Developed from Structural Measures

Structural Measures	Alternatives						
	0	1A	1B	1C	2A	2B	2C
Foreshore Protection/Rock Retention Inland Reach		X	X	X	X	X	X
Deepen to 18 feet		X	X	X			
Deepen to 20 feet					X	X	X
Adjacent Disposal Lower Reaches	X	X			X		
BU Earth Containment Lower Reaches			X			X	
BU Rock Containment Lower Reaches				X			X

Placement options in the lower reaches based on the current practice (adjacent disposal) and beneficial use of the dredged material for environmental preservation or improvement (earthen and rock containment) were also considered viable in developing the alternative plans. Alternative 0 (the No-Action Plan) and Alternatives 1A and 2A would use adjacent disposal; Alternatives 1B and 2B would place lower reach material beneficially within earthen containment; and Alternatives 1C and 2C would place lower reach material beneficially within rock containment (Table 4.7).

The two channel depths and three lower reach disposal options created six deepening alternatives to be evaluated in detail to select a TRP. The six deepening alternatives (plus the No-Action Alternative) are:

- Alternative-0–No-Action–Continued maintenance of 15-foot channel
- Alternative 1A–18-foot Channel (Lower reaches adjacent disposal)
- Alternative 1B–18-foot Channel (Lower reaches BU Earthen Containment)
- Alternative 1C–18-foot Channel (Lower reaches BU Rock Containment)
- Alternative 2A–20-foot Channel (Lower reaches Adjacent Disposal)

- Alternative 2B–20-foot Channel (Lower reaches BU Earthen Containment)
- Alternative 2C–20-foot Channel (Lower reaches BU Rock Containment)

4.4.3 Description of Alternative Plans

Alternative 0–No-Action Plan (Continued Maintenance of the 15-Foot Channel)

The authorized depth for the Inland and Terrebonne Bay Reaches is −15 feet MLG with a 150-foot bottom width (Table 4-8) and 3 Horizontal (H) to 1 Vertical (V) side slopes. The Cat Island Pass Reach has an authorized depth of -18 feet MLG and a bottom width of 300 feet. The primary source of sediments is bank erosion due to wave action created by vessel traffic. On the Inland Reach the dredged material generated from maintenance dredging for the No-Action Plan would be placed in many of the same disposal sites as the proposed deepening plans. Areas of existing foreshore protection would be refurbished during the maintenance cycle. No new foreshore protection or rock retention dikes would be added during construction.

Table 4-8. Depth and Width Features for the No-Action, 18-, and 20-Foot Depth Alternatives, by Reach

Depth Alternative	Depth Feature	Reach (depths in feet NAVD88)		
		Inland	Terrebonne Bay	Cat Island Pass
15-foot (No-Action)	Reach Mile	36.3 to 10.1	10.1 to 0.0	0.0 to −3.5
	Authorized Depth	15 (MLG)	15 (MLG)	18 (MLG)
	Bottom Width	150	150	300
18-foot	Reach Mile	36.3 to 10.1	10.1 to 0.0	0.0 to −3.5
	Proposed Depth	18	18	18
	Bottom Width[a]	150	150	300
20-foot	Reach Mile	36.3 to 10.1	10.1 to 0.0	0.0 to −3.7[b]
	Proposed Depth	20	20	20
	Bottom Width[a]	150	150	300

[a]All channel side slopes would be 3H to 1V.
[b]The 20-foot channel would have to extend about 1,000 feet further into the Gulf (Mile −3.7) to ensure connection to the 20-foot depth contour.

Estimates of the maintenance volume for the Inland and Terrebonne Bay Reaches are based on the observed results of past projects, maintenance dredging history, and professional judgement. The increased top width of the channel was used to determine the increased dredging volume that would occur due to deepening of the channel. Therefore an 11 percent increase in the top width resulted in an estimated 11 percent increase in dredging volumes. Also, based on the reductions in erosion rates observed from the 1995 Falgout Canal Marsh Management Project and the 2008 HNC CAP Section 1135 project, an estimate of a 5 percent reduction in required dredging volumes was estimated from implementation of the foreshore protection structures located throughout the inland reach. Since dredging occurs so infrequently, and when it does occur volumes are provided for the entire reach, there wasn't any specific data to base this assumption on. Therefore, the assumption, while considered conservative, was based on best professional judgement and observed reductions in shoreline erosion. The majority of dredging requirements result from the wave action that erodes the HNC shoreline within the inland reach, so a direct correlation was assumed between a stabilized shoreline and reduced dredging volumes.

The Cat Island Pass Reach maintenance volume is based on analysis by the Coastal and Hydraulics Laboratory, ERDC (Appendix A, Annex VII). The ERDC study estimated the annual maintenance volume for Cat Island Pass as 250,000 cubic yards (Rosati *et al*. 2008, Annex VII). Maintenance volume estimates for the No-Action Alternative and the two channel depths are presented in Table 4-9.

Table 4-9. Historic and Estimated Maintenance Volumes

Reach	Historical (1967–2006) cy	ERDC Study Annex VII cy	Volume per Maintenance Cycle (cy)	Maintenance Cycle (Years)[g]	Volume Used for Alternative Comparison (cy)[f]	Annual Cubic Yards (cy)	Percent Change with Foreshore Rock
15-Foot Channel (No-Action Plan)							
Inland	243,000		2,430,000	10 and 5	2,430,000	243,000	0
Terrebonne Bay	634,500		1,269,000	2	1,269,000	634,500	0
Cat Island Pass	398,000	250,000	500,000	2	500,000[e]	250,000	
18-Foot Channel							
Inland	243,000		2,430,000	10 and 5	2,478,600	247,860	2
Terrebonne Bay	634,500		1,269,000	2	1,383,200	691,600	9
Cat Island Pass	398,000	250,000	500,000	2	500,000[e]	250,000	
20-Foot Channel							
Inland	243,000		2,515,000	10 and 5	2,673,000	267,300	10
Terrebonne Bay	634,500		1,269,000	2	1,434,0000	717,000	13
Cat Island Pass	398,000	290,000	580,000	2	580,000[e]	290,000	

[a] Terrebonne Bay (Mile 0.0 to 10.1) for the historical record.

[b] Terrebonne Bay (Mile 0.0 to 11.0) for maintenance cost estimate.

[c] ERDC estimate of maintenance volume for Cat Island Pass (Annex VII).

[d] Currently authorized depth for Cat Island Pass is −18 feet MLG.

[e] ERDC value was selected for analysis for Cat Island Pass Reach.

[f] Revised annual maintenance volumes (in lieu of the historical) was used on the Inland Reach for the 18- and foot alternatives because the deepening alternatives would include foreshore protection and rock retention.

[g] Some inland reaches (Mile 36.3 to 34.0, Mile 24.0 to 22.0, and Mile 22.0 to 20.0) use 5-year cycles.

Alternatives 1A, 1B, and 1C – Deepening Channel to -18 Feet

The project design elevation for the 18-foot alternatives would commence at about Mile 36.3 along the HNC, just below the LA 663 Bridge across the HNC, and extend to the −18 foot contour in Cat Island Pass (Mile −3.5, Table 4-8). The design width and design side slopes would remain the same as that of the currently authorized project.

The proposed authorized depth for the Inland Reach for these alternatives is −18 feet NAVD88. The average top width of the −18 foot channel is 11 feet wider than the existing channel, corresponding to a seven percent increase in top width of the channel at the mud line. The 18-foot channel alternatives include construction of foreshore protection along portions of the Inland Reach and rock retention dikes for some Inland Reach disposal areas. The rock retention dikes and foreshore protection are estimated to decrease the maintenance volumes on the Inland Reach by five percent and revised values were used to estimate annual maintenance volume. The net increase in the maintenance volume for the Inland Reach is two percent over the No-Action alternative.

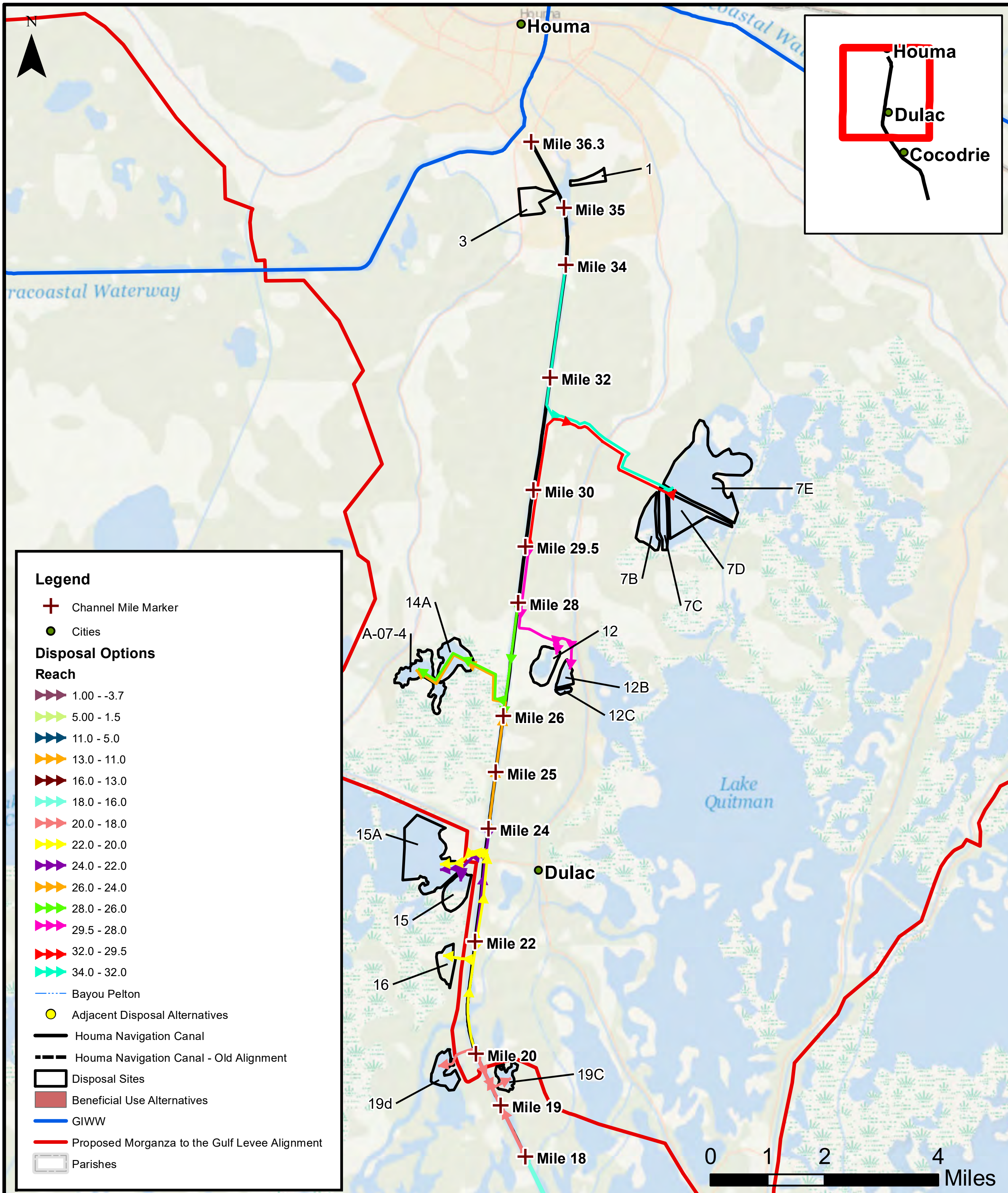
The depth for the Terrebonne Bay Reach would increase to −18 feet NAVD88, although the dimensions of the bottom width and side slopes would remain the same. The average top width would increase by 14 feet, corresponding to a nine percent annual increase in maintenance volume over the No-Action alternative.

The proposed authorized depth, bottom width, and side slopes of Cat Island Pass Reach would be nearly the same as the currently authorized channel. The top width or maintenance volume would not increase (Table 4-9). The ERDC study estimated the annual maintenance volume for Cat Island Pass as 250,000 cubic yards.

Alternative 1A would place material from the lower reaches in SPDs. The beneficial use (BU) alternatives (1B, 1C) would place material excavated from the Terrebonne Bay Reach into a containment area (Lung) on the north side of Terrebonne Bay (near Mile 10.0) and on the bay side of East Island for marsh creation (Figures 4-1 and 4-2). Dredged material from lower Terrebonne Bay would be placed unconfined at a nearshore disposal location on the Gulf side of East Island. Material excavated within Cat Island Pass would be placed unconfined at a nearshore disposal location on the Gulf side of East Island to serve as a feeder for adjacent barrier island systems.

Alternatives 2A, 2B, and 2C - Deepening Channel to -20 Feet

The project design elevation for the 20-foot alternatives would be -20 feet, commencing at approximately Mile 36.3, just below the LA 663 Bridge, and extending to the −20 foot NAVD88 contour in the Gulf near Cat Island Pass (Table 4-8). To accommodate the increased depth requirements, the 20-foot channel would end approximately 1,000 feet further into the Gulf to connect to the 20-foot depth contour. The design width and side slopes would remain the same as

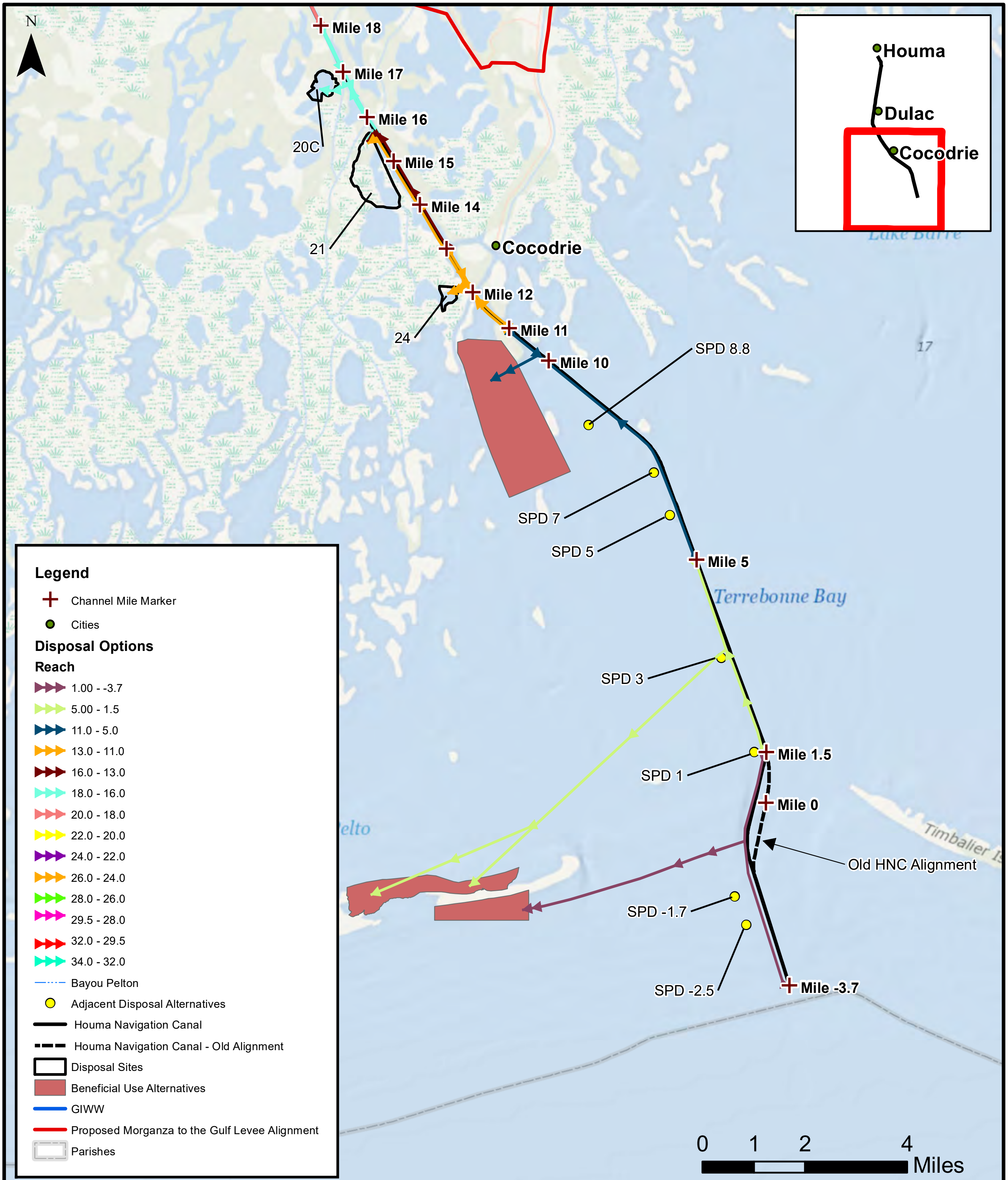


DISPOSAL AREAS
North End
Houma Navigation Canal Deepening

ERSI Ocean Map

GEC

Figure 4-1
Date: December 2014
Scale:1:150,000
Source: ESRI/GEC
Map ID: 278500218-3026



DISPOSAL AREAS
South End
Houma Navigation Canal Deepening

ERSI Ocean Map

Figure 4-2
Date: December 2014
Scale:1:165,000
Source: ESRI/GEC
Map ID: 278500218-3026

that of the currently authorized project. Foreshore protection and rock retention dikes would be constructed as detailed in Section 4.5.2.

The proposed authorized depth for these alternatives for the Inland Reach is also -20 feet NAVD88. The currently authorized plan and the proposed channels have a 150-foot bottom width and 3H to 1V side slopes. The average top width of the 20-foot channel is 23 feet wider than the existing channel. The 23-foot increase in top width corresponds to a 15 percent increase in top width at the mud line. Rock retention dikes and foreshore protection are estimated to decrease the maintenance volume on the Inland Reach by 5 percent over the No-Action alternative. The revised (in lieu of the historical) volumes were used to estimate the 20-foot annual maintenance volume. The net increase in the maintenance volume for the Inland Reach is 10 percent over the No-Action alternative.

The proposed authorized depth in the Terrebonne Bay Reach for these alternatives is −20 feet NAVD88. The currently authorized plan and the proposed channels have a 150-foot bottom width and 3H to 1V side slopes. The average top width of the 20-foot channel is 20 feet wider than the existing channel at the mud line. The 20 feet increase in top width corresponds to a 13 percent increase in maintenance volume. The estimated increase in annual maintenance volume for the Terrebonne Reach is 13 percent.

The proposed authorized depth for the Cat Island Pass Reach for these alternatives is −20 feet NAVD88. The currently authorized plan and the proposed channels have a 300-foot bottom width and 3H to 1V side slopes. The average top width of the 20-foot channel is 21 feet wider than the existing channel. The Cat Island Pass Reach will need to be lengthened approximately 1,000 feet to ensure connection to the 20-foot contour in the Gulf. This depth measure will increase the size [width (at mud line) and length] of the channel by approximately 10 percent (Table 4-8). The ERDC study estimated the annual maintenance volume for Cat Island Pass as 290,000 cubic yards. The ERDC study maintenance volume was used for Cat Island Pass.

Alternative 2A would place material dredged from the lower reaches in SPDs. The beneficial use alternatives (2B, 2C) would place material excavated from the Terrebonne Bay Reach (Mile 10.1 to 1.5) into a containment area (Lung) on the north side of Terrebonne Bay (near Mile 10.0) and on the bay side of East Island for marsh creation. Dredged material from Mile 1.5 to −3.7 would be placed unconfined at a nearshore disposal location on the Gulf side of East Island. In addition, material excavated within Cat Island Pass would be placed unconfined at a nearshore disposal location on the Gulf side of East Island to serve as a feeder for adjacent barrier island systems. Other than the timing associated with particular disposal sites, the disposal plan for both the inland and offshore reaches are the same for corresponding -18 foot deepening alternatives.

4.4.4 Dredged Material Information, by Alternative

The construction volumes and annual maintenance volumes for the No-Action Alternative and six deepening alternatives, in approximate two-mile increments, are presented in Tables 4-10 to 4-16.

Table 4-10. Dredged Material Information for Alternative 0, Authorized Channel (15-Foot MLG Channel with Adjacent Disposal)

Reach (Mile)	Construction (CY)	Maintenance (CY)	Maintenance Per Cycle (CY)	Cycle (Years)	Construction Disposal Site	Maintenance Disposal Site
36.3 to 34.0	NA	997,000	99,700	5	N/A	1 and 3
34.0 to 32.0	NA	998,000	199,600	10	N/A	7E
32.0 to 29.5	NA	753,500	150,700	10	N/A	7E
29.5 to 28.0	NA	753,500	150,700	10	N/A	12B and 12
28.0 to 26.0	NA	998,000	199,600	10	N/A	A-07-A
26.0 to 24.0	NA	998,000	199,600	10	N/A	A-07-A and 14A
24.0 to 22.0	NA	997,000	99,700	5	N/A	15
22.0 to 20.0	NA	997,000	99,700	5	N/A	16 and 15A
20.0 to 18.0	NA	998,000	199,600	10	N/A	19C and 19D
18.0 to 16.0	NA	998,000	199,600	10	N/A	20C
16.0 to 13.0	NA	1,506,500	301,300	10	N/A	21
13.0 to 11.0		1,157,000	231,400	10		24 and 21
13.0 to 11.5	NA				24	
11.5 to 10.0	NA				SPD Mile 8.8	
11.0 to 8.0		8,275,000	331,000	2		SPD Mile 8.8
10.0 to 8.0	NA				SPD Mile 8.8	
8.0 to 6.0	NA	5,707,500	228,300	2	SPD Mile 7	SPD Mile 7
6.0 to 4.0	NA	5,915,000	236,600	2	SPD Mile 5	SPD Mile 5
4.0 to 2.0	NA	5,915,000	236,600	2	SPD Mile 3	SPD Mile 3
2.0 to 0.0	NA	5,915,000	236,600	2	SPD Mile 1	SPD Mile 1
0.0 to −3.5	NA	12,500,000	500,000	2	SPD Mile −1.7 to −2.5	SPD Mile −1.7 to −2.5
TOTAL		56,379,000				

Table 4-11. Dredged Material Information for Alternative 1A (18-Foot Channel with Adjacent Disposal)

Reach (Mile)	Construction (CY)	Maintenance (CY)	Maintenance Per Cycle (CY)	Cycle (Years)	Construction Disposal Site	Maintenance Disposal Site
36.3 to 34.0	170,000	1,016,000	101,600	5	1	1 and 3
34.0 to 32.0	77,500	1,018,000	203,600	10	7E	7E
32.0 to 29.5	95,500	768,500	153,700	10	7E	7E
29.5 to 28.0	88,000	768,500	153,700	10	12B	12B and 12
28.0 to 26.0	117,000	1,018,000	203,600	10	A-07-A	A-07-A
26.0 to 24.0	171,000	1,018,000	203,600	10	A-07-A	A-07-A and 14A
24.0 to 22.0	171,000	1,016,000	101,600	5	15	15 and 15A
22.0 to 20.0	225,000	1,016,000	101,600	5	16	16 and 15A
20.0 to 18.0	21,000	1,018,000	203,600	10	19C	19C and 19D
18.0 to 16.0	77,200	1,018,000	203,600	10	20C	20C and 21
16.0 to 13.0	153,000	1,536,500	307,300	10	21	21
13.0 to 11.0		1,180,000	236,000	10		24 and 21
13.0 to 11.5	95,000				24	
11.5 to 10.0	125,000				SPD Mile 8.8	
11.0 to 8.0		9,020,000	360,800	2		SPD Mile 8.8
10.0 to 8.0	765,800				SPD Mile 8.8	
8.0 to 6.0	750,800	6,220,000	248,800	2	SPD Mile 7	SPD Mile 7
6.0 to 4.0	373,800	6,447,500	257,900	2	SPD Mile 5	SPD Mile 5
4.0 to 2.0	373,800	6,447,500	257,900	2	SPD Mile 3	SPD Mile 3
2.0 to 0.0	285,800	6,447,500	257,900	2	SPD Mile 1	SPD Mile 1
0.0 to −3.5	668,000	12,500,000	500,000	2	SPD Mile −1.7 to −2.5	SPD Mile −1.7 to −2.5
TOTAL	4,804,200	59,474,000				

Table 4-12. Dredged Material Information for Alternative 1B (18-Foot Channel with BU Earthen Containment)

Reach (Mile)	Construction (CY)	Maintenance (CY)	Maintenance Per Cycle (CY)	Cycle (Years)	Construction Disposal Site	Maintenance Disposal Site
36.3 to 4.0	170,000	1,016,000	101,600	5	1	1 and 3
34.0 to 32.0	77,500	1,018,000	203,600	10	7E	7E
32.0 to 29.5	95,500	768,500	153,700	10	7E	7E
29.5 to 28.0	88,000	768,500	153,700	10	12B	12B and 12
28.0 to 26.0	117,000	1,018,000	203,600	10	A-07-A	A-07-A
26.0 to 24.0	171,000	1,018,000	203,600	10	A-07-A	A-07-A and 14A
24.0 to 22.0	171,000	1,016,000	101,600	5	15	15
22.0 to 20.0	225,000	1,016,000	101,600	5	16	16 and 15A
20.0 to 18.0	21,000	1,018,000	203,600	10	19C	19C and 19D
18.0 to 16.0	77,200	1,018,000	203,600	10	20C	20C and 21
16.0 to 13.0	153,000	1,536,500	307,300	10	21	21
13.0 to 11.0		1,180,000	236,000	10		24 and 21
13.0 to 11.5	95,000				24	
11.5 to 10.0	125,000				Lung	
11.0 to 5.0		18,465,000	738,600	2		Lung
10.0 to 5.0	1,600,000				Lung	
5.0 to 1.5	760,000	11,282,500	451,300	2	Bay Side of East Island	Bay Side of East Island
1.5 to 0.0	190,000	4,835,000	193,400	2	Gulf Side of East Island	Gulf Side of East Island
0.0 to −3.5	668,000	12,500,000	500,000	2	Gulf Side of East Island	Gulf Side of East Island
TOTAL	4,804,200	59,474,000				

Table 4-13. Dredged Material Information for Alternative 1C (18-Foot Channel with BU Rock Containment)

Reach (Mile)	Construction (CY)	Maintenance (CY)	Maintenance Per Cycle (CY)	Cycle (Years)	Construction Disposal Site	Maintenance Disposal Site
36.3 to 34.0	170,000	1,016,000	101,600	5	1	1 and 3
34.0 to 32.0	77,500	1,018,000	203,600	10	7E	7E
32.0 to 29.5	95,500	768,500	153,700	10	7E	7E
29.5 to 28.0	88,000	768,500	153,700	10	12B	12B and 12
28.0 to 26.0	117,000	1,018,000	203,600	10	A-07-A	A-07-A
26.0 to 24.0	171,000	1,018,000	203,600	10	A-07-A	A-07-A and 14A
24.0 to 22.0	171,000	1,016,000	101,600	5	15	15
22.0 to 20.0	225,000	1,016,000	101,600	5	16	16 and 15A
20.0 to 18.0	21,000	1,018,000	203,600	10	19C	19C and 19D
18.0 to 16.0	77,200	1,018,000	203,600	10	20C	20C and 21
16.0 to 13.0	153,000	1,536,500	307,300	10	21	21
13.0 to 11.0		1,180,000	236,000	10		24 and 21
13.0 to 11.5	95,000				24	
11.5 to 10.0	125,000				Lung	
11.0 to 5.0		18,465,000	738,600	2		Lung
10.0 to 5.0	1,600,000				Lung	
5.0 to 1.5	760,000	11,282,500	451,300	2	Bay Side of East Island	Bay Side of East Island
1.5 to 0.0	190,000	4,835,000	193,400	2	Gulf Side of East Island	Gulf Side of East Island
0.0 to −3.5	668,000	12,500,000	500,000	2	Gulf Side of East Island	Gulf Side of East Island
TOTAL	4,804,200	59,474,000				

Table 4-14. Dredged Material Information for Alternative 2A (20-Foot Channel with Adjacent Disposal)

Reach (Mile)	Construction (CY)	Maintenance (CY)	Maintenance Per Cycle (CY)	Cycle (Years)	Construction Disposal Site	Maintenance Disposal Site
36.3 to 34.0	325,000	1,096,000	109,600	5	1	1 and 3
34.0 to 32.0	175,000	1,098,000	219,600	10	7E	7E
32.0 to 29.5	215,000	829,000	165,800	10	7E	7E
29.5 to 28.0	185,000	829,000	165,800	10	12B	12B and 12
28.0 to 26.0	250,000	1,098,000	219,600	10	A-07-A	A-07-A
26.0 to 24.0	300,000	1,098,000	219,600	10	A-07-A	14A
24.0 to 22.0	305,000	1,096,000	109,600	5	15	15 and 15A
22.0 to 20.0	393,000	1,096,000	109,600	5	16	16 and 15A
20.0 to 18.0	92,000	1,098,000	219,600	10	19C	19C and 19D
18.0 to 16.0	170,000	1,098,000	206,600	10	20C	20C and 21
16.0 to 13.0	315,000	1,657,000	331,400	10	21	21
13.0 to 11.0		1,272,500	254,500	10		24 and 21
13.0 to 11.5	180,000				24	
11.5 to 10.0	230,000				SPD Mile 8.8	
11.0 to 8.0		9,350,000	374,000	2		SPD Mile 8.8
10.0 to 8.0	842,000				SPD Mile 8.8	
8.0 to 6.0	822,500	6,447,500	257,900	2	SPD Mile 7	SPD Mile 7
6.0 to 4.0	705,000	6,685,000	267,400	2	SPD Mile 5	SPD Mile 5
4.0 to 2.0	665,000	6,685,000	267,400	2	SPD Mile 3	SPD Mile 3
2.0 to 0.0	295,000	6,685,000	267,400	2	SPD Mile 1	SPD Mile 1
0.0 to −3.7	1,100,000	14,500,000	580,000	2	SPD Mile −1.7 and Mile −2.5	SPD Mile −1.7 and Mile −2.5
TOTAL	7,564,500	63,718,000				

Table 4-15. Dredged Material Information for Alternative 2B (20-Foot Channel with BU Earthen Containment)

Reach (Mile)	Construction (CY)	Maintenance (CY)	Maintenance Per Cycle (CY)	Cycle (Years)	Construction Disposal Site	Maintenance Disposal Site
36.3 to 34.0	325,000	1,096,000	109,600	5	1	1 and 3
34.0 to 32.0	175,000	1,098,000	219,600	10	7E	7E
32.0 to 29.5	215,000	829,000	165,800	10	7E	7E
29.5 to 28.0	185,000	829,000	165,800	10	12B	12 and 12B
28.0 to 26.0	250,000	1,098,000	219,600	10	A-07-A	A-07-A
26.0 to 24.0	300,000	1,098,000	219,600	10	A-07-A	14A
24.0 to 22.0	305,000	1,096,000	109,600	5	15	15 and 15A
22.0 to 20.0	393,000	1,096,000	109,600	5	16	16 and 15A
20.0 to 18.0	92,000	1,098,000	219,600	10	19C	19C and 19D
18.0 to 16.0	170,000	1,098,000	206,600	10	20C	20C and 21
16.0 to 13.0	315,000	1,657,000	331,400	10	21	21
13.0 to 11.0		1,272,500	254,500	10		24 and 21
13.0 to 11.5	180,000				24	
11.5 to 10.0	230,000				Lung	
11.0 to 5.0		19,140,000	765,600	2		Lung
10.0 to 5.0	2,014,500				Lung	
5.0 to 1.5	1,050,000	11,697,500	468,000	2	Bay Side of East Island	Bay Side of East Island
1.5 to 0.0	265,000	5,015,000	200,600	2	Gulf Side of East Island	Gulf Side of East Island
0.0 to −3.7	1,100,000	1,450,000	580,000	2	Gulf Side of East Island	Gulf Side of East Island
TOTAL	7,564,500	63,718,000				

Table 4-16. Dredged Material Information for Alternative 2C (20-Foot Channel with BU Rock Containment)

Reach (Mile)	Construction (CY)	Maintenance (CY)	Maintenance Per Cycle (CY)	Cycle (Years)	Construction Disposal Site	Maintenance Disposal Site
36.3 to 34.0	325,000	1,096,000	109,600	5	1	1 and 3
34.0 to 32.0	175,000	1,098,000	219,600	10	7E	7E
32.0 to 29.5	215,000	829,000	165,800	10	7E	7E
29.5 to 28.0	185,000	829,000	165,800	10	12B	12 and 12B
28.0 to 26.0	250,000	1,098,000	219,600	10	A-07-A	A-07-A
26.0 to 24.0	300,000	1,098,000	219,600	10	A-07-A	14A
24.0 to 22.0	305,000	1,096,000	109,600	5	15	15 and 15A
22.0 to 20.0	393,000	1,096,000	109,600	5	16	16 and 15A
20.0 to 18.0	92,000	1,098,000	219,600	10	19C	19C and 19D
18.0 to 16.0	170,000	1,098,000	206,600	10	20C	20C and 21
16.0 to 13.0	315,000	1,657,000	331,400	10	21	21
13.0 to 11.0		1,272,500	254,500	10		24 and 21
13.0 to 11.5	180,000				24	
11.5 to 10.0	230,000				Lung	
11.0 to 5.0		19,140,000	765,600	2		Lung
10.0 to 5.0	2,014,500				Lung	
5.0 to 1.5	1,050,000	11,697,500	468,000	2	Bay Side of East Island	Bay Side of East Island
1.5 to 0.0	265,000	5,015,000	200,600	2	Gulf Side of East Island	Gulf Side of East Island
0.0 to −3.7	1,100,000	1,450,000	580,000	2	Gulf Side of East Island	Gulf Side of East Island
TOTAL	7,564,500	63,718,000				

Disposal Areas - The disposal plan varies by channel reach (Figures 4-1 and 4-2) and is described below.

Inland Reach (Mile 11.0 to the GIWW at Mile 36.3) -- Numerous disposal sites are available in the Inland Reach. Sites include locations already identified for current maintenance of the channel and new sites that use dredged material for environmental enhancement. A total of 62 sites were initially identified as available for the placement of dredged material above Terrebonne Bay. Site selection was restricted within approximately two miles from the canal to keep pumping to a reasonable distance. These sites were presented to Federal and state agencies to determine which disposal areas would be provide the best opportunity for both disposal capacity and environmental benefits.

Locations for disposal at inland sites were chosen based on cost and environmental needs. To identify disposal locations that met these criteria, members of both state and Federal agencies, including the USACE, U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), National Oceanic and Atmospheric Administration (NOAA), and Louisiana Department of Wildlife and Fisheries (LDWF) were collaborated with. The members of these agencies had extensive field knowledge of the sites surrounding the HNC, which aided in determining the open water areas with the potential to provide optimum environmental benefits with reduced pumping distances and disturbance to the surrounding community. Once it was determined that the sites used during recent maintenance dredging cycles would not have sufficient capacity to accommodate channel deepening and 50 years of maintenance, new sites were proposed, evaluated, and selected. Some locations were eliminated due to extensive environmental impacts. Kidney Islands were removed from consideration due to the high cost and lack of environmental benefits. Based on observations at Bay Chaland Island and Wine Island disposal areas, this method of disposal does not show growth of emergent land. The list was then pared down to 15 placement sites for the Inland Reach (Table 4-17). Two sites were previously designated and used upland placement sites. Site 1 was previously permitted and mitigated and Site 3 has developed into a bottomland hardwood area. The other placement sites are primarily open water and would be used to create marsh. Once the sites were agreed upon a preliminary disposal plan was developed and presented to the group for review. Members of the group also provided important field information such as water depth and habitat type, used in benefit modeling and capacity calculations.

Terrebonne Bay and Cat Island Pass Reaches (Mile −3.5 [–3.7] to 11.0) -- The present disposal plan for Terrebonne Bay used for the existing O&M of the channel consists of five Single Point Discharge (SPD) areas located 1,000 feet west of the channel. The Cat Island Pass existing O&M disposal plan consists of two SPD locations, designed to act as sand feeders for barrier islands west of the channel. These SPD placement locations were considered in this study and are also shown in Table 4-18.

Table 4-17. Disposal Area Types and Acreage

Reach	Disposal Site ID	Acres	River Miles to be Dredged	Disposal Area Type
Inland	1	50.9	36.3 to 34.0	Upland
	3	132.0	36.3 to 34.0	BLH
	7E	772.5	34.0 to 29.5	
	12	130.0	29.5 to 28.0	
	12B	56.5	29.5 to 28.0	
	A-07-A	200.7	28.0 to 24.0	In-water/marsh
	14A	184.2	26.0 to 24.0	
	15	148.3	24.0 to 22.0	
	15A	578.1	24.0 to 22.0	
	16	119.9	22.0 to 20.0	
	19C	74.9	20.0 to 18.0	
	19D	131.3	20.0 to 18.0	
	20C	133.3	18.0 to 16.0	
	21	527.2	18.0 to 11.0	
	24	71.3	13.0 to 11.0	
Terrebonne Bay/ Inland Reach	Lung	2,220.0	11.0 to 5.0	
Terrebonne Bay/ Cat Island Pass	East Island Bay	1,317.0	5.0 to 1.5	Nearshore
Cat Island Pass	East Island Gulf		1.5 to −3.7	Beach Nourishment
	Total Acreage	*6,848.1*		

Table 4-18. Terrebonne Bay and Cat Island Pass Single-Point Discharge (SPD) Locations

Location	River Miles to be Dredged During Construction
SPD 8.8	10.0 to 8.0
SPD 7.0	8.0 to 6.0
SPD 5.0	6.0 to 4.0
SPD 3.0	4.0 to 2.0
SPD 1.0	2.0 to 0.0
SPD –1.7and –2.5	0.0 to –3.5 or (–3.7)

In addition, the HET designated several beneficial use locations that could be used in lieu of the SPDs for material in the lower reaches. These areas included the lung, an area of broken marsh west of the channel in the northern portion of Terrebonne Bay; the bay side of East Island, a barrier island located west of Cat Island Pass; and the nearshore Gulf side of East Island (Table 4-17).

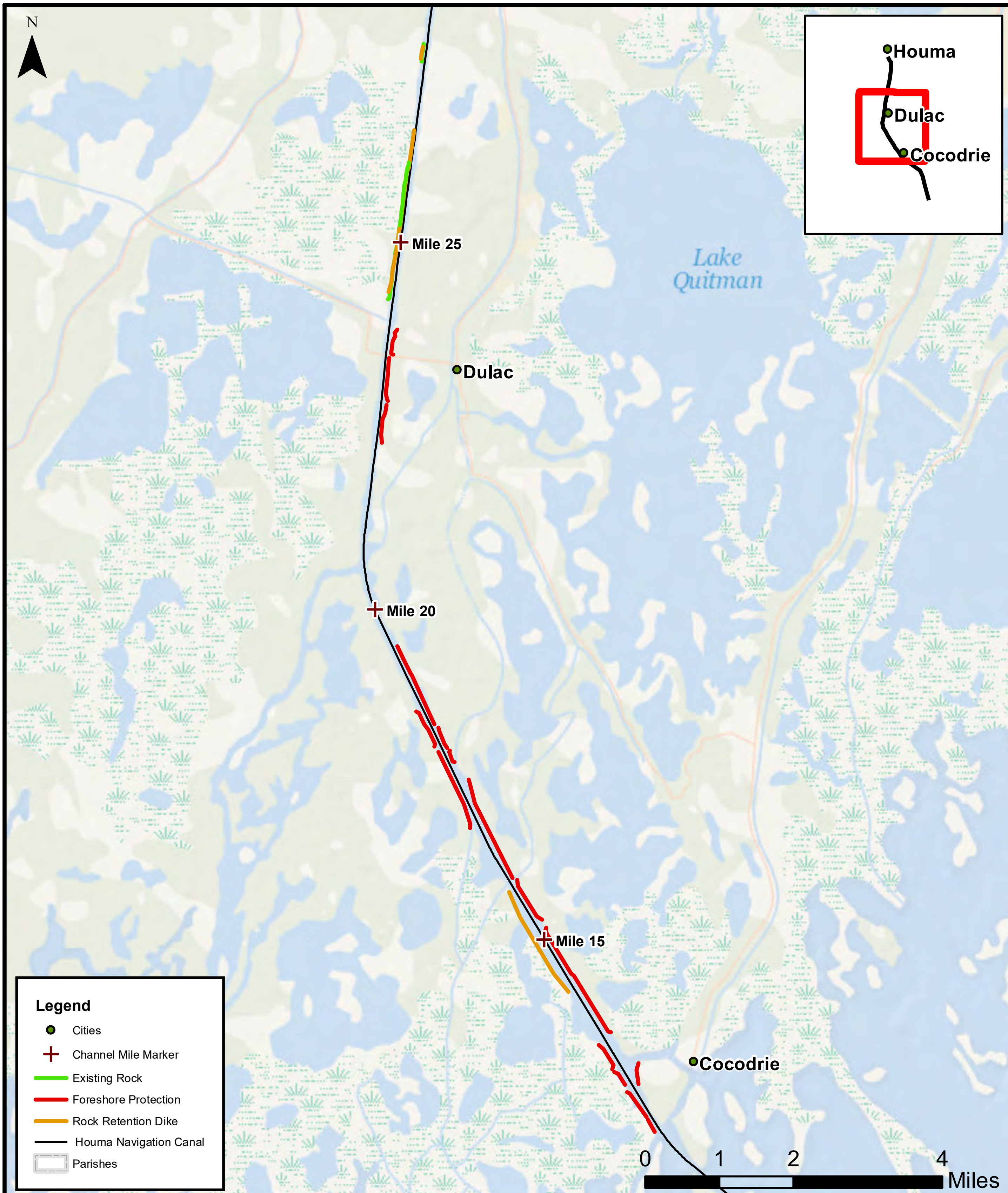
4.4.5 Additional Features Included in all Alternative Plans

As indicated in Section 2.2, bank erosion is apparent in many locations along the Inland Reach. The HNC was originally constructed at a width of 250 feet. Erosion in the Inland Reach is predominantly caused by wave action related to vessel traffic. In the lower reaches, wave action within Terrebonne Bay contributes to bank erosion. Wave action affects both existing banks and open water areas to be used for placement of dredged material. In addition, land loss in coastal marshes along the HNC has resulted in open water areas that are coalescing and connecting to the canal. Increased fetch and resulting wave heights in the open water areas also contribute to increased bank erosion along these portions of the HNC.

Measures to reduce bank erosion focused on current boat traffic and potential increases in bank erosion that could result from increased boat traffic and associated wakes expected to result from canal deepening. A boat traffic study (Appendix A, Annex IV) determined the present number of large wake producing vessel trips and future predictions. The projected total number of vessel trips under without-project conditions in 2012 will be 18,289. With the project, the total number of vessel trips will be 19,009 in 2012. This is a 3.9 percent increase in total vessel trips with the project.

Because the traffic forecast changes over the study life, the effects of the deepened channel were calculated for each of the project years based on the traffic forecast and applied to historic bank erosion rates by reach. The larger, fast moving vessels create the largest waves on the HNC; fast moving crew boats create 4-foot waves. Assuming that the higher wake-producing vessels generate the greatest impact of the bank erosion, particularly in the reaches not influenced by ocean waves, a 3.9 percent increase in this type of traffic predicted over without-project conditions. The foreshore protection is estimated to reduce the historic maintenance volume on the Inland Reach by 5 percent, the rate of erosion and land loss is reduced to 10 percent of the historic erosion rate, and the beneficial use of the disposal areas is a land gain.

Foreshore Protection/Rock Retention - Features included in all alternative plans, excluding the No-Action Plan, include foreshore protection and rock retention in the Inland Reach for placement areas adjacent to the channel and mitigation measures. Approximately 13.1 miles of foreshore protection would be refurbished or constructed along the Inland Reach (6.0 miles along the west bank and 7.1 miles along the east bank). In addition to the foreshore protection, approximately 1.6 miles of rock retention dikes would be constructed on the Inland Reach. The locations of rock foreshore protection and retention dikes are presented in Figure 4-3.



FORSHORE PROTECTION AND ROCK RETENTION DIKES

(INLAND REACH)

Houma Navigation Canal Deepening

ERSI Ocean Map

GEC

Figure 4-3	
Date: October 2012	
Scale:1:115,000	
Source: ESRI/GEC	
Map ID: 278500218-3026	

The historic rate of bank erosion along the Inland Reach is approximately 12.9 acres a year (Appendix A – Section 6.2). With land loss, the lower portion of the Inland Reach (Mile 18.0 to 11.0) is likely to become open water and the maintenance volume rate would approach that of Terrebonne Bay. A graded rock foreshore structure, or bank revetment, would be constructed in the Inland Reach to reduce bank erosion, maintenance cost, and environmental impacts. The rock retention feature is a rock dike that would be constructed along portions of the Inland Reach to confine the disposal areas to reduce shoaling, erosion, and maintenance cost. The foreshore protection structure would be built to an elevation of 5 feet and the rock retention structures to an elevation of 6 feet. Construction of the rock retention and foreshore protection structures on the Inland Reach is a feature in all alternatives, except the No-Action Plan.

Additional details of the dike design and foreshore justification are presented in Section 4.7.2 and Appendix A.

Relocations - Relocations needed for the deepening alternatives include bridges, oil and gas pipelines, electrical and communication lines, and public utilities (water, sewer, etc.). It would be required that 17 utilities are relocated before deepening the channel to -18 feet and 21 utilities are relocated to deepen the channel to -20 feet. Locations of impacted facilities were obtained from the 1990 Louisiana Parish Pipeline and Industrial Atlas Map of Terrebonne Parish and through permit research, site visits, and ownership forms.

Based on comparison of 1995 plans from Coastal Engineering and Environmental Consultants Inc. (CEEC) and the 2002 surveys, scour has occurred around the bridge pilings on Falgout Canal Rd at Mile 23.5. On the western approach pilings as much as 10 feet of material has scoured away. Drawings from CEEC also show a submerged marine electrical cable located at the bridge at an elevation of –24.0 MLG. Based on the 2002 surveys, this cable is either exposed or at the current channel bottom and should be relocated.

Impacted facilities would be relocated to accommodate the new design depth and channel cross section. To maintain continuous service for facilities during relocation operations, hot taps and temporary bypasses are assumed, as well as de-energizing submerged electrical cables. Facilities and utilities crossing the HNC that may need to be relocated include 20 gas or petroleum pipelines, seven electric lines, three water lines, and one sewer line depending on which alternative is selected as the TRP. Additional details of the facilities requiring relocation and costs are presented in Section 4.8.19, Appendix A, Appendix C, and Appendix M.

4.4.6 Mitigation

The appropriate application of mitigation is to formulate an alternative that initially avoids adverse impacts, then minimizes adverse impacts, and lastly, compensates for unavoidable impacts. This methodology was followed when practicable during the planning process.

WVAs were conducted by a HET with members from USACE, U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), U.S. Environmental Protection Agency (EPA), Louisiana Department of Natural Resources (LDNR), and Louisiana Department of Wildlife and Fisheries (LDWF). The WVA models were approved for USACE use on this project (Appendix H). WVAs were used to evaluate alternative deepening and placement options and bank restoration/containment measures considered during the study. The results of the WVA were also used to evaluate disposal areas and to assess impacts to habitat types. The WVA model considered low, intermediate, and high relative sea level rise scenarios, but based on guidance from the USFWS, the intermediate condition was utilized for evaluation of the environmental benefits. In general, it was found that for the inland reaches, placement of the dredged material in adjacent areas would allow restoring and improving wetland habitat areas that would offset most of the impacts caused by deepening of the HNC.

Depending on the alternative selected, compensatory mitigation would be necessary for the value of the wetland habitat lost and for impacted oyster leases. Compensatory mitigation would be accomplished through a mitigation bank in the area. The mitigation requirements and the self-mitigating characteristics of the project include the following:

Upland - Site 1 is an upland habitat disposal site that is one of two sites available for disposal near Houma. This site would be used for construction and every five years for maintenance. Site 1 has been previously permitted so no compensatory mitigation is required.

Bottomland Hardwoods (BLH) and Swamp - The other available disposal site near Houma contains bottomland hardwoods. Site 3, a 132-acre bottomland hardwood site in the southern part of Houma, would be used every 5 years for maintenance. Over the 50-year study period, this would cause a decrease of 1.56 and 7.32 Average Annual Habitat Units (AAHUs) for the 18- and 20-foot alternatives, respectively (intermediate relative sea level rise). In addition, under current conditions, about 155 acres of bottomland hardwood would be lost to shoreline erosion over 50 years; a loss of 57 AAHUs. This acreage lost is increased to 162 acres (59.4 AAHUs) for the deepening alternatives, due to the increased traffic and widening of the channel.

Therefore, based on the reduction in BLH habitat resulting from the proposed actions and the benefits per acre provided by the Upper Bayou Folse Mitigation Bank, it was determined that the 18-foot alternatives would require mitigation through purchase of approximately 7.45 acres of bottomland hardwood (3.95 AAHUs). The 20-foot alternatives would require purchase of approximately 18.32 acres (9.71 AAHUs).

Without project conditions, fifty years of erosion would result in the loss of 14.5 AAHUs and 36 acres of swamp habitat. The swamp acreage lost is increased to 38 acres (15.2 AAHUs) for the deepening alternatives, due to the widening of the channel.

Therefore, it would be required that an additional 2.07 acres of mitigation is purchased. For the 18-foot alternatives, this would result in a total mitigation requirement of 9.52 acres (4.67

AAHUs) to mitigate both bottomland hardwood and swamp habitat loss. Swamp and BLH mitigation requirements for the 20-foot alternatives would be 20.38 acres (10.43 AAHUs).

Intermediate, Brackish, and Salt Marsh - Most of the dredged material from the deepening of the HNC would be used for marsh creation. However, disposal sites are limited in the northern portion of the project. Therefore inland, bay, and offshore areas were identified for disposal of dredged material as marsh creation. It would be necessary to use these sites for construction and subsequently every two, five, or ten years for maintenance.

The WVA model showed that when compared to the No-Action Plan, some habitat loss occurs from implementation of the deepening alternatives. A net loss of 8.08 AAHUs would occur at Site 19C, upon implementation of the 18-foot alternatives. The net loss is reduced to 0.9 AAHUs for the 20-foot alternatives. These losses are a result of disposal material placement (intermediate relative sea level rise estimates). Also, the deepening alternatives would result in 310 acres of marsh (intermediate, brackish, and salt) erosion from each bank of the HNC channel over the next 50 years. However, future without project conditions would result in a loss of 532 acres over the same 50-year study period. Therefore, all deepening alternatives would create a net reduction in habitat loss due to bank erosion.

Marsh habitat losses would be self-mitigated by marsh creation using dredged material from the HNC deepening project and purchase of a conservation easement on the mitigation sites. Habitats utilized for disposal sites include intermediate, brackish, and salt marsh.

There are four marsh creation disposal sites in intermediate marsh; they all produce net increases in AAHUs (Sites 12, 12B, A-07-A, and 14A). The 18-foot alternatives result in a net gain of 19.8 AAHUs and 387 acres of habitat creation. The 20-foot alternatives result in a net gain of 40 AAHUs and 462 acres. A conservation easement would be purchased over disposal sites that produce net habitat gains to ensure long-term protection of the area.

There are seven marsh creation disposal sites in brackish marsh; other than site 19C as described above, they all produce net increases in AAHUs (Sites 7E, 15, 15A, 16, 19D, and 20C). The 18-foot deepening alternatives result in a net gain of 24.9 AAHUs and 810 acres of habitat creation. The 20-foot deepening alternatives result in a net gain of 79.1 AAHUs and 955 acres.

Four marsh creation disposal sites are proposed in salt marsh habitat; other than site 24, under intermediate relative seal level rise forecasts, all sites produce net increases in AAHUs (Sites 21, 24, Lung, and Bay Side East Island). Under adjacent disposal (Alternative 1A), the 18-foot alternative would result in a net gain of 19 AAHUs and 473 acres of habitat creation. With beneficial use of the material in confined cells (Alternatives 1B and 1C), the 18-foot alternative would result in a net gains of 600 to 656 AAHUs and 3,793 acres of habitat creation. The 20-foot alternatives that utilize adjacent disposal (Alternative 2A) would produce a net gain of 41.8 AAHUs and 551 acres of salt marsh created. The 20-foot alternatives that utilize beneficial use within confined cells would result in net gains of 695 to 764 AAHUs and 4,077 acres created.

Due to the net gains in habitat creation supplied by each proposed alternative, only the impacts to the bottomland hardwood would require compensatory mitigation. There would be a somewhat lesser impact from those plans deepening to −18 feet due to lesser volumes of material for disposal as shown in the Table 4-19. Alternatives 1A, 1B, 1C, 2A, 2B, and 2C would also require compensation for oyster leases.

Table 4-19. Compensatory Mitigation Needs (AAHUs)

Habitat	No-Action (Continued Maintenance)	18-foot Alternatives (1A, 1B, 1C)*	20-foot Alternatives (2A, 2B, 2C)*
Bottomland Hardwood	0	7.45	18.32
Swamp	0	2.07	2.07
Intermediate Marsh	0	0	0
Brackish Marsh	0	0	0
Salt marsh	0	0	0
Oyster leases	0	1 for 1A 63 for 1B and 1C	1 for 2A 63 for 2B and 2C

*Assumes intermediate level of relative sea level rise

In addition to the above mitigation measures, certain design and construction commitments will be required for all the alternatives to avoid undesirable impacts to various resources. These are further discussed in Section 6.

4.4.7 Increased Lock Sill Depth

A deeper channel would impact the design of the HNC lock, which was authorized for construction by Section 1000 of the WRDA of 2007. The local sponsor for the HNC Lock and Dam feature of the MTG Project had indicated their willingness to pay for the additional cost to lower the lock to –23 feet NAVD88 to allow future deepening of the HNC up to –20 feet NAVD88. However, the State of Louisiana is now planning to construct the lock and dam. The state and local sponsor have also indicated the desire to allow for construction of the lock and dam prior to moving forward with any authorized improvements to deepen the HNC. Additional information may be found in the Morganza to the Gulf Final Programmatic EIS (USACE, 2013).

4.4.8 Lock Operation

The following operation procedures for the Houma Lock are found in the MTG Final Supplemental EIS (USACE, 2013). A revised operation plan may be developed during the MTG Preconstruction, Engineering, and Design phase or by another NEPA document.

The HNC lock complex would consist of a 110-foot by 800-foot lock, an adjacent 250 foot-wide sector gate, and a dam closure that ties into adjacent earthen levees to reduce the risk of storm surge traveling up the HNC (Figure 4-4). Vessel traffic would pass through the sector gate portion of the structure for the majority of conditions. However, when the sector gates are closed, the lock would be used. The HNC Lock Complex will be deepened to -23 feet NAVD88 to accommodate the deepening of the HNC. The HNC lock/floodgate complex will have a salinity trigger which is described in the table below. The environmental control structures would be used for drainage of isolated areas within a certain timeframe and maximum inundation of the marsh areas. The lock operation plan has two triggers based on the two purposes. First, maintaining a safe water elevation in the channel for storm control and navigation, and second, controlling chloride levels at the Houma Treatment Plant and controlling salinity to protect environmental habits upstream of the structure.

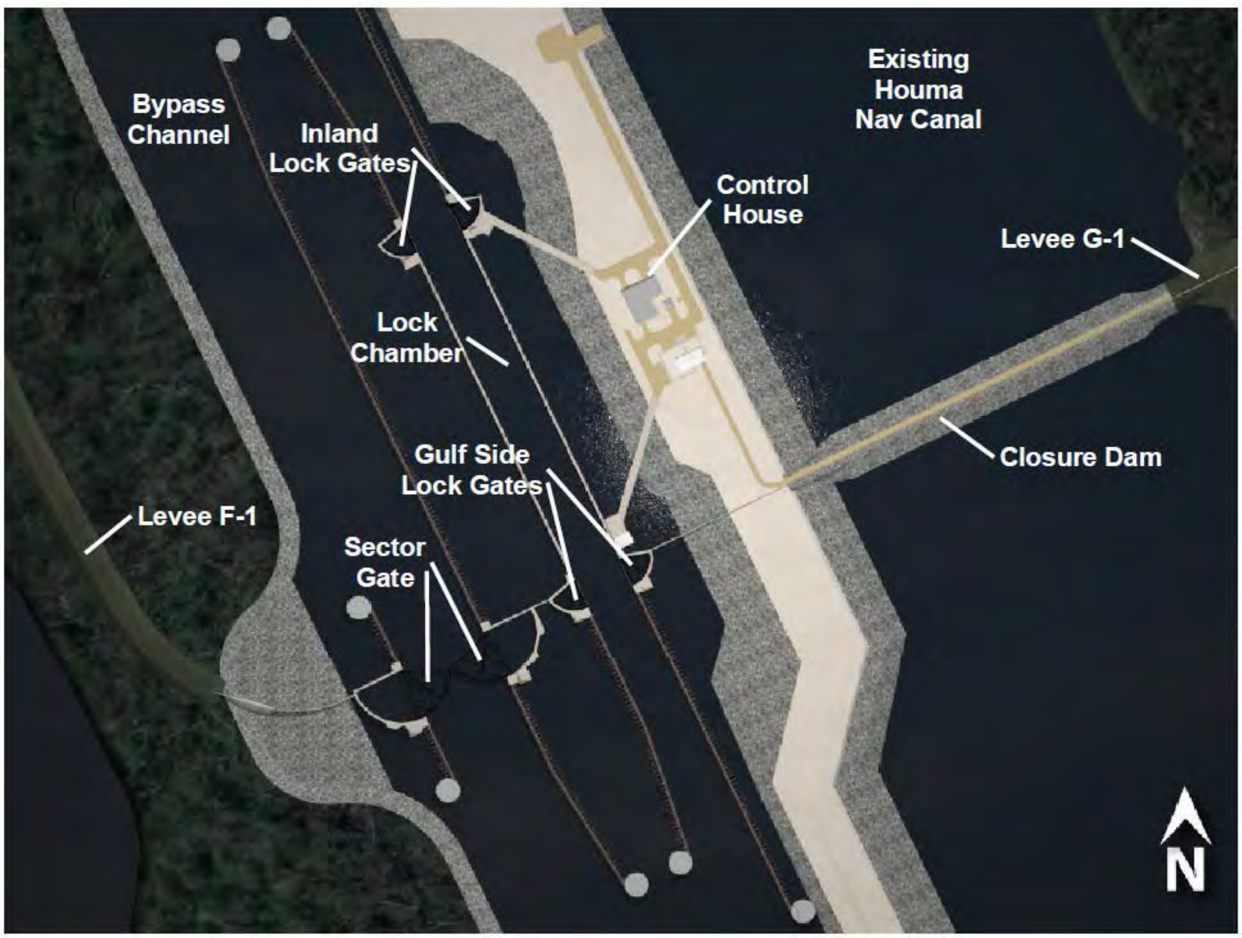


Figure 4-4. Houma Lock Complex

The HNC lock and floodgate would be closed for salinity control only if:

1. Flows in the Atchafalaya River are below 100,000 cfs as measured on the Simmesport gage (USGS 07381490 Atchafalaya River at Simmesport, LA) or

2. If a gage on the outside of the HNC Lock complex exceeds a salinity value that has been correlated with preventing exceedance of the maximum allowable chloride level of 250 ppm as defined in EPA's secondary drinking water standard at the Houma Treatment Plant. The structure should be closed for at least 12 hrs and fluctuations in chloride levels should be monitored and recorded hourly. This to be determined salinity value at the new gage should correlate with the value of 7.5 ppt measured at the HNC at Dulac monitoring station. The 7.5 ppt trigger would be used to perform the indirect impact analysis in this document. Once the new trigger is established the impact analysis would be redone to verify the assumptions made.

The HNC lock complex may be opened when all of the following additional criteria have been met (The lock may be used for navigation, as soon as the hurricane and small craft warning no longer apply to the project area, and the channel has been cleared of obstructions. This may occur before the next two criteria are met)**:**

1. The differential between the interior water level and exterior water level is equal to or less than the +1.0 feet as measured on the upstream and downstream staff gage respectively.

2. After monitoring chloride levels over the 12 hour period at the new gage on the outside of the HNC Lock complex drops below the salinity closure trigger described above. For the analysis of indirect impacts a salinity level of 13 ppt as measured near Cocodrie (LUMCON Station) would be used. The LUMCON station replaces the Bayou Grand Caillou USACE 76305 from the 2002 feasibility report because it has a more robust dataset. If the USACE re-evaluates the salinity trigger at the LUMCON station and comes up with a trigger different than 13ppt, this trigger may change. Once the new trigger is established the impact analysis would be redone to verify the assumptions made. In order to operate the HNC lock according to the criteria laid out in this plan, a monitoring program must be included in the O&M manual and in place.

Under future conditions, closure frequency could increase if the closure trigger is not adjusted to account for sea level rise. For example, under existing conditions, HNC floodgate closure (based on a 2.5-ft closure stage only, not the salinity triggers) would occur approximately 1.5 days per year. If the trigger remained the same through 2085, low RSLR would require closure 5 days per year by 2035 and 168 days per year by 2085. Intermediate RSLR would require closure for 15 days per year by 2035 and 354 days per year by 2085. High RSLR would require closure for 24 days per year in 2035 and 365 days per year in 2085. To prevent frequent structure closings, operation plans would need to be re-evaluated periodically and closure trigger elevations may need to be increased if significant sea level rise occurs.

4.4.9 Trade-Off Analysis

Trade-offs between the alternative plans recognizes differences between the deepening alternatives and the No-Action Plan, and the differences between the deepening alternatives. The first trade-offs to be considered in evaluating the final alternative plan is to distinguish between the No-Action Alternative and the deepening alternatives. This is followed by the trade-off between the deepening alternatives.

Deepening Versus No-Action - The No-Action Alternative ranks lower than the deepening alternatives because it is not effective in meeting any of the planning objectives. It has no positive benefits or impacts, since it is the basis from which the impacts and benefits are measured. It does not, however, involve incurring the implementation cost or adverse impacts of the deepening alternatives. The HNC would continue to be maintained at the currently authorized –15 feet NAVD88, and the current restrictions to navigation would continue.

Trade-Offs Between Deepening Alternatives - The second level of trade-offs to consider is those between the acceptable action alternatives. Of the action alternatives considered, there is an obvious trade-off between the economic outputs that would result from Plans 1B and 1C that deepen the channel to −18 feet and Plans 2B and 2C that deepen the channel to −20 feet. There is also a minor trade-off between the plans involving the two depths, as related to environmental restoration outputs. The additional volume of dredged material associated with providing the deeper depths provides a slightly greater opportunity to use the material to optimize environmental restoration outputs. The major tradeoff between the acceptable plans relate to the much higher cost to provide rock containment of BU marsh in the bay/bar area, as compared to the BU earthen containment marsh plans.

4.5 Plan Evaluation

The alternative plans identified through the plan formulation process were evaluated, based on study area problems and opportunities, as well as study goals, objectives, and constraints. The four criteria described in the P&G and considered during alternative plan evaluation were completeness, effectiveness, efficiency, and acceptability, as defined in Section 4.2.

In addition, ecosystem benefits, cost-effectiveness, and environmental impacts were considered to ensure the TRP best meets the project objectives. As specified in ER 1105-2-100 [Appendix E, Section II, E-7, (b)(6)]:

> *Beneficial Use of Dredged Material – When determining an acceptable method of disposal of dredged material, districts are encouraged to consider options that provide opportunities for aquatic ecosystem restoration. Where environmentally beneficial use of dredged material is the least cost, environmentally acceptable method of disposal, it is cost shared as a navigation cost. Section 204 of the WRDA of 1992, as amended, provides programmatic authority for the selection of*

> *a disposal method for authorized projects, that provides aquatic restoration or environmental shoreline erosion benefits when that is not the least costly method of disposal. The incremental cost of disposal for ecosystem restoration purposes that is not the least costly method of disposal is cost shared, with a non-Federal sponsor responsible for 25 percent of the costs*.

The impacts of the alternative plans were assessed and evaluated considering NED costs and benefits, environmental impacts, regional development impacts, and social well-being and related impacts. Details of this evaluation are provided in Sections 5 and 6 of this report.

4.6 Project Economics

4.6.1 Total Construction Costs

The development of project costs used in the NED assessment involves developing the first cost of implementing the project. This Project First Cost includes the cost for construction of project features including the dredging and disposal of material associated with deepening the HNC to depths of −18 or −20 feet NAVD88, and includes the cost for any disposal feature requirements including costs for containment measures, the cost for bank protection measures, and the costs for any mitigation measures. It also includes the costs for real estate requirements including any relocations, removals, lands, easements, and rights-of way needed for the project; and includes a contingency that is developed based on considering the risks and uncertainties associated with current design and construction information as well as the timing of design and construction activities. The detailed cost estimates for the alternative plans are presented in Appendices A and D.

4.6.2 Equivalent Average Annual Costs

The derivation of equivalent average annual costs includes interest and amortization of the economic value of the project first costs, plus interest during the 9-year construction period, using the Federal interest rate prescribed for use in civil works evaluations currently 3.979 percent over a period of 50 years. The equivalent average annual costs for operation, maintenance, repairs, rehabilitation, and replacement (OMRRR) of project features over the 50-year period increase above the maintenance dredging and disposal requirements for the existing HNC Federal project. The increases in OMRRR costs are shown in Tables 4-20 and 4-21, expressed as present values over the project life at the water resources discount rate (FY 2016 = 3.125%). Details of the cost estimates are presented in the Alternative Costs and Economic Appendices (Appendix D).

4.6.3 Equivalent Annual NED Benefits

Annual benefits are based on annualizing the expected economic benefits of the project over the 50-year project life based on the current Federal interest rate 3.979 percent. This would include

Table 4-20. Summary of Project NED Benefits (Transportation Cost Savings) and Costs by Channel Depth and Disposal Alternative (discount rate = 3.125%)

	2A - 20 ft Adjacent Disposal	1A - 18 ft Adjacent Disposal	2B - 20 ft Earthen Retention	1B - 18 ft Earthen Retention	2C - 20 ft Rock Retention	1C - 18 ft Rock Retention
Total Construction	$175,572,097	$163,650,795	$207,461,803	$187,092,748	$247,328,549	$224,001,365
Interest During Construction	$23,501,647	$21,533,875	$25,703,520	$23,324,962	$28,735,541	$26,117,308
Incremental O&M	$15,396,562	$3,446,606	$183,641,255	$171,564,422	$265,523,271	$239,063,314
Total Cost	$214,470,307	$188,631,276	$416,806,579	$381,982,132	$541,587,362	$489,181,987
NED Benefits	$1,063,761,318	$223,933,875	$1,063,761,318	$223,933,875	$1,063,761,318	$223,933,875
AAEC	$8,534,407	$7,506,196	$16,585,965	$15,200,198	$21,551,361	$19,465,997
AAEB	$42,330,206	$8,910,991	$42,330,206	$8,910,991	$42,330,206	$8,910,991
Net Benefits	$33,795,799	$1,404,795	$25,744,241	-$6,289,207	$20,778,845	-$10,555,006
BCR	4.96	1.19	2.55	0.59	1.96	0.46

Notes: Total Construction Costs furnished by New Orleans District for channel depths and disposal alternatives.
Interest During Construction based on nine-year schedule and current Federal water resources discount rate, 3.125 percent.
Present value of Incremental Operation and Maintenance expenditures for each project alternative is calculated from Table 36.
Total Cost is the sum of Total Construction Cost, Interest During Construction, and Incremental O&M.
NED Benefits (transportation cost savings) is the present value of a 50-year stream from 2028 through 2077 at 3.125 percent discount rate.
Average Annual Equivalent Cost, AAEC, is computed based on 0.0397929549 percent (50 years at 3.125 percent) capital recovery factor.
Average Annual Equivalent Benefits, AAEB, is computed based on 0.0397929549 percent (fifty years at 3.125 percent) capital recovery factor
Net Benefits is the difference between AAEB and AAEC (AAEB-AAEC = Net Benefits).
Benefit to Cost Ratio, BCR, is the ratio of AAEB to AAEC (AAEB/AAEC = BCR).

Source: G.E.C., Inc., except as noted.

Table 4-21. Summary of Project NED Benefits (Transportation Cost Savings and Fabrication Market Valuations) and Costs by Channel Depth and Disposal Alternative (discount rate = 3.125%)

	2A - 20 ft Adjacent Disposal	1A - 18 ft Adjacent Disposal	2B - 20 ft Earthen Retention	1B - 18 ft Earthen Retention	2C - 20 ft Rock Retention	1C - 18 ft Rock Retention
Total Construction	$175,572,097	$163,650,795	$207,461,803	$187,092,748	$247,328,549	$224,001,365
Interest During Construction	$23,501,647	$21,533,875	$25,703,520	$23,324,962	$28,735,541	$26,117,308
Incremental O&M	$15,396,562	$3,446,606	$183,641,255	$171,564,422	$265,523,271	$239,063,314
Total Cost	$214,470,307	$188,631,276	$416,806,579	$381,982,132	$541,587,362	$489,181,987
NED Benefits	$1,063,761,318	$223,933,875	$1,063,761,318	$223,933,875	$1,063,761,318	$223,933,875
Fabrication Benefits - 50%	$72,044,354	$0	$72,044,354	$0	$72,044,354	$0
Total Benefits	$1,135,805,672	$223,933,875	$1,135,805,672	$223,933,875	$1,135,805,672	$223,933,875
AAEC	$8,534,407	$7,506,196	$16,585,965	$15,200,198	$21,551,361	$19,465,997
AAEB	$45,197,064	$8,910,991	$45,197,064	$8,910,991	$45,197,064	$8,910,991
Net Benefits	$36,662,657	$1,404,795	$28,611,099	-$6,289,207	$23,645,702	-$10,555,006
BCR	5.30	1.19	2.73	0.59	2.10	0.46

Notes: Total Construction Costs furnished by New Orleans District for channel depths and disposal alternatives.
Interest During Construction based on nine-year schedule and current Federal water resources discount rate, 3.125 percent.
Present value of Incremental Operation and Maintenance expenditures for each project alternative is calculated from Table 36.
Total Cost is the sum of Total Construction Cost, Interest During Construction, and Incremental O&M.
NED Benefits (transportation cost savings) is the present value of a 50-year stream from 2028 through 2077 at 3.125 percent discount rate.
Average Annual Equivalent Cost, AAEC, is computed based on 0.0397929549 percent (50 years at 3.125 percent) capital recovery factor.
Average Annual Equivalent Benefits, AAEB, is computed based on 0.0397929549 percent (fifty years at 3.125 percent) capital recovery factor
Net Benefits is the difference between AAEB and AAEC (AAEB-AAEC = Net Benefits).
Benefit to Cost Ratio, BCR, is the ratio of AAEB to AAEC (AAEB/AAEC = BCR).

Source: G.E.C., Inc., except as noted.

savings in transportation costs and the estimated value of fabrication contracts that could occur if the project is built. Details for each alternative are presented in Appendix D.

Transportation Cost Savings - Of the proposed actions that do not include environmental benefits, plan 2A, which deepens the HNC to depths of –20 feet NAVD88, will providemaximum average annual equivalent benefits on the order of $42,330,206 a year (Table 4-20). The depth provided by this plan will accommodate all vessels currently requiring more costly transit options due to constraints caused by the existing authorized depth of –15 feet NAVD88, as well as future fleet expectations including barges and tugs needed to be competitive in obtaining contracts in the fabrication industry. These movements are considered critical to being cost efficient in supporting GOM petroleum operations.

The –18-foot NAVD88 alternative, Plan 1A, would realize almost 80 percent less in transportation cost savings since it could not accommodate many of the larger GOM service vessels.

Transportation Cost Savings and Fabrication Benefits - Total benefits (transportation cost savings and fabrication) for the –18- and –20-foot channel depths are shown in Table 4-22. Fabrication benefits reflect the three-firm scenario requiring a –20-foot channel, 2027–2076 as discussed in Appendix D. The 2009 Infield projections for the GOM indicate that the three-firm fabrication benefits scenario, which results in a 50 percent HNC market share of the GOM projected platforms, 2027–2076, would have a present worth value of $72,044 million, and an Average Annual Equivalent value of $2.867 Million based on 3.979 percent interest rate over 50 years. As noted previously, there are no fabrication benefits projected for the –18-foot channel using the updated 2009 Infield GOM platform projections because there are no projected platforms that would require this channel depth.

Appendix D of the report gives additional details on the NED benefit calculations, along with a sensitivity analysis of the results. As newer data becomes available it could be included in those calculations, but the variable nature of the latest data indicates the continued variability in data, which would show no recent trend and therefore, preclude the need for an updated sensitivity analysis.

4.6.4 Net NED Benefits

All alternatives include both NED and environmental benefits. However, benefit to cost ratios were developed for all alternatives based only on NED benefits. An alternative is considered economically justified if there are net positive NED benefits.

Alternative 1A, which deepens the HNC to –18 feet NAVD88, is not economically justified based on NED benefits (Tables 4-20 and 4-21). Alternative 1A is considered the least costly disposal option and therefore, marginally unjustified. Alternative 2A deepens the channel to –20 feet NAVD88, is economically justified, and is also recognized as the least cost disposal option for the given depth. This results in the highest average annual net NED benefits with and without considering fabrication benefits (Table 4-21).

Table 4-22. NED Benefits (Transportation Cost Savings) –20-foot Alternatives (millions of dollars[a])

Benefit Category	-20 Feet HNC
Rerouting	
Tugs	$80.705
Barges	$109.386
Tug Trials	$4.113
OSV Trials	$3.334
Subtotal	$197.538
Tug Assistance	
Barges	$33.071
OSV Trials	$3.557
Subtotal	$36.628
Diversions	
Barges	$134.819
Tugs	$35.572
Jackups	$119.502
Subtotal	$289.893
Deeper Loadings	
Barges	$40.474
Tug/Barge	$3.705
OSV Rigs	$35.572
Barges Exports	$44.465
Subtotal	$124.216
New Vessel Trips	$415.478
Total Benefits (PWV)	$1063.761
Total Benefits AAEB (b)	$45.197

(a) PWV estimates are in millions.
(b) AAEB based on 3.979 percent interest rate over 50 years.

4.6.5 Benefit/Cost Ratio

Benefit/Cost Ratio is derived by dividing the Equivalent Average Annual Benefits by the Equivalent Average Annual Costs. This reflects the economic return that can be expected from each dollar spent. It is sometimes used in establishing budget priorities. Alternative 2A, with the least costly disposal option, provides the highest return per dollar spent with a benefit cost ratio of 4.96 without fabrication benefits and 5.30 with fabrication benefits (Tables 4-20 and 4-21).

4.6.6 Environmental Benefit Analysis

Numerous Federal laws and executive orders as well as the USACE EOPs establish national policy for and Federal interest in the protection, restoration, and conservation and management of environmental resources. These provisions include compliance requirements and emphasize protecting environmental quality. They also endorse Federal efforts to advance environmental goals, and declare that full consideration be given to the opportunities which projects afford to ecological resources, and that a balance should be pursued between NED and environmental outputs in formulating and selecting projects for implementation.

This is also consistent with the provisions and intent of the Federal Projects for the Louisiana Coastal Area as authorized by Title VII of WRDA 2007. The authorized project requires new projects to be consistent with the State Coastal Plan. In addition, the study/project area is located within the Barataria-Terrebonne National Estuary Program which includes requirements for considering opportunities for creating marsh and other habitat types to support the sustainability of the ecology and use of sediment resources. Environmental requirements are provided in Section 8.

For studies primarily directed toward navigation improvements involving dredging projects, the focus of the environmental analysis focuses on beneficial use of the dredged material for environmental restoration. It also focuses on environmental restoration benefits associated with bank protection.

Environmental Output (Benefits) - The measure of environmental outputs or benefits is based on without- and with-project assessment of the value of ecosystem resources. For the HNC study, the value of ecosystem resources under without-project and with-project conditions for each alternative was developed by the Habitat Evaluation Team using WVA methods. Details are presented in the Appendix H.

The evaluation of environmental benefits can be examined for navigation improvements by the three distinct areas referred to as the inland channel reach, the bay/bar channel reach, and the Cat Island Bypass channel reach.

For the Inland Reach (Miles 36.3 to 11.5), impacts caused by the channel deepening in all the alternatives are offset by use of the dredged material to improve and create additional marsh areas. This includes impacts caused by the increase in wake erosion from the additional traffic resulting from the deeper channels. The environmental outputs at each of the disposal sites for the Inland Channel Reach are shown in Table 4-23. As discussed in Section 4.5.6, mitigation is required for net impacts to bottomland hardwood and swamp habitat. This mitigation is included in all the alternatives.

For the Cat Island Pass Reach (Miles 0.0 to −3.7), all deepening alternatives would place material unconfined, a minimum of 1,000 feet west of the channel. The environmental outputs at each of the disposal sites for the Lower Channel Reaches are shown in Table 4-24.

Table 4-23. Inland Reach, Environmental Output Estimates for Alternative Plans

Channel Reach	Mile	Disposal Site	Existing Habitat	Use of Material	AAHU* –18 ft	Acres –18 ft	AAHU* –20 ft	Acres –20 ft
Inland	36.3 to 34.0	1	Upland	Permitted	Permit	51	Permit	51
Inland	36.3 to 34.0	3	Bottomland Hardwood	Requires Mitigation	(1.56)	(73.47)	(7.32)	(101.90)
Inland	34.0 to 29.5	7E	Brackish Marsh/Open Water	Habitat Creation	7.37	269.90	20.86	319.15
Inland	29.5 to 28.0	12B	Intermediate Marsh/Open Water	Habitat Creation	7.06	54.46	4.72	25.48
Inland	29.5 to 28.0	12	Intermediate Marsh/Open Water	Habitat Creation	0.19	63.51	8.72	114.19
Inland	28.0 to 24.0	A-07-A	Intermediate Marsh/Open Water	Habitat Creation	9.10	193.07	6.17	185.73
Inland	26.0 to 24.0	14a	Intermediate Marsh/Open Water	Habitat Creation	3.42	75.72	20.39	136.12
Inland	24.0 to 22.0	15	Brackish Marsh/Open Water	Habitat Creation	9.42	147.15	18.50	146.50
Inland	24.0 to 20.0	15a	Brackish Marsh/Open Water	Habitat Creation	0.29	37.79	6.62	95.11
Inland	22.0 to 20.0	16	Brackish Marsh/Open Water	Habitat Creation	7.03	116.06	13.01	116.65
Inland	20.0 to 18.0	19c	Brackish Marsh/Open Water	Habitat Creation	(8.08)	53.08	(0.95)	65.85
Inland	20.0 to 18.0	19d	Brackish Marsh/Open Water	Habitat Creation	6.07	75.72	7.53	81.67
Inland	18.0 to 16.0	20c	Brackish Marsh/Open Water	Habitat Creation	2.83	110.53	13.53	129.97
Inland	18.0 to 11.0	21	Salt Marsh	Habitat Creation	10.39	403.06	41.66	497.36
Inland	13.0 to 11.0	24	Salt Marsh	Beneficial Use Habitat Creation	8.62	70.33	0.23	53.86

*Intermediate Relative Sea Level Rise

Table 4-24. Environmental Output for the HNC Lower Reaches Created by Alternative Plans

	1A –18 ft Adjacent Disposal	2A –20 ft Adjacent Disposal	1B –18 ft BU Earthen Containment	2B–20 ft BU Earthen Containment	1C –18 ft BU Rock Containment	2C –20 ft BU Rock Containment
AAHU	0	0	580.06	653.66	636.75	722.36
Acres Enhanced	0	0	3,319.99	3,526.03	3,319.99	3,526.03

4.6.7 Equivalent Average Annual NED Benefits

The Benefits of the TRP include benefits for reducing transportation constraints caused by the limited –15-foot depth of the existing HNC, and creating the opportunity for HNC fabricators to be competitive for deep platform fabrication contracts requiring complete installation platforms including all components. A summary of the equivalent average annual benefits are presented in Table 4-25. The benefits are based on NED Benefits (transportation cost savings and fabrication) at the present value of a 50-year stream from 2028 through 2073 at 3.979 percent discount rate. Details for each alternative are presented in the Appendix D.

Table 4-25. NED Plan Benefit Analysis, Houma Navigation Channel Least Cost Alternative (2A)

NED Analysis	Tentatively Recommended Plan (Millions)
Average Annual Benefits	
Transportation Savings	$1,603.761
Fabrication Benefits	$72.044
Total Average Annual Benefits	$42.330
Project Costs	
Total Cost	$214.470
Total Average Annual Cost	$8.534
Net Annual Benefits (with fabrication benefits)	$36.662
Benefit/Cost Ratio (with fabrication benefits)	5.30
Net Annual Benefits (without fabrication benefits)	$33.795
Benefit/Cost Ratio (without fabrication benefits)	4.96

4.6.8 Transportation Savings

This includes reducing current and expected future increased costs for rerouting vessels through other ports and trucking to Port Terrebonne; additional tug assistance; diverting cargo to other ports at higher cost; and light loading of vessels.

4.6.9 NED Economic Analysis

The NED economic analysis for the least cost portion of the TRP (Alternative 2A) is presented in Table 4-25. The estimates are based on April 2014 price levels adjusted by an escalation to the midpoint of the projected schedule for the construction contracts. Also displayed are the net benefits, representing the difference between average annual benefits and average annual costs, and the resulting benefit to cost ratio (BCR) for the 20-foot channel. As indicated in the table, the least cost plan is economically justified with or without considering fabrication benefits.

4.7 Plan Selection –TRP

This section presents information on the TRP. A TRP was determined based on consideration of views and comments received during coordination of the Draft IFR-EIS with the USACE and an Independent External Peer Review (IEPR) Team, and coordination with Federal, State, local agencies and interested public. This section presents the description of the TRP features, relocations, removals, and real estate requirements, construction approach, and OMRR&R requirements. It also presents the project costs, benefits, and economic analysis. Alternative 2A has been selected as the TRP, based on reasons given in Section 4.6.

- It is the most efficient plan and provides the most NED benefits;
- For most of the material dredged to deepen the HNC, it creates marsh or provides BU for environmental restoration and enhancement; and
- It is supported by the non-Federal sponsors.

4.7.1 Plan Accomplishments

The TRP would achieve the planning objectives of the study, resolve identified problems to an acceptable level, realize potential opportunities, and meet identified needs. The Plan is the Optimum Plan based on NED considerations.

Deepening the HNC channel to −20 feet NAVD88 would achieve transportation cost savings from more efficient transportation compared to the currently authorized channel depth of −15 feet MLG. The TRP would also provide benefits by allowing fabrication industries along the HNC to be competitive in responding to contract solicitations calling for fully integrated offshore platforms. The rock foreshore protection and retention dikes would help prevent further bank erosion and would also serve to provide containment and protection for dredged material disposal areas along certain portions of the channel. The disposal plan provides for beneficial use of dredged material by placing material in locations and quantities with earthen containment structures to restore wetland habitats.

4.7.2 Plan Features

The HNC begins at the GIWW in Houma, Louisiana, and extends southward to the Gulf of Mexico for 36.3 miles. The proposed plan provides for deepening the channel to an elevation of -20 feet NAVD88. The plan also provides for the construction of rock foreshore protection and retention dikes for channel bank erosion control and for retention of dredged material. The dredged material from the deepening would be placed in disposal sites that have been selected based on opportunities for habitat creation for ecosystem restoration that are consistent with the state of Louisiana Coastal Zone Management requirements to provide benefits in a cost-effective manner. The channel alignment and disposal sites of the TRP are presented in Figures 4-4 and 4-5. The general locations of rock dikes for shoreline protection and dredged material retention for the TRP are shown on Figure 4-3.

Channel Deepening - The primary feature of the TRP consists of deepening the HNC from the present maintained elevation of −15 feet MLG to an elevation of −20 feet NAVD88. The design width would remain the same as that of the currently authorized project (150 feet between Miles 36.3 and 0.0; and 300 feet between Miles 0.0 and −3.7). The side slopes of the channel would be 1V on 3H for the entire length of the HNC. Typical cross sections for the existing channel and the design profile with advance maintenance for the channel deepening are shown in Figure 4-7. Dredged material quantities required to construct and maintain the channel for the TRP over the 50-year period of analysis are provided in Table 4-26.

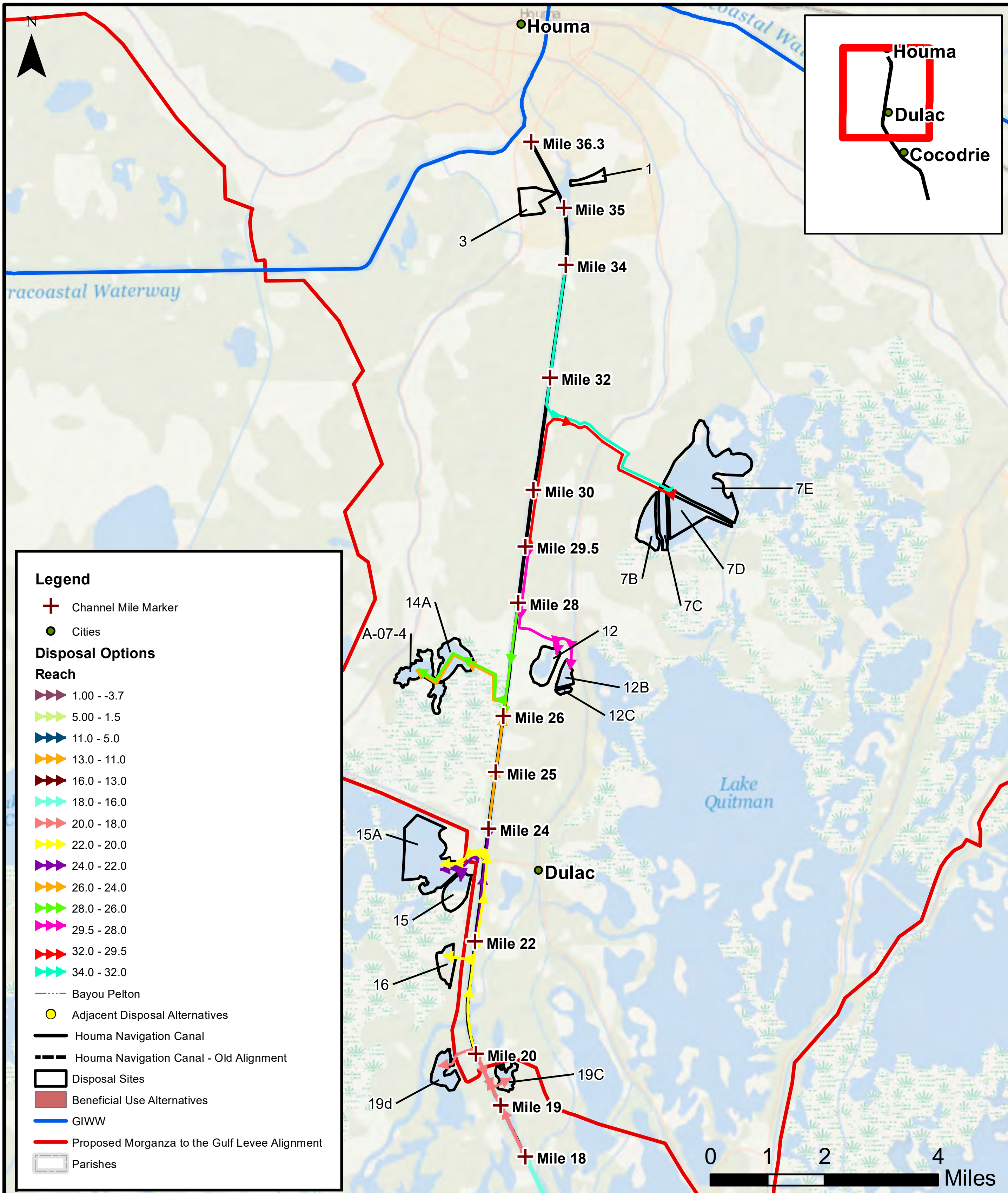
Disposal Areas - The disposal plan varies by channel reach (Figures 4-5 and 4-6) and is described in Section 4.5.4. During construction and maintenance, disposal areas will be monitored to apply any lessons learned to future dredging activities included during O&M.

Rock Dikes for Retention and Foreshore Protection – Approximately 14.7 miles of rock retention dikes and/or foreshore protection would be constructed or refurbished for bank protection. Approximately 13.1 miles of foreshore protection would be constructed or refurbished along the Inland Reach (6 miles along the west bank and 7.1 miles along the east bank). In addition to the foreshore protection, approximately 1.6 miles of rock retention dikes would be constructed on the Inland Reach. Locations of the bank protection measures are presented in Figure 4-3. A typical cross section for the four types of rock dikes for foreshore protection and rock retention are shown in Figure 4-8.

The foreshore dikes are proposed for the southern reaches to slow down land loss adjacent to the channel. The foreshore rock dikes would require a geotextile fabric to be placed under the dikes. These dikes would be built to an elevation of +6 feet NAVD88.

Table 4-26. HNC Deepening Tentatively Recommended Plan Dredged Material Disposal Locations and Estimated Quantities

Reach (Mile)	Construction (CY)	Maintenance (CY)	Maintenance Per Cycle (CY)	Cycle (Years)	Construction Disposal Site	Maintenance Disposal Site
36.3 to 34.0	325,000	1,096,000	109,600	5	1	1 and 3
34.0 to 32.0	175,000	1,098,000	219,600	10	7E	7E
32.0 to 29.5	215,000	829,000	165,800	10	7E	7E
29.5 to 28.0	185,000	829,000	165,800	10	12B	12B and 12
28.0 to 26.0	250,000	1,098,000	219,600	10	A-07-A	A-07-A
26.0 to 24.0	300,000	1,098,000	219,600	10	A-07-A	14A
24.0 to 22.0	305,000	1,096,000	109,600	5	15	15 and 15A
22.0 to 20.0	393,000	1,096,000	109,600	5	16	16 and 15A
20.0 to 18.0	92,000	1,098,000	219,600	10	19C	19C and 19D
18.0 to 16.0	170,000	1,098,000	206,600	10	20C	20C and 21
16.0 to 13.0	315,000	1,657,000	331,400	10	21	21
13.0 to 11.0		1,272,500	254,500	10		24 and 21
13.0 to 11.5	180,000				24	
11.5 to 10.0	230,000				SPD Mile 8.8	
11.0 to 8.0		9,350,000	374,000	2		SPD Mile 8.8
10.0 to 8.0	842,000				SPD Mile 8.8	
8.0 to 6.0	822,500	6,447,500	257,900	2	SPD Mile 7	SPD Mile 7
6.0 to 4.0	705,000	6,685,000	267,400	2	SPD Mile 5	SPD Mile 5
4.0 to 2.0	665,000	6,685,000	267,400	2	SPD Mile 3	SPD Mile 3
2.0 to 0.0	295,000	6,685,000	267,400	2	SPD Mile 1	SPD Mile 1
0.0 to −3.7	1,100,000	14,500,000	580,000	2	SPD Mile −1.7 and Mile −2.5	SPD Mile −1.7 and Mile −2.5
TOTAL	7,564,500	63,718,000				



DISPOSAL AREAS
North End
Houma Navigation Canal Deepening

ERSI Ocean Map

GEC

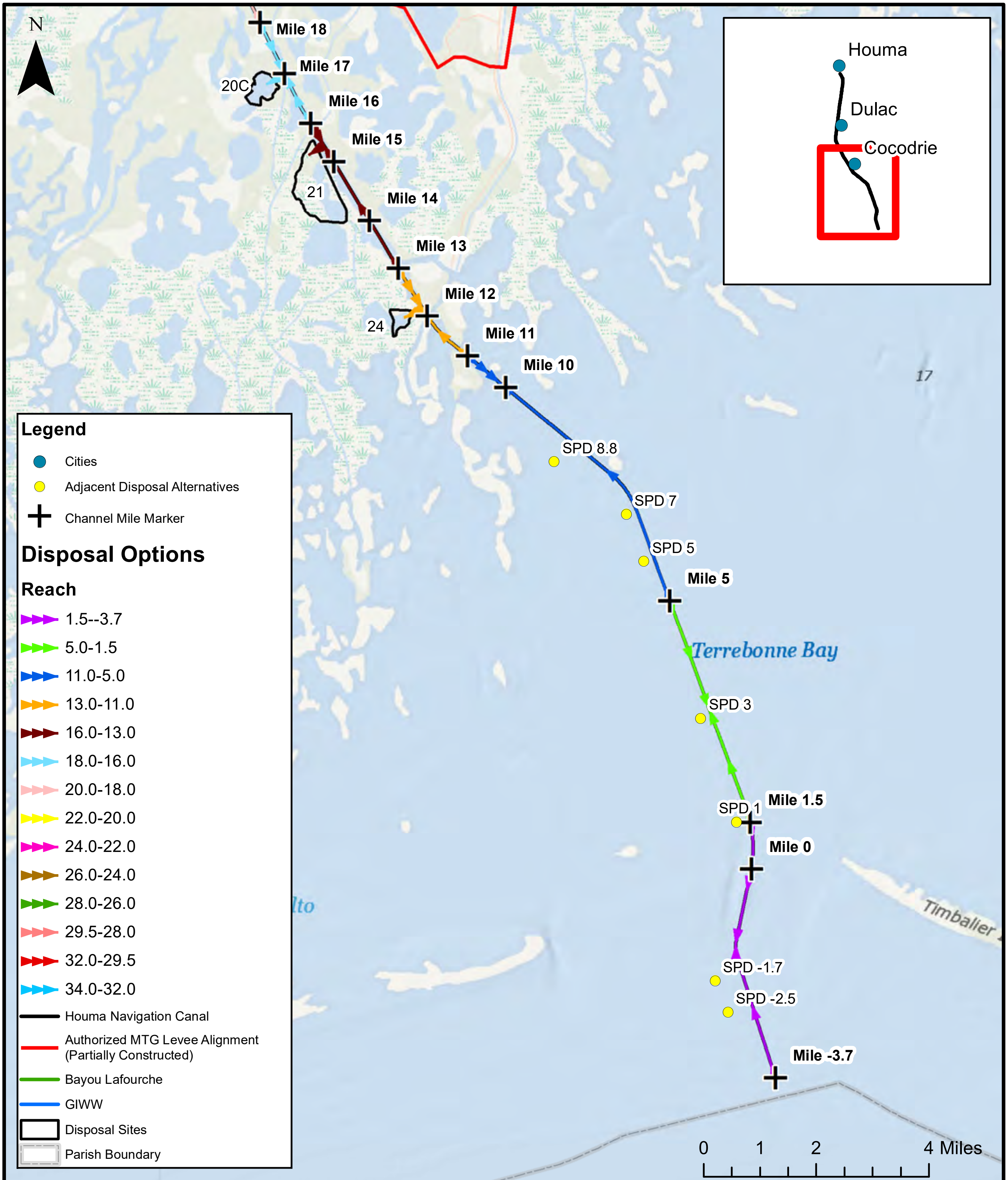
Figure 4-5

Date: December 2014

Scale:1:150,000

Source: ESRI/GEC

Map ID: 278500218-3026



DISPOSAL AREAS
South End

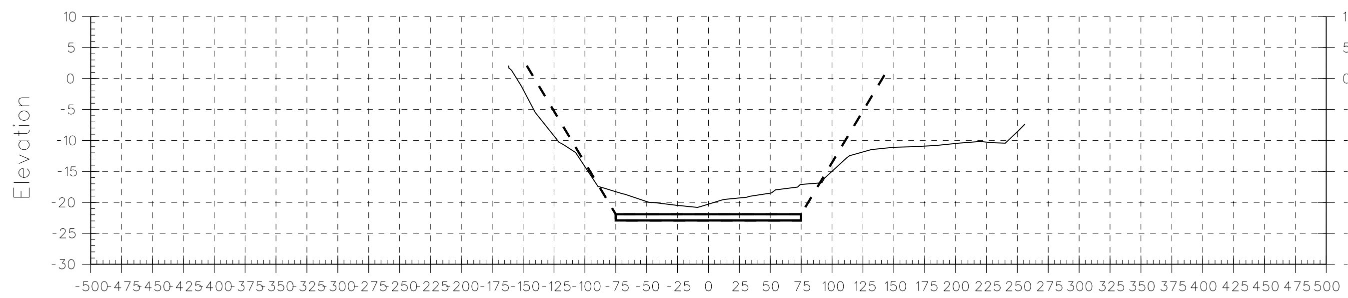
Houma Navigation Canal Deepening

Service Layer Credits: Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors
Sources: Esri, GEBCO, NOAA, National Geographic, DeLorme, HERE, Geonames.org, and other contributors

GEC

Figure: 4-6
Date: March 2017
Scale: 1:150,000
Source: ESRI/NRCS/GEC
Map ID: 278500218-3031

EAST BANK | WEST BANK



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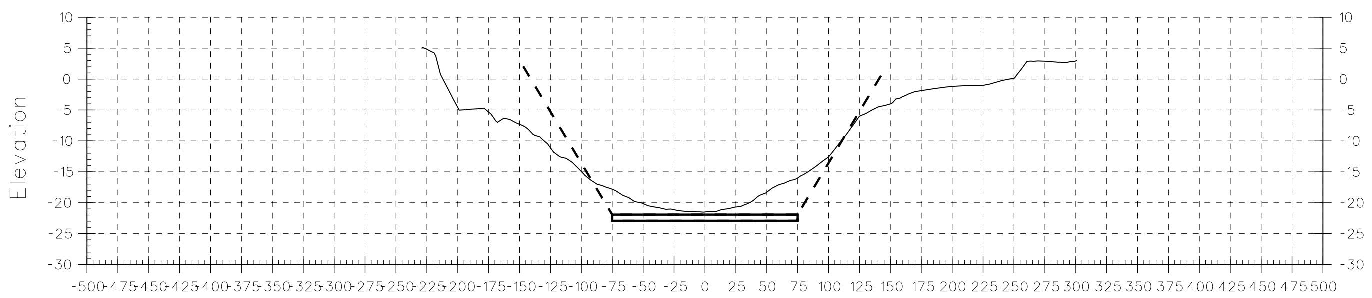

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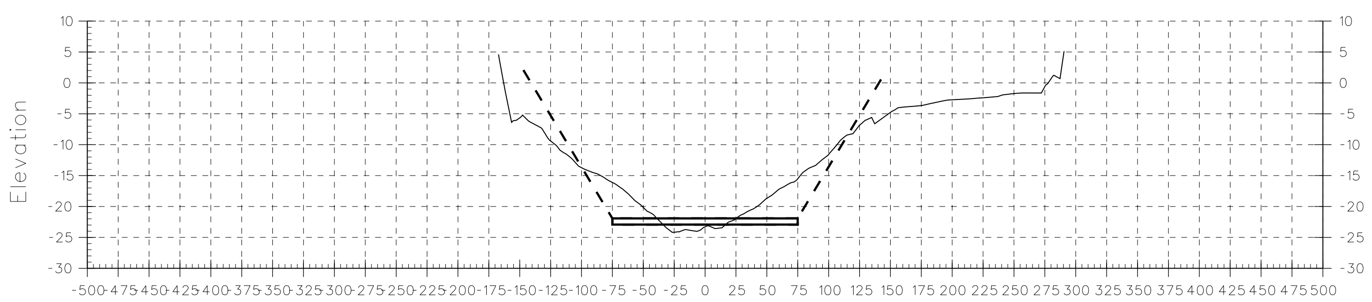

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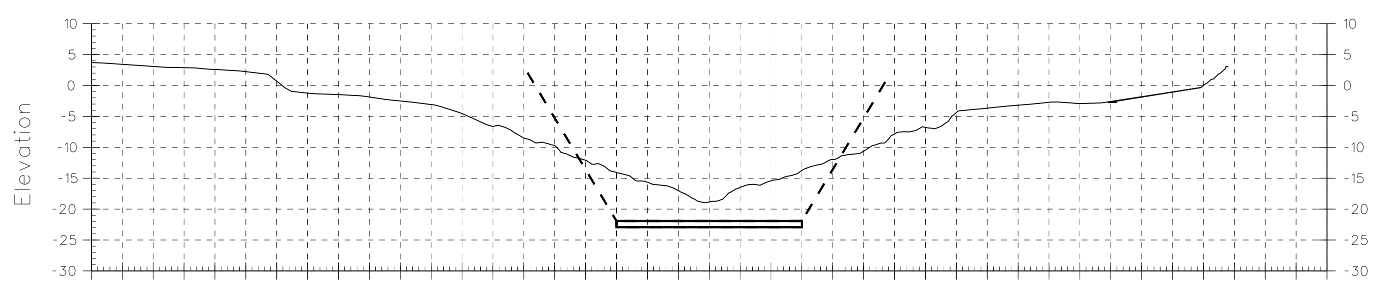

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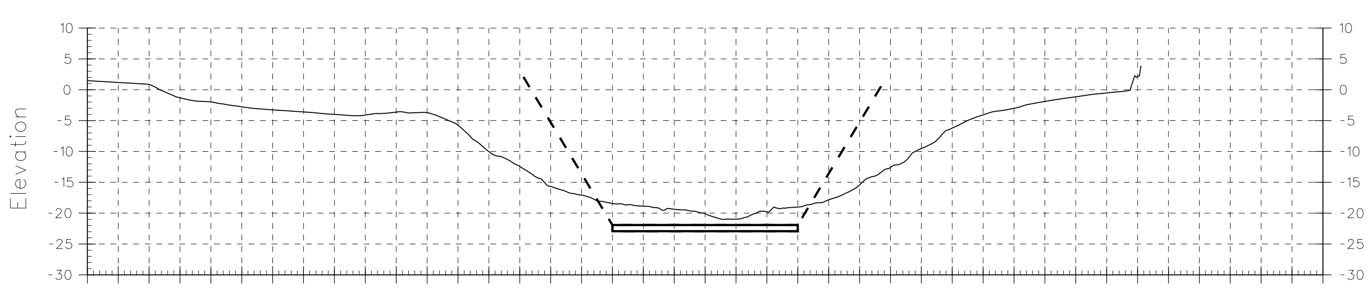

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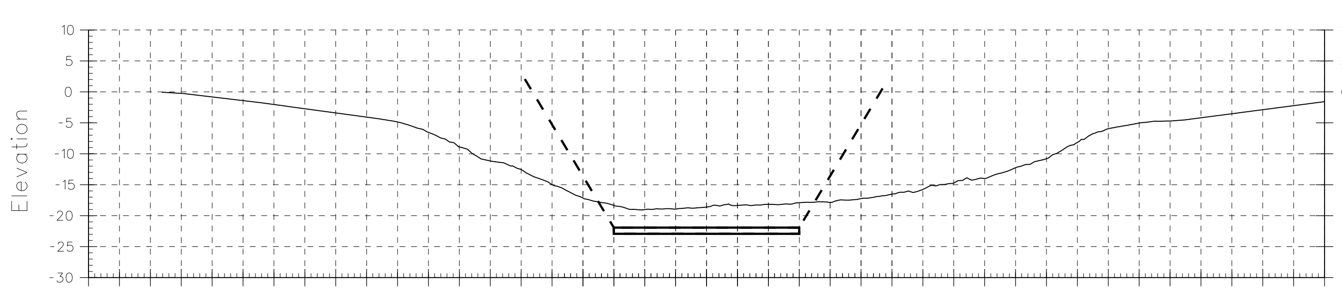
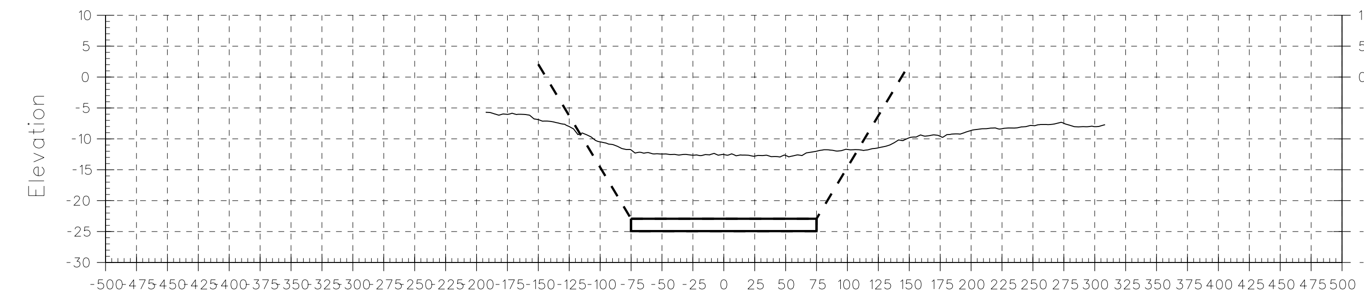


1210+00

EAST BANK | WEST BANK



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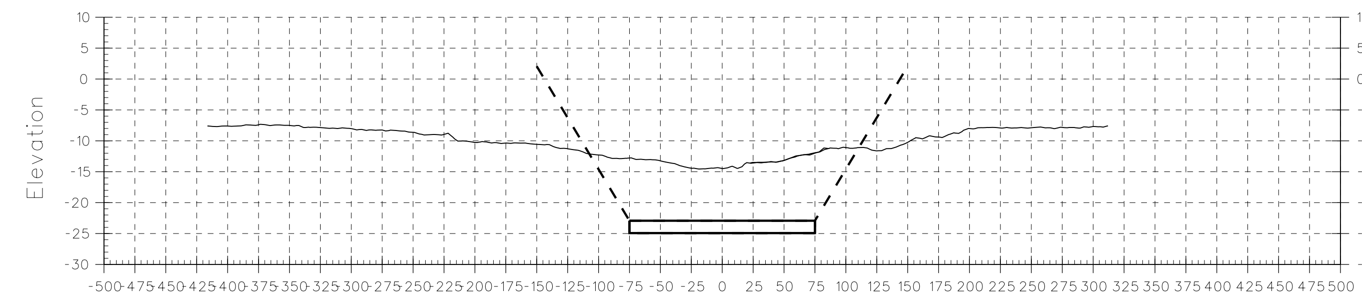

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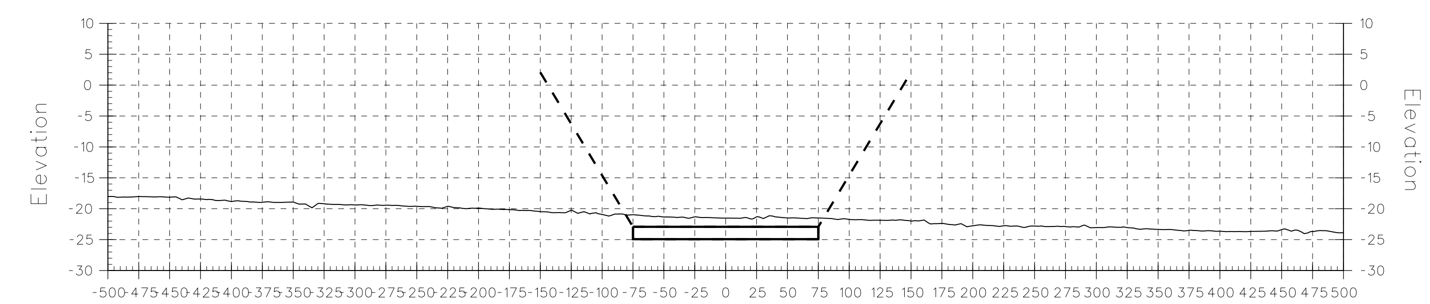

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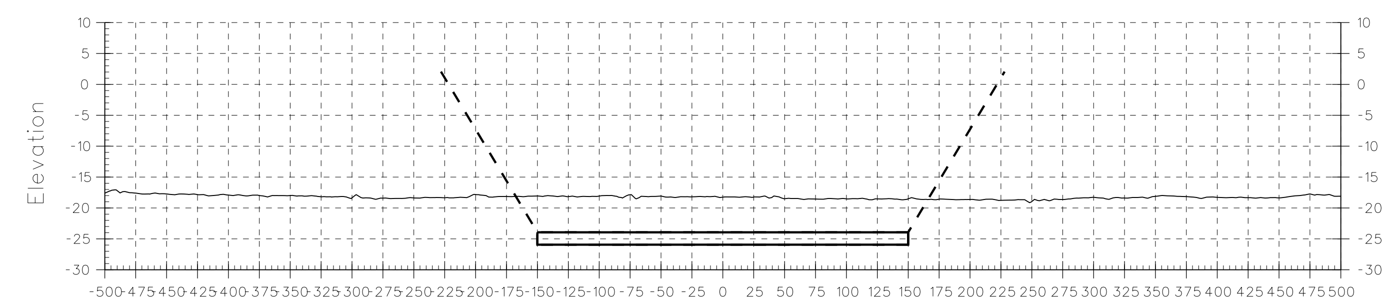

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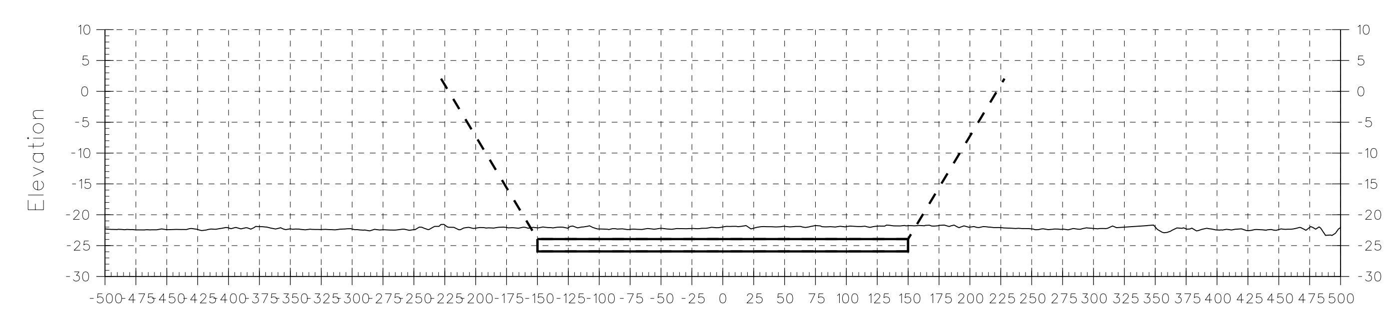


2150+00

NOTES:

1. ELEVATIONS SHOWN REFLECT NAVD88 DATUM.
2. THEORETICAL CHANNEL SIDE SLOPES ARE 1V ON 3H.
3. SIDE SLOPES ARE INCLUDED IN THEORETICAL SECTION WHICH INCLUDES ADVANCE MAINTENENCE.
4. OVERDEPTH IS INDICATED BY THE BOTTOM BOX CUT SECTION.

Figure 4-7

HOUMA NAVIGATION CANAL
HOUMA NAVIGATION DEEPENING - GENERAL REEVALUATION REPORT
MILE 36.0 TO MILE (-)15.0
TERREBONNE PARISH, LOUISIANA

TYPICAL SECTIONS -20' NAVD88 PROJECT

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
NEW ORLEANS, LOUISIANA

DESIGNED BY: T.DORCEY DRAWN BY: TD/RB CHECKED BY: R.BROUSSARD	PLOT SCALE: 500:1	PLOT DATE: MAR 10	CADD FILE: H020083.DGN
	DATE: MAR 10		FILE NO.

PLATE C16

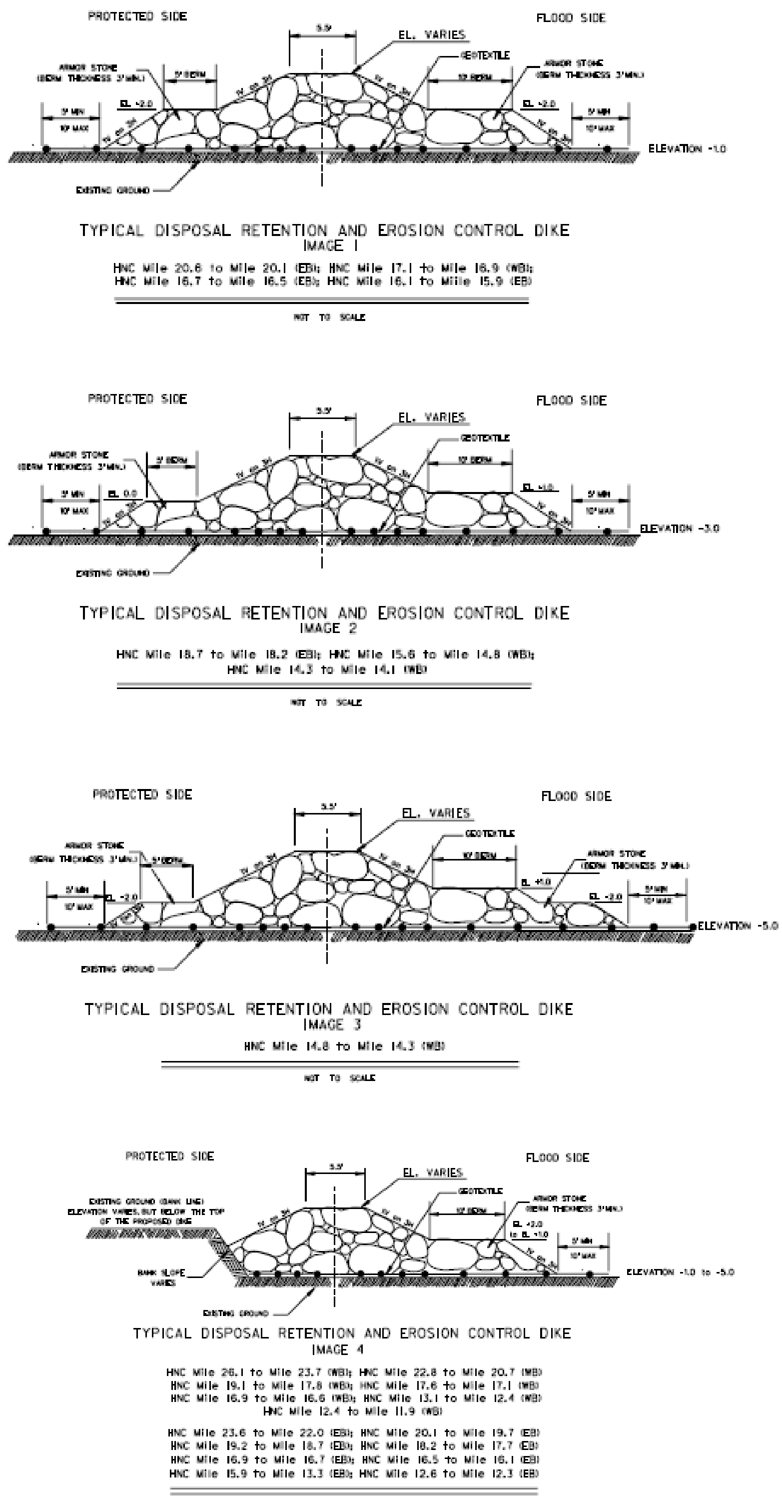


Figure 4-8. Typical Rock Retention and Foreshore Protection Dike Cross Sections

Retention dikes are proposed at strategic locations to retain material dredged from the channel. They would also require a geotextile fabric to be placed under the dikes. The retention dikes would be built to an elevation of +5 feet NAVD88.

4.7.3 Project Costs

The first costs are based on applying USACE Dredge Estimating Program and the Micro Computer-Aided Cost Engineering Systems (MCACES). The first costs include cost for construction of project features, mitigation costs, removals and relocations, real estate requirements, and associated costs for local service facilities. The first cost also includes the cost for preconstruction, engineering, and design (PED) which includes final design, plans and specifications, preparing and executing a local agreement, and advertising and awarding the first construction contract. The costs also include the cost for construction management and supervision. The costs are based on unit costs estimated for February 2015. These costs were then escalated from effective price levels of the base cost estimate of February 2015 to an effective price level for November 2016 to match the authorized budget year (FY 2017).

Price levels are then escalated again from the budget year to an effective price level for the mid-point of construction for each contract, based on the construction plan and project schedule. Contingencies are included based on consideration of risks and uncertainties associated with-project design, and funding and time of design and construction activities. Details of the construction cost estimate are presented in Appendix M.

The cost for acquisition of real estate requirements are listed in Table 4-27, based on a general appraisal at 2017 price levels. Details of the real estate requirements are presented in Appendix C, Real Estate Plan.

4.7.4 Plan Implementation

This chapter presents the Federal and non-Federal responsibilities for implementing the TRP. This includes Federal and non-Federal project cost sharing requirements and the division of responsibilities between the Federal government and the Non-Federal Sponsor. It also lists the steps toward project approval, and a schedule of the major milestones for the design and construction of the TRP.

Cost Sharing - The cost-sharing of the TRP recognizes the purposes and output that will result from this plan is based on the single purpose of navigation. The applicable authority for cost-sharing for this purpose is:

Harbor Projects*. Section 101 of the Water Resources Development Act of 1986 provides that:*
(a) Construction

(1) Payments during construction. The non-Federal interests for a navigation project for a harbor or inland harbor, or any separable element thereof, on which a contract for physical construction has not been awarded before the date of enactment of this Act shall

pay, during the period of construction of the project, the following costs associated with general navigation features:

(a) 10 percent of the cost of construction of the portion of the project which has a depth not in excess of 20 feet; plus

(2) Additional 10 percent payment over 30 years. The non-Federal interests shall pay an additional 10 percent of the cost of the general navigation features of the project in cash over a period not to exceed 30 years, at an interest rate determined pursuant to section 106. The value of lands, easements, rights-of-way, relocations, and dredged material disposal areas provided under paragraph (3) shall be credited toward the payment required under this paragraph.

(3) Lands, easements, and rights-of-way. The non-Federal interests shall provide the lands, easements, rights-of-way, relocations (other than utility relocations under paragraph (4)), and dredged material disposal areas necessary for the project.

(4) Utility relocations. The non-Federal interests for a project shall perform or assure the performance of relocations of utilities necessary to carry out the project, except that in the case of a project for a deep-draft harbor and in the case of a project constructed by non-Federal interests under section 204, one-half of the cost of each such relocation shall be borne by the owner of the facility being relocated and one-half of the cost of each such relocation shall be borne by the non-Federal interests.

Allocation of Project Costs - The TRP is the NED Plan and is considered a single purpose project. It is the least costly acceptable plan to improve navigation on the Houma Navigation Channel. The environmental benefits resulting from placement of material dredged to deepen the channel are considered incidental.

Apportionment of First Cost to Federal and Non-Federal - Table 4-27 presents the first cost apportionment of the project costs based on current legislative provisions. In addition to the non-Federal share of the general navigation features, the non-Federal interest will be required to provide 100 percent of the cost of LERRDS, and 100 percent of the Associated Costs required to provide local service facilities.

Apportionment of OMRRR Costs - There is no incremental increase in OMRRR costs above maintaining the existing Federal project for the Houma Navigation Channel, which is 100 percent Federal. The TRP is also not greater than −20 feet. Accordingly, the Federal Government will continue to provide 100 percent of the cost for maintaining the channel provided by the TRP.

Table 4-27. Houma Navigation Canal, Apportionment of Costs for the Tentatively Recommended Plan (2017 Price Levels)

Item	Federal	Non-Federal	Total
General Navigation Features			
09 Channels and Canals	$102,641,400	$11,404,600 (a)	$114,046,000
Subtotal GNF Cost During Construction	$102,641,400	$11,404,600 (a)	$114,046,000
Planning , Engineering, and Design	$35,628,300	$3,958,700 (a)	$39,587,000
Construction Management	$18,785,700	$2,087,300 (a)	$20,873,000
Total GNF Costs During Construction	$157,055,400	$17,450,600	$174,506,000
Mitigation	$932,400	$103,600 (a)	$1,036,210
LERRDs			
Real Estate	$0	$14,513,000	$14,513,000
Relocations	$0	$28,841,000	$28,841,000
Total LERRDs	$0	$43,354,000	$43,354,000
Non Federal Payment After Construction			
10% of GNF	$0	$17,450,600	$17,450,600
Credit for LERRDs	$0	$43,354,000	$43,354,000
Associated Costs (Local Service Facilities)	$0	$39,059,000	$39,059,000
Total Non-Federal Payment After Construction	$0	$0	$0
Total Project Costs	**$157,987,800**	**$60,908,200**	**$218,896,210**

(a) Based on 10 percent construction costs
(b) Operation and Maintenance. The Federal share of the cost of operation and maintenance of each navigation project for a harbor or inland harbor constructed pursuant to this Act shall be 100 percent, except that in the case of a deep-draft harbor, the non-Federal interests shall be responsible for an amount equal to 50 percent of the excess of the cost of the operation and maintenance of such project over the cost which the Secretary determines would be incurred for operation and maintenance of such project if such project had a depth of 45 feet.

Division of Plan Implementation Responsibilities - The Federal Government and the Non-Federal sponsors are responsible for implementation of the TRP, including the sharing of costs and maintenance. In addition, certain responsibilities are required by each party in accordance with Federal law.

Federal Responsibilities - Responsibilities of the Federal Government for implementation of the TRP include:

a. Sharing a percentage of the costs for Planning, Engineering and Design (PED), including preparation of the Plans and Specifications, which is cost shared at the same percentage that applies to construction of the project.

b. Sharing a percentage of construction costs for the project.

c. Administering contracts for construction and supervision of the project after authorization funding, and receipt of non-Federal assurances.

d. Monitoring shoaling based on periodic surveys and program for maintenance dredging as needed.

d. Assuming maintenance dredging activities after the HNC is deepened.

Non-Federal Responsibilities - There are 24 possible disposal sites including 7 SPD's and a beach nourishment site. Easements would be necessary for 18 of these possible sites. The remaining sites are located within the navigable waters of Terrebonne Bay or the Gulf of Mexico. The 15 sites located within privately owned land encompass approximately 3,311 acres. A perpetual disposal material easement would be required over these areas. Fifteen of the proposed sites are not located adjacent to the channel and would require a 200-foot-wide pipeline access corridor. A perpetual utility and/or pipeline easement would be required over approximately 74 acres to provide pipeline access to these sites.

Navigation Servitude would be applicable for the SPD disposal sites in Terrebonne Bay and Cat Island Pass. The Navigation Servitude would also be applicable on the existing channel for accomplishing the dredging necessary to deepen the HNC and for placement of rock retention and foreshore protection structures along the banks. The rock structures would be placed on land that is below the ordinary high water mark.

A total of one 9-acre oyster lease has been identified in the proposed TRP disposal areas. Leaseholders would be compensated for these leases.

Federal law requires that a local non-Federal sponsor provide and guarantee certain local cooperation items to ensure equitable participation in a project and to ensure continual maintenance and public receipt of the intended benefits. The particulars of the TRP were carefully reviewed and a set of applicable local cooperation items established to include cost sharing of the Project as prescribed in the above paragraphs. The TPC and LADOTD, as the local non-Federal sponsors, will be required to provide local cooperation requirements as follows:

a. Enter into an agreement, which provides, prior to execution of the project cooperation agreement, 25 percent of design costs;

b. Provide, during construction, any additional funds needed to cover the non-Federal share of design costs;

c. Provide, during the period of construction, a cash contribution equal to 10 percent of the total cost of construction of the general navigation features (which include the construction of land-based and aquatic dredged material disposal facilities that are necessary for the disposal of dredged material required for project construction, operation, and maintenance, and, for which a contract for the Federal facility's construction or improvement was not awarded on or before October 12, 1996);

d. Construct and maintain, at its own expense, all project features other than those for general navigation, including dredged depths commensurate with those in related general navigation features in berthing areas and local access channels serving the general navigation features;

e. Provide and maintain adequate local service facilities including port facilities and berthing areas open to all on equal terms and provide necessary site development for the regional harbor;

f. Pay with interest, over a period not to exceed 30 years following completion of the period of construction of the project, up to an additional 10 percent of the total cost of construction of the general navigation features. The value of lands, easements, rights-of-way, and relocations provided by the non-Federal sponsor for the general navigation features, described below, may be credited toward this required payment. If the amount of credit exceeds 10 percent of the total cost of construction of the general navigation features, the non-Federal sponsor shall not be required to make any contribution under this paragraph, nor shall it be entitled to any refund for the value of lands, easements, rights-of-way, and relocations in excess of 10 percent of the total cost of construction of the general navigation features;

g. Accomplish all removals determined necessary by the Federal Government other than those removals specifically assigned to the Federal Government;

h. Provide all lands, easements, rights-of-way, and perform or ensure the performance of all relocations determined by the Federal Government to be necessary for the construction, operation, maintenance, repair, replacement, and rehabilitation of the general navigation features (including all lands, easements, and rights-of-way, and relocations necessary for dredged material disposal facilities);

i. Provide the non-Federal share of that portion of the costs of mitigation and data recovery activities associated with historic preservation, that are in excess of 1 percent of the total amount authorized to be appropriated for the project, in accordance with the cost sharing provisions of the agreement;

j. Do not use Federal funds to meet the non-Federal Sponsor's share of total project costs unless the Federal granting agency verifies in writing that the expenditure of such funds is authorized;

k. Give the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon property that the Non-Federal Sponsor, now or hereafter, owns or controls for access to the project for the purpose of inspecting, operating, maintaining, repairing, replacing, rehabilitating, or completing the project;

l. Hold and save the United States free from all damages arising from the construction and operation, maintenance, repair, replacement, and rehabilitation of the project, any betterments, and the local service facilities, except those damages due to the fault or negligence of the United States or its contractors;

m. Comply with all applicable provisions of the Uniform Relocations Assistance and Real Property Acquisition Policies Act of 1970, Public law 9 1-646, as amended (42 U.S.C. 4601-4655), and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way necessary for the initial construction, operation and maintenance of the project, including those necessary for relocations, borrow materials, and dredged or excavated material disposal, and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act;

n. Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended (42 U.S.C. 1962d-5), and Section 103 of the Water Resources Development Act of 1986, Public Law 99-662, as amended (33 U.S.C. 2213), which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until the non-Federal sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element;

o. Perform, or cause to be performed, any investigations for hazardous substances as are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Public Law 96-5 10, as amended (42 U.S.C. 9601–9675), that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for the initial construction, operation, and maintenance of the project. However, for lands that the Federal Government determines to be subject to the navigation servitude, only the Federal Government shall perform such investigations unless the Federal Government provides the Non-Federal Sponsor with prior specific written direction, in which case the Non-Federal Sponsor shall perform such investigations in accordance with such written direction;

p. Assume, as between the Federal Government and the Non-Federal Sponsor, complete financial responsibility for all necessary cleanup and response costs of any CERCLA regulated materials located in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be necessary for the initial construction, operation, or maintenance of the project;

q. To the maximum extent practicable, operate, maintain, and repair the project in a manner that will not cause liability to arise under CERCLA;

r. Keep and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project, for a minimum of three years after completion of the accounting for which such books, records, documents, and other evidence is required, to the extent and in such detail as will properly reflect total costs of construction of the Project, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 32 Code of Federal Regulations (CFR) Section 33.20; and

s. Comply with all applicable Federal and State laws and regulations, including, but not limited to, Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d), and Department of Defense Directive 5500.11 issued pursuant thereto, as well as Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army," and all applicable Federal labor standards and requirements, including but not limited to 40 U.S.C. 3141–3148 and 40 U.S.C. 3701–3708 (revising, codifying and enacting without substantial change the provisions of the Davis-Bacon Act (formerly 40 U.S.C. 276a et seq.), the Contract Work Hours and Safety Standards Act(formerly 40 U.S.C. 327 et seq.) and the Copeland Anti-Kickback Act (formerly 40 U.S.C. 276c *et seq.*).

Local Cooperation Agreement - Prior to advertisement for the Construction Contract, a Local Cooperation Agreement will be required to be signed by the Federal Government and the non-Federal sponsor committing each party to the responsibilities for implementing and maintaining the project. This agreement will be prepared and negotiated during the Preconstruction Engineering and Design Phase.

Approval and Implementation - The necessary reviews and activities leading to approval and implementation of the TRP are listed below:

a. Environmental Impact Statement Filing. The FEIS will be circulated to State and Federal Agencies as directed by HQUSACE for the 30-Day State and Agency review. The District will concurrently distribute the FEIS to parties not included on the HQUSACE mailing list. The District will then file the decision document and FEIS together with the proposed report of the Chief of Engineers with EPA.

b. Chief of Engineers Approval. Chief of Engineer signs the report signifying approval of the project recommendation and submits the following to ASA (CW): the Chief of Engineers Report, the FEIS, and the unsigned ROD.

e. ASA (CW) Approval. The Assistant Secretary of the Army for Civil Works will review the documents to determine the level of administration support for the Chief of Engineers recommendation. The ASA (CW) will formally submit the report to the Office of

Management and Budget (OMB) OMB will review the recommendation to determine its relationship to the program of the President. OMB will approve the release of the report to Congress.

f. Funds could be provided, when appropriated in the budget, for preconstruction, engineering and design (PED), upon issuance of the Division Commander's public notice announcing the completion of the final report and pending project authorization for construction.

g. Detailed engineering and design for PED studies will be accomplished first and then plans and specifications will be completed, upon receipt of funds.

h. Prior to advertisement for the construction contract, formal assurances of local cooperation in the form of a Local Cooperation Agreement will be required from non-Federal interests (the Local Sponsor).

h. Construction would be initiated with Federal and non-Federal contributed funds, once the construction project was advertised and awarded.

Implementation Schedule - Upon submission of the Feasibility Study, construction authorization, and availability of funding, the Preconstruction Engineering and Design (PED) Phase of Project Implementation can begin. The initial step will be to prepare a Project Management Plan for the PED Phase including preparation of Detailed Design Documents as necessary, preparation and negotiation of the Local Cooperation Agreement with the non-Federal sponsor, and completion of plans and specification. A PED Phase Cost Sharing Agreement will also be prepared and negotiated with the non-Federal sponsor at this time. The Non-Federal sponsor will be required to provide 25 percent of the cost of the PED phase in cash, which will be credited towards their share of the total project cost (including PED).

The schedule for project construction assumes authorization in the Water Resources Development Act of 2018. After project authorization, the project would be eligible for construction funding. The project would be considered for inclusion in the President's budget based: on national priorities, magnitude of the Federal commitment, economic and environmental feasibility, level of local support, willingness of the non-Federal sponsor to find its share of the project cost and the budget constraints that may exist at the time of funding. Once Congress appropriates Federal construction funds, the USACE and the non-Federal sponsor would enter into a local cooperation agreement. This agreement would define the Federal and non-Federal responsibilities for implementing, operating and maintaining the project.

The USACE would officially request the sponsor to acquire the necessary real estate immediately after the signing of the Project Partnership Agreement. The advertisement of the construction contract would follow the certification of the real estate.

Fully Funded Estimate Update from MII TBD – The fully funded estimate for the TRP includes price escalation using Office of Management and Budget inflation factors. Project funding requirements by fiscal year are summarized in Table 4-28, as fully funded estimates.

Table 4-28. Fully Funded First Cost by Fiscal Year

	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	Total
Federal							
E&D	$2,765,700	$11,698,200		$23,902,200	$2,300,400	$5,780,700	$46,447,200
S&A	$1,370,700	$5,632,200		$11,120,400	$1,035,900	$2,555,100	$21,714,300
Construction		$27,914,400		$65,698,200	$7,101,000	$17,424,000	$118,137,600
Federal LERRD							$0
Mitigation		$932,400					$932,400
Total Federal	**$4,136,400**	**$46,177,200**	**$0**	**$100,720,800**	**$10,437,300**	**$25,759,800**	**$187,231,500**
Non-Federal							
E&D	$307,300	$1,299,800		$2,655,800	$255,600	$642,300	$5,160,800
S&A	$152,300	$625,800		$1,235,600	$115,100	$283,900	$2,412,700
Construction		$3,101,600		$7,299,800	$789,000	$1,936,000	$13,126,400
Non-Federal LERRDS	$25,764,000	$10,753,000		$11,467,000			$47,984,000
Mitigation		$103,600					$103,600
Total Non-Federal	**$26,223,600**	**$15,883,800**	**$0**	**$22,658,200**	**$1,159,700**	**$2,862,200**	**$68,787,500**
Total Project	**$30,360,000**	**$62,061,000**	**$0**	**$123,379,000**	**$11,597,000**	**$28,622,000**	**$256,019,000**

Non-Federal Sponsor Support - The TPC, TPCG, and LADOTD have expressed the desire for implementing the project and sponsoring project construction in accordance with the items of local cooperation that are set forth in the recommendations chapter of this report.

4.8 Environmental Considerations

This section presents information on environmental considerations associated with the TRP. Information is presented on features of the plan that have been included to restore and enhance the environment, a summary of the environmental impacts of the plan as contained in Section 6, and a summary of mitigation commitments made to reduce unavoidable impacts of the plan. Details and other information required for compliance with Federal, State, and local laws and policies are presented in the Environmental Impact Statement.

4.8.1 Hydraulics

The TRP would have limited or no direct long-term impact on the hydrology along the HNC, with the exception of possible changes in salinity in the channel and connected water bodies. The diurnal tide range would not change in the project area. Wind-generated waves would continue to erode the shoreline of the tidal ponds in the area. The Falgout Canal Marsh Management Area and other managed areas would continue to have altered hydrology. Rock foreshore protection and rock and earthen retention structures could have a short term direct impact on the hydrology of an area. These structures would be breached 3 years after completion of construction to reestablish hydrologic connections and provide access to areas by aquatic life forms. These structures would also reduce wind and wave generated erosion along the margins of protected marshes along the bank shoreline and in areas restored by placement of dredged material. As an operational measure to reduce salinity effects, the HNC would be dredged from north to south to reduce saltwater intrusion during dredging.

To compute the effects of the HNC deepening on salinity at the proposed HNC lock location, a one-dimensional analysis was done using a simplified form of the Advection-Diffusion equation (USACE, 2003). Along with the No-Action alternative, deepening scenarios for -20 and -22 foot depths were modeled. These depths included two feet of advanced maintenance above the proposed depths and are considered a conservative modeling approach due to the increased salinity levels that would result from these scenarios. The results of this analysis indicated that salinities would increase an average of 0.0054 ppt or 4.81 percent. To offset this impact, operation of the lock and gate would be carried out an average of approximately 48 days per year. Controlling for the median salinity increase projected by the model, at 3.84 percent, would require closure of the structure for 37 days per year. The rate of marsh loss due salt water intrusion could decrease if the HNC lock and floodgate is operated to reduce salinity intrusion. Operation of the Houma Lock Complex is further explained in the Morganza to the Gulf Final Programmatic EIS (UACE, 2013).

4.8.2 Water Quality

The impact from the construction of rock dikes, earthen dikes, rock foreshore protection, and rock retention structures associated with the proposed alternative would have direct and indirect surface water runoff impacts to the adjacent water bodies. Specifically, the construction activities would probably introduce non-point source discharges, such as suspended sediments. However, the beneficial use of dredged material for restoration and preservation of the wetland areas would provide water quality benefits that would far outweigh these adverse impacts.

The placement of dredged material into Site 3 would result in the discharge of effluent into the HNC. Upland disposal at Site 1 would discharge effluent into Short Cut Canal. The quality of the effluent was modeled to ensure compliance with state water quality standards since it is a regulated discharge. The weirs would be placed to ensure no overlapping of the mixing zones as required by LDEQ. Site 3 would require mitigation for wetland and habitat impacts related to the disposal of dredged material. The cost of mitigating for this type of wetland has been included in the project cost.

The placement of dredged material for the beneficial use of marsh creation at the other disposal locations would not result in point source discharges into the HNC. Rather, the dredged material would discharge into the sites, and the suspended material would settle out in the receiving area with probable runoff of the supernatant into adjoining water bodies and marsh/wetland areas. The proposed marsh creation sites would be semi-confined or unconfined. There does not appear to be cause for concern for negative impacts. The open disposal site for beach nourishment would serve as a source of sand for the Isle Dernieres barrier island system.

Construction of the foreshore protection would help prevent further erosion of the banks. The foreshore protection would also help preserve the adjacent marshes by limiting the introduction of unwanted saltwater from the HNC. The four containment cells in Terrebonne Bay would provide opportunity for beneficial use of the dredged material by creating new habitat.

4.8.3 Prime and Unique Farmland

Under the TRP, farmable land would continue to be impacted by ecological and economic factors that are similar to those under the No-Action Alternative. There would not be any direct impacts to prime and unique farmland. However, the following indirect impacts are possible. Farmable land in the Houma region may be converted at a faster rate to other commercial uses as the port expands.

4.8.4 Wetlands

Under the TRP, wetlands would continue to be impacted by the natural and man-made factors. The operation of the lock would reduce impacts to vulnerable wetlands inside the Morganza to the Gulf Hurricane protection system (USACE, 2013). Subsidence and erosional land loss in unprotected or non-restored areas would continue at the present rate. There would be a gain in wetland acres and value due to the beneficial use of dredge material to create wetlands. Rock foreshore protection dikes would reduce land loss due to erosion and wave wash. The overall habitat value and acreage of the remaining wetlands would continue to decline, but at a slower rate. Cypress swamps in the project area could show a recovery due to the reduction in salinities. The HET used the WVA model to predict net change ecosystem function that would be provided by beneficial use of dredged material at the placement sites.

Bottomland Hardwoods and Swamp - The direct impacts to BLH would occur due to placement of material at Site 3. Swamp habitat would be lost due to increased erosion of the channel banks. The loss in AAHUs for BLH and swamp habitat would require compensatory mitigation for the lost value of this habitat.

Intermediate, Brackish, and Salt Marsh - Beneficial use placement areas would increase the area of intermediate, brackish, and salt marsh by a net 347 acres, resulting in an increased habitat value of 161 AAHUs.

Submerged Aquatic Vegetation - Within disposal Sites 19C, 19D, 21, and 24 there is a small potential for the enhancement of submerged aquatic vegetation habitat due to the reduction in fetch and the increase in shallow open water (less than or equal to 1.5 feet). The predicted direct and indirect impact to SAVs is captured in Variable V2 of the WVA for each placement area.

Land Loss - All land loss resulting from the widening of the channel and increases in channel traffic will require compensatory mitigation as described in Section 4.5.6. The TRP would result in a net gain in intermediate, brackish, and salt marsh habitat. Rock retention dikes and foreshore protection dikes would reduce shoreline erosion along the canal. Subsidence rates would remain similar to existing rates. Land loss rates may decrease due to reduction of salt water intrusion with the operation of the lock (USACE, 2013).

Habitat Change - The most significant cause of habitat change in the project area is salt water intrusion. This alternative would mitigate any potential increases in salinity levels through operation of the Houma lock complex. Deepening of the channel would not occur until construction of the lock is completed. As an operational measure to reduce salinity effects, the HNC would be dredged from north to south to reduce saltwater intrusion during dredging.

4.8.5 Benthos

With the TRP, there would be a direct impact on the ecology of the benthos in the project area. The canal would be deepened for approximately 41 miles. This length works out to be just short of 1,000 acres of disturbance. Existing open water bottom would be converted into marsh with the placement of the borrow material at the placement sites. Approximately 14.7 miles of foreshore dikes and rock retention dikes would be built or refurbished with this project.

The dredging of areas can sometimes result in limited areas of anoxic conditions in surface waters. However, this is not expected to happen with the TRP. The channel should remain well oxygenated due to the tidal circulation and fresh water flows. Most members of the benthic communities are sessile or very slow moving. The dredging of material would directly impact them by digging up organisms, moving them through a pipeline, and placing them in a new location. The likelihood of an organism surviving would be extremely slim. The newly exposed sediment would be quickly recolonized from adjacent areas. Oyster reefs and other benthos would be destroyed directly by the placement process. The composition of the species that make up the benthos would change in most of the placement areas since the habitat would be converted from open water to marsh. These organisms would be disturbed during maintenance cycles; hence, a climax community may never be reached. The placement of rock would also change the available habitat and benthic community from one associated with soft bottom to one associated with hard bottom.

4.8.6 Aquatic Resources

The TRP could have a positive indirect impact on aquatic resources, by the creation of marsh. Increasing nutrients and sediments in the estuarine area would enhance the growth of marsh vegetation and slow the rate of land loss. Increased plant growth would result in greater production of organic detritus that is essential for a high rate of fisheries production.

This positive impact would not offset the long-term negative impact on aquatic resources. The deepening of the channel would cause an increase in salinity intrusion; however, this would be reduced by the operation of the HNC lock (USACE, 2013). Freshwater aquatic habitat would shrink, while marshes would be converted to different types of marshes or to open water. The gain in open water would have a short-term positive impact on aquatic resources, but as marsh disappears, so does prime habitat for many aquatic species.

Fish are transient and mobile by nature, which would allow them to avoid the construction area during the dredging and placement operation. The primary impact to fisheries would be felt from the disturbance of approximately 2,114 acres of benthic and epibenthic communities. The loss of the benthos and epibenthos, smothered during dredged material and rock placement, would temporarily disrupt the food chain. There would also be a short-term local increase in turbidity during the pumping of dredged material. The turbidity may decrease the hunting capacity of visual predators, and clog the gills of filter feeders.

Oyster reefs that exist in any placement areas would be buried. There is one oyster lease in the placement sites. The recruitment of new oysters would be minimal due to lack of hard substrate. The turbidity may clog the gills of oysters and other filter feeding bivalves.

Blue crabs and shrimp are mobile and could avoid the placement areas during construction, but some burial may occur. Juveniles recruit to the marsh from offshore, so recolonization would not be impacted.

The creation of earthen or rock dikes and the kidney islands would prevent fish access to portions of the study area. The dikes would be breached by year 3 to allow tidal flow and fish access.

4.8.7 Essential Fish Habitat

The TRP would have a positive impact on Essential Fish Habitat (EFH) due to the creation of wetlands and the limiting of salinity intrusion. Table 3.5.6 of the Generic Amendment for Addressing Essential Fish Habitat Requirements in the following Fishery Management Plans of the Gulf of Mexico lists the level of effect that various non-fishing related activities impact EFH. Altered freshwater inflow is shown in that table to have a large effect on emergent marshes, oyster bars, and nearshore mangroves; a moderate effect on estuarine and nearshore seagrasses, estuarine mangroves, estuarine hard bottom, nearshore sand/shell, soft, and hard bottoms; and some effect on estuarine sand/shell and soft bottom. In the long-term, the impact to EFH would be reduced with the lock functioning to reduce salt water intrusion (USACE, 2013). Dredge and fill is shown in that table to have a large effect on all but one of the EFH types. These large effects are offset in this alternative by the beneficial use of dredged material to create marsh. The creation of wetlands would provide EFH for many aquatic species; including Federally managed species or species groups.

The dredging of the channel would be performed in such a way as to minimize the potential to produce an anoxic zone. The change in depth would provide edge effect and could produce microhabitats that would benefit EFH.

The creation of earthen or rock dikes would impact EFH in the short-term. The dikes would be breached by year 3 to allow tidal flow and fish access to mitigate for any long-term impacts to EFH. Shoreline hardening has a large effect on estuarine and nearshore mangroves, emergent marshes, and nearshore sand/shell, soft, and hard bottoms; a moderate effect on oyster bars, and nearshore seagrasses; and some effect on estuarine seagrasses, and sand/shell, soft, and hard bottoms. Any direct negative impacts to these EFH would be offset by the long-term protection (reduced land loss rate) these hard structures would have on the protected emergent marsh.

4.8.8 Wildlife

The TRP could have a positive indirect impact on wildlife, through the creation of marsh, which could provide foraging areas for some birds and mammals. In the long-term, the rate of wildlife populations decline in the area could decrease due to the slowing of salt water intrusion with the operation of the lock (USACE, 2013). In the long-term, there could be an impact to wildlife as their habitat and prey's habitat loss rates stabilize.

If the proposed work would occur during the bald eagle nesting season (i.e., October through mid-May), USFWS recommended that a survey be conducted for the presence of undocumented eagle nests prior to initiation of construction. Construction or operational activities associated with the proposed project should not encroach within 1,500 feet of an eagle nest during that period of time.

4.8.9 Threatened and Endangered Species

The TRP could have a positive indirect impact on T&E species, by the creation of marsh, which could provide foraging areas for some birds and mammals. In the long-term, the rate of T&E populations decline in the area could decrease due to the slowing of saltwater intrusion with the operation of the lock (USACE, 2013). In the long-term, there could be an impact to T&E Species as their habitat and prey's habitat loss rates stabilize. Construction or operational activities (dredging) associated with the proposed project should not encroach within 2,000 feet of a brown pelican nest (Wine Island) during April to mid-September. Construction or operational activities (dredging) associated with the proposed project should not affect piping plover. Sea turtles may be adversely impacted during actual dredging operations of the channel. The incidence of unavoidable taking of these sea turtles would be minimized by the use of hydraulic dredges. No direct impact to threatened and endangered species should occur if these guidelines are followed. In August 2002, the United States Fish and Wildlife Service (USFWS) Endangered Species Coordinator concurred with our determination that "The proposed activities would not significantly affect listed or proposed threatened or endangered species."

4.8.10 Air Quality

With implementation of the TRP, there would be minor short-term impacts to air quality that would result from the construction phase of the HNC deepening. The air quality impacts would be primarily limited to those produced by heavy equipment. Ambient air quality would be temporarily degraded, but emission controls and limited duration would aid in minimizing the effects. No long-term significant impacts to the local air quality would be anticipated. Emissions attributable to deepening of the HNC would result in no significant impact to air quality in the Parish, and would not affect the attainment status of the Parish.

4.8.11 Economics

The impacts to economics, excluding navigation, under the TRP are the same as the Highway 57 Alternative in Section 3.8 of the Final Programmatic Environmental Impact Statement Mississippi River & Tributaries-Morganza, Louisiana, to the Gulf of Mexico Hurricane Protection and will be incorporated by reference into this document. There is one oyster lease in the placement areas that would be directly impacted. Compensation for this loss would be required.

4.8.12 Recreation

The recreational environment in and around the project area would experience limited short-term disruption imposed by the physical size and working activities of the floating dredge facility and construction activities. Dredging activities would increase turbidity in the area of work and in the vicinity of the discharge pipes. Turbidity would disrupt and displace water-oriented recreational activity occurring within the area of dredging and construction; however, these adverse impacts would be temporary and short-lived. In time, recreational use of the area would return to its pre-project condition.

4.8.13 Noise, Health and Safety

The TRP would have only short-term, and minor, direct impacts on noise during construction. There would be a long-term increase in the frequency but not the level of noise produced by navigation traffic. Any noise impacts would likely affect relatively few humans other than those employed at or near the construction sites due to the typically remote locations of the sites. When employees are subjected to sound exceeding those described under the Occupational Safety and Health Standards, feasible administrative or engineering controls would be utilized via effective hearing conservation programs. Further, in accordance with these standards, if such controls fail to reduce sound levels within acceptable levels, personal protective equipment would be provided and used to reduce sound levels.

In some instances, noise impacts may directly impact fish and wildlife species (Bender, 1997). These organisms would generally avoid the construction area. It is anticipated that, in some instances, noise impacts may be an important issue for its potential indirect effects on wildlife, such as disruption of normal breeding patterns and abandonment of nesting colonies. The implementation of appropriate buffer zones, and *activity windows* could be used to mitigate for any potential impact. If the proposed work would occur during the bald eagle nesting season (i.e., October through mid-May), USFWS (email dated January 15, 2004) recommend that a survey be conducted for the presence of undocumented eagle nests prior to initiation of construction. Construction or operational activities associated with the proposed project should not encroach within 1,500 feet of an eagle nest during that period of time.

To prevent adverse effects of construction and maintenance, USACE projects follow appropriate guidelines set by other Federal agencies, including the Occupational Safety and Health Administration.

4.8.14 Navigation

Deepening the channel to -20 feet would increase vessel utilization 38 percent over the No-Action Alternative while maintaining the same annual growth rate as the No-Action Alternative. Also, the 20-foot channel would allow for greater utilization of existing facilities and obviate the need to continue to maintain satellite facilities on deeper channels. These growth rates result from the trend in the offshore oil and gas industry for exploration and production in deeper and deeper water. This would have two important implications for the HNC. Deepwater activity requires larger service vessels as well as a greater financial commitment for any given project. Therefore, firms along the canal that can build service and maintain larger vessels at the lowest cost could win contracts that they otherwise could not compete for. Deepening the channel would allow the deeper draft service vessels to use HNC not only as a base of operations, but also take advantage of the construction and repair facilities located along the canal. The strategic location of the canal allows for less costly trips to the deepwater tracts in the Gulf. These advantages give rise to substantial NED benefits. The mean days the HNC lock complex would be closed to reduce salinity intrusion at the fresh water intake would be 48 days and the median number of days would be 37 days (USACE, 2013). These closures should not significantly impact navigation.

4.8.15 Cultural Resources

The archaeological site prediction model prepared and subsequently tested by Goodwin & Associates, Inc., in 2000 confirms a very high probability for the presence of archaeological sites on natural levees in the northern portion of the project area. In 2003 Joanne Ryan and others identified additional high probability areas along the entire length of the project area. A review of these reports, archaeological site distribution maps and USGS quadrangle maps show that the Houma Navigation Canal and the location of proposed disposal areas often bisect natural levee landforms present along the canal as well as several natural waterways and lakes such as Bayous LaCarpe, Grand Caillou and Petit Caillou, as well as Lake Quitman and Lake Boudreaux. With implementation of the proposed action, natural levee areas currently exposed along the canal bankline could be subjected to increased erosion from larger vessel wave action and also damaged from the initial placement of riprap bank protection. Proposed disposal area construction and use, which includes berm construction and dredged material placement, can also impact these high probability locations.

In addition, watercraft from all historic periods could be present within the project area. Project activities associated with channel deepening, bankline protection, berm construction, and dredged material placement could result in the disturbance of significant historic watercraft.

Therefore, the U.S. Army Corps of Engineers, Mississippi Valley Division, New Orleans District (CEMVD), plans to conduct further archaeological investigations in the project area during the next project study phase. This work will be based on the recommendations and research design provided by Ryan *et al.* (2003). In a letter to the Louisiana State Historic Preservation Office dated February 3, 2004, CEMVN submitted Ryan's draft report for comment and requested SHPO's opinion regarding the proposed research design and recommendations for further investigations. Section 106 consultation with the SHPO is ongoing and will be concluded prior to initiation of any project construction activity. In addition, if any unrecorded cultural resources are determined to exist within the proposed project boundaries once project construction begins, then no work will proceed in the area containing these cultural resources until a CEMVN archeologist has been notified and final coordination with the SHPO has been completed.

From October through December of 2003, Coastal Environments, Inc. (CEI), conducted a cultural resources literature search and records review as part of a U.S. Army Corps of Engineers (COE) New Orleans District re-evaluation study to determine if improvements to navigation along the Houma Navigation Canal, in Terrebonne Parish, Louisiana, are justified. These investigations are part of the planning to evaluate several alternatives to deepening the HNC from the authorized 15-foot depth to an 18- or 20-foot depth while maintaining the existing canal width. Both channel depths are being considered with a lock and without a lock in place. If the canal itself is assumed to be approximately 1000 ft (305 m) wide, the HNC encompassed roughly 4969.69 ac (2012.05 ha), including 2909.09 ac (1177.78 ha) of canal and 2060.60 ac (834.26 ha) of navigation channel. Three previously recorded archaeological sites and 13 sunk or salvaged vessels exist within the project's Area of Potential Effects (APE). In addition, seven unrecorded sites and 23 potential site loci were noted on the HNC during the project area site inspection conducted during this study. Those portions of the project area with a high probability for containing cultural resources have been defined on project plans and encompass 691.48 ac. A research design to guide future cultural resources fieldwork in the project area is presented.

Subsequent to the 2005 CEI report, disposal sites were modified due to capacity concerns. These new disposal sites, along with the proposed access routes between the HNC and the disposal areas were presented to SHPO to determine if additional surveys of these areas would be necessary, beyond those previously conducted. It was determined by SHPO that no further surveys would be necessary, provided that the access routes a carefully chosen to avoid several potential sites located along the HNC. Based on this response, the access routes were evaluated and none were located in areas determined to be potential cultural resources. A statement concerning the SHPO’s reevaluation of the disposal sites and access routes, along with the 2005 CEI report as located in Appendix G.

4.8.16 Mitigation

The appropriate application of mitigation is to formulate an alternative that first avoids adverse impacts, then minimizes adverse impacts, and lastly, compensates for unavoidable impacts. During the planning process, this methodology was followed where practicable. This helped avoid adverse impacts to wetlands. The following design commitments would minimize adverse impacts.

The dredged material placed within the shallow open water areas would be placed to an initial elevation that would be conducive to the development of long-term wetlands.

Any earthen or rock dikes constructed would be breached 3 years after construction if not already breached (approximately every 1,000 feet with a 20- to 25-foot bottom width at –2 feet NAVD88).

Through coordination with Houma Drinking Water Plant, CEMVN would utilize appropriate dredging operations/techniques, such as dredging the northern water quality subsegment (LA120509) (Appendix A, Annex II) during high freshwater flows, to avoid potential contaminant migration toward the drinking water intake.

The mixing zone requirements would be met for all Confined Disposal Facilities (CDFs) with appropriately sized weirs. The weirs for each CDF would be designed to meet these minimum requirements. The weirs would be placed to ensure no overlapping of the mixing zones as required by LDEQ.

If the proposed work would occur during the bald eagle nesting season (i.e., October through mid-May), U.S. Fish and Wildlife Service (USFWS; email dated January 15, 2004) recommend that a survey be conducted for the presence of undocumented eagle nests prior to initiation of construction. Construction or operational activities associated with the proposed project would not encroach within 1,500 feet of an eagle nest during that period. If placement of material is planned for the barriers islands, the nesting time frames for gulls and terns (approximately mid-April to mid-September) and brown pelicans (approximately May to mid-September) should be avoided. Consultation with USFWS would have to occur to develop a plan to prevent impacts to these species, such as the use of Best Management Practices during construction.

There would be a need for compensatory mitigation for the net value of the wetland habitat lost and for impacted oyster leases.

Impacts to intermediate, brackish, and salt marsh habitat would be mitigated through the creation of marsh habitat in some of the disposal areas.

4.8.17 Disposal Sites

The following environmentally acceptable methods for disposal of dredged material and reducing bank erosion would be utilized and prioritized as such within 15 identified disposal sites utilized within the inland reach by the TRP. The TRP utilized seven single point discharges within the Terrebonne Bay and Cat Island Pass Reaches.

- Reestablish some of the eroded bank line to prevent further erosion while decreasing maintenance requirements;
- Nourish broken marsh areas; and
- Create marsh in shallow open water

With implementation of the TRP, all of these disposal methods would be used.

Disposal plans were developed for three reaches of the channel: the Inland Reach (Mile 11.0 to the GIWW at Mile 36.3), the Bay Reach (Mile 0 to Mile 11.0), and the Cat Island Pass Reach (Mile –3.7 to Mile 0). Disposal locations are described below and are listed in Figures 4-5 and 4-6 and Tables 4-26 and 4-29. Disposal Site 24 is currently identified as a potential BUDMAT site by the USACE, but the use of this area has not been approved. In the case that Site 24 becomes no longer available, the HET believes that a sufficient number of alternate disposal sites exist within the area between the Inland and Terrebonne Bay Reaches.

Inland Reach (Mile 11.0 to the GIWW at Mile 36.3) - The inland portion of the channel has numerous locations available for disposal, these include locations already identified for current maintenance of the channel and also new sites that provide for beneficial placement of the dredged material for ecosystem restoration, consistent with the State of Louisiana's Master Plan for the Coastal Zone and the consistency requirements of the Louisiana Coastal Zone Management Program. In addition, because these sites are located adjacent to, or within close proximity of, the channel alignment, they represent the least cost disposal option for the inland reach of the channel. As a result of the HET screening process, 15 disposal sites were designated for disposal of dredged material generated from the Inland Reach. These sites are described in the Tables 4-26 and 4-29 and Figures 4-5 and 4-6.

Two sites were previously designated as disposal sites under the current maintenance dredging and have been used for upland disposal of material. Site 1 was previously permitted and mitigation has been provided for upland disposal impacts at this site. Site 3 has developed into bottomland hardwood habitat, and continued use of this site for disposal will require mitigation for impacts to this habitat type. The mitigation requirements for the TRP are provided in Section 4.5.6. The other placement sites are primarily open water and would be used to create marsh.

Terrebonne Bay Reach (Mile 0.0 to 11.0) – A number of disposal options were considered for disposal of material in the Terrebonne Bay reach. Five disposal sites were identified for material dredged to deepen and maintain the Houma navigation channel in this reach. All five disposal locations would place material unconfined, a minimum of 1,000 feet west of the channel. The single point discharge locations would be at Mile 8.8, 7, 5, 3, and 1. The unconfined disposal utilized in Terrebonne Bay would follow the same procedures currently used for maintenance dredging in the HNC. All sites identified are within the sites evaluated in Appendix H.

Table 4-29. Dredged Material Disposal Locations for Tentatively Recommended Plan

Channel Reach	Channel Miles	Disposal Site	Acres	Existing Habitat	Environmental Status
Inland	36.3 to 34.0	1	50.9	Upland	Permitted
Inland	36.3 to 34.0	3	132.0	Bottomland Hardwood	Requires Mitigation (offsite)
Inland	34.0 to 32.0	7E	772.5	Freshwater Marsh/ Open Water	Habitat Creation
Inland	32.0 to 29.5	7E	772.5	Freshwater Marsh/ Open Water	Habitat Creation
Inland	29.5 to 28.0	12B	56.5	Freshwater Marsh/ Open Water	Habitat Creation
Inland	29.5 to 28.0	12	130.0	Freshwater Marsh/ Open Water	Available for Mitigation
Inland	28.0 to 26.0	A-07-A	200.7	Freshwater Marsh/ Open Water	Habitat Creation
Inland	26.0 to 24.0	A-07-A	200.7	Freshwater Marsh/ Open Water	Habitat Creation
Inland	26.0 to 24.0	14A	184.2	Freshwater Marsh/ Open Water	Habitat Creation
Inland	24.0 to 22.0	15	148.3	Brackish Marsh/ Open Water	Habitat Creation
Inland	24.0 to 22.0	15A	578.1	Brackish Marsh/ Open Water	Habitat Creation
Inland	22.0 to 20.0	16	119.9	Brackish Marsh/ Open Water	Habitat Creation
Inland	22.0 to 20.0	15A	578.1	Brackish Marsh/ Open Water	Habitat Creation
Inland	20.0 to 18.0	19C	74.9	Brackish Marsh/ Open Water	Habitat Creation
Inland	20.0 to 18.0	19D	131.3	Brackish Marsh/ Open Water	Habitat Creation
Inland	18.0 to 16.0	20C	133.3	Brackish Marsh/ Open Water	Habitat Creation
Inland	18.0 to 16.0	21	527.2	Salt Marsh/ Open Water	Habitat Creation
Inland	16.0 to 13.0	21	527.2	Salt Marsh/ Open Water	Habitat Creation
Inland / Terrebonne Bay	13.0 to 11.0	24	71.3	Salt Marsh/ Open Water	Habitat Creation

Channel Reach	Channel Miles	Disposal Site	Acres	Existing Habitat	Environmental Status
Inland / Terrebonne Bay	13.0 to 11.0	21	527.3	Salt Marsh/ Open Water	Habitat Creation
Inland / Terrebonne Bay	11.0 to 8.0	SPD Mile 8.8	N/A	Salt Marsh/ Open Water	Adjacent Disposal
Terrebonne Bay	8.0 to 6.0	SPD Mile 7	N/A	Salt Marsh/ Open Water	Adjacent Disposal
Terrebonne Bay	6.0 to 4.0	SPD Mile 5	N/A	Salt Marsh/ Open Water	Adjacent Disposal
Terrebonne Bay	4.0 to 2.0	SPD Mile 3	N/A	Salt Marsh/ Open Water	Adjacent Disposal
Terrebonne Bay	2.0 to 0.0	SPD Mile 1	N/A	Salt Marsh/ Open Water	Adjacent Disposal
Cat Island Pass Bar Channel	0.0 to –3.7	SPD Mile -1.7 and -2.5	N/A	Barrier Shoreline/ Marine	Adjacent Disposal

Cat Island Pass Reach (Mile –3.7 to Mile 0) - The same disposal approach would be used to place the material from the Cat Island Pass (Mile 0.0 to -3.7), with disposal occurring at Miles -1.7 and -2.5. Disposal would occur a minimum of 1,000 feet to the west of the HNC and would utilize unconfined disposal of material at SPD -1.7 and SPD -2.5 (Figure 4-6). Material from Cat Island Pass is approximately 70 percent sand, percent shell, and 25 percent silt.

4.8.18 Mitigation Plan

The mitigation plan developed for the TRP would fully mitigate for the following impacts of deepening of the HNC.

Bottomland Hardwoods and Swamp - The only available disposal sites along the northernmost portion of the channel near Houma requires disposal of dredged material at Site 3, which is bottomland hardwoods (BLH). Site 3 would be used during construction and every 5 years for maintenance. This would cause a loss of 7.32 AAHUs. In addition, an additional 7 acres of BLH would be lost to shoreline erosion over 50 years (162 acres total) which is a loss of an additional 2.39 AAHUs. Thus, 9.7 AAHUs of BLH must be mitigated.

Just over two acres of swamp would be eroded from along the banks of the HNC; this would cause the loss of 0.7 AAHUs of swamp habitat. The BLH and swamp would be mitigated by the purchase of 18.3 acres of BLH and 2.1 acres of swamp habitat from the Upper Bayou Folse Mitigation Bank or other equivalent bank in the area. Therefore, implementation of the mitigation banking would require execution of a non-standard Wetland Creation and Easement for 20.4 acres to offset the impacts to these habitats.

Intermediate, Brackish, and Salt Marsh - Most of the dredged material from the deepening of the HNC would be used beneficially. However, disposal sites are limited in the inland reach of the channel. Therefore inland, bay, and offshore areas were identified for disposal of dredged material as marsh creation.

A combined 310 acres of marsh would be eroded from each bank of the HNC channel over the next 50 years. However, future without project conditions would result in a loss of 532 acres over the 50-year study period. Therefore, the TRP would result in a net reduction in erosion and compensatory mitigation would not be required.

There are four marsh creation disposal sites designated as intermediate marsh habitat; they all produce net increases in AAHUs (Sites 12, 12B, A-07-A, and 14A). The TRP would provide a net gain of 40 AAHUs and 128 acres. A conservation easement would be purchased over disposal sites that produce net habitat gains to ensure long-term protection of the area.

There are seven marsh creation disposal sites in brackish marsh; other than site 19C, they all produce net increases in AAHUs (Sites 7E, 15, 15A, 16, 19D, and 20C). The TRP would provide a net gain of 79.1 AAHUs and 101.6 acres of brackish marsh habitat.

Two marsh creation disposal sites are proposed in salt marsh habitat; under intermediate relative seal level rise forecasts, both sites 21 and 24 produce net increases in AAHUs. The TRP would provide a net gain of 41.8 AAHUs and 117 acres of habitat creation.

Due to the net gains in habitat creation supplied by each proposed alternative, only the impacts to the BLH and swamp habitat loss would require compensatory mitigation. Based on the benefits per acre provided by the Upper Bayou Folse Mitigation Bank, it was determined that the TRP would require mitigation through the purchase of approximately 18.32 acres and 9.71 AAHUs of BLH habitat. Fifty years of erosion would also result in the loss of an additional 0.72 AAHUs and 1.8 acres of swamp habitat along the HNC. This would require that 2.07 acres of swamp habitat mitigation is acquired. Therefore, implementation of the TRP would require mitigation of 20.38 acres (10.43 AAHUs) to accommodate the loss of both BLH and swamp habitat.

Retention dikes are proposed at strategic locations to retain material dredged from the channel. They would also require a geotextile fabric to be placed under the dikes. The retention dikes would be built to an elevation of +5 feet NAVD88.

For both the foreshore protection and retention rock dikes, the toe elevations of the channel side wave berm must be at or below elevation −1.0 feet and the berm top must be at least at elevation +1.0 foot, while maintaining a minimum 3-foot thickness. Protected side stability berms would be required, with a minimum width of 5 feet and thickness of 3 feet. The protected side berm may be eliminated if the dike is located against an earthen bank of +3.5 feet or higher. A flotation channel may be required if the channel is too far away from the bank line. The flotation channel for dike construction should not be dredged any closer than 50 feet to the centerline of the dike. The flotation channel may be dredged up to 8.0 feet below the water surface.

4.8.19 Real Estate

The total estimated real estate cost for this project is $12,843,000. This includes Land, Easements, Right of Way, Relocations, and Disposal Areas (LERRDs), labor, and a 25 percent contingency. The types of real estate acquisition, costs and contingency required to implement the TRP are presented in Table 4-30. Details are presented in the Real Estate Plan, Appendix C.

Table 4-30. Project Real Estate Requirements and Costs

Lands and Damages	Amount	Contingency	Project Cost
ACQUISITIONS			
BY LOCAL SPONSOR (LS)	$522,500	$130,630	$653,130
REVIEW OF LS	$302,500	$75,630	$378,130
APPRAISAL			
BY LS	$110,000	$27,500	$137,500
REVIEW OF LS	$96,250	$24,060	$120,310
TEMPORARY PERMITS/LICENSES/RIGHTS-OF-ENTRY			
BY GOVT ON BEHALF OF LS	$15,000	$3,750	$18,750
REAL ESTATE PAYMENTS			
BY LOCAL SPONSOR (LS) (Oyster Leases)	$9,000	$2,250	$11,250
BY LOCAL SPONSOR (LS) (Easements)	$9,186,108	$2,296,530	$11,482,638
LERRD CREDITING			
ADMINISTRATIVE COSTS (By Gov't and L.S.)	$33,000	$8,250	$41,250
Total			$12,842,960

Relocations and Removals - The existing facilities within the HNC project boundaries that would be impacted by the project, owners, and proposed action are presented in Table 4-31 and Appendix A, Annex V (Plates C2–C12). Facilities and utilities crossing the HNC that may need to be relocated include 20 gas or petroleum pipelines, seven electric lines, three water lines, and one sewer line.

The sponsor for the construction of this project, the LADOTD, has sufficient authority to acquire and to hold the real estate needed for this project. The Federal Government has extensive channel and disposal easements within the required right-of-way. In addition, the Navigation Servitude would be utilized where appropriate.

The preliminary report asserts that facilities which were installed *prior to* the acquisition of real estate rights for construction of the channel in 1962 may have certain rights superior to the navigational servitude, and the owners thereof may have a compensable interest unless the owners' interest was subordinated to that of the canal at some point in time. Conversely, any facilities which were installed *after* the date real estate rights were acquired for the channel in 1962 are subject to the navigational servitude, and the owners thereof

Table 4-31. Summary of Facilities Requiring Relocation for HNC Channel Deepening

Location (Channel Miles)	Suspected Owner	Facility	Compensable Interest
36.3	South Louisiana Electric Cooperative Association (SLECA)	Submarine Cable Crossing	Yes
34.5	Terrebonne Parish Consolidated Waterworks District Number 1	12-inch water main	Yes
34.5	Entergy	Submarine Cable Crossing	Yes
34.3	Charter Communications LLC	Submarine Cable Crossing	Yes
34.0	Terrebonne Parish Consolidated Government	10-inch sewer line	TBD
34.0	SLECA	Submarine Cable Crossing	Yes
31.3	Gulf South Pipeline Company, LP	20-inch Natural Gas Pipeline	Yes
29.8	Louisiana Intrastate Gas Company, LLC	16-inch Natural Gas Pipeline	Yes
29.8	Enterprise Products Company	8-inch Natural Gas Pipeline	Yes
31.3	Louisiana Intrastate Gas Company, LLC	10-inch Natural Gas Pipeline	Yes
27.8	Columbia Gulf Transmission Company	30-inch Natural Gas Pipeline	Yes
26.5	SLECA	Submarine Cable Crossing (abandoned)	No[a]
23.5	Koch Gateway Pipeline Company	12-inch Natural Gas Pipeline	Yes
23.5	Terrebonne Parish Consolidated Government	Submarine Cable Crossing	Yes
23.3	SLECA	Submarine Cable Crossing	Yes
22.8	Gulf South Pipeline Company, LP	4-inch Natural Gas Pipeline	Yes
22.8	Gulf South Pipeline Company, LP	6-inch Natural Gas Pipeline	Yes
21.8	Hope Services, Inc.	Two 4-inch water lines (abandoned)	No[a]
13.5	Williams Gas Pipeline Company	6-inch Natural Gas Pipeline	Yes
12.0	Tennessee Gas Pipeline Company	24-inch Natural Gas Pipeline	Yes
11.9	Tennessee Gas Pipeline Company	26-inch Natural Gas Pipeline	Yes
11.8	Southern Natural Gas Company	6-inch Natural Gas Pipeline	Yes
10.5	Texaco, Inc.	2½-inch Oil Pipeline	Yes
10.5	Texaco, Inc.	2½-inch Natural Gas Pipeline	Yes
10.5	Texaco, Inc.	3-inch Natural Gas Pipeline	Yes
10.5	Texaco, Inc.	2½-inch Natural Gas Pipeline	Yes
10.5	Chevron-Texaco, Inc.	3-inch Natural Gas Pipeline	Yes
6.3	Texaco Pipelines, LLC	8-inch Natural Gas Pipeline	Yes
6.3	Texaco Pipelines, LLC	16-inch Natural Gas Pipeline	Yes
6.3	Texaco Pipelines, LLC	20-inch Natural Gas Pipeline	Yes

[a]Utility may be abandoned in place or removed not relocated

do not have a compensable interest. The compensable interest report states that 27 facility/utility owners may have a compensable interest. The report of compensability is preliminary and has been prepared and used for the purpose of completing a study. Final relocation determinations and a final compensability report will be completed at a later date.

Any conclusion or categorization contained in this report that an item is a utility or facility relocation to be performed by the non-Federal sponsor as part of its Land Easements and Right of Ways responsibilities is preliminary only. The Government will make a final determination of the relocations necessary for the construction, operation, or maintenance of the project after further analysis and completion and approval of final attorney's opinions of compensability for each of the impacted utilities and facilities.

LER Requirements - The navigational servitude will be invoked over the existing channel for accomplishing the dredging necessary to deepen the HNC, and for placement of rock retention and foreshore protection structures along the banks. Rock retention structures and rock foreshore protection will be placed on land that is below the ordinary high water mark at various locations along the channel. Disposal areas located adjacent to or nearby the HNC will be utilized for placement of the excavated material and for future maintenance of the channel. Retention dikes will be required within many of the disposal sites for containment of the dredged material.

The project will require the acquisition of a Perpetual Dredged Material Disposal Easement over 15 of the 25 disposal areas proposed to be used for the project. The remaining sites are located within the navigable waters of Terrebonne Bay. The navigation servitude will be invoked in connection with utilizing the remaining Single Point Discharge sites (SPD 8.8, 7, 5, 3, 1, -1.7, and -2.5). The 15 sites located within privately owned land encompass approximately 3,311 acres. The right to construct earthen dikes is included in the disposal easement proposed to be acquired. Mapping of the disposal sites is included in Exhibit B of Appendix C. The disposal sites, their respective size, and land type impacted are listed in Table 4-32.

Table 4-32. Disposal Land Types

Site	Acres	Property Type
1	50.9	Industrial Waterfront
3	132	Industrial Waterfront
7E	772.5	Marsh/Open Water
12B	56.5	Marsh/Open Water
12	130	Marsh/Open Water
A-07-A	200.7	Marsh/Open Water
14A	184.2	Marsh/Open Water
15	148.3	Marsh/Open Water
15-A	578.1	Marsh/Open Water
16	119.9	Marsh/Open Water
19-C	74.9	Marsh/Open Water
19-D	131.3	Marsh/Open Water
20-C	133.3	Marsh/Open Water
21	527.2	Marsh/Open Water
24	71.3	Marsh/Open Water
Total	3,311.1	

Several disposal areas that are not located adjacent to the channel require pipeline access via a 100-foot-wide corridor. A Perpetual Dredged Material Pipeline Easement will be required over approximately 69 acres of privately owned marsh and/or open water to provide pipeline access to these sites.

The estates to be acquired are included as Exhibit C of the Real Estate Plan. Approximately 55 ownerships are expected to be impacted by acquisition of the disposal areas and the associated pipeline easements.

Land types impacted by the proposed project include approximately 182.9 acres of waterfront land with potential for industrial use and 3,128.2 acres of marsh and/or open water under private ownership. A summary of the land classes impacted by the project and required acres of each are listed in Table 4-33.

Table 4-33. Impacted Land Classes

Land Class	Disposal Acres	Pipeline Acres
Waterfront industrial	182.9	0
Marsh/open water	3,182.2	42
	3,311.1	42

A summary of all costs for lands, easements and rights-of-way (LERRDs) and a detailed estimate of all real estate costs in chart of accounts format is included in the Real Estate Plan.

Sponsor Owned Lands - The Terrebonne Port Commission owns, in fee title, the land designated as Site 1 for dredged material disposal. This land has not been previously provided as an item of local cooperation, thus the sponsor will receive credit for the value of easement to be acquired. Channel and associated disposal easements were acquired for the Houma Navigation Canal in the name of the Terrebonne Parish Police Jury (TPPJ) in the late 1950s and early 1960s. None of the proposed sites for the deepening project overlap the original disposal sites.

Estates - The estates to be acquired are a non-standard Dredged Material Disposal Easement and a standard Dredged Material Pipeline Easement. The estates required are provided as Exhibit C of the Real Estate Plan. Approval of the non-standard Dredged Material Disposal Easement estate was requested under separate cover. Similar non-standard Dredged Material Disposal Easement estates were previously approved in October 1990 for the Brunswick Harbor Project, and in March 2000 for the CWPPRA Marsh Island Hydraulic Restoration Project.

Existing Federal Projects - Easements that were acquired in the name of the United States for the Bayous Grand Caillou and Bayou LeCarpe project overlap with some of the proposed disposal sites for the HNC Deepening Project. The Bayous Grand Caillou and Bayou LeCarpe Project was authorized by the Rivers and Harbors Act approved 30 August 1935. This project created a 5-x-40-foot channel from the GIWW at Houma south to Dulac, a distance of approximately 16.3 miles. This work was completed in 1938. The Rivers and Harbors Act of

1962 authorized the enlargement of the channel from the GIWW to the HNC, a distance of about 1.5 miles, to 10 x 45 feet. This work was completed in August 1964, and it is the only part of this project that is currently maintained. Most of the rest of the project is still in use, but does not require regular maintenance. At several locations, channel and/or disposal easements that were acquired for the HNC overlap those of the Bayous Grand Caillou and LeCarpe Project, and some of the proposed disposal areas for the HNC Deepening also overlap existing Federal disposal areas. The existing federally owned easements are not legally sufficient for construction of the HNC Deepening.

Federally Owned Land - There is no Federally-owned land within required rights-of-way for this project.

Navigation Servitude - The navigation servitude will be invoked within the existing channel for dredging and placement of rock retention structures and rock foreshore protection.

Induced Flooding - There will be no induced flooding caused by the construction of this project for which additional just compensation would be owed.

Relocation Assistance - The provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 9 1-646, Title II, as amended, are not applicable to the proposed project. No displacement of persons will occur and there will be neither habitable nor commercial structures affected as a result of the construction of the project.

Minerals, Timber, and Crops - Mineral rights will not be impacted by the project, and there is no mineral activity in the area that would interfere with construction of the project. There are no growing crops to be impacted by the project. There may be minimal hardwood timber value associated with the upland disposal site (Sites 1). Potential timber value was accounted for in the gross appraisal.

Local Sponsor Assessment - The LADOTD does not intend to actively engage in acquiring rights-of-way for the deepening project. Furthermore, the TPCG and TPC intend to request that the USACE acquire all lands, easements, and rights-of-way, as well as perform, or assure the performance of all utility and/or facility relocations necessary for the HNC deepening on their behalf. The sponsor would only be responsible for acquiring additional rights-of-way for future maintenance of the channel, if necessary. The TPC is the local agency currently providing disposal rights-of-way for the HNC maintenance dredging program.

4.8.20 <u>Environmental Issues</u>

A Phase I site assessment was prepared to facilitate early identification of potential Hazardous, Toxic and Radioactive Waste (HTRW) contamination. Based on the assessment, there is a low risk of encountering HTRW problems. Cultural resources investigations were also completed during the study. This document constitutes the Environmental Impact Statement. No acquisition of rights-of-way will commenced before all environmental clearances are in place.

4.8.21 Other Issues

The project is expected to impact one oyster lease encompassing approximately 9 acres. The State of Louisiana, through the LDNR would buy out the leases, or the affected portions thereof, in accordance with DNR's Oyster Lease Acquisition and Compensation Program (OLACP). Under the provisions of the OLACP, LDNR would conduct a biological survey of the impacted leases to determine and document physical characteristics and productivity of the leased acreage, and complete an appraisal of the fair market value of the leases. The local sponsors for the HNC Deepening Project would be required to reimburse LDNR for all costs associated with acquisition of the leases. The costs would be creditable as a LERRDs cost incurred by the sponsors.

Oyster lease buyouts would take place concurrently with acquisition of disposal and pipeline easements. The fair market value of the oyster leases was addressed in the gross appraisal and estimated to be $9,000 (before contingencies) based on prices paid for comparable leases in transactions between private individuals. These costs, as well as LDNR's estimated administrative costs associated with buying out the leases, are included in the real estate baseline cost estimate presented earlier in this report.

4.9 Associated Features

The Associated Features are local service features required to be provided by the non-Federal sponsor to realize the benefits of the navigation improvements. Associated features include bulkheads, docks, dry docks, slips, turning basins, cranes, lifts, conveyors that are required by users of the navigation channel to take advantage of the project and realize the intended benefits (Figure 4-9). A contracted study evaluated the costs of associated features required to realize the benefits of channel deepening, based on the current configuration of associated features and work required to adapt these facilities for use of the deeper channel. Conceptual designs were developed for replacement or new bulkheads, and dredging requirements, including dimensions and dredged material quantities, were also estimated.

Conceptual Designs of Bulkheads - Typical, conceptual designs of the proposed bulkheads were performed for five sites: Cenac Towing Properties 1 and 2, Oil States, Quality Shipyard's New Construction Yard, and Chet Morrison Contractors facilities. These designs were used to estimate per-foot costs for the proposed bulkheads. At Cenac Property 1 and Quality Shipyard, the conceptual designs involve dredging and either partially or entirely removing existing bulkhead walls and constructing new ones designed for the greater dredge depth. At Chet Morrison, the conceptual design involves installing a new bulkhead wall and dredging the canal near the bank line. At Cenac Property 2 and Oil States, the conceptual designs entail installing new bulkhead walls and dredging new boat slips.

Figure 4-9. Associated Facilities Locations for the HNC Deepening Project

Dredging Operations for Facilities - Dredging calculations were performed for the five sites based on depths provided by each firm and the cross sectional information provided by the USACE. The following tables summarize the estimated quantities, without contingencies added, for the dredging required at each facility. To allow vessels to access the slips, access channels, measuring 150 feet in width were required at the Cenac Towing Properties 1 and 2, Oil States, and Quality Shipyard facilities. Dredge quantities for Chet Morrison were calculated from the bulkhead line to the centerlines of the HNC and GIWW for the entire 1,720-foot length of bulkhead to allow vessels to fleet at multiple locations. The depths of dredging within the of the existing slips at Cenac Property 1 and Quality Shipyard's New Construction facility were based on the proposed depth minus the existing depth of the slip. For the new slips to be constructed at Cenac Property 2 and Oil States, the depths of dredging were calculated by adding the height of the ground surface to the depth of the slip.

Tables 4-34 and 4-35 present preliminary estimates of the Associated Features and Costs, respectively, required using the deeper HNC Channel.

Table 4-34. Preliminary Estimate of Associated Features

Firm	Slip/ Bulkhead Dimensions	Dredge Depth (feet)	Dredge Quantity (cy)	Access Channel from C/L HNC (cy)	Access Channel from C/L ICWW (cy)	Total Quantity (cy)
Cenac Property 1	900 x 300 ft	6	60,000	1,200		61,200
Cenac Property 2	800 x 200 ft	18	107,000	2,000		109,000
Cenac Property 2	800 x 200 ft	21	124,500	3,200		127,700
Prop. 2 Difference		3	17,500	1,200		18,700
Chet Morrison	1,720 L.ft.		130,800			130,800
Oil States	150 x 800 ft	19.5	86,700		11,800	98,500
Quality Shipyards	1,585 x 195 ft	4.5	50,000		5,000	55,000

Table 4-35. Preliminary Estimate of Associated Costs

Business	Estimated Dredging Cost	Estimated Bulkhead Cost	Total Estimated Cost w/ Cont.
Cenac Towing			
Property 1	$371,790.00	$8,004,287.72	$8,376,000
Property 2 el –15	$662,175.00	$3,344,137.73	
Property 2 el –18	$775,777.50	$4,252,363.99	
Property 2 Difference in el.	$113,602.50	$908,226.26	$1,022,000
Chet Morrison Contractors	$794,610.00	$6,722,394.81	$7,517,000
Oil States Skaoit/SMATCO	$598,387.50	$8,518,867.20	$9,117,000
Quality Shipyards			
New Construction Site	$602,640.00	$9,331,228.43	$9,934,000
Repair Yard	–	–	–
Estimated Cost with 35% Contingency: $35,966,000			

4.9.1 Construction Plan

The duration and scheduling of project construction contracts would depend greatly on the amount of construction funding available. It is anticipated that if adequate funding were available, channel deepening could be completed in less than 6 years. This would be accomplished through five contracts via hydraulic cutterhead dredges as shown in Table 4-36. The first contract would cover miles 36.3 to 22.0, the second contract would cover miles 22.0 to

11.5, the third contract would cover miles 11.5 to 6.0, the next contract would cover miles 6.0 to 0.0, and the last contract would be for miles 0.0 to –3.7. Each of the construction contracts would include the mobilization, dredging, material placement and demobilization requirements to accomplish the channel deepening. The construction contract for each reach would also include the construction of all rock and earthen foreshore protection and retention dikes specified in the TRP.

Table 4-36. First Construction Contract Sequence

Construction Contract	Channel Deepening	Contract Award Date	Contract Completion Date
1	Mile 36.3 to Mile 22.0	October 2021	September 2023
2	Mile 22.0 to 11.5	April 2023	March 2025
3	Mile 11.5 to 6.0	December 2024	April 2026
4	Mile 6.0 to 2.0	April 2025	August 2026
5	Mile 2.0 to –3.5	November 2025	April 2027

4.9.2 Operation, Maintenance, Repair, Rehabilitation, and Replacement (OMRR&R)

OMRR&R requirements for this project involve maintenance of the navigation channel, bank protection features, disposal containment features and disposal sites.
Maintenance Dredging – For the deepening alternatives to – 18 feet, a net increase of 2 % is assumed for the inland reach. Within Terrebonne Bay, since no foreshore protection or rock retention is utilized within this reach, an increase of 9% is assumed. Since no channel width changes or rock protection would occur, the historic (ERDC) maintenance volumes are assumed within Cat Island Pass. For the deepening alternatives to – 20 feet, a net increase of 10 % is assumed for the inland reach. Within Terrebonne Bay, an increase of 13% is assumed. Once again, the historic maintenance volumes were utilized within Cat Island Pass. Maintenance dredging cycles and history were presented in Section 4.5.3 and estimates of required maintenance dredging for each alternative are presented in Section 4.5.5.

Maintenance of Bank Protection - Maintenance of the rock placed along the HNC and disposal containment sites are expected due to settlement, subsidence, and possible sea level rise. Accordingly, five maintenance cycles have been included for these reaches. The first maintenance cycle would be in year 10, the second in year 20, and the third in year 30, until year 50.

Channel Maintenance - The existing authorized HNC Federal project involves maintaining a channel depth of –15 feet, NGVD88. Based on historic data on the shoaling, dredging volumes and frequencies, the anticipated maintenance dredging requirements for the channel have been projected and are summarized in Table 4-37.

Table 4-37. Projected Maintenance Requirements

Channel Reach (Miles)	Maintenance Requirements
36.3 to 34.0	Maintenance dredging would occur every 5 years. The dredged material would be disposed of in confined upland Site 1 and BLH Site 3.
34.0 to 32.0	Maintenance dredging would occur every 10 years. The material would be placed within semi-confined Site 7E. Approximately 6,900 LF of dikes would also need to be refurbished every 10 years as well. A 200-ft-wide pipeline access corridor would be required for the disposal of dredged material.
32.0 to 29.5	Maintenance dredging would occur every 10 years. The material would be placed within semi-confined Site 7E. Approximately 6,900 LF of dikes would also need to be refurbished every 10 years as well. A 200-ft-wide pipeline access corridor would be required for the disposal of dredged material.
29.5 to 28.0	Maintenance dredging would occur every 10 years. The material would be disposed of semi-confined within Wetland Sites 12 and 12B. Approximately 1,800 and 1,600 LF of dikes would also need to be refurbished every 10 years, respectively. A 200-ft-wide pipeline access corridor would be required for the disposal of dredged material.
28.0 to 26.0	Maintenance dredging would occur every 10 years. The material would be disposed of semi-confined within Wetland Site A-07-A. Approximately 9,300 LF of dikes would also need to be refurbished every 10 years as well. A 200-ft-wide pipeline access corridor would be required for the disposal of dredged material.
26.0 to 24.0	Maintenance dredging would occur every 10 years. The material would be disposed of semi-confined within Wetland Site 14A. Approximately 9,000 LF of dikes would also need to be refurbished every 10 years as well. A 200-ft-wide pipeline access corridor would be required for the disposal of dredged material.
24.0 to 22.0	Maintenance dredging would occur every 5 years. The material would be disposed of semi-confined within Wetland Sites 15 and 15A. Approximately 2,450 and 4,800 LF of dikes would also need to be refurbished every 5 years, respectively. A 200-ft-wide pipeline access corridor would be required for the disposal of dredged material.
22.0 to 20.0	Maintenance dredging would occur every 5 years. The material would be disposed of within unconfined Wetland Site 16 and semi-confined Wetland Site 15A. Approximately 4,800 LF of dikes would also need to be refurbished every 5 years. A 200-ft-wide pipeline access corridor would be required for the disposal of dredged material.
20.0 to 18.0	Maintenance dredging would occur every 10 years. The material would be disposed of within unconfined Wetland Site 19C and semi-confined Wetland Site 19D. Approximately 1,300 LF of dikes would also need to be refurbished every 10 years. A 200-ft-wide pipeline access corridor would be required for the disposal of dredged material.
18.0 to 16.0	Maintenance dredging would occur every 10 years. The material would be disposed of within unconfined Wetland Site 20C and semi-confined Wetland Site 21. Approximately 2,000 LF of dikes would also need to be refurbished every 10 years. A 200-ft-wide pipeline access corridor would be required for the disposal of dredged material.
16.0 to 13.0	Maintenance dredging would occur every 10 years. The material would be disposed of semi-confined within Wetland Site 21. Approximately3,850 LF of dikes would also need to be refurbished every 10 years as well. A 200-ft-wide pipeline access corridor would be required for the disposal of dredged material.
13.0 to 11.0	Maintenance dredging would occur every 10 years. The material would be disposed of semi-confined within Wetland Sites 24 and 21. Approximately 4,100 and 11,600 LF of dikes would also need to be refurbished every 10 years, respectively. A 200-ft-wide pipeline access corridor would be required for the disposal of dredged material.
11.0 to 4.0	Maintenance dredging would occur every 2 years. The material would be disposed of unconfined as single point discharges 1,000 feet to the west of the channel at Miles 8.8 and 7, and 5.

Channel Reach (Miles)	Maintenance Requirements
4.0 to 2.0	Maintenance dredging would occur every 2 years. The material would be disposed of unconfined as a single point discharge 1,000 feet to the west of the channel at Mile 3.
2.0 to 0.0	Maintenance dredging would occur every 2 years. The material would be disposed of unconfined as a single point discharge 1,000 feet to the west of the channel at Mile 1.
0.0 to –3.7	Maintenance dredging would occur every 2 years. The material would be disposed of unconfined as single point discharges 1,000 feet to the west of the channel at Miles -1.7 and -2.5.

Disposal of maintenance dredged material is proposed to be at the disposal locations identified for material placement which is evaluated in this report. Any changes in disposal of material generated through maintenance dredging would be addressed in future NEPA documents as necessary.

Maintenance of Rock Dikes and Containment Dikes - Maintenance of the rock placed along both the HNC and disposal containment sites are expected due to settlement and subsidence. Accordingly, three maintenance cycles have been included for these reaches. The first maintenance cycle would be in years 10 and 11, the second in years 20 and 21, and the third in years 30 and 31, until year 51. Rock placement and repair of any failures or breaches of the rock structures would be performed during each maintenance cycle.

Maintenance of Disposal Sites - Typically, completion of construction at disposal sites used for marsh creation includes planting of vegetation and gapping of sacrificial dikes to establish hydraulic connections with adjacent waters that provide benefits to aquatic species and other wildlife. Maintenance activities at the disposal sites would include activities needed to maintain the integrity and function of the rock retention structures. The following maintenance is anticipated for those structures:

- River Mile 27.6 to 27.4. Maintenance of foreshore protection would be required every 10 years; 1,900 tons of stone would be placed on the west bank of the canal each year maintenance is required.
- River Mile 26.4 to 25.9. Maintenance of foreshore protection would be required every 10 years after initial construction has ended; 5,320 tons of stone would be placed on the west bank of the canal each year maintenance is required.
- River Mile 25.9 to 24.1. Maintenance of foreshore protection would be required every 10 years; 21,300 tons of stone would be placed on the west bank of the canal each year maintenance is required.
- River Mile 15.6 to 14.0. Maintenance of rock retention would be required every 10 years after initial construction has ended; 18,900 tons of stone would be placed on the west bank of the canal each year maintenance is required.
- River Mile 23.7 to 22.4. Maintenance of foreshore protection would be required every 10 years after initial construction has ended; 11,820 tons of stone would be placed on the east bank of the canal each year maintenance is required.
- River Mile 19.1 to 17.8. Maintenance of foreshore protection would be required every 10 years after initial construction has ended; 3,640 tons of stone would be placed on the west bank of the canal each year maintenance is required.

- River Mile 19.2 to 17.5. Maintenance of foreshore protection would be required every 10 years after initial construction has ended; 19,900 tons of stone would be placed on the east bank of the canal each year maintenance is required.
- River Mile 17.7 to 16.7. Maintenance of foreshore protection would be required every 10 years after initial construction has ended; 13,480 tons of stone would be placed on the west bank of the canal each year maintenance is required.
- River Mile 16.9 to 13.3. Maintenance of foreshore protection would be required every 10 years after initial construction has ended; 42,600 tons of stone would be placed on the east bank of the canal each year maintenance is required.
- River Mile 13.2 to 11.9. Maintenance of foreshore protection would be required every 10 years after initial construction has ended; 15,180 tons of stone would be placed on the west bank of the canal each year maintenance is required.
- River Mile 12.7 to 12.3. Maintenance of foreshore protection would be required every 10 years after initial construction has ended; 5,420 tons of stone would be placed on the east bank of the canal each year maintenance is required.

4.10 Risk and Uncertainty

Areas of risk and uncertainty are analyzed and described so that decisions can be made with knowledge of the degree of reliability of the estimated benefits and costs and of the effectiveness of alternative plans. Areas of risk and uncertainty are described in Table 4-38.

Table 4-38. Areas of Risk and Uncertainty

Area of Concern	Likelihood	Potential Impacts	Mitigation Measures
Relative Sea Level Rise	High	Marginal	Operation of Houma Lock*
Fluctuating Costs	Moderate	Low	Development and Use of Risk Based Contingency for Costs and Schedule

* Operation of lock described in Final Morganza to the Gulf EIS (USACE, 2013)

4.10.1 Sea Level Rise Considerations

Based on sea level guidance contained in EC 1165-2-111, dated July 2009, feasibility scope level sea level rise rates were determined for historical, intermediate, and high. Based on estimated completion of the Houma Lock, construction is estimated to end in 2026 and maintenance is estimated to end 50 years later in 2076. Estimated sea level changes for the years 2051 and 2076 are shown in Tables 4-39 and 4-40. The year 2051 can be used to represent year 25 for the Houma Navigation Canal study and the year 2076 can be used to represent year 50. The increase in water level elevation as a result of sea level rise will not affect future navigation or maintenance of the Houma Navigation Canal since the depth of the canal is to be constructed and maintained as measured from the water surface. Design heights for the bank protection structures would be examined during maintenance cycles at years 10, 25, and 40 and can be adapted to sea level rise, as necessary. Design height for creating marsh areas would also be considered during future maintenance dredging cycles.

Table 4-39. Sea Level Rise in 2051 (Year 25)

Sea Level Rise Case	Sea Level Rise in feet
Historic	1.05
Intermediate	1.33
High	2.22

Table 4-40. Sea Level Rise in 2076 (Year 50)

Sea Level Rise Case	Sea Level Rise in feet
Historic	1.68
Intermediate	2.28
High	4.18

4.10.2 Areas of Resolved Controversy

For the HNC project to be consistent with the MTG project, it was decided to use the three sea levels that were calculated for the MTG project based on the new sea level guidance contained in EC 1165-2-111, dated July 2009. The three rates include the historical rate of 2.56 ft/100 yrs (15 inches over the project life), the intermediate rate of 3.76 ft/100 yrs (28 inches over the project life), and the high rate of 7.60 ft/100 yrs (51 inches over the project life). The intermediate rate will be used during the project analysis and during the selection of the TRP. Most of the economic benefits for a navigation project are on the front end where there will be minimal change due to sea-level rise.

Because this project will not be constructed in the next year, an updated T&E review will have to occur no more than a year before construction begins and be coordinated with USFWS and NMFS, and an updated HTRW review will have to occur no more than a year before construction begins.

A demonstration project could be proposed, based on WRDA Implementation Guidance dated 10 July 2009, for Louisiana Coastal Area, Sections 7001–7008, and 7011 of Title VII of the Water Resources Development Act of 2007. This proposed demonstration project would comprise features for beneficial use of maintenance dredged material from the Houma Navigation Canal. The demonstration would resolve an issue of engineering uncertainty regarding the efficacy of creating small cells as disposal locations within the open water environment of Terrebonne Bay and the bay side of East Island. The demonstration project could also verify conclusions on transport pathways from a 2007 study that would have direct impact on the selection of disposal location for the constructions of the HNC deepening and maintenance events in the future.

4.10.3 Areas of Unresolved Controversy

Decisions shall be made with knowledge of the degree of reliability of the available information; recognizing that even with the best available engineering and science, risk and uncertainty will always remain. Risks and uncertainties shall be identified and described in a manner that allows the public and decision makers to understand. This includes quantifying and describing the nature, likelihood, limitations, and magnitude of risks and uncertainties associated with key supporting data, projections, and evaluations for competing alternatives. Climate change represents persistent uncertainty that should be addressed in the planning process. The increased variability in temporal and spatial patterns of precipitation and water availability will challenge water systems serving all human needs.

Disposal of maintenance dredged material is proposed to be at the disposal locations identified for material placement which is evaluated in this report. Any changes in disposal of material generated through maintenance dredging would be addressed in future NEPA documents as necessary.

Maintenance of Rock Dikes and Containment Dikes - Maintenance of the rock placed along both the HNC and disposal containment sites are expected due to settlement and subsidence. Accordingly, three maintenance cycles have been included for these reaches. The first maintenance cycle would be in years 10 and 11, the second in years 20 and 21, and the third in years 30 and 31, until year 51. Rock placement and repair of any failures or breaches of the rock structures would be performed during each maintenance cycle.

Other areas of risk and uncertainty are addressed in the Cost and Schedule Risk Analysis in Appendix N.

5.0 AFFECTED ENVIRONMENT

This process includes reviewing the study area conditions and problems, needs, and opportunities to establish specific planning objectives and constraints that provide the focus in developing alternative plans.

This section presents information describing the navigation and socioeconomic, physical, and environmental conditions of the study area. The Affected Environment section describes the existing environmental resources of the study area that would be affected if any of the alternatives were implemented. This section, in conjunction with the description of the No-Action Alternative, forms the baseline conditions for determining the environmental impacts of the reasonable alternatives. The future without project conditions forms the basis from which alternative plans are formulated and impacts are assessed. Under the future without project conditions there would be no Federal action to address the navigation concerns. Within the study area there are economic, physical, environmental, and cultural and historic changes underway that will likely impact future conditions.

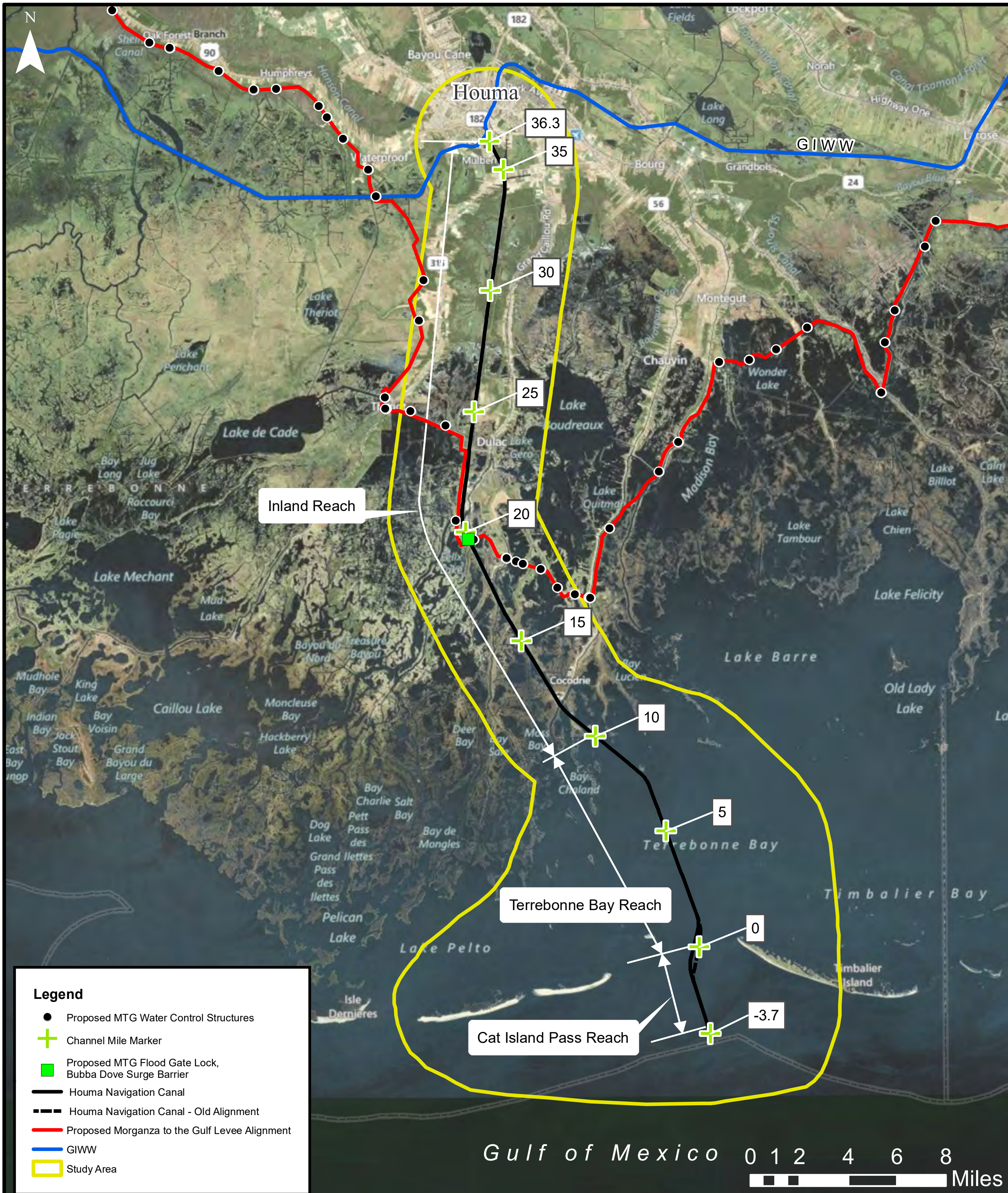
5.1 Environmental Setting of the Study Area

5.1.1 Description of the Study Area

The study area is located in Terrebonne Parish in southeast Louisiana at the northern edge of the Gulf of Mexico (Figure 5-1). The city of Houma and the towns of Boudreaux, Dulac, Theriot, Mulberry, Crozier, and Cocodrie are within the study area. The HNC runs approximately 41 miles from Houma, Louisiana, to the Gulf of Mexico. The study area extends 3 miles from each bank of the HNC, or 3 miles beyond the outer edge of the placement areas, whichever is further.

The project area is within the Barataria-Terrebonne estuary. This estuary extends from the west bank levees of the Mississippi River (north and east), to the east guide levee of the Atchafalaya River (west), to the Gulf of Mexico (south), to the town of Morganza (north). The study area lies within the southern end of the Terrebonne Basin and contains a complex of habitat types, including natural levees, lakes, swamps, marshes, and bayous formed from sediments of abandoned Mississippi River deltas. The Terrebonne Basin covers an area of nearly 2.1 million acres and the Barataria Basin covers nearly 1.6 million acres.

Waterways within, or influencing, the study area include the HNC, GIWW, Atchafalaya River, Bayou du Large, Bayou Grand Caillou, Bayou Petit Caillou, and Falgout Canal (Figure 5-2). There are no scenic streams in the study area designated under the Louisiana Natural and Scenic River System. The HNC generally runs north and south, curving to the southeast at about river mile 20. The GIWW generally follows an east-west path, intersecting the HNC in the northern portion of the study area. Other significant water features within the study area include Lake Boudreaux, Lake Pelto, Lake Barre, Terrebonne Bay, and Timbalier Bay. In addition to these



STUDY AREA MAP

Houma Navigation Canal Deepening

ERSI Basemap - Bing Maps Hybrid

GEC

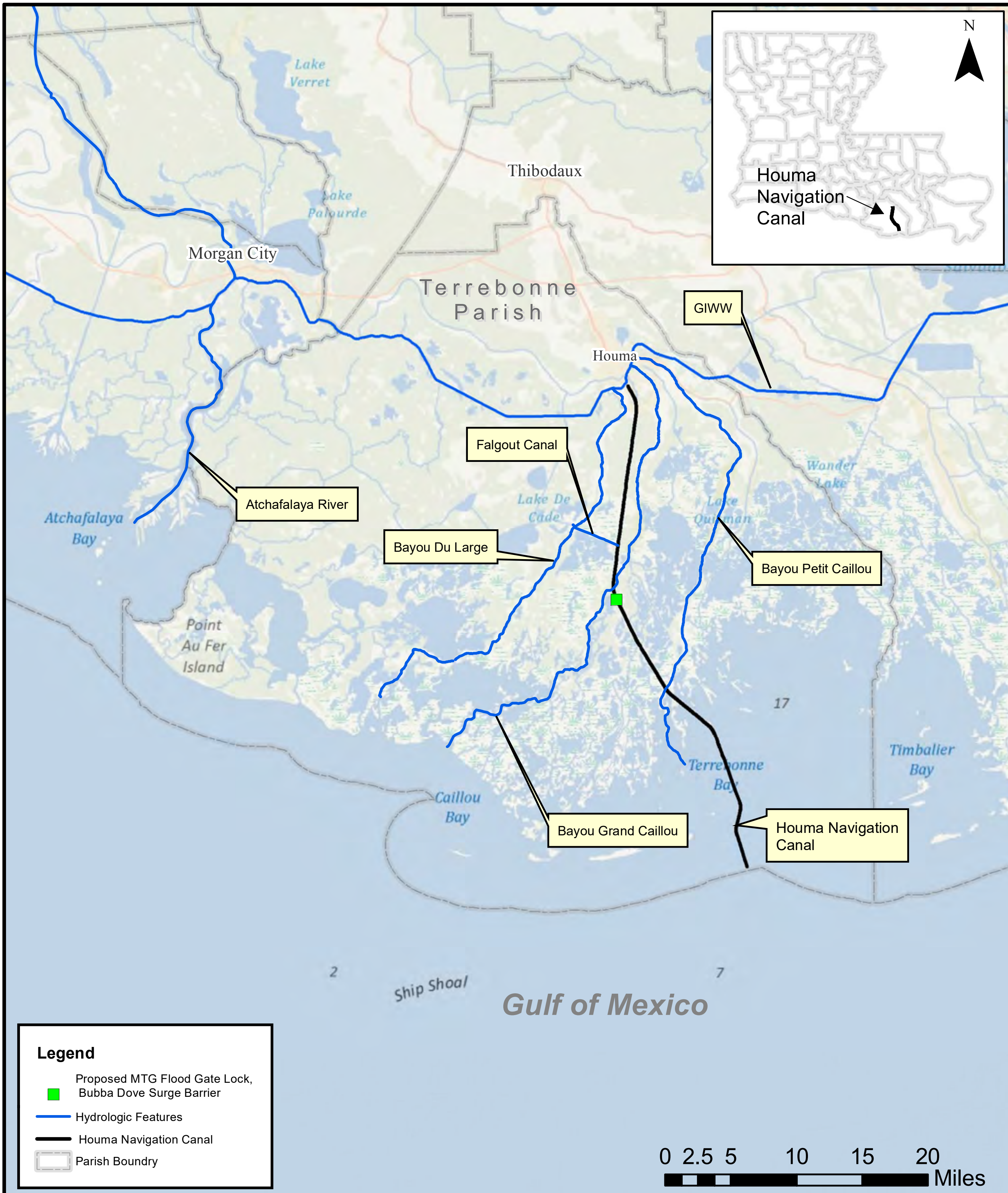
Figure 5-1

Date: October 2012

Scale:1:350,000

Source: ESRI/GEC

Map ID: 278500218-3026



HYDROLOGIC FEATURES

Houma Navigation Canal Deepening

ERSI Ocean Map

GEC

Figure 5-2

Date: October 2012

Scale:1:650,000

Source: ESRI/GEC

Map ID: 278500218-3026

major water features, natural bayous, manmade canals, pond, lakes, and bays are located within the study area. Elevations in the study area vary from about 10 feet NAVD88 near Houma, to 4 to 5 feet NAVD88 along the bayou ridges, to less than 1 foot NAVD88 along the southern portion near the Gulf. In addition to natural ridges in the study area, the Morganza to the Gulf (MTG) Project is also in the area (Figure 5-1). The MTG Federal Plan includes 98 miles of levees, 23 environmental water control structures, and 22 navigable structures, including the HNC floodgate and lock complex. The 1 percent Annual Exceedance Period (AEP) storm surge risk reduction (100-year) levee elevations vary from approximately 9 to 15 feet National Geodetic Vertical Datum (NGVD) (approximately 8.5 to 14.9 feet NAVD88). The HNC floodgate and lock complex is shown in Figure 5-3.

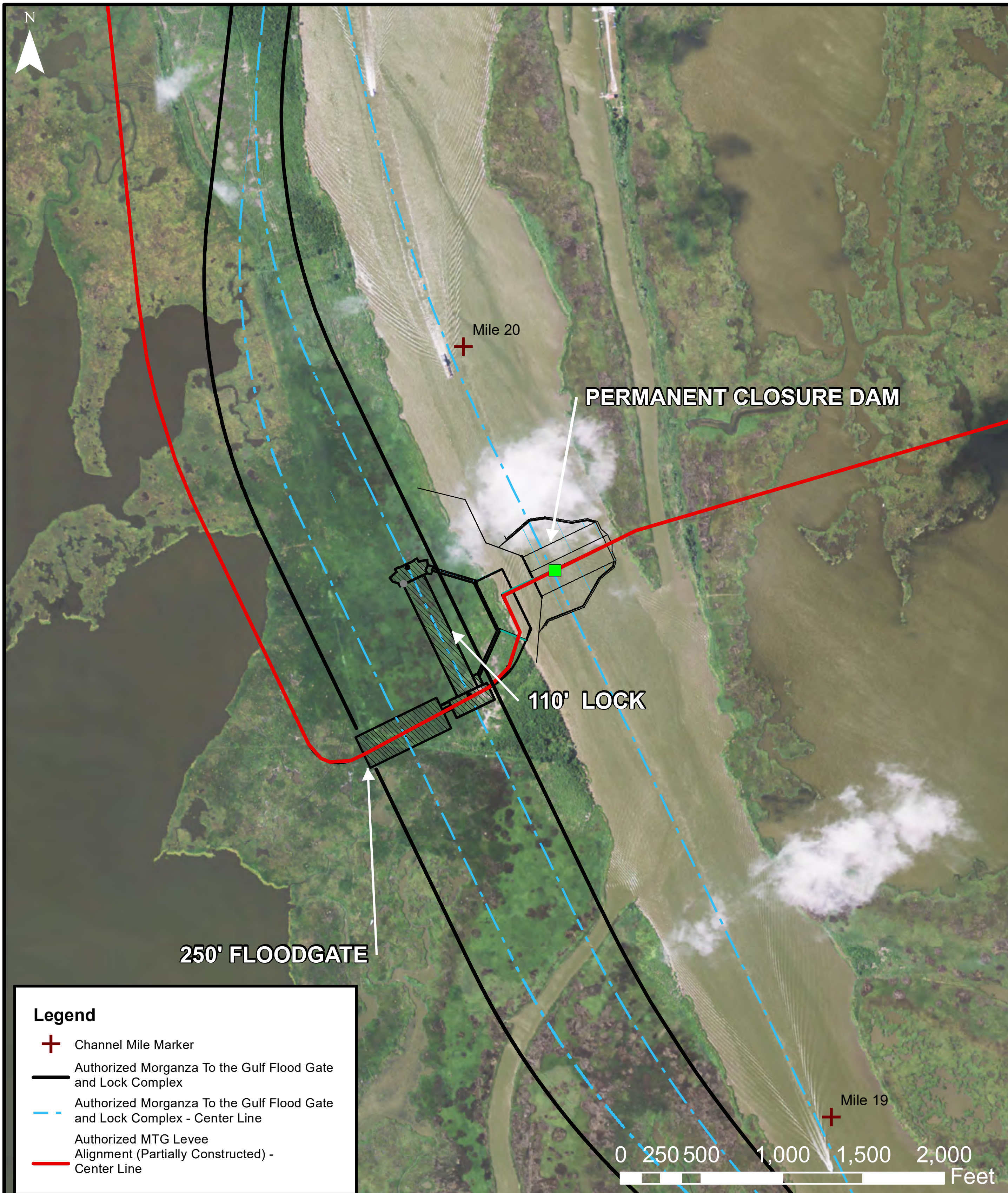
5.1.2 Navigation

The HNC is part of a commercial waterway network that is primarily oriented to support domestic offshore oil and gas exploration and production in the Gulf. The HNC also supports commercial fishing vessels and local commerce; however, most commercial waterway traffic is related to the offshore oil and gas sector. The Houma area is regarded as a central location for the provision of offshore oil and gas equipment and services because of its skilled workforce and proximity to traditional industry supply chains domiciled at the ports of New Orleans and Fourchon. The Port of Terrebonne is located on the HNC in Houma and works in conjunction with Port Fourchon, which currently services half of the platforms operating in the Gulf and is projected to serve 47 percent of pending future deepwater plans (Appendix D).

Waterborne Commerce Statistics (WCS) cargo tons for the HNC are largely related to offshore oil and gas activity (USACE Navigation Data Center; Table 5-1). The historical trend between 1995 and 2004 for HNC-reported cargo tons was uneven to flat. However, beginning in 2005 there was a relatively large increase in waterborne tonnage, primarily due to increases in petroleum, and to a lesser extent crude materials, with a total annual cargo tonnage over 0.8 million tons in 2005 and 2006, declining to 0.621 million tons in 2007 and then returning to levels seen in 2005 and 2006, greater than 0.8 million tons in 2008. Traffic declined after 2008 ranging around 0.4 million tons through 2012 and thereafter increasing to 0.6 million tons in 2013.

Numerous navigation-related businesses in the Houma area support offshore Gulf oil and gas industries through ship building, repair, and the provision of offshore supply equipment and materials. Unfortunately, vessels are limited by the HNC −15-foot channel depth, which causes transportation delays, rerouting, and light loading, resulting in higher transportation costs for local navigation-related businesses (see Problems in Section 3.3).

Shoaling and Maintenance Cycles – The USACE was authorized to maintain the HNC in 1964; historic dredging is shown in Appendix A, Table A-23. The Inland Channel reaches have generally been dredged every 10 years, and the Terrebonne Bay and Cat Island Pass reaches have been dredged every two years. Although it is not shown separately, maintenance dredging in the Port of Terrebonne area has occurred about every five years. The Terrebonne Bay Reach has historically been considered



Authorized Morganza To the Gulf Flood Gate and Lock Complex

Houma Navigation Canal Deepening

ERSI Basemap - Bing Map Hybrid

GEC

Figure 5-3
Date: August 2012
Scale:1:10,000
Source: ESRI/GEC
Map ID: 278500218-3026

Table 5-1. Houma Navigation Canal Commodities, 1995-2013
(in 1,000 tons)

Commodity	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Petroleum and petroleum products	364	462	426	383	322	319	444	302	266	442	821	844	621	823	477	411	404	382	606
Chemicals and related products	2	0	0	0	0	3	0	0	0	0	0	0	0	1	0	0	0	0	2
Crude materials, inedible except fuels	228	79	38	32	22	78	79	92	133	112	200	184	205	165	138	29	57	85	116
Primary manufactured goods	23	30	55	28	5	4	2	3	4	11	4	2	5	6	3	3	2	1	5
Food and farm products	62	28	0	19	13	2	0	2	2	1	0	0	0	0	1	0	0	0	0
All manufactured equipment, machinery, and products	8	13	6	14	34	6	6	4	0	14	1	1	14	2	1	3	0	3	3
Total waste and scrap nec	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0
Unknown or not elsewhere classified	0	0	0	0	0	0	0	0	20	20	0	0	0	0	0	0	0	0	0
Total	**687**	**612**	**525**	**476**	**396**	**412**	**531**	**404**	**426**	**600**	**1026**	**1031**	**845**	**997**	**621**	**446**	**463**	**471**	**732**

Source: Waterborne Commerce Statistics.

to be from Mile 0.0 to 10.1. However, the portion up to Mile 11.0 is currently maintenance dredged about every two years. As land loss continues and the bay encroaches inland, shoaling rates in the bottom portion of the Inland Reach have increased.

Shoaling of the Inland Reach channels results primarily from material eroding from banks; this is a relatively gradual process. The major cause of shoaling in the Terrebonne Bay and Cat Island Pass areas is littoral drift movement during major storms and hurricanes. Major storms and hurricanes could transport material historically placed in the Ocean Dredged Material Disposal Site (ODMDS) back into the navigation channel. Cat Island Pass was relocated westward into deeper water to reduce maintenance dredging and Rosati (2008) recommended realigning the pass westward to reduce shoaling to mitigate for the likelihood of increased shoaling rates due to the deepening and channel lengthening.

Each HNC reach is subject to different physical factors affecting the maintenance volumes per cycle and the frequency of the maintenance dredging cycle. Bank erosion is the primary source of sediments on the Inland Reach. The predominant cause of bank erosion is wave action by vessel traffic. In Terrebonne Bay, wind and wave action suspends bottom sediments and contributes to filling the channel. The Cat Island Pass Reach is subject to more external forces. The primary source of sediment in Cat Island Pass Reach is generally from the east, by erosion of the Lafourche headlands and transport along Timbalier Island. Transport pathways east of the channel are expected to continue.

The frequency of required maintenance dredging in the Terrebonne Bay and Cat Island Pass Reaches is influenced by the proximity, strength, and number of tropical storms.

5.2 Geomorphic and Physiographic Setting

Geomorphic and physiographic conditions relevant to this study include the geology, subsidence, and soils characteristics pertinent to the establishment of the HNC for navigation from Houma, Louisiana to the Gulf of Mexico.

5.2.1 Geology

The geology of the area is heavily influenced by the Mississippi River and its Deltaic Plain, a complex of abandoned and active deltas of the Mississippi River. Three of four abandoned delta complexes shaped Terrebonne and Lafourche Parishes as sediments were deposited on the Pleistocene Prairie. The Mississippi River laid down sediments from 100 to 200 meters (m) thick at each delta (Penland *et al.* 1988). The abandoned deltas were formed generally from the west to the east in chronological sequence starting about 9,000 years before present and ending less than 100 years ago (Sevier 1990).

After delta abandonment occurs, sediments slowly deteriorate as they subside under their own weight. In addition, sea level has been rising throughout this time by about 5 to 8 m (Mossa *et al.* 1990). Historically, the cycle of delta growth and destruction took about 5,000 years (Gosselink and Sasser 1991). However, because of a variety of factors (most notably human), delta destruction is occurring over a few human generations rather than thousands of years.

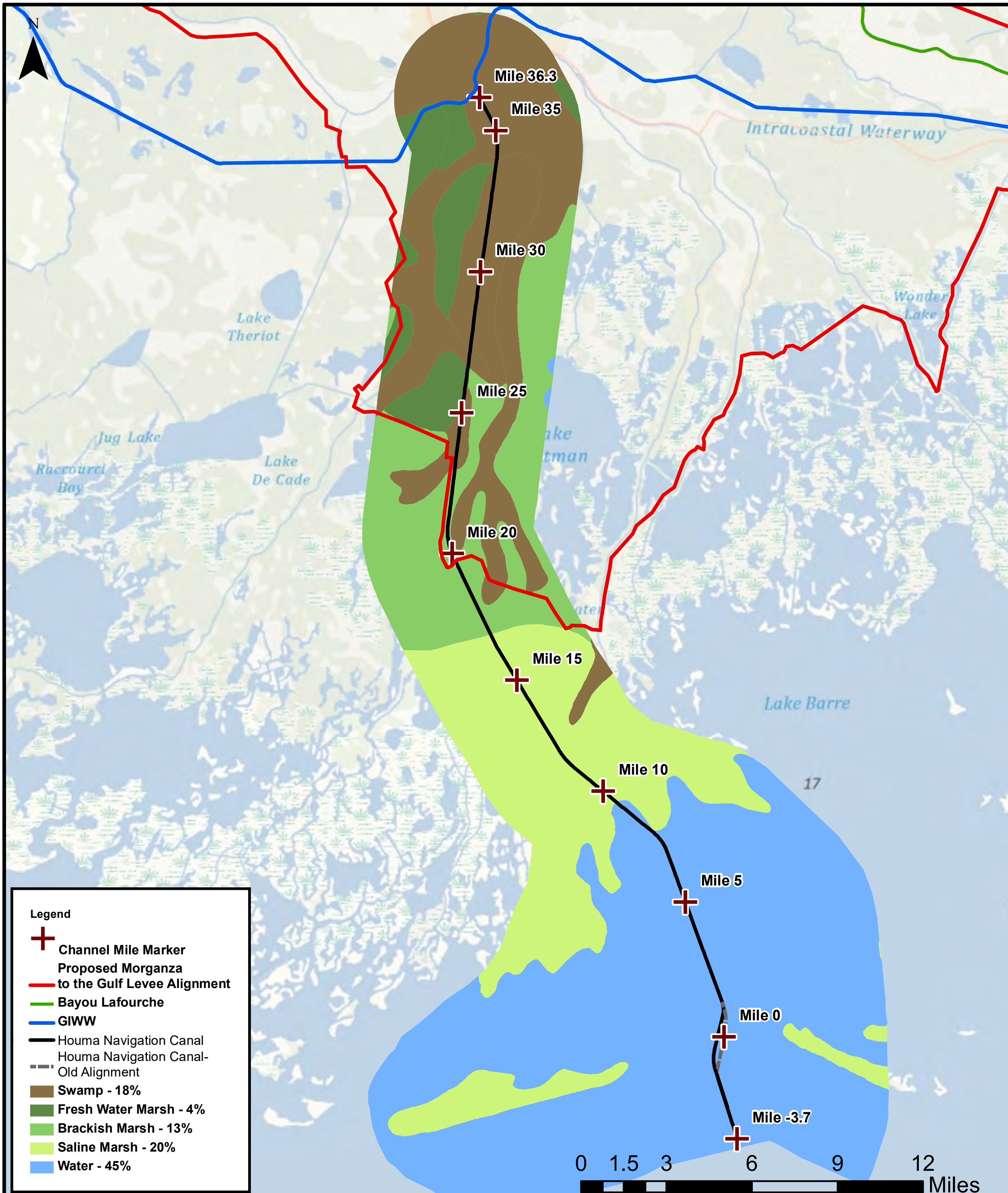
According to Turner (1990), the driving factors in landscape changes include sea level rise, geological compaction, a 50 percent reduction in sediment supply from the Mississippi River since the 1950s, and hydrologic changes. Delaune *et al.* (1994), Kuecher (1994), and Gagliano (1999) conclude that geological factors, such as consolidation of deltaic sediments and active faulting, appear to be the underlying cause for most of the land loss in coastal Louisiana. Hydrocarbon withdrawals may also be a significant factor by activating faults that lead to subsidence (White and Morton 1997).

5.2.2 Soils

Soils are a critical element of coastal habitats because they support vegetation growth and open-water benthic productivity. The study area lies entirely within the south-central region of the Mississippi River Delta Plain. It falls within two major land resource areas (MLRAs), MLRA 131 (Southern Mississippi River Alluvium) and MLRA 151 (Gulf Coast Marsh). Approximately 18 percent of the study area is classified as backswamps (MLRA 131), approximately 37 percent as intermediate, brackish or saline marsh (MLRA 151), and the remaining 45 percent as open water (NRCS 2012). Soils formed from sediments deposited by former channels of the Mississippi River and its distributaries on the Atchafalaya and Lafourche Delta Complex. The surface and shallow subsurface in the study area is composed of natural levees, marsh, swamp, interdistributary and abandoned distributary deposits.

Natural levee deposits are found adjacent to several distributaries that dissect the study area and are generally composed of oxidized clays, silts, and silty clays with relatively low water contents and higher compressive strengths than the surrounding environments. The lower portions of the natural levees are formed by Sharkey and Schriever soil associations (Figure 5-4). These soils are black to dark gray on the surface and have higher clay material and organic matter content than soil associations on the highest portions of the natural levees. They are subject to rare or occasional flooding, and support bottomland vegetation. The highest parts of the natural levees along the bayous contain soils of the Commerce and Cancienne-Gramercy associations. These level, somewhat poorly drained and poorly drained brown to grayish brown soils have a loamy or clayey surface layer and clayey subsoil or are loamy throughout and rarely flood. In some areas narrow, loamy, natural levee ridges extend south into the Gulf Coast Marsh and are subject to occasional flooding during tropical storms.

Marsh soils cover a large portion of the study area. This association is frequently flooded and occurs over a broad plain about level with the Gulf of Mexico between the ridges. Marsh soils, including fresh, brackish and saline areas, generally have a semifluid peat or muck surface layer, up to four feet thick, over alluvial clays and silty clays. Soil associations include Allemands-Kenner-Larose, Clovelly-Lafitte-Bancker, and Scatlake-Timbalier-Bellpass. These soils are generally too wet and soft for agricultural uses. The organic content of the marsh soil decreases as conditions move from fresh to saline. Fresh marsh soils generally contain about 52 percent organic matter, whereas saline soils contain only 18 percent (Chabreck 1982).



GENERALIZED SOILS

Houma Navigation Canal Deepening

Data Sources: ESRI Ocean Basemap and STATSGO Soils

GEC

Figure 5-4

Date: October 2012

Scale:1:300,000

Source: ESRI/STATSGO/GEC

Map ID: 278500218-3031

Soils in the swamp soil association are usually wet and frequently flooded. These soils, identified primarily as Schriever-Fausse-Barbary soils, are level, very poorly drained soils with a mucky or clayey surface layer and a clayey subsoil. Swamp deposits are found at the surface, as thick as 17 feet, and interbedded within interdistributary deposits throughout the study area. A laterally extensive layer of swamp deposits is found at approximately -35.0 feet between Miles 19.0 to 12.5 and Miles 11.4 to 7.5. This layer of deposits is about 5 to 10 feet thick. Swamp deposits have soft to medium fat clays with organic material and wood. Swamp deposits are also found at approximately -70.0 feet and extend to the bottom of the soil borings. Deeper swamp deposits are medium to stiff, fat clays with relatively high strength, organic material, and wood.

Interdistributary deposits are found at the surface throughout the study area. Where penetrated, interdistributary deposits extend down to -750 feet NAVD88. Interdistributary deposits are fat and lean clays with lenses and layers of silt and silty sand. Substratum sands are located beneath interdistributary deposits and swamp deposits and are approximately 100-feet thick. Abandoned distributary deposits are found in the northern half of the study area at Miles 34.1, 23, 20.7, and 19.4. These deposits are generally found at or near the surface down to about -50 to -60 feet NAVD88. They are not laterally extensive. Abandoned distributary deposits consist of silty sands, silts, and clay strata.

5.2.3 Relative Subsidence

Relative subsidence and reworking of the abandoned deltaic deposits are occurring throughout the area. The long-term (over 100 years) relative subsidence rate, calculated using radiocarbon dating of buried peat deposits, is approximately two feet per century (Section 4.10.1). Compaction and dewatering of the thick Holocene deltaic deposits is the major cause of relative subsidence. An additional one foot per century is predicted due to the current rise in eustatic sea level (EPA 1995). The stream gage Bayou Lafourche at Leeville, Louisiana was used to compute the historic subsidence rate in the study area at approximately two feet per century.

5.3 Land Loss

5.3.1 Bank Erosion

Construction of the HNC directly converted 1,838 acres of natural wetland habitats into open water and dredged material banks (Turner and Cahoon 1987; T. Baker Smith 2002). Since construction, the HNC has widened along much of its length and additional land converted to open water. According to original designs, the channel top width ranged from about 200 to 250 feet. The average top channel width has increased from 301 (1965) to 579 (1987) to 666 feet (1998). The channel has widened faster in the southern portion of the study area than in the northern portion and the canal is over 1,000 feet wide in several areas.

The USACE measured the shoreline retreat rate of both banklines every half mile from 1998 and 2005 imagery. Channel bank erosion is apparent in many locations along the HNC Inland Reach (Mile 36.3 to 10.1). The top width was originally 250 feet wide; the canal is now as wide as 450 to 1,000 feet. Historic bank erosion rates were calculated from measurements based on 1998 and

2005 aerial photography. Bank erosion rates varied from 0.0 to 5.3 feet per year (Table 5-2); this equates to approximately 12.9 acres of land loss annually. The difference in rates is primarily due to the institution of shoreline protection projects on portions of the channel.

Table 5-2. Historic Bank Erosion Estimates

Mile	West Bank (feet/year)	East Bank (feet/year)
36.6 to 31.6	2.5	0
31.1 to 26.6	1	2.7
26.1 to 21.6	2.6	2.9[a]
21.1 to 16.6	3.8	0.6
16.1 to 11.6	5.3	1

[a]Erosion rates calculated exclusive of value indicating placement of fill between 1998 and 2005.

Shoreline erosion was evident between 1958 and 1998 in marsh ponds in the southern portion of the study area. In particular, ponds on the western side of the LA Hwy 57 ridge and the west side of the HNC south of Bayou Grand Caillou expanded due to shoreline erosion (an average of about 5.4 feet per year). However, this shoreline erosion is unlikely to be directly related to the HNC because this phenomenon is common across south Louisiana marshes and the erosion is usually attributed to wind-driven waves.

Bank erosion is the result of several factors including sea level rise, subsidence, ship wakes, and wind-driven wave action. The predominant cause of erosion is wave action created by vessel traffic. This wave action affects the existing banks and newly placed dredged material. Light Tugs, Crew Boats and Offshore Supply Vessel trips were 31.9 percent of the boat traffic in a study of boat traffic on the HNC (Appendix A, Annex IV). These classes of vessels produce the largest wakes on the HNC.

5.3.2 Conversion to Open Water

Coastal Louisiana has lost an average of 34 square miles of land, primarily marsh, each year for the last 50 years. From 1932 to 2000, Coastal Louisiana lost 1,900 square miles of land (Coalition to Restore Coastal Louisiana 2011). This land is an important habitat for fish and wildlife; it also provides an indispensable storm buffer for communities, transportation routes, and energy infrastructure. Human activities such as oil exploration have further contributed to the decline of Louisiana's coastal wetlands by deepening and straightening existing water bodies and digging new ones. The introduction of nutria has also been very damaging to Louisiana's wetlands since this invasive species has few natural predators in south Louisiana. The nutria feed on the roots of wetland vegetation, which hold the fragile marsh together. Natural phenomena such as hurricanes, global sea level change (rise), and subsidence have further degraded the wetlands.

Many acres of marsh have converted to open water throughout the Terrebonne Basin. The area has been deprived of the valuable sediments and nutrients from the river since the construction of the Mississippi River levees in the early 18th century. The land loss rate in the Terrebonne Basin was estimated at 9.5 (between 1956 and 1978) and 10.4 (between 1978 and 1988) square miles per year (Fuller *et al.* 1995). Interior loss rates for the placement sites were measured by USGS from 1978 to 2000 imagery (Table 5-3).

Table 5-3. Interior Land Loss Rates for Placement Sites (percent/year)

Site	Interior Land Loss Rate
1, 3	0.00%
12, 12B, 14A, A-07-A	2.40%
7E, 15, 15A	1.98%
16, 19C, 19D	0.41%
20C	0.55%
21, 24, Lung	0.54%

5.4 Climate

The climate of the study area is subtropical marine with long humid summers and short moderate winters. The climate is strongly influenced by the water surface of the numerous sounds, bays, lakes, and the Gulf of Mexico, as well as by seasonal changes in atmospheric circulation. During the fall and winter, the area experiences cold continental air masses that produce frontal passages and falling temperatures; snow is very infrequent. The average annual mean temperature of the area recorded at the NOAA station in Houma was 68.4º F. The mean air temperature from October to March was 59.1º F. During the spring and summer, the study area experiences tropical air masses that produce a warm, moist airflow conducive to thunderstorm development. Summer winds are generally from the south, bringing warm, moist Gulf air, which can produce periods of intense rainfall associated with thunderstorms. The mean temperature from April to September is 76.1º F. The average annual rainfall in Houma is approximately 62 inches; the mean monthly rainfall is 5.2 inches and the highest rainfall typically occurs from July through September (NOAA 2014a).

The study area is susceptible to tropical waves, tropical depressions, tropical storms, and hurricanes. Historical data from 1899 to 2012 indicate that 32 hurricanes and 43 tropical storms have made landfall along the Louisiana coastline (NOAA 2014b).

The largest recent hurricanes were Katrina and Rita in 2005 (Category 3), Gustav and Ike in 2008, and most recently, Isaac in 2012, which resulted in substantial coastal land loss in the vicinity. Overall marsh loss (i.e., conversion to open water) resulting from Katrina and Rita throughout the entire Mississippi Deltaic Plain of southeastern Louisiana was as follows: fresh marsh (22 square miles); intermediate marsh (49 square miles); brackish marsh (18 square miles); salt and marsh (27 square miles) (USGS 2006).

The area of marsh lost along the Louisiana coast as a result of Hurricanes Katrina and Rita (192,000 acres) was over a third of the total wetland losses predicted to occur by the year 2050 by the Coast 2050 Report (LCWCRTF and WCRA 1998). In the Terrebonne Basin, roughly 12,160 acres of wetlands were converted to open water between 2004 and 2005 (Barras 2006), equal to 8.4 percent of the losses predicted to occur by 2050. Hurricane Isaac caused serious marsh erosion in Terrebonne Parish, although many marshes in the area were dying off (brown marsh) prior to the hurricane.

5.4.1 Climate Change

USACE Engineering Circular 1165-2-212 requires consideration of impacts of sea level change on all phases of USACE Civil Works programs and provides guidance for incorporating the direct and indirect physical effects of projected future sea-level change in managing, planning, engineering, designing, constructing, operating, and maintaining USACE projects. It is important to distinguish between eustatic and RSLR. RSLR consists of eustatic or regional sea level rise combined with subsidence. Eustatic sea level rise is defined as the global increase in oceanic water levels primarily due to changes in the volume of major ice caps and glaciers, and expansion or contraction of seawater in response to temperature changes. Regional sea level rise may differ slightly from eustatic sea level rise in large, semi-enclosed water bodies like the northern Gulf of Mexico. Regional sea level rise in the project area was determined to be approximately 1.77 feet per century, when evaluated over the study period. Subsidence is the decrease in land elevations, primarily due to the consolidation of sediments, faulting, groundwater depletion, and possibly oil and gas withdrawal. Subsidence in the project area was calculated using the closest long-term gage, located at Bayou Lafourche at Leeville, Louisiana, and was determined to be approximately two feet per century (Intermediate Level of RSLR).

5.5 Human Environment

5.5.1 Population and Housing

The population of Terrebonne Parish has steadily increased over the last three decades. Historic population figures for Terrebonne Parish and neighboring communities in the study area are presented in Table 5-4. Between 2000 and 2015, the population of the parish increased by 9,469 residents (from 104,503 to 113,972).

Housing trends in Terrebonne Parish have paralleled the population growth. Between 2000 and 2015, an additional 4,435 housing units (from 39,928 to 44,363) were added in the parish (U.S. Census Bureau).

Table 5-4. Population of Communities in the Study Area, by Year

Community	Year					
	1980	1990	2000	2006-2010	2012	2015
Terrebonne Parish	94,393	96,982	104,503	111,131	111,590	113,972
Houma	32,602	30,495	32,393	33,727	33,707	34,287
Dulac	N/A	3,273	2,556	1,463	1.133	1,088
Cocodrie (Chauvin)	3,338	3,375	2,925	2,192	3,280	2,945

Sources: U.S. Census Bureau, 1980, 1990, 2000, 2010 Decennial Censuses; 2006-2017 American Community Survey; N/A=Not Available.

Houma is the parish (county) seat of Terrebonne Parish and is the largest city in the study area. The local government of Houma has been absorbed by the parish and is now run by the Terrebonne Parish Consolidated Government. The population of Houma was 33,727 during the 2010 census, an increase of 1,334 over the 2000 population (32,393); the estimate for 2015 is 34,287. Dulac is a census-designated place (CDP) in Terrebonne Parish; the population was 1,463 during the 2010 census, a decrease of 1,093 from the 2000 census (2,556); the estimate for 2015 is 1,088. Cocodrie is an unincorporated community and its population is recorded with the town of Chauvin. The population of Chauvin was 2,925 during the 1990 census and 2,192 in 2010, a decrease of 733; the estimate for 2015 is 2,495. The population of Terrebonne Parish is 69.7 percent white, 18.4 percent black, 5.3 percent Native American, and 0.9 percent Asian (U.S. Census Bureau 2013; U.S. Census Bureau 2014a, U.S. Census Bureau 2014b; U.S. Census Bureau 2014c; U.S. Census Bureau 2017).

5.5.2 Employment, Business, and Industrial Activity

Economic activities in the project area include sugarcane harvesting, oil and gas production, the transport of these resources, the construction and maintenance of oil rigs, commercial and recreational fishing, and hunting. Education, health, and social services employ the largest number of workers in Terrebonne Parish, followed by the retail trade (Table 5-5). The city of Houma was originally a market center for agricultural (primarily sugarcane), fish, and wildlife production. The growth of the oil and gas support industry greatly increased employment and income opportunities in the area. Employment and income increased between 2000 and the 2008-2012 periods. Unemployment declined and per capita personal income and median household income improved (Table 5-6).

5.5.3 Commercial Fishing

Commercial fishing for fish and shellfish is important to the economy of the project area. In 2012, Louisiana's fishery landings were over 856 million pounds (over $309 million dockside value) (NMFS 2014a). Fishery landings in 2012 at ports in, or near, the study area were: Dulac-Chauvin with 42.63 million pounds ($64 million dockside value) and Golden Meadow-Leeville with 17.1 million pounds ($25.9 million dockside value) (NMFS 2014a).

Table 5-5. Business and Industry in Terrebonne Parish in Recent Years

Business and Industry	Year	
	2000	2008-2012
Education, Health, and Social Services	7,988	8,999
Retail Trade	5,362	5,716
Construction	3,248	3,689
Manufacturing	3,437	4,520
Agriculture	4,916	6,741

Sources: U.S. Census Bureau, 2000 Decennial Census; 2008-2012 American Community Survey. http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=bkmk

Table 5-6. Employment and Income Characteristics for Terrebonne Parish

Employment and Income	Year	
	2000	2008-2012
Employed	41,406	49,207
Unemployed	2,602	3,425
Per capita person	$16,051	$23,885
Median household income	$35,235	$65,038

Sources: U.S. Census Bureau, 2000 Decennial Census; 2008-2012 American Community Survey. http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=bkmk

Most shellfish landed in Louisiana in 2012 were brown and white shrimp. In Louisiana, nearly 30 million pounds of brown shrimp ($33.2 million dockside value) and over 71 million pounds of white shrimp ($112.5 million dockside value) were landed in 2012 (NMFS 2014). The blue crab is another important Louisiana shellfish. In 2012, over 45.2 million pounds of blue crab was landed in Louisiana, with a dockside value of approximately $42.6 million (NMFS 2014). Soft shell (postmolt) and peeler (pre-molt) blue crab landings in Louisiana made up a smaller percentage of the landings but had a higher price per pound (over 152 thousand pounds with over $432 thousand dockside value, and over 8 thousand pounds with over $46 thousand dockside value, respectively) (NMFS 2014b).

The Eastern oyster is an important resource in the Terrebonne Estuary. Over 11.1 million pounds of oysters were harvested in Louisiana in 2012, with a dockside value of more than $41.5 million (NMFS 2014b). The central coast of Louisiana, including the Terrebonne Estuary, supplies 26 percent of Louisiana oyster landings (Keithly and Roberts 1988). Most oyster leases and seed grounds near the project area are located in Tambour Bay, Bayou Couteau, and Bayou Petit Caillou. Seed grounds are managed by the LDWF to produce a ready supply of seed oysters for placement on private leases for later harvest. Approximately 1,444 acres of active oyster leases are reported within disposal site 21 (9) and the Lung (1,435) (Figure 5-5); no oyster seed grounds are present in the construction footprint.

5.5.4 Public Facilities and Services

Public and quasi-public facilities and services near the project area include schools, hospitals, police and fire protection, an extensive network of pumps and levees for flood protection, and a series of navigation canals, including the HNC and the GIWW. Public facilities and services generally serve residents and recreational visitors. During the threat of less severe hurricanes and flood events, public buildings are occasionally used as temporary shelter for residents who are impacted.

Along the northern portion of the HNC study area, near Houma, sewage treatment is provided by A&E Sewage Treatment Inc. The remaining portion of the study area, from Mile 34 south, is not serviced by a municipal sewer system. Properties within portions of HNC study area not receiving sewer service from private companies use septic systems for treatment and disposal of sewage.

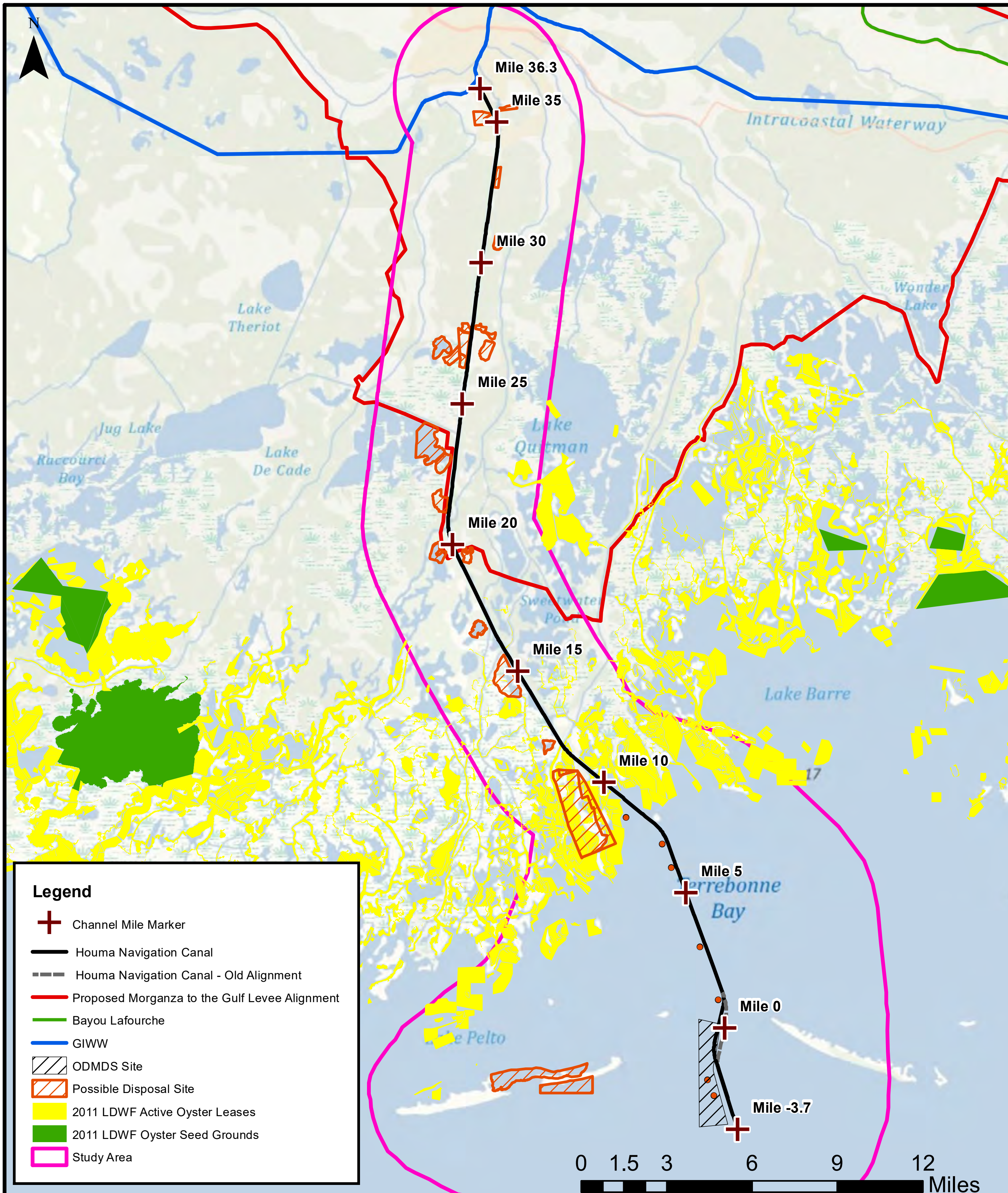
Mail service is provided through both the Houma Post Office north of the project area and the Dulac Post Office located east of channel Mile 23.

5.5.5 Transportation

The transportation infrastructure includes major roads, highways, railroads, and navigable waterways that have developed historically to meet the needs of the public. State and local roads traverse the HNC study area. Traffic is generally confined to residents and recreational visitors. Louisiana Highways 315 and 53 are major roads located west and east of the HNC study area, respectively. Both roads run south from Houma for approximately 15 miles. Falgout Canal Road, which provides access between both LA 315 and 53, crosses the HNC between Miles 23 and 24. Eventually, LA 53 turns east and provides access to LA 56 along Bayou Petit Gaillou. Other roads in the study area are residential or camp access roads, primarily located along both state highways. Other modes of transportation include water transport along the GIWW and the HNC, all of which accommodate ocean-going vessel and barge traffic (Section 5.1.2).

5.5.6 Community and Regional Growth

Community and regional growth primarily tracks population and employment trends that were described in the preceding sections. Table 5-7 shows per capita growth in income since 2005.



ACTIVE OYSTER LEASES AND OYSTER SEED GROUNDS

Houma Navigation Canal Deepening

Data Sources: ESRI Ocean Basemap

GEC

Figure 5-5
Date: October 2012
Scale:1:300,000
Source: ESRI/NRCS/GEC
Map ID: 278500218-3031

Table 5-7. Nominal Per Capita Income in the Study Area

Year	Per Capita Income
2005	$23,781.00
2010	$25,224.00
2014	$23,092.00

Note: Dollar amounts reflect the income in associated year prices.

5.5.7 Tax Revenue and Property Values

Jobs, income, and tax revenue is closely associated with the shipping industry along the HNC. Without sufficient infrastructure in place, businesses and jobs continue to relocate to other areas of the country, resulting in reduced tax income for the region.

Property located within the study area can be categorized as industrial waterfront, residential, marsh, open water, and navigable waterway. Property along the HNC holds the potential for industrial use and therefore, holds a higher potential for property values. However, as the need for industrial use diminishes, so do property values. Private property along the HNC is primarily residential or fishing camps.

5.5.8 Community Cohesion

Community cohesion is based on the characteristics that keep the members of the group together long enough to establish meaningful interactions, common institutions, and agreed upon ways of behavior. These characteristics include race, education, income, ethnicity, religion, language, and mutual economic and social benefits. The area is comprised of communities with a long history and long-established public and social institutions including places of worship, schools, and community associations. The communities of Houma and Dulac, which are located along the HNC, are supported by the shipping industry. A reduction in these types of industries has reduced community cohesion throughout the study area.

5.5.9 Other Social Effects (OSE)

The Hazards and Vulnerability Research Institute at the University of South Carolina created an index that compares the social vulnerability of U.S. counties/parishes to environmental hazards. The variables included in the index are based on previous research which has found that certain characteristics (e.g., poverty, racial/ethnic composition, educational attainment, and proportion over the age of 65) contribute to a community's vulnerability when exposed to hazards. According to the Institute for Water Resources Other Social Effects handbook (USACE, 2008), the Social Vulnerability Index (SoVI®) is a valuable tool that can be used in the planning process to identify areas that are socially vulnerable and whose residents may be less able to withstand adverse impacts from hazards. The SoVI® was computed as a comparative measure of social vulnerability for all counties/parishes in the U.S., with higher scores indicating more social vulnerability than lower scores. Terrebonne Parish has a SoVI® 2006-10 score of -0.85 (0.36 national percentile. Based on this score, Terrebonne Parish is rated as more socially vulnerable than roughly 64 percent of counties/parishes in the U.S. By comparison, Orleans Parish, notorious for its enduring levels of high poverty, has a SoVI® 2006-10 score of 2.46 making it less socially vulnerable than 85 percent of counties/parishes in the nation.

5.5.10 Environmental Justice

Executive Order (EO) 12898 of 1994 and the Department of Defense's Strategy on Environmental Justice of 1995 direct Federal agencies to identify and address any disproportionately high adverse human health or environmental effects of Federal actions to minority and/or low-income populations and/or children. Minority populations are those persons who identify themselves as Black, Hispanic, Asian American, American Indian/Alaskan Native, and Pacific Islander. A minority population is defined when the percentage of minorities in an affected area either exceeds 50 percent or is meaningfully greater than the general population. Minorities comprise 28.7% of the population in the Parish. The poverty line was defined in 2015 as $27,853 in annual income for a family of four in Terrebonne Parish. According to 2011-2016 U.S. Census data, 16.8 percent of individuals in the Parish lived below the poverty line or were underemployed (U.S. Census Bureau 2017).

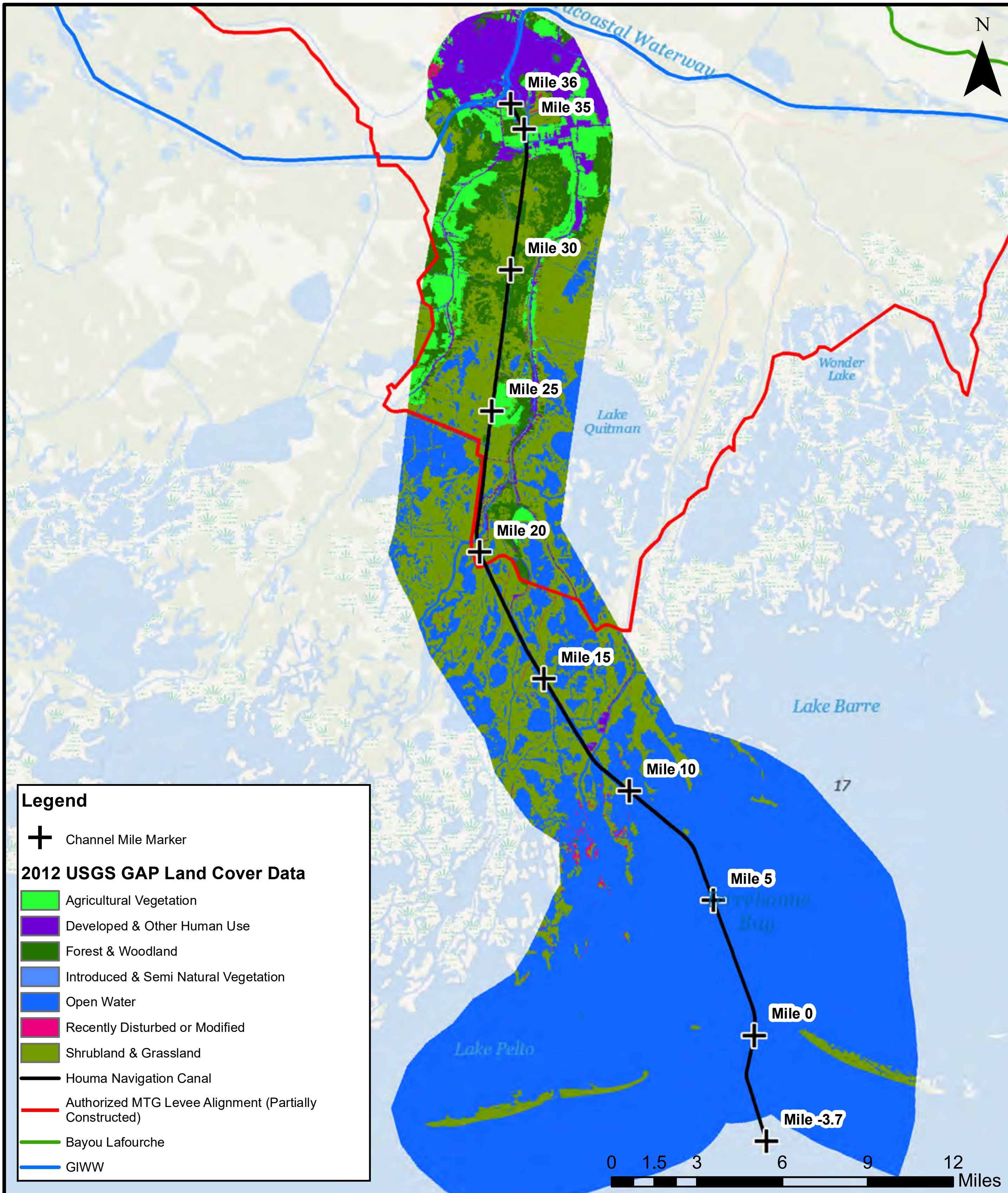
5.6 Natural Environment

This section presents a description of the environmental attributes and environmental resources pertinent to the HNC study area including land use/land cover, habitat change, and prime and unique farmland.

5.6.1 Land Use/Land Cover

Land use in the study area is primarily open water, salt marsh, and a variety of vegetation types common to coastal areas. According to the U.S. Geological Survey (USGS) National Land Cover Database (2012) for the study area, 64 percent of the study area is open water (Figure 5-6; Table 5-8), and includes the HNC, numerous bayous and drainage canals, portions of Terrebonne Bay, and the Gulf.

Approximately 21 percent of the study area is classified as salt marsh, located adjacent to or at the interface of coastal lands with the open Gulf waters. Only about four percent of the study area has been developed. Cultivated crops, primarily sugar cane, cover about four percent of the study area. Flooded swamp habitat, common to the coastal plain, covers about four percent of the study area. Forested areas of woody wetlands (primarily baldcypress/tupelo swamps and bottomland hardwood forest) cover about two percent of the study area. The remaining one percent of the study area is barrier island beaches and coastal prairie habitats (USGS).



LAND COVERAGE DATA

Houma Navigation Canal Deepening

Service Layer Credits: Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors
Sources: Esri, GEBCO, NOAA, National Geographic, DeLorme, HERE, Geonames.org, and other contributors

GEC

Figure: 5-6
Date: February 2017
Scale:1:300,000
Source: ESRI/NRCS/GEC
Map ID: 278500218-3031

Table 5-8. Land Cover in the HNC Study Area

Land Cover Type	Acres	Percent of Study Area
Open Water (Brackish/Salt)	151,338	64%
Salt Marsh	50,352	21%
Developed, Open Space	10,635	4%
Cultivated Cropland	10,018	4%
Swamp	9,206	4%
Forested	3,754	2%
Beach	1,056	0.5%
Coastal Prairie	6	0.5%
Total	236,365	100.00%

Source: National Land Cover Database (USGS 2012) (http://seamless.usgs.gov/nlcd.php).

About 12 percent of the land area in Terrebonne Parish is developed. Approximately 25 percent of the study area has historically been open water (natural lakes and bays), primarily Terrebonne Bay. The remaining study area is approximately 5 percent developed/urbanized, 5 percent bottomland hardwoods, and 90 percent marsh or open water (depending on freshwater and tidal flow). Study area marshes were: saline (40 percent), brackish (20 percent), intermediate (5 percent), and fresh (35 percent).

5.6.2 Habitat Change

The HNC has been suspected of influencing the landscape in other ways, such as allowing salt water to penetrate into freshwater wetlands. Habitat changes are defined as the conversion to other terrestrial habitat types and can be natural and/or manmade. A common feature of a habitat change is the replacement of one vegetative community by another. For example, cypress forests killed by salt water can be replaced by intermediate marsh. Fresh water can eventually convert a brackish marsh into an intermediate marsh.

The extent and distribution of wetland habitats in the study area have changed since the construction of the HNC. In 1949, the boundary between fresh and non-fresh species appears to be the present location of Falgout Canal (O'Neil1949). By 1968, fresh marsh extended south of Falgout Canal (Chabreck and Linscombe 1968). The northern boundaries of brackish and intermediate marshes migrated progressively northward between 1968 and 1988, displacing freshwater marshes in the central portion of the study area. From 1988 to 1997, freshwater marshes replaced intermediate marshes in the central portion of the study area, and the southern boundaries of intermediate and brackish marshes migrated southward. Cypress swamps have been converted to marsh and/or open water in the central portion of the study area. However, 70 percent of the existing cypress swamp was dead or dying within the Falgout Canal Marsh Management Area in 1989 (Bourgeois and Webb 1999).

5.6.3 Prime and Unique Farmland

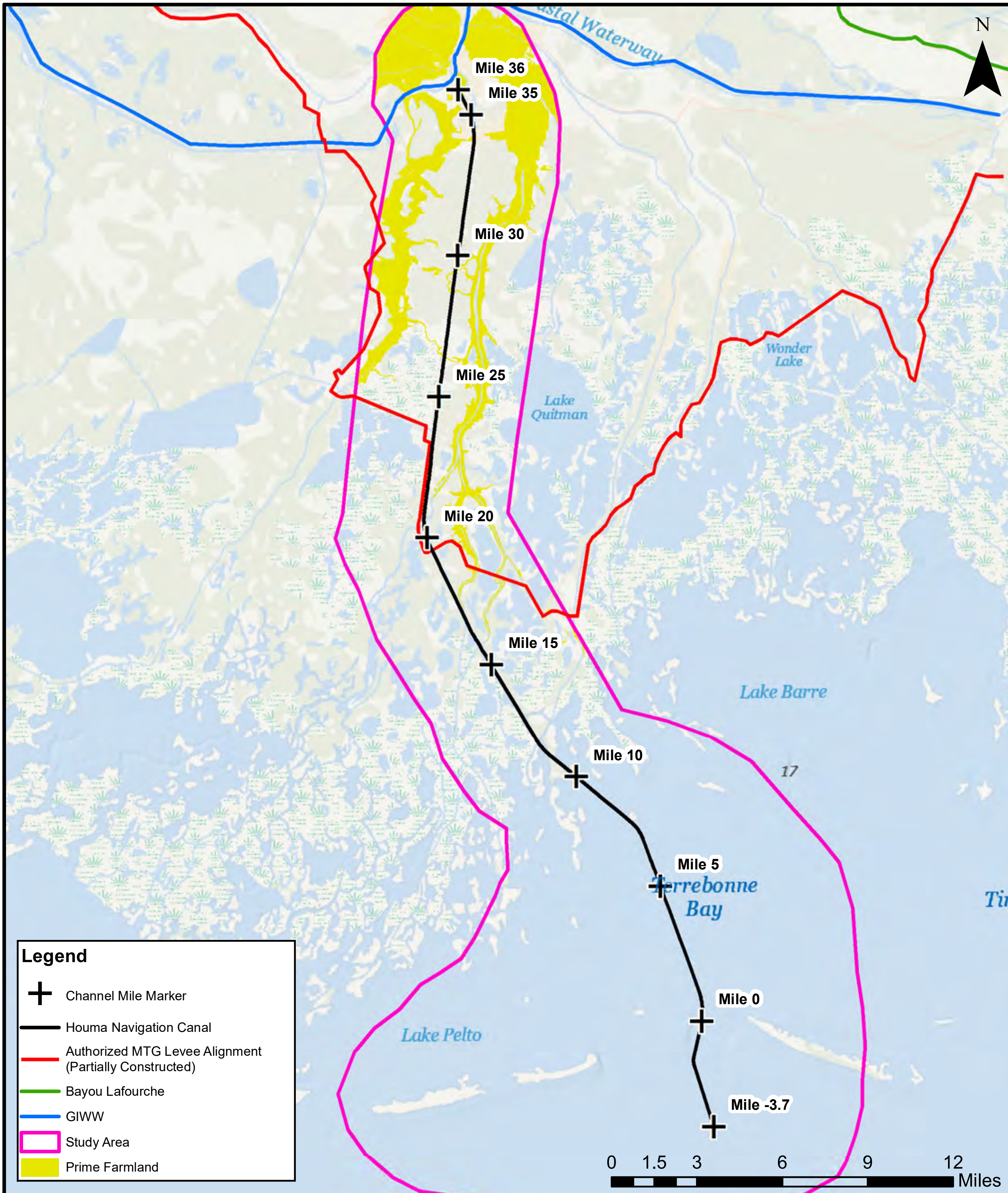
The Farmland Protection Policy Act of 1981 was enacted to minimize the extent that Federal programs contribute to the unnecessary and irreversible conversion of prime or unique farmland to non-agricultural uses. The USDA-NRCS is responsible for designating prime or unique farmland protected by the act. Prime farmland, as defined by the act, is land with the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops that is available for these uses. It can be cultivated land, pastureland, forestland, or other land, but is not urban or built-up land or water areas. Unique farmland is defined by the act as land other than prime farmland that is used for the production of specific high value food and fiber crops, such as citrus, tree nuts, olives, and vegetables.

Based on 2016 NRCS data, approximately 20,965 acres (8.2 percent), of the total study area acreage meet the soil requirements for prime farmland (Figure 5-7). There are no unique farmlands in the study area. Prime farmland within the study area is limited to natural ridge tops and consists of Cancienne silt loam, Cancienne silty clay loam, Gramercy-Cancienne silty clay loams, Gramercy silty clay loam, and Schriever clay soils.

According to the NRCS, nearly all prime farmland acreage in Terrebonne Parish is planted in crops. Sugarcane is the main agricultural crop in Terrebonne Parish; other important crops include corn, soybeans, rice, vegetables, and pasture grasses, such as common bermudagrass, improved bermudagrass, and bahiagrass.

5.6.4 Rare Plant Species and Natural Communities

The Louisiana Department of Wildlife and Fisheries (LDWF)–Louisiana Natural Heritage Program (LNHP) describes rare, unique, and imperiled plant species and vegetative communities in Louisiana. These plants and natural communities are within broader vegetative habitats and contribute to the extensive diversity of the coastal ecosystem, enhance its productivity, and are essential to the stability of the bionetwork. The LNHP lists 16 rare plant species and 9 natural communities in Terrebonne Parish (Table 5-9).



PRIME FARMLAND

Houma Navigation Canal Deepening

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Sources: Esri, GEBCO, NOAA, National Geographic, DeLorme, HERE, Geonames.org, and other contributors

GEC

Figure: 5-7
Date: February 2017
Scale:1:300,000
Source: ESRI/NRCS/GEC
Map ID: 278500218-3031

Table 5-9. Rare Plant Species and Natural Communities of Terrebonne Parish

Common Name or Natural Community	Scientific Name
Arrow-grass	*Triglochin striata*
Big Sandbur	*Cenchrus myosuroides*
Canada Spikesedge	*Eleocharis geniculata*
Coast Indigo	*Indigofera miniata*
Coastal Ground Cherry	*Physalis angustifolia*
Creeping Spikerush	*Eleocharis fallax*
Dune Sandbur	*Cenchrus tribuloides*
Floating Antler-fern	*Ceratopteris pteridoides*
Gulf Bluestem	*Schizachyrium maritimum*
Hairy Comb Fern	*Ctenitis submarginalis*
Millet Beakrush	*Rhynchospora miliacea*
Sand Dune Spurge	*Chamaesyce bombensis*
Sand Rose-gentian	*Sabatia arenicola*
Scaevola	*Scaevola plumieri*
Sea Oats	*Uniola paniculata*
Swamp Milkweed	*Asclepias incarnata*
Coastal Dune Grassland	
Coastal Dune Shrub Thicket	
Coastal Live Oak-Hackberry Forest	
Coastal Mangrove-Marsh Shrubland	
Cypress-Tupelo Swamp	
Freshwater Marsh	
Marine Submergent Vascular Vegetation	
Salt Marsh	
Scrub/Shrub Swamp	

Source: LNHP 2014.

5.7 Aquatic Resources

Benthic Resources - Benthic animals are directly or indirectly involved in most of the physical and chemical processes that occur in estuaries (Day *et al.* 1989). The bottom of an estuary regulates or modifies most physical, chemical, geological, and biological processes throughout the entire estuarine system via the *benthic effect*. The benthic habitat is a storehouse of organic matter and inorganic nutrients and a site for vital chemical exchanges and physical interactions. Benthos generally includes the entire bottom community and its immediate physical environment, termed the *benthic boundary layer* (Day *et al.* 1989). Benthic invertebrates play an important role in transitional ecosystems, by filtering phytoplankton and then acting as a food source for larger organisms such as fish, thereby linking primary production with higher trophic levels. They also structure and oxygenate the bottom by reworking sediments and play a fundamental role in breaking down organic material before bacterial remineralization. In addition, a number of benthic invertebrates, particularly clams, are consumed by humans and others, such as worms, are used for recreational purposes as fishing bait.

The benthic community structure is not static; it provides a residence for many sessile, burrowing, crawling, and some swimming organisms (Day *et al.* 1989). The composition and distribution of the macroinfaunal community (relatively large organisms living beneath the sediment surface) in an area is a function of the response of individual species to factors such as sediment characteristics, salinity regime, position in the intertidal zone, and oxygen levels.

The marsh edge is an important component of the ecosystem, linking the marsh and waterbodies. Marsh edge samples contain detritus and organisms, including a diverse group of detritivores. Most plant biomass dies and decays and its energy is processed through the detrital pathway. A major link in the aquatic food web between plants and predators is formed by the conversion of plant material (formed in primary production) by benthic detritivores and herbivores to animal tissue (Cole 1975). Detritus export and the shelter found along marsh edges make salt marshes important nursery areas for many commercially important fish and shellfish. Primary consumer groups of the benthic habitat include bacteria and fungi, microalgae, meiofauna, and microfauna (Mitsch and Gosselink 2000). Less than 10 percent of the above-ground primary production of the salt marsh is grazed by aerial consumers.

Benthic fauna include infauna (animals living in the substrate, including burrowing worms, crustaceans, and mollusks) and epifauna (animals living on or attached to the substrate; mainly crustaceans, as well as echinoderms, mollusks, hydroids, sponges, and soft and hard corals) (DOI-MMS 2002). Shrimp and demersal fishes are closely associated with the benthic community. Substrate is the most important factor in the distribution of benthic fauna. Estuarine benthic organisms can also be categorized by size: macrobenthic (e.g., molluscs, worms, large crustaceans); microbenthic (e.g., protozoa); and meiobenthic (e.g., microscopic worms and crustaceans) groups (Day *et al.* 1989). Macrobenthic organisms in these areas can be divided into oyster and non-oyster reef assemblages.

Strand biota commonly seen on Gulf barrier island beaches are not residents, but are transient offshore fauna (Britton and Morton 1989). Three groups of strand biota (bottom dwelling, flotsam dwelling, and *Sargassum*-associated) are carried onto the upper beach by high tides and storm waves. Bottom-dwelling strand biota can include shells, sea whips, sea pens, sand dollars, and worm tubes. The flotsam-attached biota includes gooseneck barnacles *(Lepas anatifera)*, marine wood boring isopods, Portuguese man-o-war *(Physalia physalia)*, jellyfish, mollusks, and crustaceans. *Sargassum*-associated strand biota includes *Sargassum* algae. Sessile biota may remain attached to the algae, whereas motile biota may cling to the algae but can exist independently (Britton and Morton 1989).

Plankton Resources - Plankton provide a major, direct food source for animals in the water column and in the sediments (Day *et al.* 1989). Plankton are responsible for at least 40 percent of the photosynthesis occurring on the earth and have an important role in nutrient cycling. Plankton productivity is a major source of primary food energy and are the major source of autochthonous organic matter in most estuarine ecosystems (Day *et al.* 1989).

Plankton communities have an important role in Louisiana coastal waters. There are three groups of plankton: bacterioplankton, phytoplankton, and zooplankton (Knox 2001). Bacterioplankton are microscopic bacteria important in the decomposition of organic material. Phytoplankton include the primary producers of the water column and form the base of the estuarine food web. Zooplankton provide the trophic link between bacterioplankton and phytoplankton and the intermediate level consumers such as aquatic invertebrates, larval fish, and smaller forage fishes (Day *et al.* 1989).

Phytoplankton are tiny, single-cell algae that drift with the motion of water. Diatoms and dinoflagellates are the dominant phytoplankton groups; other important groups include green and blue-green algae. In Louisiana, eutrophic conditions can lead to blue-green algae blooms. Some blue-green algae produce toxins, and large-scale blooms can lead to hypoxia and result in fish kills. Algal blooms tend to occur in fresh or oligohaline waters, with salinities up to 7 ppt. In more saline environments, dinoflagellates have been associated with red tides, which can kill fish and shellfish and can create public health problems through airborne respiratory toxins and shellfish contamination. Although phosphorus is typically the limiting nutrient attributed to algal blooms, phytoplankton production in coastal wetland systems is most likely to be nitrogen limited (Day *et al.* 2001).

Zooplankton include small crustaceans, jellyfishes and siphonophores, worms and mollusks, and egg and larval stages of most benthic and nektonic animals (Rounsefell 1975). Zooplankton are consumed by a variety of estuarine consumers, but are also important in nutrient cycling. Although some members of the zooplankton community are euryhaline, others have distinct salinity tolerances (Hawes and Perry 1978). Freshwater zooplankton are dominated by four major groups: protozoa, rotifers, cladocerans, and copepods. The copepod *Acartia tonsa* is the dominant zooplankton found in the area. Cyclopoid copepods, represented by *Cyclops vermalis, Oncaea meditrranea, Oithona* sp., and *Saphirella* sp. are found during most of the year. Harpacticoid copepods, rotifers, polychaetes, opossum shrimp, isopods, decapod larvae, comb jellies, and sea nettles are also present. Some seasonal patterns of zooplankton abundance in estuaries occur regionally, although there are no clear general patterns (Day *et al.* 1989). The zooplankton of many estuarine waterbodies are dominated by copepods. Copepods and cladocerans are frequently abundant in low salinity waters of Louisiana (Hawes and Perry 1978). Larval crustaceans can be a large component of the zooplankton community.

Fishery Resources - Fishery resources are a critical element of many valuable freshwater and marine habitats. They are an indicator of the health of various freshwater and marine habitats, and many species are important commercial resources. Fishes and macrocrustaceans in the study area are of three general types: freshwater, resident, and transient marine species. Freshwater species generally live in the freshwater portions of the area, although some species can tolerate low salinities. Resident species are generally smaller and do not commonly migrate very far. Marine transient species spend a portion of their life cycle in the estuary, generally spawning offshore or in high-salinity bays, and use coastal marshes as nursery areas (Herke 1971, 1995).

The open water portion of the study area contains a variety of aquatic habitats, including small ponds and lakes, bayous and tidal creeks, manmade canals such as the HNC and GIWW, Terrebonne Bay and other embayments and large lakes, and nearshore Gulf waters. Salinities in the area range from fresh water to saline. Fresh and intermediate waterbodies frequently contain submerged or floating aquatic vegetation; however, inshore brackish and saline waterbodies are typically shallow and turbid with muddy substrate, creating poor habitat for large aquatic plant species. Open water is becoming the dominant habitat type in the study area; much of the open water area has been generated at the expense of emergent marsh.

Salinity and submerged vegetation affect the distribution of fish and macrocrustaceans in coastal marshes. The most abundant species collected in freshwater and intermediate marsh areas adjacent to the project area were residents predominantly associated with submerged aquatic vegetation such as grass shrimp (*Palaemonetes* sp.), sheepshead minnow *(Cyprinodon variegatus)*, rainwater killifish *(Lucania parva)*, least killifish *(Heterandria formosa)*, inland silverside *(Menidia beryllina)*, sailfin molly *(Poecilia latipinna)*, and western mosquitofish *(Gambusia affinis)* (Rogers *et al.* 1992). The most abundant marine transient species collected near the project area included Gulf menhaden *(Brevoortia patronus)*, blue crab *(Callinectes sapidus)*, bay anchovy *(Anchoa mitchilli)*, and striped mullet *(Mugil cephalus)* (Rogers *et al.* 1992).

The most abundant species collected by otter trawling in Lake Barre included brown shrimp *(Farfantepenaeus aztecus)*, Atlantic croaker *(Micropogonias undulatus)*, blue crab, bay anchovy, white shrimp *(Litopenaeus setiferus*), spot *(Leiostomus xanthurus)*, hardhead catfish *(Ariopsis felis)*, sand seatrout *(Cynoscion arenarius)*, brief squid *(Lolliguncula brevis)*, least puffer *(Sphoeroides parvus)*, Gulf menhaden *(Brevoortia patronus)*, gafftopsail catfish *(Bagre marinus)*, and Atlantic bumper *(Chloroscombrus chrysurus)* (Rogers *et al.* 1997 a,b).

The most abundant finfish species collected by LDWF otter trawls from 1998 to 2008 in the Lake Mechant area were bay anchovy, Atlantic croaker, spot, Gulf menhaden, and sand seatrout (USACE 2010). White shrimp, blue crab, and brown shrimp were also collected by otter trawls. LDWF gillnets in the Catfish Lake area frequently collected spotted seatrout *(Cynoscion nebulosus)*, Gulf menhaden, spot, Atlantic croaker, hardhead catfish, and black drum *(Pogonias cromis)*. The most abundant species collected by LDWF seines in Lake Boudreaux were bay anchovy, inland silverside, naked goby *(Gobiosoma bosc)*, Atlantic croaker, and Gulf killifish *(Fundulus grandis)*. Grass shrimp, brown shrimp, blue crab, and white shrimp were also commonly collected in the seines (USACE 2010).

Freshwater and intermediate marshes in and around the project area also provide habitat for freshwater recreational and commercial fisheries species. Freshwater species include largemouth bass *(Micropterus salmoides)*, yellow bass *(Morone mississippiensis)*, black crappie *(Pomoxis nigromaculatus)*, bluegill *(Lepomis macrochirus)*, redear sunfish *(L. microlophus)*, warmouth *(L. gulosus)*, blue catfish *(Ictalurus furcatus),* channel catfish *(I. punctatus)*, buffalo *(Ictiobus* sp.*)*, freshwater drum *(Aplodinotus grunniens)*, bowfin *(Amia calva)*, and gar *(Lepisosteus* sp.*)*.

Marshes in the area support many commercially and recreationally important marine fish and shellfish species including red drum *(Sciaenops ocellatus)*, black drum, sheepshead *(Archosargus probatocephalus)*, striped mullet, southern flounder *(Paralichthys lethostigma)*, Gulf menhaden, sand seatrout, gray snapper *(Lutjanus griseus)*, Spanish mackerel *(Scomberomorus maculatus)*, white shrimp, brown shrimp, blue crab, eastern oyster *(Crassostrea virginica)*, and Gulf stone crab *(Menippe adina)*.

Brown and White Shrimp - Brown and white shrimp spawn in the Gulf of Mexico. Postlarval shrimp are transported into estuarine waters and coastal wetlands. Brown shrimp generally enter estuaries from February to April (White and Boudreaux 1977); white shrimp enter from late spring to autumn (Baxter and Renfro 1967). White shrimp typically spawn in shallower Gulf waters; postlarval and juvenile white shrimp move farther inshore than brown shrimp (Turner and Brody 1983). Juvenile shrimp move from the estuaries into offshore waters where they become adults. Brown shrimp migrate from the estuaries to the Gulf from May to August (Lassuy 1983); white shrimp migrate offshore from September to December (Muncy 1984).

Blue Crab - Blue crabs are found throughout estuaries and in adjacent marine waters. Crabs mate during the warmer months in fresher waters (Darnell 1959). Sperm transferred to female crabs can remain viable for over a year and can be used for multiple spawnings (Perry and McIlwain 1986). Female crabs migrate southward to higher salinity waters after mating (Adkins 1972; Perry 1975). Spawning and larval development occur in the more saline waters (Darnell 1959).

Larval blue crab abundances peak during February and March (Adkins 1972); megalopae then enter fresher areas. Juvenile crabs prefer areas with soft, mud substrate and are most abundant from November to May, more frequently in the northern portions of estuaries. After 1 to 1.5 years, crabs move from shallow areas into larger bays and bayous as adults where they reside for at least one more year (Adkins 1972). Recruitment of blue crabs in some areas is highest during the late spring, early summer, and fall. Male and female crabs are distributed differently in relation to salinity. Adult male crabs may prefer lower salinity waters, whereas mature females prefer higher salinities (Perry and McIlwain 1986). Adult male crabs are frequently observed in rivers and lakes miles from the Gulf.

A significant recreational fishery for blue crab also exists; however, little data are available. Since the mid- to late-1950s, crab traps (or pots) have become the primary gear type used to capture hard crabs (Adkins 1972). Large numbers of blue crabs are also collected by commercial and recreational trawling. The number of crab captured by trawls is unknown, but may be quite high.

Eastern Oyster - Oyster leases in the HNC project area are primarily located south of Mile 25. No oyster seed grounds are located in the study area. A total of 61 active oyster leases are within the possible disposal sites; 60 leases are in the Lung disposal site (1,435 acres) and one lease is within Site 21 (9 acres). Active oyster leases and oyster seed grounds in the vicinity of the study area in 2016 are shown in Figure 5-5.

Salinity affects oyster distributions, and very low salinities can cause oyster mortalities, although the low salinity tolerance of oysters has been subject to debate. Adult oysters are typically found within a salinity range of 10 to 30 ppt in estuaries in the Gulf; however, oysters can tolerate 2 to 40 ppt (Stanley and Sellers 1986). The susceptibility of oysters to low salinities may depend on the previous condition of the oyster (fatness), the length of exposure time, and the water temperature (Gunter 1953). Lower temperatures are generally positively correlated with the quality or condition of the oysters (Owen and Walters 1950). Oyster abundance appears to increase one or two years after periods of increased freshwater inflow; low abundances may occur one to three years after declines in freshwater inflow (Buzan *et al.* 2009).

Salinity also affects the distribution of oyster predators and parasites. Higher levels of parasitism generally occur in higher salinity waters (Gauthier *et al.* 2007). Susceptibility to infection by the protozoan *Perkinsus mannus* in oysters is significantly and positively correlated with salinity (Chu *et al.* 1993; Chu and La Peyre 1993).

The southern oyster drill is an important predator of oysters. Oyster drill populations fluctuate due to environmental changes, such as changes in salinity or temperature (Brown *et al.* 2004). Oyster drills are typically found in the higher salinity portions of estuaries, where salinities are greater than 15 ppt (Butler 1954). However, the salinity at which mortality occurs fluctuates depending upon the salinity the oyster drills were accustomed to and how quickly the salinity declines (Butler 1985). Water temperatures below 12°C also have been found to limit oyster drill feeding (Butler 1985). Black drum *(Pogonias cromis)* also prey on oysters (Brown *et al.* 2003) and are likely to be more abundant in higher salinity areas in the northern Gulf of Mexico.

Invasive Aquatic Species - Invasive aquatic species likely to be in the project area are presented in Table 5-10.

5.7.1 Essential Fish Habitat

The Magnuson-Stevens Fishery Conservation and Management Act, as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-267), requires Federal agencies to consult with NMFS on activities that may adversely affect Essential Fish Habitat (EFH). EFH is defined as those waters and substrate necessary to fish for spawning, breeding, or growth to maturity for species regulated under a Federal fisheries management plan.

Specific categories of EFH in estuaries include all estuarine waters and substrates (mud, sand, shell, rock, and associated biological communities), including the sub-tidal vegetation (sea grasses and algae) and adjacent inter-tidal vegetation (marshes and mangroves). The Gulf of Mexico Fishery Management Council (GMFMC), through the generic amendment of the Fishery Management Plans for the Gulf of Mexico, lists the following Federally managed species or species groups potentially found in coastal Louisiana: brown shrimp, white shrimp, Gulf stone crab, red drum, gray snapper, and Spanish mackerel (GMFMC 2005). Coastal wetlands provide nursery and foraging habitat that supports economically important marine fishery species such as spotted seatrout, southern flounder, Atlantic croaker, Gulf menhaden, striped mullet, and blue crab. These species serve as prey for other federally managed fish species such as mackerels, snappers, groupers, billfishes, and sharks. EFH encompasses all the wetlands and bays along the Louisiana coast.

Table 5-10. Invasive Aquatic Species Likely to be in the Study Area

Common Name	Scientific Name
Mammals	
Nutria	*Myocaster coypus*
Fish	
Bighead Carp	*Hypophthalmichthys nobilis*
Black Carp	*Mylopharyngodon piceus*
Common Carp	*Cyprinus carpio*
Grass Carp	*Ctenopharyngodon idella*
Silver Carp	*Hypophthalmichthys molitrix*
Rio Grande Cichlid	*Cichlasoma cyanoguttatum*
Tilapia	
Mollusks	
Asian Clam	*Corbicula fluminea*
Brown Mussel	*Perna perna*
Apple Snails	*Pomacea spp*
Green Mussel	*Perna viridis*
Zebra Mussel	*Dreissena polymorpha*
Other	
Australian Spotted Jellyfish	*Phyllorhiza punctata*
Chinese Mitten Crab	*Eriocheir sinensis*
Daphnia	*Daphina pulex*
Green Crab	*Carcinus maenas*

Source: Barataria-Terrebonne National Estuary Program, 2014
http://invasive.btnep.org/invasivesvsnatives/invasivesinla2list.aspx

In addition to being designated as EFH for the species listed in the attached tables, barrier islands provide unique transitional habitat from the marine to the estuarine environment. Categories of barrier island aquatic habitats include ponds, lagoons, creeks, tidal channels, sand flats, surf zone, and back-barrier marshes. These island habitats and associated nearshore water bodies in the study area support fish and crustacean assemblages distinctly different from mainland marshes. Economically important marine fishery species in the study area include striped mullet, white mullet, Atlantic croaker, spot, gulf menhaden, Florida pompano, spotted seatrout, sand seatrout, southern flounder, black drum, and blue crab. Barrier island habitats also support a number of ecologically important estuarine and marine fishery species, such as spot, white mullet, anchovies, killifishes, lesser blue crab, and inland silverside. EFH in Terrebonne and Timbalier Bays and nearshore Gulf waters is shown in Table 5-11.

Table 5-11. Essential Fish Habitat for Life Stages of Federally Managed Species in Terrebonne/Timbalier Bays and Nearshore Gulf Waters

Species	Life Stage	System*	EFH
Shrimp Fishery Management Plan			
Brown shrimp *(Farfantepenaeus aztecus)*	eggs	M	All estuaries; the US/Mexico border to Fort Walton Beach, Florida, from estuarine waters out to depths of 100 fathoms; Grand Isle, Louisiana, to Pensacola Bay, Florida, between depths of 100 and 325 fathoms; Pensacola Bay, Florida, to the boundary between the areas covered by the GMFMC and the SAFMC out to depths of 35 fathoms, with the exception of waters extending from Crystal River, Florida, to Naples, Florida, between depths of 10 and 25 fathoms and in Florida Bay between depths of 5 and 10 fathoms.
	larvae/postlarvae	M/E	
	juveniles	E	
	adults	M	
White shrimp *(Litopenaeus setiferus)*	eggs	M	
	larvae/postlarvae	M/E	
	juveniles	E	
	adults	M	
Red Drum Fishery Management Plan			
Red drum *(Sciaenops ocellatus)*	eggs	M	All estuaries; Vermilion Bay, Louisiana, to the eastern edge of Mobile Bay, Alabama, out to depths of 25 fathoms; Crystal River, Florida, to Naples, Florida, between depths of 5 and 10 fathoms; and Cape Sable, Florida, to the boundary between the areas covered by the GMFMC and the SAFMC between depths of 5 and 10 fathoms.
	larvae/postlarvae	E	
	juvenile	M/E	
	adults	M/E	
Reef Fish Fishery Management Plan			
Lane snapper *(Lutjanus synagris)*	eggs	M	All estuaries; the U.S./Mexico border to the boundary between the areas covered by the GMFMC and the SAFMC from estuarine waters out to depths of 100 fathoms
	larvae	M/E	
	juvenile	M/E	
Dog snapper *(Lutjanus jocu)*	juvenile	M/E	
Greater amberjack *(Seriola dumerili)*	eggs	M	
	larvae	M	
	juvenile	M	
Lesser amberjack *(Seriola fasciata)*	eggs	M	
	larvae	M	
Coastal Migratory Pelagics Fishery Management Plan			
Cobia *(Rachycentron canadum)*	eggs	M	All estuaries; the U.S./Mexico border to the boundary between the areas covered by the GMFMC and the SAFMC from estuarine waters out to depths of 100 fathoms
	larvae	M	
	juvenile	M	
King mackerel *(Scomberomorus cavalla)*	larvae	M	
	juvenile	M	
Highly Migratory Pelagics Fishery Management Plan			
Bonnethead shark *(Sphyrna tiburo)*	juvenile	E	Coastal areas in the Gulf of Mexico along Texas, and from eastern Mississippi through the Florida Keys. Atlantic east coast from the midcoast of Florida to South Carolina.
	adult	M	

* M – Marine; E - Estuarine

5.8 Wildlife

Amphibians - Amphibians inhabit a wide variety of natural habitats throughout the study area, including marshes, streams, treetops, lakes, and ponds. Amphibians are typically restricted to the less saline areas that are located primarily in the most northern portions of the study area. Many frogs and salamanders are known to enter estuarine habitats, but few are abundant there because of difficulties with osmoregulation. Within the study area, the bullfrog and pig frog continue to be over-harvested, despite evidence that their populations have decreased since the 1930s (Condrey *et al.*1995). Amphibians ingest a variety of insects, arthropods, finfish, other amphibians, reptiles, birds, and mammals.

Reptiles - The American alligator is the largest reptile in the study area. The alligator was removed from the USFWS endangered species list in 1987. Alligators are common in fresh to brackish bayous and lakes (Joanen and McNease 1972, Platt *et al.* 1989). Their diet consists of a broad range of prey including insects, crawfish, crabs, birds, fish, muskrat, nutria, turtles, shrimp, and snails (Chabreck 1971). Marshes with salinities less than 10 ppt are preferred nesting sites (Gosselink 1984). In addition, there are 23 species of snakes, 21 species of turtles, and 6 species of lizards, anoles, and skinks.

Marine Mammals - The marine mammals of the Gulf include members of the order Cetacea, which is divided into the suborders Mysticeti (i.e., baleen whales) and Odontoceti (i.e., toothed whales), as well as the order Sirenia (manatees). There are 28 species of cetaceans (7 mysticete and 21 odontocete species) and 1 sirenian species, the Florida manatee (*Trichechus manatus latirostris*) in the Gulf (Jefferson *et al.* 1992; Davis *et al.* 2000).

Bottlenose dolphins (*Tursiops truncatus)* and Atlantic spotted dolphins (*Stenella frontalis*) are common in shallow Gulf waters, up to 656 feet (200 m) deep. Bottlenose dolphins are common over the continental shelf and upper slope waters of the northern Gulf and feed on a wide variety of fishes, cephalopods, and shrimp (Davis and Fargion 1996; Jefferson and Schiro 1997; Wells and Scott 1999). There appears to be two bottlenose dolphin ecotypes, a coastal form and an offshore form (Hersh and Duffield 1990; Mead and Potter 1990). Inshore stocks are further divided into 32 separate provisionally delineated northern Gulf bay, sound, and estuarine stocks (Waring *et al.* 2010). The bottlenose dolphin is the primary marine mammal commonly observed in estuarine/marine open water portions of the project area (USFWS 2011a, b). Various whale species have been documented in nearby offshore waters (USFWS 2011a, b). The Atlantic spotted dolphin is endemic to tropical to temperate waters (Perrin *et al.* 1987, 1994a) and feeds on a wide variety of fishes, cephalopods, and benthic invertebrates (Leatherwood and Reeves 1983; Jefferson *et al.* 1993; Perrin *et al.* 1994a). In the Gulf, Atlantic spotted dolphins are commonly observed in continental shelf waters less than 6,556.2 feet (200 m) deep. The sperm whale is common in oceanic waters of the northern Gulf and may be a resident species, whereas the baleen whales are considered rare or extralimital in the Gulf (Würsig *et al.* 2000).

Birds - Louisiana's coastal wetlands are an important habitat for millions of Neotropical and other migratory avian species such as wading birds, shorebirds, rails, gallinules, and numerous songbirds.

The coastal wetlands provide migratory birds an essential stopover habitat on their migration route. Over 200 species of birds, including 35 species of waterfowl, have been reported in the Barataria-Terrebonne estuary (Condrey *et al.* 1995, Mitchell 1991). Species diversity decreases as the salinity increases; the greatest numbers of bird species occur in the freshwater swamps. Louisiana's coastal wetlands and marshes provide winter habitat for more than 50 percent of the duck population of the Mississippi Flyway. Waterfowl populations vary greatly from year to year. Waterfowl are primarily winter residents and migrate north in the spring and summer. In freshwater marsh, the American coot and blue-winged teal are the most prevalent species (Sasser *et al.* 1982). Gadwall, American coot, mallard, and blue-winged teal are the most abundant species in salt and brackish marshes. Puddle ducks inhabit marshes with shallow (less than half a meter deep) ponds; preferring pondweed, naiad, and duckweed in freshwater areas and widgeongrass in brackish marsh. Diving ducks, such as scaup, prefer deeper water and often dive more than 10 meters underwater to feed on invertebrates (Gosselink 1984).

A 2001 survey reported 197 shorebird colonies of wading birds and seabirds (representing 215,249 pairs of nesting birds) in coastal Louisiana (Michot *et al.* 2003). Species of wading birds likely to inhabit the project area include: great blue heron, little blue heron, tricolored heron, green heron, yellow crowned night heron, black crowned night heron, tri-colored heron, white-faced ibis, white ibis, roseate spoonbill, great egret, cattle egret, and snowy egret. These birds are generally carnivorous, with a diet consisting primarily of frogs, small fish, snakes, crawfish, worms, and insects found in shallow ponds and along bayous. Brackish marshes are their preferred feeding areas (Gosselink 1984). Colonies tend to be located in wooded and shrub swamps, which typically flood during the nesting season (Mitchell 1991).

Numerous species of seabirds and shorebirds inhabit shallow water areas and mudflats. Seabirds commonly nest on barrier and bay islands on shell, sand, or bare soil (Mitchell 1991). Seabirds likely to inhabit the project area include the brown pelican, white pelican, laughing gull, herring gull, and several species of terns. Shorebirds likely to utilize the project area include killdeer, willet, black-necked stilt, American avocet, dowitchers, common snipe, and various species of terns.

Other bird species common in the project area include red winged black bird, boat-tailed grackle, seaside sparrow, osprey, northern harrier, belted kingfisher, and marsh wrens. Game birds, excluding migratory waterfowl, likely to be present in the study area include the clapper rail, Virginia rail, sora, American coot, and common snipe. Raptor species that could be present in the study area include red tailed hawk, red-shouldered hawk, osprey, American kestrel, screech owl, northern harrier, Mississippi kite, great horned owl, and barred owl. Bald eagles are known to be present within the study area. Birds which may be present in Terrebonne Parish are listed in Table 5-12.

Table 5-12. Bird Checklist for Terrebonne Parish, Louisiana

Common Name	Scientific Name	Common Name	Scientific Name
Ducks, Geese, Swans			
Black-bellied Whistling-Duck	*Dendrocygna autumnalis*	Redhead	*Aythya americana*
Fulvous Whistling-Duck	*Dendrocygna autumnalis*	Ring-necked Duck	*Aythya collaris*
Greater White-fronted Goose	*Anser albifrons*	Greater Scaup	*Aythya marila*

Common Name	Scientific Name	Common Name	Scientific Name
Snow Goose	*Chen caerulescens*	Lesser Scaup	*Aythya affinis*
Canada Goose	*Branta canadensis*	Surf Scoter	*Melanitta perspicillata*
Wood Duck	*Aix sponsa*	Black Scoter	*Melanitta americana*
Gadwall	*Anas strepera*	Long-tailed Duck	*Clangula hyemalis*
Mallard	*Anas platyrhynchos*	Bufflehead	*Bucephala albeola*
Mottled Duck	*Anas fulvigula*	Common Goldeneye	*Bucephala clangula*
Blue-winged Teal	*Anas discors*	Hooded Merganser	*Lophodytes cucullatus*
Northern Shoveler	*Anas clypeata*	Common Merganser	*Mergus merganser*
Northern Pintail	*Anas acuta*	Red-breasted Merganser	*Mergus serrator*
Green-winged Teal	*Anas carolinensis*	Ruddy Duck	*Oxyura jamaicensis*
Canvasback	*Aythya valisineria*		
Grouse, Turkeys, Quail			
Northern Bobwhite	*Colinus virginianus*		
Loons, Grebes			
Common Loon	*Gavia immer*	Horned Grebe	*Podiceps auritus*
Pied-billed Grebe	*Podilymbus podiceps*	Eared Grebe	*Podiceps nigricollis*
Albatrosses, Shearwaters, Petrels, Tropicbirds			
Cory's Shearwater	*Calonectris diomedea*	Wilson's Storm-petrel	*Oceanites oceanicus*
Audubon's Shearwater	*Puffinus lherminieri*		
Storks			
Wood Stork	*Mycteria americana*	Magnificent Frigatebird	*Fregata magnificens*
Frigatebirds, Boobies, Gannet			
Magnificent Frigatebird	*Fregata magnificens*	Brown Booby	*Sula leucogaster*
Masked Booby	*Sula dactylatra*	Northern Gannet	*Northern Gannet*
Cormorants, Anhinga			
Neotropic Cormorant	*Phalacrocorax brasilianus*	Anhinga	*Anhinga anhinga*
Double-crested Cormorant	*Phalacrocorax auritus*		
Pelicans			
American White Pelican	*Pelecanus erythrorhynchos*	Brown Pelican	*Pelecanus occidentalis*
Bitterns, Herons			
American Bittern	*Botaurus lentiginosus*	Little Blue Heron	*Egretta caerulea*
Least Bittern	*Ixobrychus exilis*	Yellow-crowned Night Heron	*Nyctanassa violacea*
Great Blue Heron	*Ardea herodias*	Green Heron	*Butorides virescens*
Great Egret	*Ardea alba*	Black-crowned Night Heron	*Nycticorax nycticorax*
Snowy Egret	*Egretta thulu*		
Ibises, Spoonbills			
White Ibis	*Eudocimus albus*	Roseate Spoonbill	*Platalea ajaja*
Glossy Ibis	*Plegadis falcinellus*		
Vultures			
Black Vulture	*Coragyps atratus*	Turkey Vulture	Cathartes aura
Hawks, Kites, Eagles			
Osprey	*Pandion haliaetus*	Bald Eagle	*Haliaeetus leucocephalus*
White-tailed Kite	*Elanus leucurus*	Cooper's Hawk	*Accipiter cooperii*
Swallow-tailed Kite	*Elanoides forficatus*	Red-shouldered Hawk	*Buteo lineatus*
Mississippi Kite	*Ictinia mississippiensis*	Broad-winged Hawk	*Buteo platypterus*
Northern Harrier	*Circus cyaneus*	Swainson's Hawk	*Buteo swainsoni*
Sharp-shinned Hawk	*Accipiter striatus*	Red-tailed Hawk	*Buteo jamaicensis*
Rails, Gallinules, Coots			
Yellow Rail	*Coturnicops noveboracensis*	Sora	*Porzana carolina*
Clapper Rail	*Rallus longirostris*	Purple Gallinule	*Porphyrio martinica*
King Rail	*Rallus elegans*	Common Gallinule	*Gallinula galeata*

Common Name	Scientific Name	Common Name	Scientific Name
Virginia Rail	*Rallus limicola*	American Coot	*Fulica americana*
Oystercatchers, Stilts, Avocets			
Black-necked Stilt	*Himantopus mexicanus*	American Oystercatcher	*Haematopus palliatus*
American Avocet	*Recurvirostra americana*		
Plovers			
Black-bellied Plover	*Pluvialis squatarola*	Semipalmated Plover	*Charadrius semipalmatus*
American Golden-Plover	*Pluvialis dominica*	Piping Plover	*Charadrius melodus*
Snowy Plover	*Charadrius alexandrinus*	Killdeer	*Charadrius vociferus*
Wilson's Plover	*Charadrius wilsonia*		
Sandpipers, Phalaropes			
Spotted Sandpiper	*Actitis macularia*	Baird's Sandpiper	*Calidris bairdii*
Solitary Sandpiper	*Tringa solitaria*	Least Sandpiper	*Calidris minutilla*
Greater Yellowlegs	*Tringa melanoleuca*	White-rumped Sandpiper	*Calidris fuscicollis*
Willet	*Tringa semipalmata*	Buff-breasted Sandpiper	*Tryngites subruficollis*
Lesser Yellowlegs	*Tringa flavipes*	Pectoral Sandpiper	*Calidris melanotos*
Upland Sandpiper	*Bartramia longicauda*	Semipalmated Sandpiper	*Calidris pusilla*
Whimbrel	*Numenius phaeopus*	Western Sandpiper	*Calidris mauri*
Long-billed Curlew	*Numenius americanus*	Short-billed Dowitcher	*Limnodromus griseus*
Marbled Godwit	*Limosa fedoa*	Long-billed Dowitcher	*Limnodromus scolopaceus*
Ruddy Turnstone	*Arenaria interpres*	Wilson's Snipe	*Gallinago delicata*
Red Knot	*Calidris canutus*	American Woodcock	*Scolopax minor*
Stilt Sandpiper	*Calidris himantopus*	Wilson's Phalarope	*Phalaropus tricolor*
Sanderling	*Calidris alba*	Red-necked Phalarope	*Phalaropus lobatus*
Dunlin	*Calidris alpina*		
Jaegers			
Pomarine Jaeger	*Stercorarius pomarinus*	Parasitic Jaeger	*Stercorarius parasiticus*
Gulls, Terns, Skimmers			
Bonaparte's Gull	*Chroicocephalus philadelphia*	Least Tern	*Sterna antillarum*
Laughing Gull	*Leucophaeus atricilla*	Gull-billed Tern	*Gelochelidon nilotica*
Franklin's Gull	*Leucophaeus pipixcan*	Caspian Tern	*Hydroprogne caspia*
Ring-billed Gull	*Larus delawarensis*	Black Tern	*Chlidonias niger*
Herring Gull	*Larus argentatus*	Common Tern	*Sterna hirundo*
Lesser Black-backed Gull	*Larus fuscus*	Forster's Tern	*Sterna forsteri*
Glaucous gull	*Larus hyperboreus*	Royal Tern	*Thalasseus maximus*
Great black-backed Gull	*Larus marinus*	Sandwich Tern	*Thalasseus sandvicensis*
Sooty Tern	*Onychoprion fuscatus*	Black Skimmer	*Rynchops niger*
Bridled Tern	*Onychoprion anaethetus*		
Pigeons, Doves			
Rock Pigeon	*Columba livia*	Mourning Dove	*Zenaida macroura*
Eurasian Collared-Dove	*Streptopelia decaocto*	Inca Dove	*Scardafella inca*
White-winged Dove	*Zenaida asiatica*	Common Ground-Dove	*Columbina passerina*
Cuckoos, Roadrunners, Anis			
Yellow-billed Cuckoo	*Coccyzus americanus*	Black-billed Cuckoo	*Coccyzus erythropthalmus*
Owls			
Barn Owl	*Tyto alba*	Barred Owl	*Strix varia*
Eastern Screech-Owl	*Megascops asio*	Short-eared Owl	*Asio flammeus*
Great Horned Owl	*Bubo virginianus*		
Goatsuckers			
Common Nighthawk	*Chordeiles minor*	Chuck-will's-widow	*Caprimulgus carolinensis*

Common Name	Scientific Name	Common Name	Scientific Name
Swifts			
Chimney Swift	*Chaetura pelagica*		
Hummingbirds			
Ruby-throated Hummingbird	*Archilochus colubris*	Calliope Hummingbird	*Stellula calliope*
Black-chinned Hummingbird	*Archilochus alexandri*	Broad-billed Hummingbird	*Cynanthus latirostris*
Rufous Hummingbird	*Selasphorus rufus*	Buff-bellied Hummingbird	*Amazilia yucatanensis*
Allen's Hummingbird	*Selasphorus sasin*		
Kingfishers			
Belted Kingfisher	*Megaceryle alcyon*		
Woodpeckers			
Red-headed Woodpecker	*Melanerpes erythrocephalus*	Hairy Woodpecker	*Picoides villosus*
Red-bellied Woodpecker	*Melanerpes carolinus*	Northern Flicker	*Colaptes auratus*
Yellow-bellied Sapsucker	*Sphyrapicus varius*	Pileated Woodpecker	*Dryocopus pileatus*
Downy Woodpecker	*Picoides pubescens*		
Caracaras, Falcos			
American Kestrel	*Falco sparverius*	Peregrine Falcon	*Falco peregrinus*
Merlin	*Falco columbarius*		
Flycatchers			
Olive-sided Flycatcher	*Contopus cooperi*	Vermilion Flycatcher	*Pyrocephalus rubinus*
Eastern Wood-Pewee	*Contopus virens*	Great Crested Flycatcher	*Myiarchus crinitus*
Yellow-bellied Flycatcher	*Empidonax flaviventris*	Tropical/Couch's kingbird	*Tyrannus melancholicus*
Acadian Flycatcher	*Empidonax virescens*	Western Kingbird	*Tyrannus verticalis*
Alder Flycatcher	*Empidonax alnorum*	Eastern Kingbird	*Tyrannus tyrannus*
Least Flycatcher	*Empidonax minimus*	Gray kingbird	*Tyrannus dominicensis*
Gray Flycatcher	*Empidonax wrightii*	Scissor-tailed Flycatcher	*Tyrannus forficatus*
Eastern Phoebe	*Sayornis phoebe*		
Shrikes			
Loggerhead Shrike	*Lanius ludovicianus*		
Vireos			
White-eyed Vireo	*Vireo griseus*	Blue-headed Vireo	*Vireo solitarius*
Yellow-throated Vireo	*Vireo flavifrons*	Red-eyed Vireo	*Vireo olivaceus*
Jays, Crows			
Blue Jay	*Cyanocitta cristata*	Fish Crow	*Corvus ossifragus*
American Crow	*Corvus brachyrhynchos*		
Larks			
Horned Lark	*Eremophila alpestris*		
Swallows			
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	Barn Swallow	*Hirundo rustica*
Purple Martin	*Progne subis*	Cliff Swallow	*Petrochelidon* pyrrhonota
Tree Swallow	*Tachycineta bicolor*	Cave Swallow	*Petrochelidon fulva*
Bank Swallow	*Riparia riparia*		
Chickadees, Titmice			
Carolina Chickadee	*Poecile carolinensis*	Tufted Titmouse	*Baeolophus bicolor*
Wrens			
House Wren	*Troglodytes aedon*	Marsh Wren	*Cistothorus palustris*
Winter Wren	*Troglodytes hiemalis*	Carolina Wren	*Thryothorus ludovicianus*
Sedge Wren	*Cistothorus platensis*		
Gnatcatchers, Kinglets			
Blue-gray Gnatcatcher	*Polioptila caerulea*	Ruby-crowned Kinglet	*Regulus calendula*

Common Name	Scientific Name	Common Name	Scientific Name
Golden-crowned Kinglet	*Regulus satrapa*		
Thrushes			
Eastern Bluebird	*Sialia sialis*	Hermit Thrush	*Catharus guttatus*
Veery	*Catharus fuscescens*	Wood Thrush	*Hylocichla mustelina*
Gray-cheeked Thrush	*Catharus minimus*	American Robin	*Turdus migratorius*
Swainson's Thrush	*Catharus ustulatus*		
Mockingbirds, Thrashers			
Gray Catbird	*Dumetella carolinensis*	Northern Mockingbird	*Mimus polyglottos*
Brown Thrasher	*Toxostoma rufum*		
Starlings, Wagtails, Pipits, Waxwings			
European Starling	*Sturnus vulgaris*	Sprague's Pipit	Anthus spragueii
American Pipit	*Anthus rubescens*	Cedar Waxwing	Bombycilla cedrorum
Warblers			
Ovenbird	*Seiurus aurocapillus*	Magnolia Warbler	*Dendroica magnolia*
Worm-eating Warbler	*Helmitheros vermivorus*	Bay-breasted Warbler	*Dendroica castanea*
Northern Waterthrush	*Parkesia noveboracensis*	Blackburnian Warbler	*Dendroica fusca*
Blue-winged Warbler	*Blue-winged Warbler*	Yellow Warbler	*Dendroica petechia*
Black-and-white Warbler	*Mniotilta varia*	Chestnut-sided Warbler	*Dendroica pensylvanica*
Prothonotary Warbler	*Protonotaria citrea*	Blackpoll Warbler	*Dendroica striata*
Swainson's Warbler	*Limnothlypis swainsonii*	Palm Warbler	*Dendroica palmarum*
Tennessee Warbler	*Oreothlypis peregrina*	Pine Warbler	*Dendroica pinus*
Orange-crowned Warbler	*Vermivora celata*	Yellow-rumped Warbler	*Dendroica coronata*
Nashville Warbler	*Vermivora ruficapilla*	Yellow-throated Warbler	*Dendroica dominica*
Mourning Warbler	*Oporornis philadelphia*	Prairie Warbler	*Dendroica discolor*
Kentucky Warbler	*Oporornis formosus*	Black-throated Green Warbler	*Dendroica virens*
Common Yellowthroat	*Geothlypis trichas*	Canada Warbler	*Wilsonia canadensis*
Hooded Warbler	*Wilsonia citrina*	Wilson's Warbler	*Wilsonia pusilla*
American Redstart	*Setophaga ruticilla*	Yellow-breasted Chat	*Icteria virens*
Northern Parula	*Parula americana*		
Sparrows			
Green-tailed Towhee	*Pipilo chlorurus*	Seaside Sparrow	*Ammodramus maritimus*
Eastern Towhee	*Pipilo erythrophthalmus*	Fox Sparrow	*Passerella iliaca*
Chipping Sparrow	*Spizella passerina*	Song Sparrow	*Melospiza melodia*
Clay-colored Sparrow	*Spizella pallida*	Lincoln's Sparrow	*Melospiza lincolnii*
Field Sparrow	*Spizella pusilla*	Swamp Sparrow	*Melospiza georgiana*
Vesper Sparrow	*Pooecetes gramineus*	White-throated Sparrow	*Zonotrichia albicollis*
Lark Sparrow	*Chondestes grammacus*	White-crowned Sparrow	*Zonotrichia leucophrys*
Savannah Sparrow	*Passerculus sandwichensis*	Dark-eyed Junco	*Junco hyemalis*
Nelson's Sparrow	*Ammodramus nelsoni*		
Tanagers, Grosbeaks, Buntings			
Summer Tanager	*Piranga rubra*	Blue Grosbeak	*Passerina caerulea*
Scarlet Tanager	*Piranga olivacea*	Indigo Bunting	*Passerina cyanea*
Northern Cardinal	*Cardinalis cardinalis*	Painted Bunting	*Passerina ciris*
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	Dickcissel	*Spiza americana*
Black-headed Grosbeak	*Pheucticus melanocephalus*		
Blackbirds, Orioles			
Bobolink	*Dolichonyx oryzivorus*	Shiny Cowbird	*Molothrus bonariensis*
Red-winged Blackbird	*Agelaius phoeniceus*	Bronzed Cowbird	*Molothrus aeneus*
Eastern Meadowlark	*Sturnella magna*	Brown-headed Cowbird	*Molothrus ater*
Yellow-headed Blackbird	*Xanthocephalus*	Orchard Oriole	*Icterus spurius*

Common Name	Scientific Name	Common Name	Scientific Name
	xanthocephalus		
Common Grackle	*Quiscalus quiscula*	Bullock's Oriole	*Icterus bullockii*
Boat-tailed Grackle	*Quiscalus major*	Baltimore Oriole	*Icterus galbula*
Great-tailed Grackle	*Quiscalus mexicanus*		
Finches, House Sparrow			
House Finch	*Carpodacus mexicanus*	American Goldfinch	*Spinus tristis*
Purple Finch	*Carpodacus purpureus*	House Sparrow	*Passer domesticus*

Source: Bird Checklist for Terrebonne Parish, LA. Checklist of North American Birds, 7th edition, American Ornithologists Union, 1998, updated through the 54th Supplement, 2013.

Invasive Terrestrial Species - In Louisiana, the nutria, feral hog, and Norway rat are the only mammals considered invasive species. The nutria is also listed as an aquatic invasive species. Nutria were discussed previously. Large populations of feral hogs are present in Louisiana. Feral hogs are the most prolific mammal in North America. Their reproductive rates can exceed four times that of native ungulate species. They damage habitats and impact native plant and animal species. Feral hogs contribute to soil erosion, leaching of minerals and nutrients, habitat destruction, native plant species destruction, exotic plant species introduction, habitat destruction, and changes in vegetative success rates. Native wildlife are impacted though direct competition for food and predation of native amphibians, reptiles, mammals, and ground-nesting birds (USFWS 2009, 2010).

Mammals - Mammals present in the study area include the muskrat, mink, beaver, otter, Virginia opossum, bobcat, fox, and coyote. The white-tailed deer, swamp rabbit, fox squirrel, and gray squirrel are important mammalian species because of the recreational hunting opportunities they provide. The threatened Louisiana black bear is not presently found in the study area; the endangered red wolf, and Florida panther have disappeared from the area. Twenty-two species of small mammals (rats, mice, shrews, and bats) are also found in the area.

White-tailed deer are most prevalent in bottomland hardwood and swamp habitat with density declining with increasing marsh salinity. Deer prefer dryer area out of standing water, such as natural levees and dredged material embankments, and prefer foraging on newly grown succulent vegetation (Self 1975) including alligator weed, eastern false-willow, black willow, and common reed. However, they are common in fresh and intermediate marshes, provided there is suitable cover and browse plants.

Invasive Insects and Other Animals - Invasive insects, mammals, and birds likely to be in the project area are presented in Table 5-13 (BTNEP 2014).

Table 5-13. Invasive Insects and Other Animals

Common Name	Scientific Name
Invasive Insects	
Africanized Honeybee	*Apis mellifera scutellata*
Asian Tiger Mosquito	*Aedes albopictus*
Formosan Termite	*Coptotermes formosanus*
Mexican Boll Weevil	*Anthonomus grandis*
Red Imported Fire Ant	*Solenopsis invicta*
Invasive Mammals	
Nutria	*Myocastor coypus*
Norway Rat	*Rattus norvegicus*
Feral Hog	*Sus scrofa*
Invasive Birds	
Monk Parakeet	*Myiopsitta monachus*
European Starling	*Sturnus vulgaris*
Cattle Egret	*Bubulcus ibis*
Brown Anole	*Anolis sagrei*

Source: Barataria-Terrebonne National Estuary Program, 2014
http://invasive.btnep.org/invasivesvsnatives/invasivesinla2list.aspx

5.8.1 Threatened and Endangered Species

This section describes the biology of threatened and endangered species present in Terrebonne Parish. The species listed in Table 5-14 may be present in the area and may be affected by the project. There are no known threatened and endangered floral species in the vicinity of the study area.

Table 5-14. Threatened and Endangered Species in Vicinity of Study Area

Species	Scientific Name	Federal Status
FISHES		
Gulf sturgeon	*Acipenser oxyrinchus desotoi*	**T**
Smalltooth sawfish	*Pristis pectinata*	**E**
SEA TURTLES		
Green turtle	*Chelonia mydas*	**T**
Hawksbill	*Eretmochelys imbricate*	**E**
Kemp's ridley	*Lepidochelys kempii*	**E**
Leatherback	*Dermochelys coriacea*	**E**
Loggerhead	*Caretta caretta*	**T**
MARINE MAMMALS		

Species	Scientific Name	Federal Status
West Indian manatee	*Trichechus manatus*	**E**
Sperm whale	*Physeter macrocephalus*	**E**
Sei whale	*Balaenoptera borealis*	**E**
Humpback whale	*Megaptera novaeangliae*	**E**
Fin (Finback) whale	*Balaenoptera physalus*	**E**
Blue whale	*Balaenoptera musculus*	**E**
Northern right whale	*Eubalaena glacialis*	**E**
BIRDS		
Piping plover	*Charadrius melodus*	**TC**
Red knot	*Calidris canutus rufa*	**PT/C**

T=Threatened; E=Endangered; C=Critical habitat

Source: USFWS, April 2014 (http://www.fws.gov/endangered/)

To provide compliance with Section 7(c) of the Endangered Species Act (ESA) of 1973, as amended, a Biological Assessment (BA) was prepared pursuant to the ESA and implementing regulation (50 CFR 402.14) (Appendix H). The BA provides an assessment of the effects of the project on the protected species in the vicinity of the project. Because this project will not be constructed in the next year, an updated T&E review will have to occur no more than a year before construction begins and be coordinated with USFWS and NMFS. Coordination with USFWS and NMFS is ongoing.

Gulf Sturgeon - The Gulf sturgeon, federally listed as a threatened species under both the USFWS and NMFS, is anadromous and occurs in many rivers, streams, and estuarine waters along the northern Gulf Coast between the Mississippi River and the Suwannee River in Florida. In Louisiana, the Gulf sturgeon has been reported at Rigolets Pass, rivers and lakes of the Lake Pontchartrain Basin, and adjacent estuarine areas. Spawning occurs in coastal rivers between late winter and early spring (i.e., March to May). Adults and sub-adults may be found in those rivers and streams until November, and in estuarine or marine waters during the remainder of the year. Sturgeons, less than two years old, appear to remain in riverine habitats and estuarine areas throughout the year, rather than migrate to marine waters. Habitat alterations such as those caused by water control structures that limit and prevent spawning, poor water quality, and overfishing have adversely affected the species (USACE 2010).

On March 19, 2003, the USFWS and the NMFS published a final rule in the Federal Register (Volume 68, No. 53) designating critical habitat for the Gulf sturgeon in Louisiana, Mississippi, Alabama, and Florida. Portions of the Pearl and Bogue Chitto rivers, Lake Pontchartrain east of the Lake Pontchartrain Causeway, all of Little Lake, the Rigolets, Lake St. Catherine, and Lake Borgne within Louisiana were included in that designation. No critical habitat occurs within or in proximity to the project area.

Smalltooth Sawfish - Historically, smalltooth sawfish were relatively common in the shallow Gulf waters and along the east coast as far north as North Carolina. The current distribution of smalltooth sawfish is likely centered near the southern tip of the Florida peninsula. Recent sawfish observations are limited to Georgia, Florida, and Texas. However, the Texas sighting was unverified and may have been a largetooth sawfish (*P. perotteti*); both species are rare throughout the western Gulf. No known sawfish breeding or juvenile habitats are adjacent to, or associated with, the project area (USFWS 2011a). Smalltooth sawfish are rare in the action area, the likelihood of their entrainment is very low, and the chances of the proposed action affecting them are discountable (NMFS 2005).

Sea Turtles - Five sea turtle species are found in the Gulf of Mexico and Caribbean, green, Kemp's ridley, hawksbill, loggerhead, and leatherback. Loggerheads and leatherbacks are Federally listed as threatened; the other three species are endangered. All five species have been observed in Louisiana's coastal waters. These species, in decreasing order of abundance, were Kemp's ridley, loggerhead, green turtle, leatherback, and hawksbill (Fuller *et al.*1987).

Since March 15, 2011, sea turtle strandings have notably increased in the northern Gulf, primarily in Mississippi (NOAA Fisheries 2011c). In 2011, 525 sea turtles stranded along the coasts of Louisiana (148), Mississippi (283), and Alabama (94; NOAA Fisheries 2011c). Most of the 2011 strandings occurred between March and June. In 2011 (through April 29), 206 sea turtles stranded along the coasts of Louisiana (74), Mississippi (105), and Alabama (27; NOAA Fisheries 2011c).

Green Turtle - Green turtles are found in tropical and sub-tropical waters around the world. In U.S. Atlantic waters, green turtles are found from Texas to Massachusetts, the U.S. Virgin Islands, and Puerto Rico. Distribution is correlated to grassbed distribution, the location of nesting beaches, and associated ocean currents (Hirth 1971; Perrine 2003; Spotila 2004). Green turtles likely occur throughout coastal Louisiana and may nest on the Chandeleur Islands (Dundee and Rossman 1989). The green turtle was the third most abundant sea turtle reported in Louisiana; most turtles observed were juveniles and were primarily in southeastern Louisiana (Fuller *et al.* 1987). During the nesting season, adults remain in nearshore and estuarine waters near nesting beaches. In 2011, green turtle strandings were documented in Louisiana (6), Mississippi (7), and Alabama (4) (NOAA Fisheries 2011c). In 2012 (through April 29), green turtle strandings were documented in Louisiana (3) and Mississippi (1) (NOAA Fisheries 2011c). Critical habitat for green turtles consists of waters surrounding Culebra Island, Puerto Rico.

Long migrations are often made between feeding and nesting grounds (Carr and Hirth 1962). Green turtles are generally found over shallow flats, seagrass and algae areas inside bays and inlets. Resting areas include rocky bottoms and oyster, worm, and coral reefs. Post-hatchling pelagic turtles may be omnivorous. During the first year, green turtles are primarily carnivorous, feeding mainly on invertebrates; adult turtles are herbivorous. Green turtles are the only sea turtles that consume large amounts of plants, feeding in shallow water areas with abundant seagrass or algae (Fritts *et al.* 1983; Spotila 2004).

Green turtles often nest on open high-energy beaches with a sloping platform and minimal disturbance; nests are dug above the high-water line. In Florida, nesting occurs from June to late September. Hatchlings swim to convergence zones and may remain in *Sargassum* rafts. Older turtles leave the pelagic habitat to feed benthically. Nesting does not occur in Louisiana.

Hawksbill - Hawksbills are found in tropical and subtropical seas of the Atlantic, Pacific, and Indian oceans. In the continental U.S., hawksbills have been observed along the Gulf Coast. Although hawksbills have been seen along the east coast as far north as Massachusetts, they are rare north of Florida. Hawksbills are scarce in Louisiana; only one turtle was reported by Fuller *et al.* (1987) off Cameron Parish, Louisiana. A few juvenile (1 to 2 years old) hawksbills have been observed in Texas. No hawksbill strandings were documented in 2011 or 2012 (through April 29) in Alabama, Louisiana, or Mississippi (NOAA Fisheries 2011c).

Hawksbills are frequently found along rocky areas, coral reefs, shallow coastal areas, lagoons, oceanic islands, narrow creeks, and passes. They typically inhabit waters less than 70 feet. Post-hatchlings are pelagic and occupy convergence zones, floating among *Sargassum* and debris (NMFS and USFWS 1993). Juveniles may eat fish eggs, *Sargassum*, and debris; feeding primarily on certain species of sponges once they become benthic. Critical habitat for hawksbills has been designated at Isla Mona, Culebra Island, Cayo Norte, and Island Culebrita, Puerto Rico.

In the continental U.S., hawksbills only nest along the southeastern coast of Florida and the Florida Keys. Hawksbills nest on low- and high-energy beaches, on various types of substrates, and may nest under vegetation. Nesting densities are generally low, ranging from a few dozen to a few hundred females. Hawksbills nest on scattered undisturbed small, deep-sand beaches, except for long expanses of beach on the Gulf and Caribbean coasts of the Yucatán Peninsula, Mexico. Hawksbills nest between April and November in most areas. Females frequently return to the same beach to nest.

Since hawksbills are scarce in Louisiana, there is a very low likelihood that they will be affected by this project.

Kemp's Ridley - Kemp's ridleys are found in shallow nearshore and inshore waters of the northern Gulf, particularly in Louisiana. In the northwestern Atlantic Ocean, Kemp's ridleys feed in coastal waters as far north as New England during the summer, migrating south during the winter (NMFS and USFWS 1992). Kemp's ridleys have been observed in Louisiana year-round; most of the turtles observed have been juveniles (Fuller *et al.* 1987). The Kemp's ridley is the most abundant sea turtle off the Louisiana coast (Viosca 1961; Gunter 1981) accounting for 67 percent of Louisiana turtles (Fuller *et al.* 1987). In 2011, Kemp's ridley strandings were documented in Louisiana (204), Mississippi (265), and Alabama (66; NOAA Fisheries 2011c). In 2012 (through April 29), Kemp's ridley strandings were documented in Louisiana (62), Mississippi (99), and Alabama (23; NOAA Fisheries 2011c). Sea turtles may seasonally use the bays and saline marshes adjacent to, and including, Gulf and barrier island beaches (USFWS 2011a). Kemp's ridleys are observed inshore more frequently than any other sea turtle species (Fuller *et al.* 1987) and are often found in salt marsh waterbodies. In the northern Gulf, Kemp's ridleys may move to deeper water during the winter. No critical habitat for Kemp's ridleys has been designated.

Neonatal Kemp's ridleys feed on *Sargassum*, infauna, and other epipelagic species. Post-pelagic turtles are benthic feeders over sand and mud bottoms, primarily consuming crabs (particularly portunids) and other crustaceans. Hatchlings may become entrained in Gulf eddies, are dispersed by oceanic surface currents, then enter shallow coastal habitats when they reach about 20 cm in length. Low salinity, high turbidity, and high organic content waters, and areas with abundant shrimp appear to be preferred by Kemp's ridleys (Zwinenberg 1977; Hughes 1972). Important feeding grounds for adults and sub-adults include the highly productive white shrimp and Portunid crab beds of Louisiana from Marsh Island to the Mississippi Delta (Hildebrand 1981).

Kemp's ridleys generally nest on beaches or large open waterbodies with seasonal narrow connections to the ocean. Nesting primarily occurs on beaches of the western Gulf from April to July. During the nesting season, females may remain in nearshore waters or may move up to 10 km along the beach before returning to the nesting beach.

Leatherback - Leatherbacks are highly migratory and pelagic. Only two leatherbacks were reported in Louisiana in the Fuller *et al.* (1987) study; both were spotted offshore by pilots. No leatherback strandings were documented in 2011 or 2012 (through April 29) in Alabama, Louisiana, or Mississippi (NOAA Fisheries 2011c). Critical habitat for leatherbacks is in the U.S. Virgin Islands.

Leatherbacks are able to regulate their core body temperature and have been found in deeper water than other species and in cold waters, including Alaska. They may occasionally feed on aggregations of jellyfish in shallower waters. Leatherbacks primarily feed on jellyfish, but also consume sea urchins, squid, crustaceans, tunicates, fish, blue-green algae, and floating seaweed. In the Gulf, leatherbacks are frequently associated with cabbage head *Stomolophus* and *Aurelia* jellyfish. The distribution and food habits of post-hatchling and juvenile leatherbacks are unknown, although they may be pelagic and associate with *Sargassum*.

Females nest in the U.S. from March to July. The Pacific coast of Mexico has the largest known concentration of nesting leatherbacks. Preferred nesting sites are well-sloped high-energy sand beaches backed with vegetation near deep water and generally rough seas. Nesting surveys likely underestimate the number of leatherbacks because leatherbacks nest as early as late February and surveys generally do not begin until May. Although many females return to the same beaches to nest, some nest on beaches up to 100 km apart in a single season.

The improbability of a leatherback being present nearshore and their non-benthic feeding habits combine to produce a very low likelihood of hopper dredge entrainment (NMFS 2005).

Loggerhead - Loggerheads are widely distributed throughout temperate and tropical regions of the Atlantic, Pacific, and Indian Oceans. Loggerheads were the second most abundant sea turtle reported in Louisiana; most of the turtles observed were juveniles (Fuller *et al.* 1987). Their range likely includes all of coastal Louisiana. However, loggerheads have only been reported from Chandeleur Sound, Barataria Bay, and Cameron Parish (Dundee and Rossman 1989), and most were observed east of the Vermilion River (Fuller *et al.* 1987). In 2011, loggerhead strandings were documented in Louisiana (19), Mississippi (10), and Alabama (4) (NOAA Fisheries 2011c). In 2012 (through April 29), loggerhead strandings were documented in Louisiana (2), Mississippi (2), and Alabama (2) (NOAA Fisheries 2011c). No critical habitat has been designated for the loggerhead.

Loggerheads have been seen hundreds of miles offshore or inshore in bays, coastal lagoons, salt marshes, creeks, ship channels, and the mouths of large rivers (USFWS 2010). They remain dormant in the winter, remaining buried in the mud at the bottom of sounds, bays, and estuaries. Loggerheads mainly feed on marine invertebrates including mollusks, shrimp, crabs, sponges, jellyfish, squid, sea urchins, and basket stars (Caldwell *et al.* 1955; Hendrickson 1980; Nelson 1986) and discarded bycatch from shrimp trawling. Feeding areas often include coral reefs, rocky areas, and shipwrecks. Loggerheads may migrate long distances between foraging areas and nesting beaches. Adults typically feed in waters less than 50 meters deep; primary foraging areas for juveniles appear to be estuaries and bays (Nelson 1986; Rabalais and Rabalais 1980).

In the continental U.S., loggerheads nest from Texas to Virginia. Many loggerheads nest from Florida to North Carolina and most (90 percent) nesting occurs on the south-central Florida Gulf Coast (Hildebrand 1981). Only minor and solitary nesting has historically been observed in Louisiana; nests were seen on the Chandeleur Islands in 1962 and Grand Isle in the 1930s. It is unknown whether loggerheads currently nest in Louisiana. Over the past decade, nesting is estimated to be between 47,000 and 90,000 annually in the U.S. (NMFS and USFWS 2008). Loggerheads nest between late April and early September. During the nesting season, adults remain in nearshore and estuarine waters near nesting beaches. Females generally return to natal beaches to nest. Loggerheads typically nest above the high-tide mark on open beaches or along narrow bays with suitable sand. They may prefer steeply sloped beaches with gradually sloped offshore approaches. Females lay 3 to 5 or more nests during a single nesting season; eggs incubate about two months later. Hatchlings are pelagic, moving to convergence zones (downwelling areas) where seagrass and debris accumulates. Juveniles may remain among *Sargassum* for years; larger juveniles feed in coastal areas. Loggerheads sexually mature at about 35 years.

West Indian Manatee - West Indian manatees are large, gray aquatic mammals also known as sea cows. The average adult manatee is about 9.8 feet long and weighs between 800 pounds to 1,200 pounds. Manatees can be found in shallow, slow-moving rivers, estuaries, salt water bays, canals, and coastal areas. Manatees migrate within the U.S. They are concentrated in Florida in the winter, but they can be found in summer months as far west as Texas and as far north as Virginia. However, these more western and northern sightings are rare. West Indian manatees occasionally enter Lakes Pontchartrain and Maurepas, and associated coastal waters and streams during the summer months (i.e., June through September). Manatees have been reported in the Amite, Blind, Tchefuncte, and Tickfaw Rivers, and in canals within the adjacent coastal marshes of Louisiana. They have also been occasionally observed elsewhere along the Louisiana Gulf coast. Manatees are completely herbivorous on aquatic plants and can consume 10 percent to 15 percent of their body weight daily. West Indian manatees have no natural enemies, and it is believed they can live 60 years or more. The manatee has declined in numbers due to collisions with boats and barges, entrapment in flood control structures, poaching, habitat loss, and pollution. Cold weather and outbreaks of red tide may also adversely affect these animals. Most human-related manatee mortalities occur from collisions with watercraft. Other causes of human-related manatee mortalities include being crushed and/or drowned in canal locks and flood control structures; ingestion of fish hooks, litter and monofilament line; entanglement in crab trap lines; and vandalism.

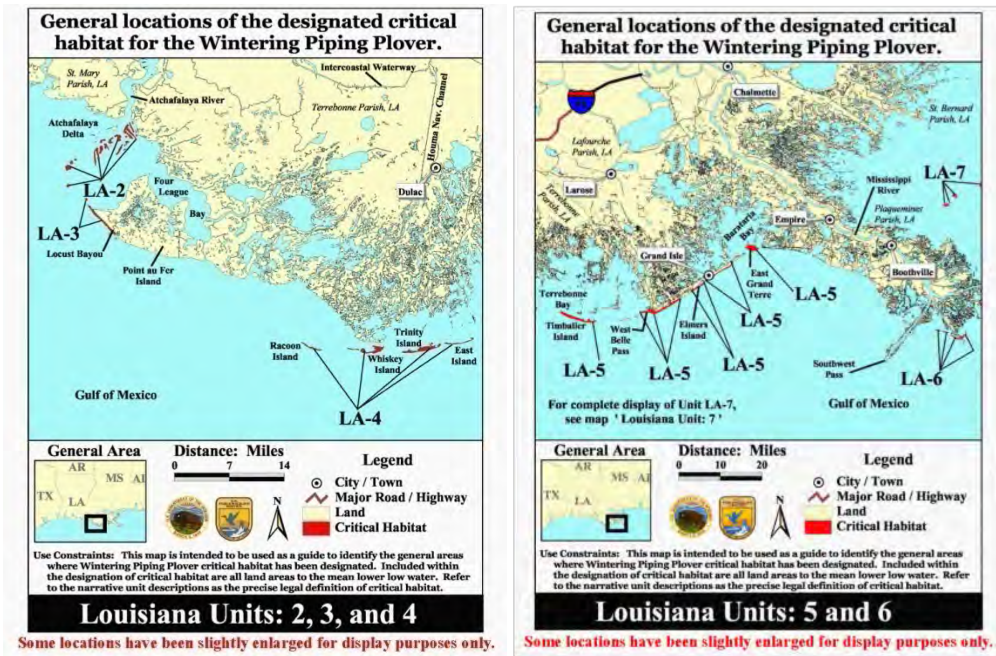
Whales - Sperm whales *(Physeter macrocephalus)* occur in the Gulf of Mexico but are rare inshore (NMFS 2005). Other endangered whales, including North Atlantic right whales *(Eubalaena glacialis)* and humpback whales *(Megaptera novaeangliae)* have been occasionally observed in the Gulf of Mexico. Various species of whales have been documented in the offshore waters of the study area (USFWS 2011b). These were likely inexperienced juveniles straying from the normal range of these stocks (NMFS 2005). Generally speaking, these species are not likely to be found in the project area.

Piping Plover - The piping plover is a migratory shorebird that winters on coastal sandy beaches and mudflats in the Caminada Headland area. The piping plover breeds during the late spring and summer in three discrete areas of North America: the Northern Great Plains, the Great Lakes, and the Atlantic Coast. Plover winter in the coastal U.S. from North Carolina to Texas. The density of wintering Great Lakes plover was highest between St. Catherine's Island, Georgia, and Jacksonville, Florida, and the Florida Gulf coast, particularly around Tampa Bay (Stucker and Cuthbert 2006).

Piping plover arrive in Louisiana as early as late July and remain until late March or April. Most plover may migrate non-stop from interior breeding areas to wintering grounds. Individual plover tend to return to the same wintering sites year after year (Nicholls and Baldassarre 1990). In late February, piping plover begin to migrate from wintering grounds to breeding sites. Northward migration peaks in late March, and most birds have left the wintering grounds by late May (Eubanks 1994).

Winter feeding areas include beaches, mud flats, sand flats, algal flats, and washover passes with no or very sparse emergent vegetation (Doonan *et al.* 2006). Piping plovers are frequently observed at the accreting ends of barrier islands, along sandy peninsulas, and near coastal inlets (USFWS 1996). Wintering piping plovers spend most of their time foraging (Nicholls and Baldassarre 1990). Primary prey for wintering plover includes polychaetes, various crustaceans, insects, and occasionally bivalves (Nicholls 1989). Roosting areas are sparsely vegetated or unvegetated, generally with debris, detritus, or micro-topographic relief, which provide refuge from high winds and cold temperatures. Wintering piping plover use a variety of sites as environmental conditions change. They are patchily distributed along the coast, correlated with the availability of suitable, open habitat. The population of piping plover declines with the loss and degradation of their habitat.

The piping plover is currently in decline and is listed as endangered in the Great Lakes area and threatened elsewhere in its range. The USFWS designated 142 critical habitat units along the Gulf and Atlantic coasts for wintering piping plover. Critical Habitat Unit LA-4 includes portions of the Louisiana shoreline from Racoon Island to East Island, which includes the project area (Figure 5-8). Timbalier Island is included in Unit LA-5. Critical habitat includes components that support foraging, roosting, and sheltering, and the physical features necessary for maintaining the natural processes that support those habitat components. The designated critical habitat identifies specific areas essential to the conservation of the species.



Source: http://www.fws.gov/plover/finalchmaps/Plover_LA_5_to_6.jpg.
http://www.fws.gov/plover/finalchmaps/Plover_LA_2_to_4.jpg

Figure 5-8. Wintering Piping Plover Critical Habitat

Red Knot - The red knot is a medium-sized shorebird about 9 to 11 inches (23 to 28 centimeters) in length with a proportionately small head, small eyes, short neck, and short legs. The black bill tapers steadily from a relatively thick base to a relatively fine tip; bill length is not much longer than head length. Legs are typically dark gray to black, but sometimes greenish in juveniles or older birds in non-breeding plumage. Non-breeding plumage is dusky gray above and whitish below. The red knot breeds in the central Canadian arctic but is found in Louisiana during spring and fall migrations and the winter months (generally September through March). During migration and on their wintering grounds, red knots forage along sandy beaches, tidal mudflats, salt marshes, and peat banks. Observations along the Texas coast indicate that red knots forage on beaches, oyster reefs, and exposed bay bottoms, and roost on high sand flats, reefs, and other sites protected from high tides. In wintering and migration habitats, red knots commonly forage on bivalves, gastropods, and crustaceans. Coquina clams *(Donax variabilis),* a frequent and often important food resource for red knots, are common along many gulf beaches. Piping plover and red knot share similar habitats and winter and migration patterns in Louisiana. Major threats to this species along the Gulf of Mexico include the loss and degradation of habitat due to erosion, shoreline stabilization, and development; disturbance by humans and pets; and predation.

The red knot was listed as threatened in 2014. As required by the ESA, USFWS is reviewing the U.S. range of the red knot to identify critical habitat.

Species Recently Delisted as Threatened or Endangered - The brown pelican was removed from the USFWS endangered species list in 2009 (Federal Register, Volume 74, Number 220, November 17, 2009) due to successful recovery efforts. The brown pelican is still protected under the Migratory Bird Treaty Act.

Brown pelicans nest in colonies on small coastal islands in salt and brackish waters. Nesting islands are often chosen near channels where shipping and shrimping operations make fish easily available to nesting pairs (USACE 2004). They were reintroduced into Louisiana from Florida from 1968 to 1980, and nesting populations were established on North Island in the Chandeleur Islands. In 2000, Chandeleur Island nesting populations were relocated to the mouth of Baptiste Collette Pass, but the birds returned to the Chandeleur Islands. Other nesting areas in Louisiana are Raccoon and Wine Islands in the Isles Dernieres barrier island system, Queen Bess Island in Barataria Bay, West Breton Island in Breton Sound, and most recently, Rabbit Island in Calcasieu Lake (USACE 2004).

Bald eagles were removed from the USFWS endangered species list in 2007 (Federal Register, Volume 72, Number 130, July 9, 2007) because their populations recovered sufficiently. However, this species is still protected under the Migratory Bird Treaty Act, the Bald and Golden Eagle Protection Act, and the Lacey Act. The USFWS developed the National Bald Eagle Management (NBEM) Guidelines to provide landowners, land managers, and others with information and recommendations regarding how to minimize potential project impacts to bald eagles, particularly where such impacts may constitute “disturbance”, which is prohibited by the Bald and Golden Eagle Protection Act.

Bald eagles are known to occur within the study area. At least one bald eagle nest is currently located within 1,500 feet of HNC and a proposed dredge disposal site. Other bald eagle nests may also be proposed project area. The USFWS Fish and Wildlife Coordination Act (FWCA) Report for the 2002 MTG PEIS, documented at least 30 bald eagles nests (present and historical) in the MTG study area (USACE 2002). This species prefers habitat near large rivers, lakes, and estuaries with large trees in fairly open stands required for roosting and nesting. In southeastern Louisiana, nests are often built in large bald cypress trees that are located near fresh to intermediate marshes or open water (USACE 2004).

The Louisiana black bear is distinguished from other black bears by a longer and narrower skull and it possesses proportionately larger molar teeth. They are big, bulky mammals. They have brown muzzles and long black hair, although fur can vary in shades of brown or red, and some have white chest patches. Weight ranges between 200 to 400 pounds for males and 120 to 200 pounds for females.

The Louisiana black bear is a habitat generalist and often overwinters in hollow cypress trees either in or along sloughs, lakes or riverbanks in bottomland hardwoods. These bears are mobile, opportunistic, largely herbivorous omnivores that exploit a variety of foods, including insects.

The distribution and abundance of foods, particularly mast such as nuts and berries, largely affect their movements. Important elements of black bear habitat include hard and soft mast, escape cover, den sites, travel corridors and minimum human disturbance.

The Louisiana black bear was once distributed throughout eastern Texas, southern Arkansas, Louisiana and southern Mississippi, but populations in this region were decimated from excessive harvest and habitat loss and degradation. Only about 300 Louisiana black bears are left in Louisiana, with breeding populations currently existing in three isolated pockets of Louisiana. The northernmost population is found in the Tensas River basin, the southernmost population is in the lower Atchafalaya River basin, and a third population is sandwiched between these two in the Morganza floodway system.

Additionally, Bayou Teche National Wildlife Refuge (NWR), located west of the HNC study area in St. Mary parish, was established under the authority of the Endangered Species Act on lands important to the coastal subpopulation of bears and became the first Federal lands within the area of this surviving sub-population. The Refuge is also the only NWR with a primary mission of conservation of habitat for the threatened Louisiana black bear.

5.9 Historic and Cultural Resources

Numerous cultural resources investigations have been conducted in the project vicinity. In the first investigation as part of the MTG project, Brown *et al.* (1997) reviewed cultural resources reports, consulted state archaeological site files and standing structure surveys, mapped known cultural resources within the right-of-way of two proposed protection levee alternatives, conducted geomorphic analysis to identify potential site locations, developed a predictive model of cultural resources site occurrence, and prepared recommendations for further archaeological investigations.

In the second report presented in two volumes, Brown *et al.* (2000) and Robblee *et. al*. (2000) respectively, researchers edit Brown's 1997 report and present the results of a Phase I sample survey. The Phase I fieldwork confirmed the predictive model prepared and subsequently tested by Goodwin & Associates Inc. in 2000, which confirmed a very high probability for the presence of archaeological sites on natural levees in the northern portion of the project area. All of the archaeological sites were located on natural levees in areas predicted to contain sites. No sites were identified in the low probability areas. Researchers conclude that additional significant prehistoric and historic cultural resource sites might be found within the unsurveyed portions of the right-of-way.

Additionally, CEMVN conducted underwater cultural resources investigations for two proposed projects located along the southern end of the HNC in Terrebonne Bay. Birchett and Pearson (1998) presented the results of a remote-sensing survey and diving investigations undertaken to locate and assess underwater cultural resources within the Cat Island Pass Channel. The survey was conducted to locate and assess significant historic shipwrecks or other underwater resources that may exist in the approximately 100-acre project area. The remote sensing survey identified four targets exhibiting shipwreck characteristics. Underwater investigations revealed that none of the targets represented significant cultural remains.

Pearson (2001) presented the results of remote sensing survey data obtained from a 450-acre open-water area proposed for the construction of an artificial island using shoal material removed from the adjacent HNC. A number of small side-scan sonar targets were conducted along portions of the HNC with several magnetic anomalies recorded during the survey but were not considered to represent significant cultural remains.

Ryan and others (2003) conducted a cultural resource evaluation of the entire length of the HNC project area. Researchers utilized an exhaustive literature search, site records review, and sample archaeological survey to identify and map previously recorded and newly discovered archaeological sites and to determine high probability locations in the study area. Based on these results, the authors prepared a research design to guide further cultural resource investigations in specific terrestrial and submerged project areas that could be directly impacted by proposed construction.

Although the three investigations noted above did not identify any significant resources, numerous historic shipwrecks have been identified within the project vicinity. Bayous Terrebonne, du Large, and Grand Caillou were primary routes for waterborne commerce. A cultural resource investigation conducted along Bayou du Large by Robinson and Seidel in 1997 recorded six vernacular watercraft and strongly suggests that watercraft from all time periods could be present within the project area.

The most recent investigation conducted in 2008 was an intensive survey of the high probability areas previously identified by Coastal Environments, Inc. (CEI) , as well as offshore disposal areas, were surveyed and remote sensing for the HNC Deepening and Cat Island Pass project areas. Researchers located and evaluated cultural resources that might be affected by the proposed project. The overall cultural resources effort undertaken for the HNC Deepening Project involved an extensive amount of terrestrial survey of upland construction and disposal areas and Phase I remote-sensing surveys of portions of Bayou Grand Caillou as well as areas in Terrebonne Bay where marsh restoration and shoreline protection efforts are planned. Fourteen sites and two magnetic anomalies were located during the course of the investigation.

To date, 12 previously recorded archeological sites and four new archeological sites were identified during intensive survey investigations for the HNC. Fourteen of those archeological sites are not considered eligible for inclusion in the National Register of Historic Places (NRHP) as they have since lost cultural integrity due to continued erosion since they were first previously recorded in other cultural investigations. Two magnetic anomalies, located outside of the proposed project area long Bayou Grand Caillou, were discovered during remote-sensing surveys but both locations would not be directly impacted by the proposed project as Bayou Grand Caillou has since been removed.

In a letter to the Louisiana State Historic Preservation Office dated May 27, 2009, CEMVN submitted CEI's final report which was accepted on August 13, 2009, with the condition that no cultural resources would be impacted by the proposed project implementation with avoidance of the two previously mentioned remote sensing anomalies in Bayou Grand Caillou.

The CEMVN plans to conduct additional archaeological investigations in the project area during the next project study phase. This work will be based on the recommendations and research design provided by Ryan and others (2003). In a letter to the Louisiana State Historic Preservation Office dated February 3, 2004, CEMVN submitted Ryan's draft report for comment and requested SHPO's opinion regarding the proposed research design and recommendations for further investigations.

Recently, modifications to the disposal plan made it necessary to consult SHPO to determine if additional cultural sites would be present within new disposal locations. It was determined that no new cultural resources are located within those sites (Appendix G – Annex I). However, it should be noted that some cultural resources have been identified in the vicinity of newly identified disposal locations. Therefore, care must be taken when planning access routes to those areas. The current access routes identified in Figures 4-2 and 4-3 do not disturb the cultural resources identified near those areas.

5.10 Coastal Vegetation and Wetlands

The Terrebonne Basin covers an area of over 2.06 million acres. The study area is in the southern end and contains a complex of wetlands and habitat types, including natural levees, lakes, swamps, marshes, and bayous formed from sediments of abandoned Mississippi River deltas.

In order to document the quality of the habitat in the project area in terms of its suitability for fish and wildlife use, the Wetland Value Assessment (WVA) methodology was used (CWPPRA 2007). A description of the WVA analysis can be found in Appendix L. The WVA methodology has been approved for use in the HNC Deepening project. On November 11, 2011, HQUSACE approved the use of the Barrier Headland, Barrier Island, Bottomland Hardwood, Coastal Chenier, and Swamp Models for use in coastal Louisiana. On February 28, 2012, HQUSACE approved the Coastal Marsh Community Model for this project. On March 12, 2012, the USACE National Ecosystem Planning Center of Expertise recommended single use approval for this project (Appendix L).

5.10.1 Common Plant Species in the Study Area

Approximately 50 percent of the study area consists of emergent herbaceous wetlands, including fresh, intermediate, brackish, and saline marsh (USGS 2006). The remaining wetlands are primarily wooded (mainly baldcypress/tupelo swamps and bottomland hardwood forest), which comprise almost 14 percent of the study area (USGS 2006). Plant species common in these and other habitats of the study area, including open water, scrub/shrub, and deciduous/mixed forests, are listed in Table 5-15. Some fresh and intermediate waterbodies contain submerged or floating aquatic vegetation, as shown for the Open Water habitat type (Table 5-15).

5.10.2 Coastal Wetlands

Wetlands provide necessary habitat for various species of plants, fish, and wildlife; serve as groundwater recharge areas; provide storage areas for storm and flood waters; serve as natural water filtration areas; provide protection from wave action, erosion, and storm damage; and provide various consumptive and nonconsumptive recreational opportunities.

Table 5-15. Common Plant Species in the HNC Study Area

Habitat Type	Commonly Encountered Plant Species	
Deciduous/Mixed Forest	▪ American elm *(Ulmus americana)* ▪ Drummond's maple *(Acer rubrum drummondii)* ▪ Green ash *(Fraxinus pennsylvanica)* ▪ Live oak *(Quercus virginiana)*	▪ Sugarberry *(Celtis laevigata)* ▪ Sweetgum *(Liquidambar styraciflua)* ▪ Water oak *(Quercus nigra)*
Scrub/Shrub	▪ Black willow *(Salix nigra)* ▪ Buttonbush *(Cephalanthus occidentalis)* ▪ Chinese tallow *(Triadica sebifera)* ▪ Drummond's maple *(Acer rubrum var. drummondii)*	▪ Elderberry *(Sambucus nigra canadensis)* ▪ Green ash *(Fraxinus pennsylvanica)* ▪ ▪ Groundsel bush *(Baccharis halimifolia)* ▪ Wax myrtle *(Morella cerifera)*
Woody Wetlands	▪ American elm *(Ulmus American)* ▪ Baldcypress *(Taxodium distichum)* ▪ Bitter pecan *(Carya aquatica)* ▪ Black willow *(Salix Nigra)* ▪ Boxelder *(Acer negundo)* ▪ Chinese tallow *(Triadica sebifera)*	▪ Drummond's maple ▪ Elderberry *(Sambucus nigra)* ▪ Live oak *(Quercus virginiana)* ▪ Sugarberry *(Celtis laevigata)* ▪ Water oak *(Quercus nigra)*
Fresh Marsh	▪ American cupscale *(Sacciolepis striata)* ▪ Alligatorweed *(Alternanthera philoxeroides)* ▪ Baldwin's spikerush *(Eleocharis baldwinii)* ▪ Bulltongue *(Sagittaria lancifolia)* ▪ California bulrush *(Schoenoplectus californicus)* ▪ Cattail *(Typha* sp.*)* ▪ Coastal arrowhead *(Sagittaria graminea)*	▪ Coastal water-hyssop *(Bacopa monnieri)* ▪ Common reed *(Phragmites australis)* ▪ Giant cutgrass *(Zizaniopsis miliacea)* ▪ Maidencane *(Panicum hemitomon)* ▪ Pennywort *(Hydrocotyle* spp.*)* ▪ Saltmeadow cordgrass *(Spartina patens)* ▪ Spikerush *(Eleocharis* sp.*)*

Habitat Type	Commonly Encountered Plant Species	
Intermediate Marsh	▪ Bulltongue *(Sagittaria lancifolia)* ▪ Cattail *(Typha angustifolia)* ▪ Coastal arrowhead *(Sagittaria latifolia)* ▪ Common reed *(Phragmites australis)* ▪ Coastal water-hyssop ▪ Louisiana vetch *(Vicia ludoviciana)*	▪ Fall panicgrass *(Panicum dichotomiflorum)* ▪ Chairmaker's bulrush *(Schoenoplectus americanus)* ▪ Saltmeadow cordgrass ▪ Seashore paspalum *(Paspalum vaginatum)* ▪ Wild millet *(Echinochloa* spp.*)*.
Brackish Marsh	▪ Camphorweed *(Heterotheca subaxillaris)* ▪ Coastal water-hyssop *(Bacopa monnieri)* ▪ Louisiana vetch (*Vicia ludoviciana)* ▪ Leafy three-square *(Schoenoplectus robustus)*	▪ Chairmaker's bulrush *(Schoenoplectus americanus)* ▪ Saltmeadow cordgrass *(Spartina patens)* ▪ Saltgrass *(Distichlis spicata)*
Saline Marsh	▪ Black needlerush *(Juncus roemerianus)* ▪ Leafy three-square *(Schoenoplectus robustus)* ▪ Saltgrass *(Distichlis spicata)*	▪ Smooth cordgrass *(Spartina alterniflora)* ▪ Saltmeadow cordgrass
Barrier Island	▪ Saltmeadow cordgrass ▪ Smooth cordgrass ▪ Saltwort (*Batis maritima*) ▪ Black mangrove (*Avicennia germinans*) ▪ Coastal dropseed (*Sporobolus virginicus*) ▪ Perennial pickleweeds (*Salicornia bigelovii*) ▪ Seaoxeye (*Borrichia frutescens*) ▪ Bitter panicgrass (*Panicum amarum*)	▪ Groundsel bush *(Baccharis halimifolia)* ▪ Jesuit's bark (*Iva frutescens*) ▪ Beach morning glory (*Ipomoea stolonifera*) ▪ Seashore paspalum (*Paspalum vaginatum*) ▪ Annual seepseed (*Suaeda linearus*) ▪ Seaside goldenrod (*Solidago sempervirens*) ▪ *M*arsh fimbry (*Fimbristylis castaneae*) ▪ Olney's bulrush (*Scirpus olneyi*) ▪ Shoreline seapurslane (*Sesuvium portulacastrum*)

Habitat Type	Commonly Encountered Plant Species	
Open Water (Submerged and Floating-Leaved Vegetation)	▪ American lotus (*Nelumbo lutea)* ▪ Common salvinia *(Salvinia minima)* ▪ Coontail *(Ceratophyllum* spp.*)* ▪ Duckweeds *(Lemna* spp.*)* ▪ Elodea *(Elodea canadensis)* ▪ Eurasian milfoil *(Myriophyllum spicatum)* ▪ Carolina fanwort *(Cabomba caroliniana)* ▪ Hydrilla *(Hydrilla verticillata)* ▪ Pondweeds *(Potamogeton* spp.*)*	▪ Southern naiad *(Najas guadalupensis)* ▪ Carolina mosquitofern *(Azolla caroliniana)* ▪ Water hyacinth *(Eichhoria crassipes)* ▪ Water lettuce *(Pistia stratiotes)* ▪ Watermeal *(Wolffia* sp.*)* ▪ Water stargrass *(Heteranthera dubia)* ▪ White waterlily *(Nymphaea odorata)* ▪ Wigeongrass *(Ruppia maritima)* ▪ Wild celery *(Vallisneria americana)*

Sources: Bahr *et al.* 1983; Chabreck and Condrey 1979; Connor and Day 1987; Gosselink 1984; Sasser *et al.* 1995, 1996; Ritchie and Penland 1990; Ritchie *et al* 1989, 1995; Rogers *et al.* 1990; Visser and Peterson 1995.

Louisiana contains 40 percent of the coastal wetlands in the continental United States (Gosselink 1984) and wetlands are prevalent in the study area. Coastal wetlands in the study area range from fresh marshes in the northern portion, to intermediate and brackish marshes in the central portion, to back-barrier saline marshes along the Gulf of Mexico. Typical salinity ranges for these habitats are: freshwater marsh (generally less than 0.5 ppt, but as high as 3 ppt); intermediate marsh (0.5 to 5.0 ppt); brackish marsh (5 to 18 ppt); and saline marsh (18 to 30 ppt) (Cowardin *et al.* 1979). Coastal marshes are flooded 50 to 80 percent of the time (Swenson and Swarzenski 1995). Elevation, hydrology, salinity, and soil type influence wetland community types. Elevation is critical to wetland type; small (inches) elevation changes can result in major shifts in community type (Brown 1972).

5.10.3 <u>Wetland Influences</u>

Sedimentation in salt marshes in the Terrebonne Basin appears to come mainly from open bay areas, mainly during winter prior to cold front passage when strong southerly winds precede the frontal passage (Reed 1989). After frontal passage, previously set-up water returns to the Gulf, bringing suspended matter out to the bays and Gulf (Roberts *et al.* 1987).

In addition to human and abiotic factors, coastal wetlands in the study area can be affected by animals, particularly furbearers (muskrat and nutria). Waterfowl and wading birds are abundant and can exert an influence on vegetative species composition and biomass (Fuller *et al.* 1985).

Muskrat (probably a native species) is a furbearer found mainly in brackish marshes with Olney bulrush. Nutria (introduced from South America in 1938 and about six times larger than the muskrat) has become the predominant furbearer in fresh marsh (especially flotant) and swamp (Gosselink and

Sasser 1995). Reports of muskrat damage in brackish marsh are common under high population pressure. There appears to be a 10- to 14-year cycle of marsh growth and collapse associated with muskrat populations (O'Neil 1949). Recovery of the vegetation following a muskrat eat-out is poor (Gosselink and Sasser 1995). Muskrat eat one-third of their weight per day (about 0.3 kg/day) (O'Neil 1949) or less than 1 percent of plant production. It is actually their nest building and digging that causes most of the marsh deterioration. Vegetation damage by nutria can also be serious, particularly in fresh marsh (Linscombe and Kinler 1994). Recovery appears to take longer than a year.

5.10.4 Swamp

About 4 percent of the Terrebonne hydrologic unit as of 1978 was swamp (Bahr *et al.* 1983). Coastal habitat coverage as of 2013 is presented in Figure 5-9. The two dominant species normally associated with this type of habitat in the area are baldcypress and water-tupelo. Most of the cypress was clear-cut prior to 1920, which destroyed the old-growth cypress forest (Emmer *et al.* 1993).

Historically, cypress-tupelo swamps covered much of the low-lying coastal regions of the Southeast. However, saltwater intrusion and increased flooding over the past 30 years, combined with past logging, have depleted the number of trees, and decreased the survival and growth of baldcypress in Gulf coastal areas, including the HNC area. None of the placement sites were classified as cypress swamp; however, the upper portion of the channel where shoreline retreat is occurring contains some cypress trees. Some living baldcypress trees are present in placement site 1 (Figure 4-4). The cypress trees in some of the other sites were dead. There are approximately 48 acres of cypress swamp in the project area along the bankline.

Baldcypress is a large deciduous conifer and has long been recognized for its decay resistant wood. It can grow to a height of 100 to 120 feet with a diameter of 3 to 5 feet. In the original old grove forests of the south, virgin baldcypress averaged over 500 years old and could reach a diameter of 6 feet to 8 feet. Young baldcypress tree trunks are considerably tapered and support an open, narrowly pyramidal crown. As the tree ages, the trunk become more cylindrical and the crown irregularly fattened. Older trunks often are ashy-gray with swollen, fluted bases, and branches bearded with Spanish moss. Older baldcypress trees also have a very distinctive root system. The trees will consist of several descending roots providing anchorage and many wide-spreading roots from which rise structures called *knees*. This type of root system makes the baldcypress exceptionally stable even on the most unstable sites.

5.10.5 Marshes

This study used a four-zone salinity-based classification system to document conditions and impacts in marsh as fresh, intermediate, brackish, and saline.

Fresh Marsh - About 12 percent of the Terrebonne hydrologic unit in 1978 was fresh marsh habitat and has been undergoing a precipitous decline. Fresh marshes covered approximately 24 percent of this area in 1955 according to aerial photography (Bahr *et al.* 1983). Salinities in fresh marsh are normally less than 1 ppt (parts per thousand), but can range from 0.1 to 3 ppt

(Chabreck 1982). There are two basic types of fresh marsh in the area, flotant and attached emergent.

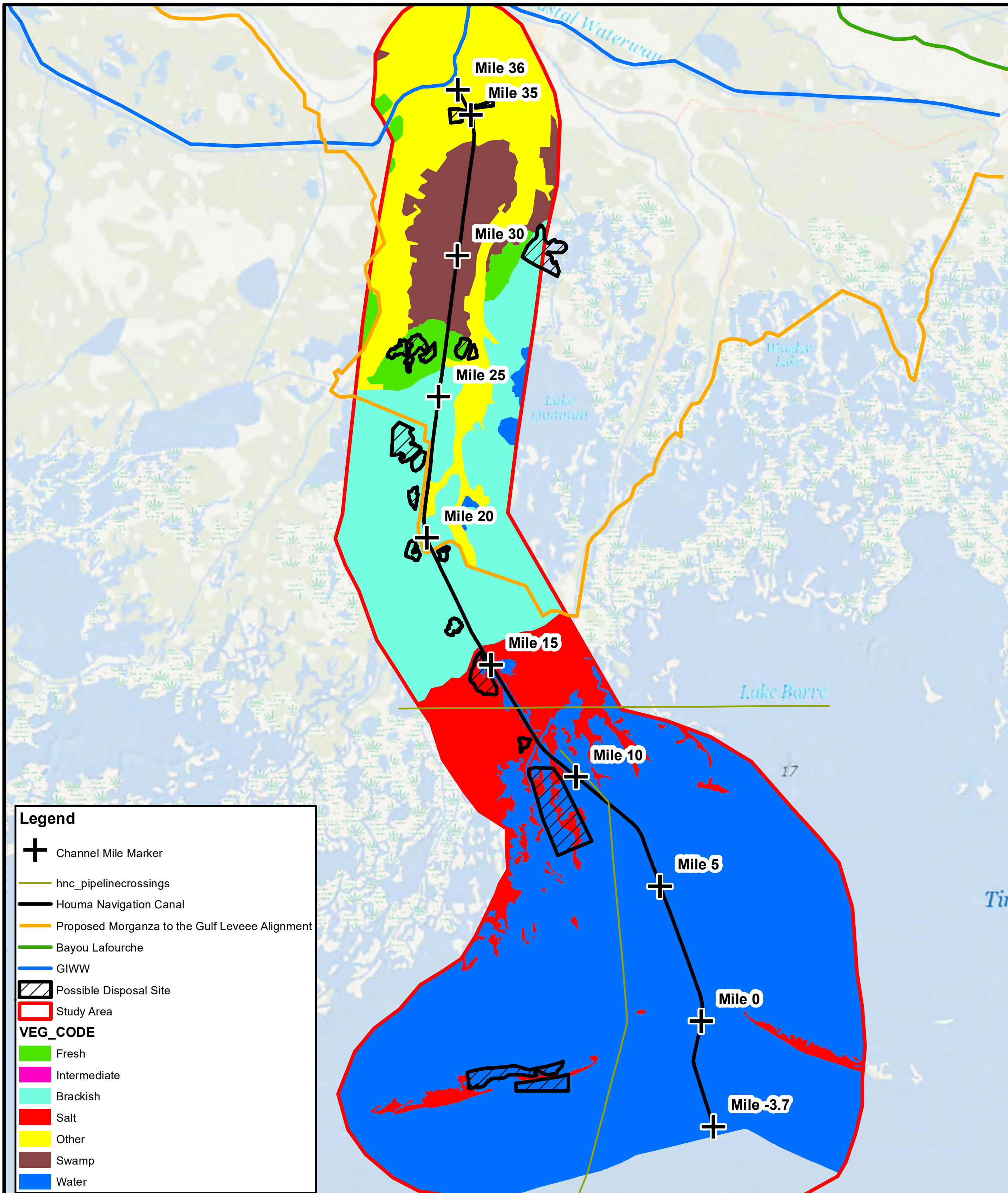
Many floating marshes (flotant or quaking mats), are found in Terrebonne Parish. Floating marshes consist of a mat of freshwater marsh vegetation on top of a layer of water. The vegetation grows on a layer of highly organic substrate. The flotant marsh is not attached to the underlying soil although the marsh plants form a dense mat that appears to be solid. Flotant marshes contain primarily maiden cane, coastal arrowhead, and Baldwin's spikerush (Sasser *et al.* 1994).

The different species and thickness of the vegetation determine the buoyancy of the mat. At certain times of year, the water level decreases and the vegetation mat lowers. During other times, the marsh floods and the vegetation mat floats higher. Landscape data from 1990 in the Barataria and Terrebonne basins of the Mississippi River Deltaic Plain indicate that flotant marshes covered about 70 percent of the freshwater and low salinity marsh zones, an area of more than 350,000 acres (Sasser *et al.* 1994).

Emergent fresh marsh is attached to the underlying soil and also contains predominantly maiden cane and coastal arrowhead, along with spikerush, alligatorweed, common reed, coastal water-hyssop, penny-wort, and saltmeadow cordgrass (Bahr *et al.* 1983; Gosselink 1984; Conner and Day 1987).

Ledet (1986) found that from 1956 to 1978, fresh marsh in the eastern half of Terrebonne Parish had been displaced inland about 1 km to 4 km. Based on current conditions, no placement sites were analyzed using the fresh marsh WVA. Fresh Marsh areas located near the study area are shown in Figure 5-9. According to the 2013 data, disposal sites 14A and A-07-A were classified as fresh marsh. However, based on more recent evaluations from the USFWS, those areas were designated as intermediate marsh when running the WVA models.

Intermediate Marsh - Intermediate marsh habitat is between fresh and brackish marsh and the species of vegetation are not much different from fresh marsh. Salinities average 3 ppt and range from 0.5 to 8 ppt (Chabreck 1982) which overlaps the fresh marsh range. The boundary between fresh and intermediate marsh approximates the influence of salt water. The dominant species differ between these two habitat categories. Many investigators have not distinguished intermediate marsh, particularly in older literature (such as Bahr *et al.* 1983). Saltmeadow cordgrass is the dominant species in intermediate marsh; coastal arrowhead, common reed, coastal water-hyssop, seashore paspalum, spikerush, and Olney's bulrush are also common (Gosselink 1984). Placement sites 12, 12B, A-07-A, and 14A (Figure 4-4) were analyzed using the intermediate marsh WVA. Approximately 629 acres of intermediate marsh are in the shoreline retreat area along the channel bank and within the proposed disposal areas (Table 5-16).



COASTAL HABITAT

Houma Navigation Canal Deepening

Service Layer Credits: Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors
Sources: Esri, GEBCO, NOAA, National Geographic, DeLorme, HERE, Geonames.org, and other contributors

Figure 5-9	
Date: May 2016	
Scale:1:300,000	
Source: ESRI/NRCS/GEC	
Map ID: 278500218-3032	

Table 5-16. Intermediate Marsh Placement Sites

Sites	Land (acres)	Open Water (acres)	Total (acres)
12	5.7	138.9	144.6
12B	50.9	5.5	56.4
A-07-A	3.9	196.7	200.6
14A	1.5	182.8	184.3
Bankline	43	0	43
Total	**105**	**523.9**	**628.9**

Brackish Marsh - Brackish marsh, as described by Bahr *et al.* (1983) covered 16 percent of the Terrebonne hydrologic unit in 1978. However, intermediate marsh was included in this category. No figures were given for 1955. Salinities in brackish marsh average 8 ppt with a range of 1 to18 ppt (Chabreck 1982). The dominant brackish marsh plant is saltmeadow cordgrass, comprising about one-half of the plants (Gosselink 1984: Conner and Day 1987). By comparison, this species comprises about one-third of the plants in intermediate marsh (Gosselink 1984). Other important species include seashore saltgrass, camphorweed, and coastal water-hyssop (Conner and Day 1987). The brackish marsh WVA model was used to analyze sites 7E, 15, 15A, 16, 19C, 19D, and 20C. The acres of marsh and open water in the brackish marsh placement sites are presented in Table 5-17.

Table 5-17. Brackish Marsh Placement Sites

Sites	Land (acres)	Open Water (acres)	Total (acres)
7E	344.3	428.2	772.5
15	28.5	112.2	140.7
15A	1.6	544.6	546.2
16	40.0	60.2	100.2
19C	4.8	70.1	74.9
19D	5.2	123.8	129.0
20C	3.2	126.4	129.6
Bankline	163	0	163
Total	**590.6**	**1465.5**	**2,056.1**

Salt Marsh - Salt marsh has the least diverse plant community. Although many plants can tolerate a periodically flooded substrate, few can tolerate the combined stresses of flooding and high salinity. Salinities average 18 ppt and range from 8 to 29 ppt (Chabreck 1982). The salt marsh represented 10 percent of the Terrebonne hydrologic unit in 1978, down considerably from 24 percent in 1955 (Bahr *et al.* 1983). Saltmarsh cordgrass dominates (62 percent) this community. Sites 21, 24, lung, and bay side of East Island were assessed using the salt marsh

WVA model. The acres of marsh and open water in these placement sites are presented in Table 5-18. These placement sites are primarily open water areas that may have been marsh in the past; there is a very high shoreline retreat rate in this area.

Table 5-18. Salt Marsh Placement Sites

Sites	Land (acres)	Open Water (acres)	Total (acres)
21	167.6	329.1	496.7
24	39	101.4	140.4
Bankline	427	0	427
Lung	156.2	2,063.8	2,220.0
Bay Side of East Island	15.2	728.2	743.4
Total	**805**	**3,222.5**	**4,027.5**

Large aggregations of decaying organic material accumulate along the edges of streams and tidal lakes. This material is the primary basis of the detrital food chain in salt marshes. The banks of the streams are slightly elevated and often support marsh hay cordgrass and the salt tolerant shrubs sea ox-eye, and marsh elder. The shrubs are occasionally covered with the parasitic vines common dodder, and pretty dodder.

The succulent saltwort, the perennial creeping glasswort, and the annual Bigelow glasswort are found in pockets of high salinity. These are often areas that are only intermittently flooded due to slightly higher elevation. In these high marsh areas, the highly salt-tolerant species salt grass, and black needle rush are also frequently present. Seaside goldenrod, and groundsel bush are occasionally found in the slightly elevated marsh areas subjected to frequent drying.

Nonvascular Plants - Not much is known about nonvascular plants in salt marshes. The regularly flooded bases of smooth cordgrass support a vigorous epiphytic population of algae, including the filamentous forms *Enteromorpha* and *Ectocarpus* in the winter, *Bostrichia*, and *Polysiphonia* in the summer, as well as a diverse population of diatoms (Stowe 1982). These epiphytes are net producers only along stream edges where adequate light is available. The microflora of the marsh surface has not been studied in Louisiana, but the cyanobacteria *Lyngbya* and *Rivularia* and the green algae *Ulothrix*, *Rhizoclonium, Chaetomorpha*, *Ulva*, *Enteromorpha*, and *Monostroma* are distributed in salt marshes around the world (Ursin 1972).

Submerged Aquatic Vegetation - Open water areas frequently contain submerged and floating leaf vegetation, particularly within water bodies in forested wetlands and low salinity marshes and areas under the influence of water control structures. Submerged aquatic vegetation in the study area includes coontail, hydrilla, elodea, pondweeds, water stargrass, wild celery, fanwort, and Eurasian milfoil. Floating leaf species such as American lotus, water lettuce, water hyacinth, water sprangles, and duckweed are common. During field observation by the HET, small quantities of submerged aquatic vegetation was found in placement sites A-07-A, 7E, 12, 12B, 14A 15, 15A, 16, 19C, and 19D.

5.10.6 Bottomland Hardwoods

Bottomland hardwoods are alluvial-forested wetlands. The Terrebonne hydrologic unit (a subunit of the Terrebonne Basin) includes the study area south to the Gulf of Mexico and west to the Atchafalaya River protection levee. Bottomland hardwoods (e.g., red maple, green ash, oaks, and American elm) covered less than 1 percent of the Terrebonne hydrologic unit as of 1978 (Bahr *et al.* 1983). This is not surprising given the low elevations, flat relief, and coastal influences of the area. Bottomland hardwoods areas are not flooded for extended periods.

The bottomland hardwoods WVA model was used to evaluate placement site 3 (Figure 4-4). Site 3 has been enclosed with dikes for use as a disposal area. Site 3 is 132 acres of primarily willows, and there are approximately 172 acres of bottomland hardwoods found within proposed disposal Sites 1 and 3.

Between the forested wetlands and marsh lies a thin band of scrub-shrub habitat. Typical vegetation includes elderberry, wax myrtle, buttonbush, Drummond red maple, and eastern baccharis.

Vegetative Invasive Species - The project area has a mild climate and abundant rainfall; this allows invasive plant species a greater chance to thrive. Exotic aquatic plants can be a particular problem for the Barataria-Terrebonne system (BTNEP 2012). Dozens of exotic plant species are already established in the Barataria-Terrebonne system. These exotics can impede water flow, block navigation, and clog structures such as drinking water intakes. The Chinese tallow is a successful invader and has become the most abundant woody species at many locations. The Chinese tallow can convert surrounding marshes from herbaceous to woody plant communities (Neyland and Meyer 1997). Other invasive plant species in marshes and canals in the area include water hyacinth and giant salvinia (*Salvinia molesta*). Both plants can form dense mats that cover water bodies with a thick layer that blocks sunlight, reducing photosynthesis and dissolved oxygen, and contributing to fish kills. Invasive plant species in Terrebonne Parish are presented in Table 5-19.

Table 5-19. Invasive Plant Species in Terrebonne Parish, Louisiana

Common Name	Scientific Name
velvetleaf	*Abutilon theophrasti*
common yarrow	*Achillea millefolium*
alligator weed	*Alternanthera philoxeroides*
redroot pigweed	*Amaranthus retroflexus*
common ragweed	*Ambrosia artemisiifolia*
stinking chamomile	*Anthemis cotula*
wild celery	*Apium graveolens*
coral ardisia	*Ardisia crenata*
mugwort	*Artemisia vulgaris*
giant reed	*Arundo donax*
oat	*Avena sativa*

Common Name	Scientific Name
hairy beggarsticks	*Bidens pilosa*
birdsrape mustard	*Brassica rapa*
field brome	*Bromus arvensis*
rescuegrass	*Bromus catharticus*
hedge bindweed	*Calystegia sepium*
shepherd's purse	*Capsella bursa-pastoris*
balloonvine	*Cardiospermum halicacabum*
common caraway	*Carum carvi*
cornflower	*Centaurea cyanus*
sticky chickweed	*Cerastium glomeratum*
night Jessamine night Jessamine	*Cestrum nocturnum*
lambsquarters	*Chenopodium album*
camphortree	*Cinnamomum camphora*
field thistle	*Cirsium discolor*
rose glorybower	*Clerodendrum bungei*
turk's turbin	*Clerodendrum indicum*
coco yam, wild taro	*Colocasia esculenta*
Asiatic dayflower	*Commelina communis*
hairy fleabane	*Conyza bonariensis*
lesser swinecress	*Coronopus didymus*
melon	*Cucumis melo*
dudaim melon	*Cucumis melo* var. *dudaim*
tarweed cuphea	*Cuphea carthagenensis*
bermudagrass	*Cynodon dactylon*
rice flatsedge	*Cyperus iria*
purple nutsedge	*Cyperus*
crowfootgrass	*Dactyloctenium aegyptium*
jimsonweed	*Datura stramonium*
violet crabgrass	*Digitaria violascens*
Indian mock-strawberry	*Duchesnea indica*
mexicantea	*Dysphania ambrosioides*
junglerice	*Echinochloa colona*
barnyardgrass	*Echinochloa crus-galli*
Brazilian waterweed	*Egeria densa* Planch.
common water hyancith	*Eichhornia crassipes*
goosegrass	*Eleusine indica*
loquat	*Eriobotrya japonica*
petty spurge	*Euphorbia peplus*
wild buckwheat	*Fallopia convolvulus*
tall fescue	*Festuca arundinacea*
edible fig	*Ficus carica*
fennel	*Foeniculum vulgare*
hydrilla	*Hydrilla verticillata*
red morningglory	*Ipomoea coccinea*
ivyleaf morningglory	*Ipomoea hederacea*
cypressvine morningglory	*Ipomoea quamoclit*

Common Name	Scientific Name
goldenrain tree	*Koelreuteria paniculata*
Kummerowia	*Kummerowia* spp.
common lespedeza	*Kummerowia striata*
crapemyrtle	*Lagerstroemia indica*
Henbit	*Lamium amplexicaule*
largeleaf lantana	*Lantana camara*
lionsear	*Leonotis nepetifolia*
glossy privet	*Ligustrum lucidum*
Chinese privet	*Ligustrum sinense*
privet	*Ligustrum* spp.
common flax	*Linum usitatissimum*
perennial ryegrass	*Lolium perenne*
Japanese honeysuckle	*Lonicera japonica*
bush honeysuckles (exotic)	*Lonicera* spp.
large-flower primrose-willow	*Ludwigia grandiflora*
Japanese climbing fern	*Lygodium japonicum*
threelobe false mallow	*Malvastrum coromandelianum*
black medic	*Medicago lupulina*
California burclover	*Medicago polymorpha*
alfalfa	*Medicago sativa*
alfalfa	*Medicago sativa* spp. *sativa*
chinaberry	*Melia azedarach*
annual yellow sweetclover	*Melilotus indicus*
yellow sweet-clover	*Melilotus officinalis*
natalgrass	*Melinis repens*
spearmint	*Mentha spicata*
peppermint	*Mentha x piperita*
common four-o'clock	*Mirabilis jalapa*
balsamapple	*Momordica charantia*
parrotfeather	*Myriophyllum aquaticum*
Eurasian water-milfoil	*Myriophyllum spicatum*
oleander	*Nerium oleander*
pink woodsorrel	*Oxalis debilis* var. *corymbosa*
torpedograss topedograss	*Panicum repens*
ragweed parthenium	*Parthenium hysterophorus*
dallisgrass	*Paspalum dilatatum*
vaseygrass	*Paspalum urvillei*
parsley	*Petroselinum*
canarygrass	*Phalaris canariensis*
timothy	*Phleum pratense*
European common reed	*Phragmites australis* subsp. *australis*
chamber bitter	*Phyllanthus urinaria*
buckhorn plantain	*Plantago lanceolata*
broadleaf plantain	*Plantago major*
annual bluegrass	*Poa annua*
prostrate knotweed	*Polygonum aviculare*

Common Name	Scientific Name
black bindweed	*Polygonum convolvulus var. convolvulus*
rabbitfoot polypogon	*Polypogon monspeliensis*
common purslane	*Portulaca oleracea*
peach	*Prunus persica*
pomegranate	*Punica granatum*
scarlet firethorn	*Pyracantha coccinea*
common pear	*Pyrus communis*
Macartney rose	*Rosa bracteata*
Cherokee rose	*Rosa laevigata*
itchgrass	*Rottboellia cochinchinensis*
Britton's wild petunia	*Ruellia simplex*
curly dock	*Rumex crispus*
curly dock	*Rumex crispus* ssp. *crispus*
Russian thistle	*Salsola kali*
water fern	*Salvinia minima*
giant salvinia	*Salvinia molesta*
common groundsel	*Senecio vulgaris*
red sesbania	*Sesbania punicea*
yellow foxtail	*Setaria pumila*
cattail grass	*Setaria pumila* ssp. *pallidefusca*
bristlegrass	*Setaria spp.*
hedge mustard	*Sisymbrium officinale*
spiny sowthistle	*Sonchus asper*
annual sowthistle	*Sonchus oleraceus*
sorghum	*Sorghum bicolor*
johnson grass	*Sorghum halepense*
common chickweed	*Stellaria media*
common chickweed	*Stellaria pallida*
common dandelion	*Taraxacum officinale* ssp. *officinale*
Chinese tallowtree	*Triadica sebifera*
puncturvine	*Tribulus terrestris*
small hop clover	*Trifolium dubium*
red clover	*Trifolium pratense*
white clover	*Trifolium repens*
tall vervain	*Verbena bonariensis*
Brazilian vervain	*Verbena incompta*
seashore vervain	*Verbena montevidensis*
corn speedwell	*Veronica arvensis*
common vetch	*Vicia sativa*
garden vetch	*Vicia sativa* ssp. *nigra*
hairy vetch	*Vicia villosa*
big periwinkle	*Vinca major*
periwinkle	*Vinca* spp.
English violet	*Viola odorata*
Chinese wisteria	*Wisteria sinensis*
wisterias	*Wisteria* spp.

Common Name	Scientific Name
Asiatic hawksbeard	*Youngia japonica*

Source: (EDDMapS, 2014).

5.11 WATER ENVIRONMENT

5.11.1 Hydrologic Features

As described in Section 5.1.1, the HNC generally runs north-south, connecting the GIWW with the Gulf of Mexico. The GIWW follows an east-west path across the northern portion of the study area. These two manmade channels, along with the natural streams in the area, strongly influence surface water and salinity in the area. The streams and waterways within, or influencing, the study area include the Atchafalaya River, Bayou du Large, Bayou Grand Caillou, Bayou Petit Caillou, Falgout Canal, the GIWW, and the HNC (Figure 5-2).

The Atchafalaya River located west of the study area influences freshwater inflows to the study area. Water from the Atchafalaya River enters the GIWW and flows eastward to the HNC. The influence of the Atchafalaya River on the study area varies annually depending on the flow of the Mississippi River. The Old River Control structures are operated to maintain the distribution of flow between the Mississippi and Atchafalaya Rivers, and to prevent the Atchafalaya River from capturing the flow of the Mississippi River. The Old River Control project consists of several large engineering structures, including the Old River Low Sill and Overbank Structures, the Old River Lock, and the Auxiliary Structure. The Old River Control Structure maintains a 70 percent distribution of flow down the Mississippi River and 30 percent down the Atchafalaya River. The flow from the Red River is a part of the 30 percent in the Atchafalaya River.

Terrebonne Basin - The Terrebonne Basin is in southeastern Louisiana between the Mississippi River and the Gulf of Mexico. The basin is comprised of lowlands that are prone to flooding, except in areas protected by levees. The coastal portion of the basin is prone to tidal flooding and consists of fresh to saline marshes (LDEQ 1999). The project area is in the coastal portion of the basin. Land use in the project area was determined using USGS GAP data collected between 2007 and 2012. The project area is approximately 64 percent open water, 21 percent salt marsh, 6 percent forest and swamp, 4 percent agricultural, 4 percent developed, and 1 percent beach and coastal prairie.

The 2010 LDEQ IR reported 27 water bodies in the basin were either partially or not supporting the designated uses, and that the primary causes of impairment included low dissolved oxygen, fecal coliform, solids/sedimentation, and turbidity (LDEQ 2010).

Houma Navigation Canal – The Houma Navigation Canal is a 39.8 mile long Federal navigation channel that generally runs north-south and connects the Gulf Intracoastal Waterway (GIWW) with the Gulf of Mexico (Gulf). The Northern portion of the HNC intersects the GIWW. The Port of Terrebonne is located on the Houma Navigation Canal less than 0.5 mile south of the GIWW. The HNC channel ends at approximately Mile −3.5 in the Gulf.

The HNC consists of three reaches, Inland Reach (Mile 36.3 to 10.1), Terrebonne Bay Reach (Mile 10.1 to 0.0), and Cat Island Pass Reach (Mile 0.0 to −3.5) (Figure 3-1). The HNC is presently authorized to a -15 feet Mean Low Gulf (MLG) depth by 150 foot-wide channel, beginning at Mile 36.3, at the intersection of the HNC with the GIWW in Houma, proceeding southward through Terrebonne Bay Reach to Mile 0.0. The Cat Island Pass Reach is authorized to a depth of −18 feet MLG by 300 feet wide to the −18 feet MLG contour (approximately Mile −3.5).

5.11.2 Tides and Currents

Tides in the study area are diurnal with mean ranges of about 0.2 feet at the GIWW tidal gauge at Houma and 1.2 feet at Bayou Petit Caillou at Cocodrie. Spring tidal ranges at the Cocodrie station can be more than 2 feet and neap tidal ranges can be less than 0.5 foot. The tidal amplitude decreases inland. Tides and winds primarily control water levels near Wine Island and adjacent barrier islands. Wave action, freshwater runoff, and atmospheric pressure also contribute to water levels. Water levels can be affected by natural events such as hurricanes and winter storms. Hurricanes can raise the water level by 12 feet or more; whereas, northerly winter winds can depress nearshore water levels by more than 3 feet.

The Louisiana inner shelf is a low-energy environment where significant hydrodynamic activity is generated almost exclusively by local tropical and extratropical storms. Circulation of coastal waters depends on driving forces such as tides, wind, and atmospheric pressure. Additional circulation mechanisms include high rainfall, large volumes of fresh water from the Mississippi and Atchafalaya Rivers, currents induced by density differences and mixing processes between fresh and saltwater masses, local shoreline and bathymetric features such as the mouth of the Mississippi River, barrier islands, marshes, inlets, and bays. Much of the tidal exchange between the back-barrier areas of Caillou Bay, Terrebonne Bay, and Timbalier Bay and the Gulf of Mexico occurs through broad shallow channels; however, several relatively deep (20- to 33-ft) passes are maintained by relatively strong tidal currents (3.3 ft/s). Wind- and barometric pressure-induced circulation is important in the bays, lakes, marshes, and subtidal areas and can result in extreme water level fluctuations.

5.11.3 Relative Sea Level Rise

Relative sea level rise (RSLR) is the combined rate of sea level rise and the rate of subsidence. RSLR affects marshes in the study area by gradually inundating marsh plants. Marsh soil surfaces must vertically accrete to keep pace with the rate of RSLR, or marshes eventually convert to open water due to the depth of submergence. Estimates for RSLR are based on Engineering Circular (EC) 1165-2-212 *Sea-Level Change Considerations for Civil Works Projects, October 1, 2011*. According to the EC guidance, the RSLR is estimated for low (historic), intermediate, and high sea level rise scenarios. The low (historic) rate of RSLR is based on the USACE Gage (82350) Bayou Lafourche at Leeville, Louisiana. Historic RSLR is 7.79 mm/yr and the rate of subsidence is 6.09 mm/yr. The intermediate and high scenarios of RSLR use the eustatic sea level rise derived from the National Research Council equations NRC I (intermediate) and NRC III (high), and the subsidence rate computed from the Leeville gage. The USACE gage Bayou Lafourche at Leeville, Louisiana was used to compute the historic subsidence rate in the study area as approximately 2.0 feet/century. Estimates of low, intermediate, and high rates of RSLR are presented for the year that construction is expected to be completed (2027) and for the 50-year project life (2077) (Table 5-20; Figure 5-10).

Table 5-20. Relative Sea Level Rise

Scenarios	Construction Completed (2027) RSLR (feet)	Project Life 50 years (2077) RSLR (feet)
Low (historic)	0.43	1.71
Intermediate	0.51	2.33
High	0.77	4.27

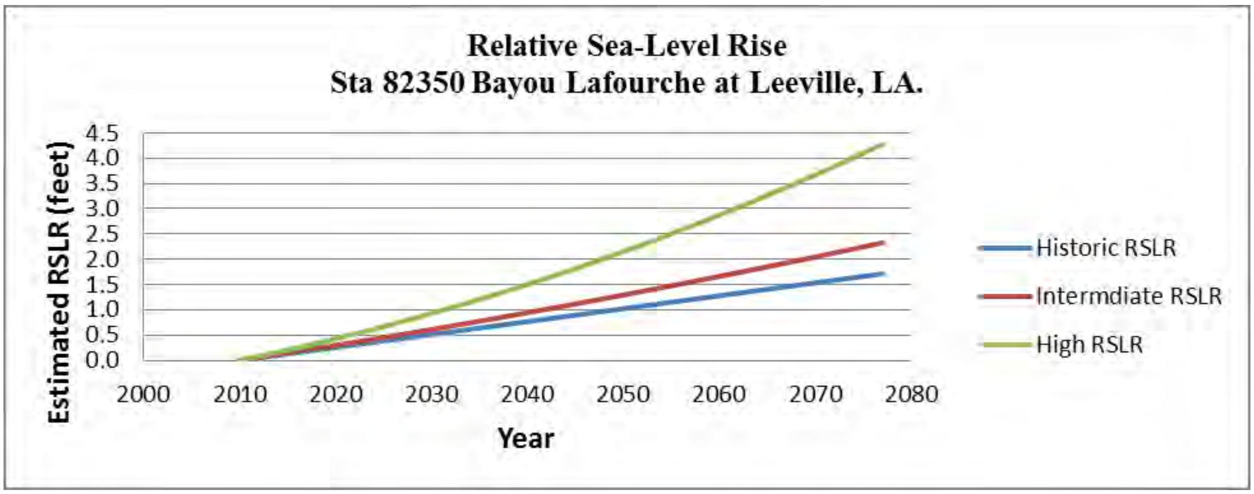


Figure 5-10. Relative Sea Level Rise

5.11.4 Storms and Floods of Record

The study area has experienced numerous floods from tides, hurricanes, tropical storms, and heavy rainfall. Eighteen hurricanes have caused high stages and flooding along the HNC since 1957, and have shut down navigation use for several days (National Weather Service, 2010). A description of these significant storms and floods follows:

a. June 1957. Hurricane Audrey, June 25-28, 1957, caused tidal flooding along the Louisiana coast. A high stage of 8.05 ft NGVD at the Sweet Bay Lake gage in the Atchafalaya area and 3.29 ft NGVD at Grand Isle were recorded.

b. September 1961. Hurricane Carla, September 4-14, 1961, raised tides 3 to 4 feet above normal along the entire Louisiana coastline. A high stage of 4.6 ft NGVD at the Sweet Bay Lake gage and 4.04 ft NGVD at Leeville were recorded. A high stage of 3.15 ft NGVD was observed at the Houma gage on September 14, 1961.

c. October 1964. Hurricane Hilda, during the period of October 3-5, 1964, caused extensive tidal and headwater flooding in the area. Heavy rainfall and several tornadoes were generated by this storm. A high water mark of 5.5 ft NGVD occurred near the Sweet Bay Lake gage. High stages of 5.49 ft NGVD at the Leeville gage and 3.27 ft NGVD was recorded at the Houma gage were recorded on 4 October 1964.

d. September 1971. Hurricane Edith, September 5-17, 1971, had a stage of 4.26 ft NGVD at the Cocodrie gage and 3.52 ft NGVD at the Houma gage.

e. 1973 Flood. Headwater from rainfall events caused flooding throughout the area during the spring of 1973.

f. September 1974. Hurricane Carmen, September 7-8, 1974, caused tidal and headwater flooding. A questionable high water mark of 11.67 ft NGVD was observed near the Cocodrie gage and high stages of 5.66 ft NGVD at the Leeville gage and 3.81 ft NGVD at the Houma gage were recorded.

g. September 1977. Hurricane Babe, September 3-9, 1977, a Category 1 storm, made landfall just west of the project area producing high stages and rainfall. High stages of 8.68 ft NGVD at the Cocodrie gage and 3.77 ft NGVD at the Houma gage were recorded.

h. August 1985. Hurricane Danny, August 12-20, 1985, was a minimal hurricane that produced high tides in the area. A high stage of 6.70 ft NGVD was recorded at the Eugene Island gage in the Atchafalaya Bay and 5.63 ft NGVD at the Grand Isle gage.

i. October 1985. The prolonged stay of Hurricane Juan during October 26-31, 1985 produced backwater flooding and high water levels throughout the area. A high stage of 5.05 ft MLG was recorded at the Belle Isle gage near the mouth of the Atchafalaya River, 7.39 ft NGVD at the Cocodrie gage, 6.62 ft NGVD at the Leeville gage, and 5.63 ft NGVD at the Grand Isle gage. The storm surge propagated inland and a high stage of 5.17 ft NGVD was recorded at the Houma gage.

j. August 1992. Hurricane Andrew, August 24-27, 1992, caused flooding from high tides and heavy rains in the study area. High stages of 7.65 ft NGVD at the Deer Island gage near the mouth of the Atchafalaya River, 5.61 ft NGVD at the Leeville gage on Bayou Lafourche, and 3.54 ft NGVD at Grand Isle were recorded.

k. July 1997. Hurricane Danny, July 16-27, 1997, a Category 1 storm that originated in the northern Gulf produced a stage of 4 ft NGVD at Barataria Pass.

l. June 2001. Tropical Storm Allison, June 4-12, 2001, produced heavy rains in the study area. Stages above 3 ft persisted for several weeks along the lower Atchafalaya River producing backwater high stages throughout the project area.

m. October 2002. Hurricane Lili, October 1-6, 2002, produced high stages of 8.0 ft NGVD at the Cocodrie gage, 6.05 ft at the Golden Meadow gage, 5.01 ft at the USGS gage at Barataria Pass on October 3, 2002, and a stage of 4.09 ft NGVD at the Houma gage on October 4, 2002.

n. August 2005. Hurricane Katrina, August 23-31, 2005, crossed the Mississippi River east of the study area. A high stage of 8.53 ft was recorded at the USGS gage at Barataria Pass. High stages in the study area were considerably lower because winds to the west of the storm were generally offshore.

o. September 2005. Hurricane Rita, September 18-26, 2005, produced very high stages throughout southern Louisiana, particularly western Louisiana. A peak stage of 10.1 ft NGVD was recorded at the Eugene Island gage in Atchafalaya Bay and 6.95 ft NAVD88 at the USGS gage at Caillou Lake southwest of Dulac.

p. September 2008. Hurricane Gustav, August 25-September 5, 2008, came ashore east of the project area but still produced high stages of 4.76 ft NGVD at Sweet Bay Lake on the lower Atchafalaya River and 3.57 ft NGVD at Houma.

q. September 2008. Hurricane Ike, September 1-15, 2008, produced high stages throughout coastal Louisiana. High stages of 7.72 ft NGVD at Sweet Bay Lake and 6.33 ft NGVD at Golden Meadow were recorded.

r. August 2012. Hurricane Isaac, August 29-30, 2012, crossed the HNC near Dulac, Louisiana. A high stage of 8.88 feet was recorded at the USGS gage at the Rigolets near Slidell, Louisiana. High stages in the study area were considerably lower. A high stage of 4.08 ft was recorded at the USGS gage Caillou Lake (Sister Lake) southwest of Dulac.

Numerous tropical storms have passed through or near the project area since 1957, raising stages by several feet and producing significant rainfall (National Weather Service, 2010). Some of these storms include:

- Tropical Storm Bertha in August 1957
- Tropical Storm Esther in September 1957
- Tropical Storm Arlene in May 1959
- Tropical Storm Felice in September 1970
- Tropical Storm Frances and Tropical Storm Hermine in September 1998
- Tropical Storm Bertha in August 2002
- Tropical Storm Isidore in September 2002
- Tropical Storm Bill in June 2003
- Hurricane Ivan’s second approach to the northern Gulf shoreline as a tropical storm on 23-24 September 2004
- Tropical Storm Mathew in October 2004
- Tropical Storm Edouard in August 2008

- Tropical Storm Bonnie in July 2010
- Tropical Depression 5 in August 2010
- Tropical Storm Lee in September 2011
- Tropical Storm Karen in October 2013

5.11.5 Groundwater

Groundwater in the study area is at or near the surface. Most potable water in the area comes from the surface waters of bayous and the GIWW; however, this water may require considerable treatment. Aquifers at a depth of 150 to 200 feet in the northern portions of Terrebonne Parish may contain fresh water but become contaminated with salt water during drought periods.

5.11.6 Saltwater Intrusion

Salinities in the HNC grade from predominantly fresh water in the interior to seawater in the Gulf. Daily variations in salinity occur due to tidal flow and at greater intervals due to meteorological and seasonal factors. Winter frontal systems and tropical storms can create wind-driven tides which may substantially change water levels in the shallow estuary. RSLR will likely increase future salinities in the HNC and the GIWW.

Salinity fluctuations due to tidal flow and winter frontal systems at the Cocodrie gage are shown in Figure 5-11. The hourly record for the USACE gage at Bayou Petit Caillou at Cocodrie (76305) during January 2001 is presented. During the first 5 to 7 days, there was a daily salinity fluctuation of about 1 part per thousand (ppt); subsequent fluctuations of 3 to 4 ppt occurred every 3 to 4 days. Although winter frontal fluctuations are significantly greater than the fluctuations due to tidal flow, the tidal influence can still be discerned.

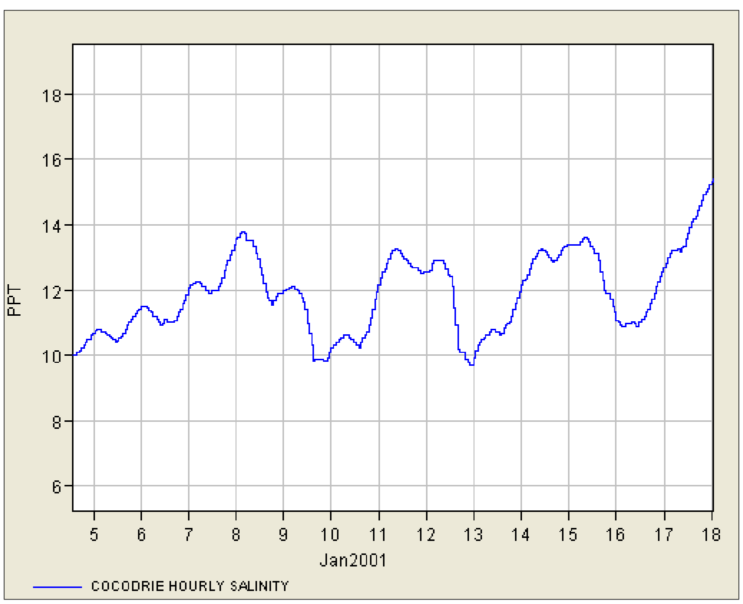


Figure 5-11. Typical Salinity Fluctuations at the Cocodrie Gage

Many natural and manmade pathways convey saltwater into, and out of, the project area and to the GIWW at Houma. Mississippi and Atchafalaya River flows also vary seasonally, affecting salinities in the area. Variations in the flow of the Mississippi and Atchafalaya Rivers create salinity changes on a greater time scale and can induce larger changes in salinity levels in the project area. During large Atchafalaya River discharges, considerable quantities of fresh water flow eastward into the GIWW from Morgan City to Houma. Salinities can be reduced throughout the project area as fresh water enters the HNC and proceeds toward the Gulf. Conversely, when the flow in these rivers is very low, salinity levels throughout the project area may substantially increase. Large river discharges can greatly reduce offshore salinities in the project area.

Daily and hourly salinities within the HNC study area (except during the 1999–2000 drought) had no obvious pattern of increasing levels after the HNC was constructed (Steyer *et al.* 2008). There is a long-term trend of increasing salinities at Bayou Grand Caillou at Dulac. This pattern is similar to that observed at the Houma Water Treatment Plant. Possible explanations for the long term trend of increasing salinity are that the HNC increased hydraulic connectivity and allowed salinities to increase, or the increasing salinity could be a result of the general breakup of the marsh, subsidence, and sea level rise resulting in greater flow exchange of higher salinity bay water (Steyer *et al.* 2008).

Prior to construction of the HNC, vegetation in marshes east of the HNC shifted from fresh to intermediate types (Steyer *et al.* 2008). This vegetative shift may be a result of the general breakup of the marsh, which was quite extensive by 1978, rather than a direct impact of the HNC. Prior to construction of the HNC, the salinities at Bayou Grand Caillou were high enough to impact the fresh floating marshes in the areas east of the HNC (Steyer *et al.* 2008). During this time, the marshes and the Bayou Grand Caillou were primarily connected through smaller, sinuous channels with limited water exchange (Steyer *et al.* 2008). The HNC provided a more efficient connection between the HNC and Bayou Grand Caillou (USACE 1975). This increased connectivity may have allowed higher salinity waters to reach the marshes west of the HNC and the lower portion of Bayou Grand Caillou (south of Dulac); in particular, areas just north and south of Falgout Canal. These areas also were impounded by numerous canal spoil banks, which may have exacerbated any salinity intrusion events by holding water for greater periods (Swenson and Turner 1987).

5.12 Water Quality

Louisiana's coastal plain is rich with water resources, including rivers and streams, lakes, estuaries, and wetlands. These water resources to support the state's economy as well as basic, daily needs such as drinking water supply. These resources need to be protected from anthropogenic pollutants that can enter water bodies from point sources and/or nonpoint sources. As defined by the U.S. Environmental Protection Agency (EPA), point sources are discrete conveyances such as pipes or man-made ditches. Individual homes connected to a municipal system, use a septic system, or do not have a surface discharge do not need a NPDES (National Pollutant Discharge Elimination System) permit; however, industrial, municipal, and other facilities must obtain permits for discharges that directly enter surface waters. Nonpoint sources are defined by the Louisiana Department of Environmental Quality (LDEQ) as diffuse sources of water pollution that typically do not enter the water through a discharge pipe, but flow freely across exposed surfaces, transporting sediments from construction sites, agricultural fields and harvested forests (LDEQ 2007).

The *2016 LDEQ Integrated Report* (IR) documents the LDEQ progress towards protecting the chemical, physical, biological, and aesthetic integrity of the water resources and aquatic environment of Louisiana pursuant to Clean Water Act (CWA) sections 303(d) and 305(b) (LDEQ 2016). Section 303(d) requires that states list water bodies that are impaired for their designated use, and formulate a Total Maximum Daily Load (TMDL) for impaired water bodies. An impaired water body is a subsegment of water that is unable to meet the water quality criteria for its designated uses. LDEQ defines a subsegment as a named regulatory water body as defined by Louisiana water quality standards regulation LAC 33:IX.1123. They are considered representative of the watershed through which they flow and have numerical criteria assigned to them. LDEQ has three categories of primary designated uses for most state waters, including: primary contact recreation, secondary contact recreation, and fish and wildlife propagation. These are defined along with secondary designated uses in the Water Quality Evaluation (Appendix A, Annex II) and listed here: Primary Contact Recreation (PCR), Secondary Contact Recreation (SCR), Fish and Wildlife Propagation (FWP), Drinking Water Supply (DWS), Outstanding Natural Resource (ONR), Oyster Propagation (OYS), Agricultural Use (AGR), Limited Aquatic Life and Wildlife (LAL).

According to the 2016 LDEQ IR, the most common individual designated uses in the coastal plain include primary contact recreation, secondary contact recreation, fish and wildlife propagation, shellfish propagation, and drinking water supply. In 2016, 72 percent of Louisiana's named water quality management subsegments or watersheds assessed for primary contact recreation were fully supporting the designated use, 96 percent of those assessed for secondary contact recreation were fully supporting the use, and 31 percent of those assessed for fish and wildlife propagation were fully supporting their designated use. In coastal Louisiana, 94 percent of estuaries assessed for primary contact recreation were supporting their use and 96 percent of secondary contact recreation were fully supporting their use, and 73 percent of those assessed for fish and wildlife propagation were fully supporting their use. Of the Louisiana rivers and streams assessed for the primary designated uses, 66 percent were fully supporting primary contact recreation, 95 percent were fully supporting secondary contact recreation, and 73 percent were fully supporting fish and wildlife propagation. Of the Louisiana wetlands assessed for the primary designated uses, 67 percent were fully supporting primary contact recreation, 100 percent were fully supporting secondary contact recreation, and 50 percent were fully supporting fish and wildlife propagation.

Low dissolved oxygen, fecal coliform, total dissolved solids, and mercury were cited as the most prevalent causes of impairment for Louisiana water bodies. The leading suspected sources of these impairments include unknown sources, atmospheric deposition, and natural conditions (an indication that the water quality standard was not set appropriately for the assessed water body). Fecal coliform, mercury, and low dissolved oxygen were the leading causes of impairment of the estuaries assessed in the 2016 LDEQ IR. The suspected sources of impairment include unknown sources, atmospheric deposition, and natural conditions. Low dissolved oxygen, mercury, and fecal coliform were the leading causes of impairment according to the 2016 LDEQ IR for streams. Suspected sources of impairment include unknown sources, atmospheric deposition, and natural conditions. Mercury, low dissolved oxygen, total dissolved solids, sulfates, and chloride were the suspected causes of impairment, whereas atmospheric deposition, unknown sources, non-irrigated crop production, on-site treatment systems, and wetland drainage/filling/loss were the leading sources of impairment of wetland areas throughout the state assessed at the time the report was written. This assessment included all wetlands, not just those in coastal areas.

5.12.1 Water Body Subsegments

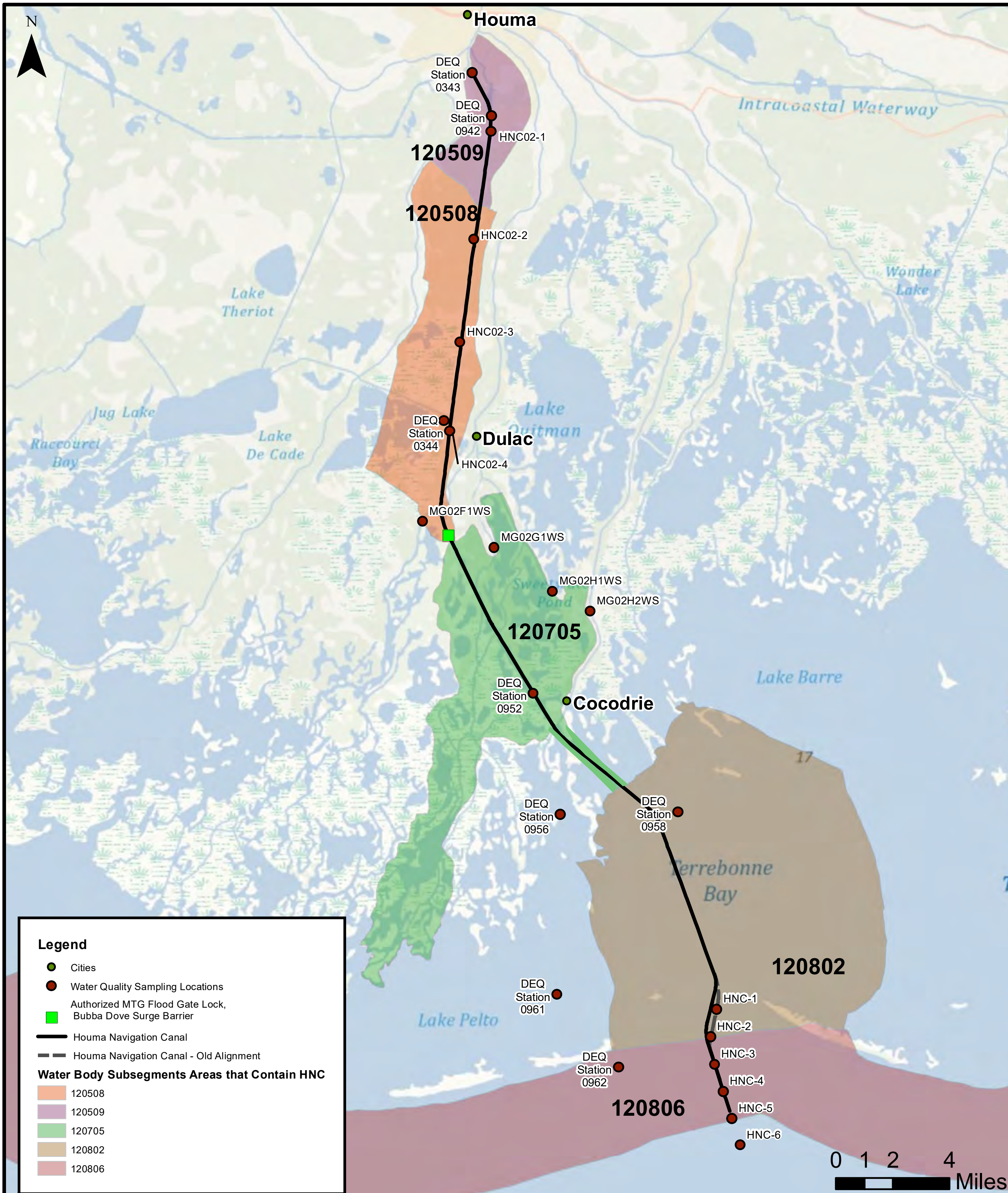
The limits of the proposed project include four HNC water body subsegments from the city of Houma to Terrebonne Bay and the subsegment for Gulf of Mexico (Table 5-21). Boundaries of these water body subsegments are presented in Figure 5-12.

Table 5-21. Water Body Subsegments in the Project Area

Water Body Subsegment Number	Water Body Name	Water Body Type
LA 120509	Houma Navigation Canal–Houma to Bayou Pelton	River
LA 120508	Houma Navigation Canal–Bayou Pelton to the boundary between segments 1205 and 1207 (Estuarine)	River
LA 120705	Houma Navigation Canal–From the segment boundary between 1205 and 1207 to Terrebonne Bay (Estuarine)	River
LA 120802	Terrebonne Bay	Estuary
LA 120806	Terrebonne Basin Coastal Bays and Gulf Waters to the State 3 mile limit	Estuary

Source: LDEQ.

The most common individual designated uses of water bodies in the coastal plain include primary contact recreation, secondary contact recreation, fish and wildlife propagation, shellfish propagation, and drinking water supply. Designated uses for each subsegment in the proposed project are listed in Table 5-22. Except for LA 120806, these subsegments are fully supporting their designated uses, and fall within Integrated Report Category (IRC) 1. LA 120806 is listed as impaired for fish and wildlife and oyster propagation and is listed in IRC Category 5. Suspected sources of impairment include upstream sources, marina/boating sanitary on-vessel discharges, petroleum/natural gas activities, and waterfowl. IRC provides a focused approach to water quality management by clearly determining what management actions are required to protect or improve individual water bodies. The IRC descriptions can be found in the Water Quality Evaluation (Appendix A, Annex II).



WATER QUALITY SAMPLING LOCATIONS AND WATER BODY SUBSEGMENTS

Houma Navigation Canal Deepening

ERSI Ocean Map

GEC

Figure 5-12

Date: August 2012

Scale: 1:301,000

Source: ESRI/GEC

Map ID: 278500218-3026

Table 5-22. LDEQ Assessments of Subsegments Included in the Proposed Project Area

Water Body Subsegment Number	Designated Uses							
	PCR	SCR	FWP	DWS	ONR	OYS	AGR	LAL
LA 120508	F	F	F			F		
LA 120509	F	F	F	F				
LA 120705	F	F	F			F		
LA 120802	F	F	F			F		
LA 120806	F	F	N			N		

F = Fully Supporting, N=Not Supporting
Source: LDEQ.

5.12.2 Water Quality Standards and Criteria

The LDEQ has established general written water quality standards applicable to all Louisiana waters. The general written standards relate to the condition of the water as affected by waste discharges or human activity, as opposed to purely natural phenomena. The standards were last revised in May 2014 and can be obtained at http://www.deq.louisiana.gov/portal/. The LDEQ standards provide criteria, which specify general and numerical limitations for various water quality parameters that are required for designated water uses. General criteria apply at all times to the surface waters of the state, including wetlands, except where specifically exempted in the standards. The general criteria include parameters such as aesthetics; floating, suspended, and settleable solids; taste and odor; toxic substances; oil and grease; foaming or frothing materials; nutrients; turbidity; flow; radioactive materials; biological and aquatic community integrity; and other substances and characteristics that will be developed as needed. Numerical criteria apply to specified water bodies, and to their tributaries, distributaries, and interconnected streams and water bodies contained in the water management subsegment if they are not specifically named therein, unless unique chemical, physical, and/or biological conditions preclude the attainment of the criteria. In those cases, natural background levels of these conditions may be used to establish site-specific water quality criteria. Those water bodies officially approved and designated by the state and EPA as intermittent streams, man-made water bodies, or naturally dystrophic waters can be excluded from some or all numerical criteria as stated in LAC 33:IX.1109. Although naturally occurring variations in water quality may exceed criteria, water quality conditions attributed to human activities must not exceed criteria when flows are greater than or at critical conditions (as defined in LAC 33:IX.1115.C).

The EPA has established ambient water quality criteria applicable to surface waters in the study area. The numerical criteria have been developed for various physical parameters, nutrients, metals, PCBs, and organic pesticides for uses of freshwater aquatic life, marine and estuarine aquatic life, and public water supply, respectively. The EPA has also established written water quality criteria, which are applicable to all waters of the United States. EPA's criteria can be obtained at http://www.epa.gov/waterscience/.

Sediment Quality Benchmarks - There are no sediment quality standards promulgated by the EPA or the State of Louisiana. The National Oceanic and Atmospheric Administration (NOAA) has developed a set of sediment quality benchmarks known as Screening Quick Reference Tables, or SQuiRTs, which present sediment benchmarks for inorganic and organic contaminants. These benchmarks are available at http://response.restoration.noaa.gov/sites/default/files/SQuiRTs.pdf. These benchmarks, although not criteria or standards, provide a basis by which to evaluate relative sediment quality. Results of sediment tests conducted by the USACE and the LDEQ were compared to the effects range-low (ER-L), effects range-median (ER-M), threshold effects level (TEL), and probable effects level (PEL) benchmarks for those parameters tested. The benchmarks definitions can be found in the Water Quality Evaluation (Appendix A, Annex II).

Total Maximum Daily Loads (TMDLs) - The state of Louisiana is working with the EPA to develop TMDLs for the water bodies that were included on the state's 303(d) list (See www.deq.state.la.us). Section 303(d) of the CWA requires states to identify, list, and rank waters that do not meet applicable water quality standards after implementation of technology-based controls for development of TMDLs. According to the EPA, developing a TMDL is part of a process whereby impaired or threatened water bodies and the pollutant(s) causing the impairment are systematically identified and a scientifically based strategy (TMDL) is established to correct the impairment or eliminate the threat and restore the water body.

In 2007, EPA developed a TMDL for fecal coliform on subsegment 120508, Houma Navigation Canal–Bayou Pelton to the boundary between segments 1205 and 1207. The TMDL lists six affected point source dischargers in subsegment 120508. No other TMDLs were listed within the subsegments included within the project area. TMDL development for LA 120806, Terrebonne Basin Coastal Bays and Gulf Waters, is listed as a low priority and there is no target date for completion.

National Pollutant Discharge Elimination System (NPDES)/ Louisiana Pollutant Discharge Elimination System (LPDES) - In 1996, the EPA granted NPDES delegation authority to LDEQ.As authorized by the CWA, the NPDES permit program controls water pollution by regulating point sources that discharge pollutants into waters of the U.S. In most cases, the NPDES permit program is administered by authorized states; and Louisiana established the Louisiana Pollutant Discharge Elimination System (LPDES) permitting program. Through this program, LDEQ maintains records for point source discharges into Louisiana waters, including the heavily industrialized portion of the Mississippi River located between Baton Rouge and New Orleans. In 1990, the NPDES program was expanded to include the Phase I NDPES Storm Water Discharge Program. This program was established in response to 1987 Amendments to the CWA to address storm water runoff from municipalities with populations of 100,000 or more and construction activity disturbing 5 or more acres of land. Phase II of the program was developed in 1999 to address storm water runoff from certain small municipalities and construction activity disturbing 1 to 5 acres.

There are currently 59 LPDES permitted dischargers on file with LDEQ who discharge directly into the HNC or into tributaries which ultimately drain into the HNC. Typical discharges are classified as sanitary wastewater, industrial wastewater, and stormwater runoff. Detailed information is presented in Appendix A, Annex II.

Data Collection - Data from 23 sampling locations were analyzed to assess the existing water quality conditions in the project area. Chemical analyses of ambient water, sediment, and standard elutriate were conducted for nine samples (HNC02-1, HNC02-2, HNC02-3, HNC02-4, MG02F1WS, MG02G2WS, MG02H1WS, MG02H2WS, and HNC-Lock). Chemical analyses of ambient water, sediment, and standard elutriate and solid phase bioassays were conducted for six samples (HNC-1, HNC-2, HNC-3, HNC-4, HNC-5 and HNC-6). Chemical analysis of ambient water was conducted for three samples (LDEQ Stations 343, 344, 942, 952, 956, 958, 961, and 962). The CEMVN or their contractors collected 15 samples and LDEQ collected 8. Sampling locations, collecting agency, and sampling locations are presented in the Water Quality Evaluation (Appendix A, Annex II and Appendix H).

Data Analysis - Data from the 23 sampling locations were compared to the water quality standards and criteria and the sediment quality benchmarks. Based on LDEQ's descriptions, one HNC subsegment is a fresh water body; the other subsegments are marine water bodies. Therefore, freshwater criteria were only used to analyze LA120509. Marine water criteria were used to analyze the other subsegments. Results of the analyses are discussed in the Water Quality Evaluation (Appendix A, Annex II) and presented in Table 5-23. Only parameters quantified as above detection levels are discussed in the Water Quality Evaluation. In some samples the reporting limit or detection sensitivity for the CEMVN tests and the target detection sensitivity associated with LDEQ standards differ.

Table 5-23. Parameters Exceeding Louisiana Water Quality Criteria and NOAA[3] Sediment Benchmarks

Water Quality Subsegment	Station	Sample Type	Parameters	Criteria/Standard	Results, ppb[4]
120509	HNC02-1	Water (Fresh)	Lead	Fresh – Chronic (1.24)	1.53
		Elutriate	Arsenic	Drinking Water Supply (10)	61.7
			Copper	Fresh-Acute & Chronic (10.04 & 7.08)	30.5
			Cadmium	Fresh-Chronic (0.64)	1.19
			Lead	Fresh-Chronic (1.24)	9.09
			Zinc	Fresh-Acute & Chronic (66.3 & 60.54)	335
		Sediment	None		
	DEQ 343	Water (Fresh)	None		
	DEQ 942	Water (Fresh)	None		
120508	[1]HNC02-2	Water (Marine)	Copper	Marine-Acute & Chronic (3.63 & 3.63)	1.53
		Elutriate	Arsenic	Marine-Acute & Chronic (69 & 36)	104
			Zinc	Marine-Acute & Chronic (90 & 81)	829

Water Quality Subsegment	Station	Sample Type	Parameters	Criteria/Standard	Results, ppb[4]
		Sediment	Zinc	TEL & ER-L (124 ppm & 150 ppm)	154 (ppm)[5]
	HNC02-3	Water (Marine)	Copper	Marine-Acute & Chronic (3.63 & 3.63)	6.53
		Elutriate	Arsenic	Marine-Acute & Chronic (69 & 36)	81.9
			Copper	Marine-Acute & Chronic (3.63 & 3.63)	48.3
			Lead	Marine-Chronic (8.08)	11.2
			Nickel	Marine-Acute & Chronic (74 & 8.2)	81.6
			Zinc	Marine-Acute & Chronic (90 & 81)	259
		Sediment	None		
	HNC02-4	Water (Marine)	Copper	Marine-Acute & Chronic (3.63 & 3.63)	6.53
		Elutriate	Copper	Marine-Acute & Chronic (3.63 & 3.63)	7.26
		Sediment	None		
	DEQ 344	Water (Marine)	Fecal Coliform	Water body subsegment criteria - oyster propagation (median – 14 MPN[6], 10% -43 MPN[7])[7]	2400 (MPN)[6]
120705	HNCLock	Water (Marine)	Copper	Marine-Acute & Chronic (3.63 & 3.63)	4.0
			Cyanide	Marine-Acute (1.0)	9.0
		Elutriate	Copper	Marine-Acute & Chronic (3.63 & 3.63)	4.0
			Cyanide	Marine-Acute	7.0
		Sediment	Nickel	TEL (15.9 ppm)	19.9 (ppm)[5]
	DEQ 952	Water (Marine)	None		
120802	NOD Report	Water	None		
		Elutriate	None		
		Sediment	None		
	DEQ 958	Water (Marine)	None		
	DEQ 956	Water (Marine)	None		
	DEQ 961	Water (Marine)	None		
	DEQ 962	Water (Marine)	None		
[2]N/A	MG02F1	WS Water (Marine)	None		
		Elutriate	Mercury	Marine-Chronic (.025)	0.55
		Sediment	Arsenic	ER-L & TEL (8.2 ppm & 7.24 ppm)	10 (ppm)[5]

Water Quality Subsegment	Station	Sample Type	Parameters	Criteria/Standard	Results, ppb[4]
			Copper	TEL (18.7 ppm)	22.7 (ppm)[5]
			Zinc	TEL (124 ppm)	124 (ppm)[5]
	MG02G1 WS	Water (Marine)	Copper	Marine-Acute & Chronic (3.63 & 3.63)	33.9
		Elutriate	None		
		Sediment	Arsenic	ER-L & TEL (8.2 ppm & 7.24 ppm)	9.24 (ppm)[5]
			Copper	TEL (18.7 ppm)	27.5 (ppm)[5]
			Zinc	TEL (124 ppm)	133 (ppm)[5]
	MG02H1 WS	Water (Marine)	None		
		Elutriate	None		
		Sediment	None		
	MG02H2 WS	Water (Marine)	None		
		Elutriate	None		
		Sediment	None		

[1]Ambient water sample collected at HNC02-1 and HNC02-4 used to represent HNC02-2 and HNC02-3, respectively, and also used in standard elutriate analyses. HNC02-2 is located in a different water quality subsegment than HNC02-1, and they are classified differently; i.e., HNC02-1 is fresh and HNC02-2 is estuarine. Therefore, freshwater criteria applied to HNC02-1 and marine criteria applied to HNC02-2 even though same water sample.
[2]The Morganza to the Gulf of New Mexico Project's sampling locations are not located in the Houma Navigation Canal. However, they are located adjacent to the canal along water quality Subsegment 120705 and provide a perspective on the water and sediment quality conditions in the adjacent water bodies and marshes.
[3]NOAA - National Oceanic and Atmospheric Administration.
[4]ppb - parts per billion.
[5]ppm - parts per million.
[6]MPN - most probable number.
[7]The fecal coliform bacteria median MPN shall not exceed 14 colonies/100 mL, and not more than 10 percent of the samples shall exceed an MPN of 43 colonies/100 mL for a five tube decimal dilution test in those portions of the area most probably exposed to fecal contamination during the most unfavorable hydrographic and pollution conditions.

Sediment Assessment - The HNC is a manmade channel that does not receive influxes of sediment from upstream. The GIWW, which is located north of the channel, has not required dredging in decades. Rather, shoaling within the inland reach occurs mostly due to erosion of the channel bank which is local material that does not migrate from additional areas. Therefore, material found within the channel bottom is representative of material located along the channel banks and within proposed disposal areas. As indicated in Section 4, the USACE performs maintenance dredging within the channel on a periodic basis and disposes of this material within the project area. The channel is dredged enough so that the channel bottom can be considered virgin material and no adverse impacts have resulted from the placement of the material to date.

Soil borings indicate that most of the channel depths to be dredged consist of clay with intermittent silt lenses, with no significant anomalies (Appendix A – Annex V).

5.13 Hazardous, Toxic, Radioactive Waste (HTRW)

A Phase I Initial Site Assessment (ISA) was prepared to facilitate early identification and appropriate consideration of potential HTRW problems (Appendix F). The purpose of the Phase I ISA is to ensure that HTRW and contamination issues are properly considered in project planning and implementation. The ISA generally consists of a review of all properties in the project area to determine the potential for HTRW concerns on each property. In addition, a complete review of appropriate state and Federal environmental enforcement agency records is conducted to identify any potential hazardous situations. The results of the ISA provide early detection of HTRW, determine viable options to avoid HTRW problems, and establish procedures for resolution of HTRW concerns, issues, or problems. Preliminary data gathered during the ISA has raised concerns regarding the presence of abandoned oil and gas wells in the vicinity of dredged material disposal sites.

HTRW Phase I Summary - The proposed dredged material disposal sites from the HNC Deepening project were investigated for the potential presence of HTRW. Land use in the project area encompasses residential, industrial, and commercial areas, as well as marsh and forested wetland habitat.

Pipeline maps and databases indicate the locations of more than 30 known and recorded oil and gas lines in the HNC corridor. A review of oil and gas wells located within the project area showed most wells are located a safe distance from the disposal areas. However, five orphan (abandoned) wells are located adjacent to three proposed disposal sites. One orphan well is located at the southwestern border of Site 15 (29° 22' 27.479"N, 90° 44' 34.439"W). Two orphan wells are located along the western border of Site 15A (29° 23' 22.559"N, 90° 46' 4.079"W and 29° 23' 20.353"N, 90° 46' 16.613"W). Two orphan wells are also located along the southeastern border of the lung (29° 12' 57.239"N, 90° 40' 5.159"W and 29° 12' 46.799"N, 90° 40' 8.039"W).

In addition, the EPA proposed to add the former Delta Shipyard site at 200 Dean Court located along the northern portion of the HNC, to the National Priorities List (NPL) of Superfund sites, a list of sites that pose risks to people's health and the environment. Superfund is the federal program that investigates and cleans up the most complex, uncontrolled or abandoned hazardous waste sites in the country.

The facility is located in a mixed industrial and residential area south of the city of Houma, Louisiana. Delta Shipyard was a cleaning and repair facility for small cargo boats, fishing boats, and oil barges. Oily waste from the cleaning process was stored in several unlined earthen pits used as evaporation ponds. These pits were reportedly also used to dispose of oil field drilling material. Delta Shipyard was owned by Delta Ironworks, Inc. The entire property consisted of 165 acres and was home to seven divisions of Delta Ironworks, including Delta Shipyard. During the 1970s and 1980s, the property changed hands through several mergers and sales. In January

2012, the Louisiana Department of Environmental Quality asked the EPA for assistance in evaluating this site.

Wetlands at the Delta facility are contaminated with arsenic, antimony, anthracene, barium, benzene, cadmium, chromium, ethylbenzene, fluorene, lead, manganese, mercury, 2-methylnaphthalene, naphthalene, phenanthrene, pyrene, o-xylene and m,p-xylene to the surface water pathway. In addition, three evaporation pits containing greater than 30,000 cubic yards of hazardous material are located in a wetland and may potentially release waste to nearby waterways.

Large volumes of waste remain on site, and hazardous substances have been found in ground water, surface water, and soil. The closest residential property is located approximately 400 feet west of the open pits. Without remediation of the site, additional releases to ground water, surface water and soil will continue to occur. However, according to the EPA's Superfund Site, subsequent to NPL listing, no clean up or remediation of the site has occurred.

On May 18, 2016, the Agency for Toxic Substances and Disease Registry (ATSDR) released the Public Health Assessment for Delta Shipyard. The Agency came to four conclusions:

1) Incomplete data exist to fully evaluate the surface soil in and around the area of the pits and ditch. Although exposure to the remote area of the pits is unlikely, ATSDR used the limited, available samples to evaluate exposures to the resident, children visitors and workers for health protectiveness. Based on the available data, individuals are not expected to be harmed from exposure to contaminants in surface soil on and near the pits and ditch.

2) Site conditions make frequent contact with surface water and sediments in the canal very unlikely. Chemicals are present in water and sediments in the canal at very low concentrations. Therefore, infrequent exposure to surface water and sediments is not expected to harm people's health.

3) ATSDR does not have the information to determine if people's health could be harmed from eating fish, shellfish and other marine life caught near the site. There are no reports of recreational or commercial fishing near the site, but crabbing has been reported nearby. The sediment in the deep water near the site has low levels of chemicals and there are other industries near the shipyard. There are currently no fishing restrictions in the area.

4) A public water supply distributes drinking water to homes within 4 miles of the site. Water samples collected near the intake to the public water supply do not show site impact. Registered, private wells in the area are located greater than 1 mile from the site and are unlikely to be impacted by site activities.

Based on information gathered during the preparation of the ISA, it is reasonable to assume that, other than those areas of concern described previously, no significant HTRW would be encountered during the course of project-related activities. There is a low risk of encountering HTRW within the proposed dredged material disposal sites. The project should proceed as scheduled with construction. Should the construction methods change or the area of construction increase, the HTRW risk would require re-evaluation. No additional work relative to HTRW or land use surveys is recommended, but caution is recommended during dredging and construction activities in the vicinity of pipelines and orphan wells.

Subsequent to conducting the ISA, modifications were made to the disposal plan. Based on these changes, an updated HTRW review was conducted in July 2017. Findings indicated that the project area has not substantially changed since the previous assessment. While results of the updated investigation showed that the Delta Shipyard facility was added to the National Priorities List, no significant changes were found. Since the Delta Shipyard facility is located over a half mile from the project area, it was determined that the project area has not substantially changed since the previous assessment. Therefore, the previous recommendations from the first HTRW assessment remain the same.

Deepwater Horizon Oil Spill - Hydrocarbons are the highest concern in terms of HTRW. Hydrocarbons in the Gulf of Mexico come from natural seeps and anthropogenic shore-based and offshore sources. On or about April 20, 2010, the mobile offshore drilling unit *Deepwater Horizon,* which was being used to drill a well for BP Exploration and Production, Inc. (BP) in the Macondo prospect (Mississippi Canyon 252 – MC252), experienced an explosion, leading to a fire and its subsequent sinking in the Gulf of Mexico. This incident resulted in discharges of oil and other substances from the rig and the submerged wellhead into the Gulf of Mexico. An estimated 5 million barrels (210 million gallons) of oil were subsequently released from the well over a period of approximately three months (Oil Budget Team 2010). In addition, approximately 771,000 gallons of dispersants were applied to the waters of the spill area in an attempt to minimize impacts from spilled oil. Dispersants do not remove oil from the ocean. Rather, they are used to help break large globs of oil into smaller droplets that can be more readily dissolved into the water column.

The U.S. Coast Guard responded and directed Federal efforts to contain and clean up the spill (hereafter referred to as the *Deepwater Horizon* oil spill). At one point, nearly 50,000 responders were involved in cleanup activities in open water, beach, and marsh habitats. The magnitude of the oil spill and response was unprecedented, causing impacts to coastal and oceanic ecosystems ranging from the deep ocean floor, through the oceanic water column, to the highly productive coastal habitats of the northern Gulf of Mexico, including estuaries, shorelines and coastal marsh.

Since the spill, oil has been found on the gulfward shorelines of each island in the Isle Dernieres and Timbalier Island reaches. Oil has also been found on Atchafalaya, Locust Bayou, West Belle Pass, Elmer's Island, and East Grand Terre. The oiling on the barrier islands is characterized by both surface and buried oil in various forms occurring throughout the intertidal and supratidal zones.

Cleanup activities have included both manual (e.g., rakes and shovels) and mechanical (e.g., excavators) methods to remove surface and buried oil. As of February 2016, manual and mechanical cleanup operations had ended.

5.14 Noise, Health, and Safety

Noise, defined as unwanted sound, is typically associated with human activities and development. Ambient noise in the area is generated by a broad range of natural and anthropogenic sources. Natural noise sources include thunder, wind, and precipitation. Potential sources of anthropogenic sound include dredging and construction activities, agricultural activities, industrial activities, outdoor recreation (e.g. hunting and fishing), and commercial and residential waterborne traffic. Ambient noise monitoring does not appear to have been conducted in the study area; consequently, no quantitative data on noise levels within the study area are available for analysis.

The study area includes remote barrier islands and dredged material placement areas. Additionally, noise from offshore oil and gas production facilities within the study area has little, if any impacts on the area.

5.15 Air Quality

Ambient air quality is a function of the size, distribution, and activities directly related to population, in association with the resulting regional economic development, transportation, and energy policies. Meteorological conditions and topography can confine, disperse, or distribute air pollutants. Assessments of air quality depend on multiple variables such as the quantity of emissions, dispersion rates, distances from receptors, and local meteorology. These independent factors are variable and ambient air quality is a dynamic process.

The Clean Air Act Amendment of 1990 directed the EPA to establish National Ambient Air Quality Standards (NAAQS) for all regulated air pollutants. Federal air quality standards have been established for six criteria air pollutants:

- Carbon monoxide (CO);
- Nitrogen dioxide (NO_2);
- Ozone (O_3);
- Sulfur oxides (commonly measured as sulfur dioxide [SO_2]);
- Lead (Pb);
- Particulate matter no greater than 2.5 micrometers (µm) in diameter ($PM_{2.5}$); and
- Particulate matter no greater than 10 µm in diameter (PM_{10}).

The EPA classifies air quality by Air Quality Control Region (AQCR). An AQCR is a contiguous area with relatively uniform air quality, and thus air pollution. AQCRs often correspond with airsheds and may cross parish and state lines. Each AQCR is treated as a unit for developing pollution control strategies to achieve NAAQS.

An AQCR, or portion of an AQCR, can be classified as attainment, nonattainment, or unclassified. Attainment indicates that criteria air pollutants within the region are within NAAQS values; nonattainment indicates air pollution levels persistently exceed the NAAQS values; and unclassified indicates air quality within the region cannot be classified (generally due to lack of data). A region designated as unclassified is treated as an attainment region.

The EPA AirData database contains measurements of air pollutant concentrations for the entire U.S. Measurements include criteria and hazardous air pollutants as compared to the NAAQS specified by the EPA. The AirData database was queried for air quality data in Terrebonne Parish for the interval 2002–2016 (the most recent year data were available). Air quality in this parish for all criteria pollutants for the 2002–2016 period was better than the NAAQS at all monitoring sites.

The USEPA's *Nonattainment Areas for Criteria Pollutants* (Green Book) maintains a list of all areas within the U.S. that are currently designated non-attainment areas with respect to one or more criteria air pollutants. Terrebonne Parish is not listed as a non-attainment area in the Green Book, indicating it is currently in attainment.

In 2004, the EPA designated and classified area for the new eight-hour ozone NAAQS and published the final Phase I rule for implementation of the eight-hour ozone NAAQS.

The AirData database also provides annual summaries of Air Quality Index (AQI) values for counties or MSAs. The AQI takes into account all of the criteria air pollutants measured within a geographic area and is an approximate indicator of overall air quality. The AQI summary values include qualitative (i.e., days of the year having good air quality) and descriptive statistics (i.e., median AQI value). According to AQI summary for Terrebonne Parish and for the Houma MSA for the interval 2002-2016, air quality in most of the study area (Terrebonne Parish/Houma MSA) is good, with minimal periods when air quality is classified as unhealthy. Of the six criteria air pollutants, ozone and particulate matter of 2.5 µm or less are most likely to occur within the study area. Due to its primarily undeveloped setting, air quality in most of the study area is above average.

5.16 Aesthetics

Within each regional landscape, similarity zones are established to provide a more specific framework with which to define and evaluate the visual resources of a study area. Seven landscape similarity zones have been identified for the study area. These zones are described in the paragraphs below.

Urban 1– This zone encompassing the city of Houma is within the Southern Holocene Meander Belts ecoregion. The area is characterized by the water resources that are the visual core of the area including Bayous Terrebonne and Black and the GIWW. This zone includes spaces that are prominent and contain landmarks or places of assembly that have national and regional importance including the Houma Historic District located in its downtown area. Development patterns are typical of tract-type subdivisions along with older residential areas adjacent to the urban center and multi-family complexes. The area contains commercial facilities including restaurants and retail establishments and community facilities such as neighborhood parks, schools and athletic fields. The density of development limits vegetation in some areas, and typical views are limited in the downtown areas to the nearby streetscape due to multi-story commercial, residential and municipal buildings. Visual access to adjacent areas is wider along the roads and waterways and the less densely developed areas as one transitions out of the downtown area. The Wetlands Cultural Scenic Byway provides viewsheds along LA 182 and LA 56.

Residential–This zone primarily is within the Deltaic Coastal Marshes and Barrier Islands ecoregion. The area's terrain is flat and follows the meandering bayous. The residential area is characterized by the development that was driven by its proximity to the Gulf of Mexico's fisheries. Low-density rural development, typically limited to road frontage lots, is prevalent. Small-scale commercial seafood related industry is prevalent as one travels LA 57 to Dulac and the Wetlands Cultural Scenic Byway's LA 56 to Cocodrie. The zone includes small retail facilities including restaurants and food stores and community facilities such as neighborhood parks, schools and athletic fields. Visual access to the area is wider along roads and waterways and the less densely developed areas.

Industrial–This zone primarily is within the Southern Holocene Meander Belts ecoregion and adjacent to Morgan City's urban area. Although residences and commercial facilities can be located within this zone, maritime industrial uses, including resources for petroleum and natural gas exploration, predominate. There is little canopy cover, but views are typically diverted to the industrial development that lines LA 182 and Bayou Cocodrie. Terrain is typically flat. Regional access to the area is from U.S. Route 90.

Agricultural–This zone is within the Southern Holocene Meander Belts ecoregion. This area is marked primarily by flat, mostly open land associated with various bayous sometimes with vegetation along the edges or between fields helping to define the space. Isolated small citrus orchards are found within these areas. Associated low-density, rural development along road frontages and at the various crossroads is included in this zone. The zone includes small retail facilities including restaurants and food stores and community facilities such as neighborhood parks, schools and athletic fields. Panoramic views are possible but may be limited by the interspersed pockets of forest vegetation. The Wetlands Cultural Scenic Byway provides viewsheds along LA 182 from Houma to Gibson and along LA 56 south of Houma.

Nonforested Wetlands–This zone is within the Deltaic Coastal Marshes and Barrier Islands ecoregion. The terrain is mostly marsh interspersed with numerous lakes, ponds, bayous, and canals. Manmade features include petroleum and natural gas wells, and the Gulf-Intracoastal Waterway. Public recreation access areas include Mandalay NWR and Pointe aux Chenes WMA. Physical access to most of the area is limited to boat travel that allows for panoramic viewsheds of the area. The Wetlands Cultural Scenic Byway provides viewsheds along its southern spurs from Houma to Cocodrie along LA 56 and then to Dulac on LA 57.

Forested Wetlands–This zone is within the Inland Swamps ecoregion. The terrain is mostly bottomland hardwood and Bald Cypress communities. Water resources include Lake Palourde in the area north of Morgan City and numerous canals in the area south of Houma. Manmade features include petroleum and natural gas wells and the HNC. Lake End Park provides visual access to Lake Palourde. LA 315 and LA 57 provide viewsheds to the area south of Houma as one travels to Theriot and Dulac. Physical access to most of the area is limited to boat travel. Viewsheds may be limited by the interspersed pockets of forest vegetation.

5.17 Recreation

Like much of coastal southeast Louisiana, much of the study area has experienced substantial coastal erosion, loss of wetlands, and increasing salinities. Although the study area has traditionally provided excellent saltwater fishing, increased salinity levels have allowed saltwater species much farther inland in recent years. As fresh and intermediate marshes, cypress trees, and submerged aquatic vegetation in the area have disappeared, waterfowl habitat has become less abundant, resulting in a decrease in hunting opportunities.

The project area within Terrebonne Parish is included in Region 3 of the Louisiana State Comprehensive Outdoor Recreation Plan (SCORP). The project area is approximately three miles east of Mandalay National Wildlife Refuge (NWR), two miles west of Lake Boudreaux, and nine miles west of Pointe Au Chein Wildlife Management Area (WMA). Recreational use of the HNC and the surrounding area is primarily consumptive and includes fishing, shrimping, waterfowl hunting, and deer hunting. The HNC is primarily industrial and most recreational boating is associated with hunting or fishing.

The Mandalay NWR contains freshwater marsh with ponds, levees, manmade canals, and natural ridges. Common recreational activities include fishing, waterfowl hunting, recreational crabbing, shrimping, and crawfishing; and less frequently bird and wildlife observation, hiking, boating and photography. Wine Island in the study area is part of the Terrebonne Barrier Islands Refuge. Terrebonne Barrier Islands Refuge consists of three barrier islands (Wine, Whiskey, and Raccoon Islands) in the Isles Dernieres chain located across the shoreline of Terrebonne Parish.

Pointe Aux Chein WMA includes about 35,000 acres of primarily freshwater to brackish marsh, interspersed with numerous ponds, bayous, and canals. Hunting and fishing, boating, wildlife observation, camping, and picnicking are popular activities. Recreational use of Lake Boudreaux includes fishing, shrimping, crabbing, waterfowl, and deer hunting.

The public places a high value on fishing, boating, and hunting as measured by the large number of fishing and hunting licenses and the large number of recreational boat registrations in Terrebonne Parish. In additional many non-residents hunt and fish in the area. Many of the predominant recreational activities in the study area are only accessible by boat. Approximately 15,029 recreational boats were registered in 2011 in Terrebonne Parish (LDWF 2014). A total of 40,297 resident fishing licenses (20,337 freshwater; 19,960 saltwater) and 117 non-resident fishing licenses (60 freshwater; 57 saltwater) were issued in Terrebonne Parish in 2012 (LDWF 2014). A total of 4,990 hunting licenses (4,987 resident; 3 non-resident) were issued in Terrebonne Parish in 2012 (LDWF 2014).

6.0 ENVIRONMENTAL CONSEQUENCES

This section provides the scientific and analytical basis for comparison of the project alternatives to assist in the decision making process. The following sections include summaries of anticipated changes to resources within the area of influence of the proposed action (the tentatively recommended plan -TRP) including direct, secondary, and cumulative effects.

Significance of resources and effects will be derived from institutional, public, or technical recognition. Institutional recognition of a resource or effect means its importance is recognized and acknowledged in the laws, plans, and policies of government and private groups. Technical recognition of a resource or an effect is based on scientific or other technical criteria that establish its significance. Public recognition means some segment of the general public considers the resource or effect to be important. Public recognition can be manifested in controversy, support, or opposition expressed in any number of formal or informal ways. Another scenario considered besides the NED and Environmental Quality (EC) included Other Social Effects (OSE).

For the purposes of evaluating the impacts inherent to the No-Action plan and the deepening alternatives, the construction of the Houma Lock is considered existing conditions, since it has been authorized as part of the Morganza to the Gulf (MTG) project. A preliminary operation plan for the Houma Lock is provided in the Final Supplemental Programmatic EIS for MTG (USACE, 2013).

6.1 Navigation

6.1.1 No-Action Alternative

The current channel depth of the HNC would be maintained under the No-Action Alternative. Operations and Maintenance (O&M) dredging would be expected to continue on approximately 10-year cycles for the Inland Reach and 2-year cycles for the Terrebonne Bay and Cat Island Pass Reaches. Minor short-term impacts to navigation may occur during maintenance dredging; however, delays due to the dredging would not significantly impact navigation.

There is a clear trend of building larger vessels for the offshore market. The emerging trend in the platform supply fleet toward larger vessels cannot be sustained by the HNC under the current 15-foot channel. Because of depth constraints, there is no trend to deeper vessels. The current channel depth constraints limit vessel size and are expected to continue to limit growth around the canal. Larger vessels are unable to take advantage of existing port facilities and have increased transit times for vessels forced to use other facilities. There is little use by vessels drafting more than 12 to 13 feet due to potential groundings or damages.

The constrained channel depth increases transportation costs for several categories of actual or potential users. Ocean tugs destined for Houma shipyards must use a considerably longer detour route between Houma and the Gulf. New deep-draft vessels transiting from Houma shipyards to the Gulf for sea trials must reroute. Offshore derrick barges and pipe-laying barges requiring repairs will typically avoid the HNC because of tug draft constraints. As a result, nearly all oil sector service barges domiciled at Houma that are typically accompanied by large ocean tugs either use alternate routes or less efficient shallow-water tugs. Deep-draft ocean barges and offshore vessels built in Houma shipyards require costly additional tug assistance to use the HNC. Three or four smaller ocean tugs or inland shallow-draft tugs are typically used in place of a single ocean tug, incurring additional costs.

Draft constraints restrict the type of vessels that can domicile at Houma. Companies divert barges to New Orleans for cleaning after each trip with increased costs. A significant amount of potential shipyard business in Houma is lost because deep-draft tugs and jackup rigs requiring repairs are too large to transit the HNC and operators are reluctant to take the detour. These vessels instead travel to more distant shipyards for repairs, incurring significant travel costs.

Draft constraints result in additional trips or diverted cargo. Load outs of heavy offshore equipment require additional barges and trips than necessary with a deeper channel. Oversize/overweight permitted highway vehicles are used in some cases; multiple trucks are used instead of a single barge. Larger specialty offshore, deepwater service vessels fabricated at Houma for domestic markets must be conveyed to the Gulf on barges and/or dry docks.

6.1.2 Alternatives 1A, 1B, 1C

Waterway depth requirements of the oil and gas offshore industry have outstripped efficient use of the HNC. An 18-foot project would only serve the periphery of demands for the NED and fabrication sectors of benefits. Channel usefulness in terms of authorized depth or operating draft is substantially less at depths much less than 20 feet. Based on the most recent long-term forecast for Gulf deepwater oil/gas sea level production, the 18-foot project has no fabrication benefits. Alternative 1A has NED present value benefits of $223.9 million. The benefit/cost ratios (BCR) for transportation cost savings for Alternatives 1A, 1B, and 1C are 1.19, 0.59, and 0.46, respectively. These differences in BCR demonstrate the difference in cost of the different alternatives to achieve the same level of benefit.

Deepening the channel to 18 feet could cause minor short-term impacts to navigation during the initial construction, utility relocation, and maintenance dredging; however, delays due to dredging would not significantly impact navigation. Deepening would have positive indirect impacts to navigation. No additional maintenance dredging events are anticipated with the deepening.

6.1.3 Alternatives 2A (TRP), 2B, 2C

Deepening the HNC to 20 feet would allow vessels to avoid rerouting. Ocean tugs would be able to travel directly to Houma via the HNC. Derrick barges and specialty (pipe laying) barges would be able to navigate the HNC using only a light tug for steering assistance. There would be no need to reroute newly built vessels around the HNC for sea trials. The need for costly additional tug assistance would be reduced; ocean tugs could transit directly to Houma with the barge. The ocean tug would require only one inland tug (for steering assistance). A deeper HNC would reduce diversions to more distant ports and increase Houma shipyard business. Tug-barge combinations moving food-grade products could come to Houma and reduce costs associated with cleaning, dockage, and use of one-day tug barges at other ports. Deep-draft tugs and jackup rigs using more distant ports in Texas and Alabama for repairs could use Houma vicinity shipyards, saving more than a day of travel time and thousands of dollars in travel costs. Shipyard business in Houma would be expected to increase, creating jobs and contributing benefits to the regional economy.

Vessels with deeper loadings would no longer require additional trips or diverted cargo. Risers from offshore locations could be directly routed by ocean barge to Houma for refurbishing, saving considerable distance and costs required to route to Texas. Rig setup and takedown costs would decline. Specialty vessels fabricated in Houma would no longer require costly navigation aids. Deepening the channel to 20 feet would allow for greater utilization of existing facilities and remove the need to continue to maintain satellite facilities on deeper channels.

Alternative 2A has NED and fabrication benefits ranging from $1,207.8 million (100 percent market share) to $1,099.7 million (25 percent market share). The total present value benefits (NED and fabrication) for the 50 percent market share would be $1,135.8 million. The total benefits (transportation cost savings) for Alternative 2A is $1,063.7 million. These total benefits are nearly four times greater than the total benefits for the 18-foot deepening alternatives ($1,063 million versus $223 million). The BCR for transportation cost savings for Alternatives 2A, 2B, and 2C are 4.96, 2.55, and 1.96, respectively. There appears to be no change in the projected annual O&Mcosts during the period of analysis between the No-Action Alternative (15-foot channel) and the 20-foot deepening alternatives.

Deepening the channel to 20 feet could cause minor short-term impacts to navigation during the initial construction, utility relocation, and maintenance dredging; however, delays due to dredging would not significantly impact navigation. Deepening would have positive indirect impacts to navigation. No additional maintenance dredging events are anticipated with the deepening.

HUMAN ENVIRONMENT

6.2 Socioeconomics

6.2.1 No-Action Alternative

The current channel depth of the HNC would be maintained under the No-Action Alternative. Terrebonne Parish has experienced a steady increase in population and housing over the last three decades and this trend is expected to continue. Increasing employment in education, health, and social services; retail trade; agriculture; manufacturing; and construction is expected to continue. Increasing per capita personal income and median household income and decreasing unemployment has also occurred. The current navigation limits the growth in the area, affecting the local economy.

6.2.2 Alternative 1A

Deepening could improve growth and local economy. One oyster lease in Disposal Site 21 would be directly impacted. Compensation for this loss would be required and these effects would be assessed and mitigated prior to use.

6.2.3 Alternatives 1B, 1C

Deepening could improve growth and local economy. A total of 61 oyster leases (1 in Disposal Site 21 and 60 in the lung) would be directly impacted. Compensation for this loss would be required and these effects would be assessed and mitigated prior to use.

6.2.4 Alternative 2A (TRP)

Deepening could improve growth and local economy. One oyster lease in Disposal Site 21 would be directly impacted. Compensation for this loss would be required and these effects would be assessed and mitigated prior to use.

6.2.5 Alternatives 2B, 2C

Deepening could substantially improve growth and local economy. A total of 61 oyster leases (1 in Disposal Site 21 and 60 in the lung) would be directly impacted. Compensation for this loss would be required and these effects would be assessed and mitigated prior to use.

6.3 Noise, Health, and Safety

6.3.1 No-Action Alternative

The current channel depth of the HNC would be maintained under the No-Action Alternative. O&M dredging would have only short-term, and minor, direct and indirect noise effects. Noise during O&M dredging would likely affect relatively few people other than those employed at or near the construction sites. Except for the city of Houma and the towns of Dulac and Cocodrie, much of the HNC study area is generally remote. The frequency and level of noise produced by navigation traffic would remain the same as current conditions.

To prevent adverse noise effects of maintenance, USACE projects follow appropriate guidelines set by other Federal agencies, including the Occupational Safety and Health Administration (OSHA). Feasible administrative or engineering controls would be utilized via effective hearing conservation programs when employees are subjected to sound exceeding those described under

OSHA Standards. In accordance with these standards, if controls fail to reduce sound levels within acceptable levels, personal protective equipment would be used to reduce sound levels.

In some instances, noise may directly affect fish and wildlife species (Bender 1997). These organisms would likely avoid the maintenance dredging area. In some instances, noise could potentially indirectly affect wildlife, including disruption of normal breeding patterns and abandonment of nesting colonies. The implementation of appropriate buffer zones and activity windows could be used to mitigate for potential impacts. Operational activities associated with the proposed dredging should not encroach within 1,500 feet of a bald eagle nest during the nesting season (i.e., October through mid-May). If the proposed work occurs during the bald eagle nesting season (i.e., October through mid-May), USFWS (email dated January 15, 2004) recommend that a survey be conducted for the presence of undocumented eagle nests prior to initiation of construction.

6.3.2 Alternatives 1A, 1B, 1C

The 18-foot deepening alternatives (1A, 1B, 1C) would have similar short-term and minor, direct and indirect noise effects during construction as the No-Action Alternative, although effects would be slightly greater due to the initially greater amount of dredged material from the deepening. Following the deepening, noise effects of maintenance dredging would be similar to the No-Action Alternative. As a result of the deepening, the frequency of noise produced by navigation traffic would increase over current conditions; however, the level of noise would likely remain the same.

6.3.3 Alternatives 2A (TRP), 2B, 2C

The 20-foot deepening alternatives (2A, 2B, 2C) would have similar short-term and minor, direct and indirect noise effects during construction of the 18-foot deepening alternatives, although effects would be slightly greater due to the initially greater amount of dredged material from the deepening. Following the deepening, noise effects of maintenance dredging would be similar to the No-Action Alternative. As a result of the deepening, the frequency of noise produced by navigation traffic would increase over current conditions; however, the level of noise would likely remain the same.

6.4 Environmental Justice

6.4.1 No-Action Alternative

The current channel depth of the HNC would be maintained under the No-Action Alternative. No minority and/or low-income communities have been identified in the study area that would be directly adversely affected by the No-Action Alternative. Therefore, no disproportionately high or adverse human health or environmental effects on minority or low-income populations would occur. No disproportionately high or adverse human health or environmental indirect impacts on minority, low-income populations, or children would occur.

6.4.2 Alternatives 1A, 1B, 1C, 2A (TRP), 2B, 2C

Direct and indirect effects of the 18- and 20-foot deepening alternatives (1A, 1B, 1C, 2A, 2B, 2C) on Environmental Justice would be similar to the No-Action Alternative.

NATURAL ENVIRONMENT

6.5 Land Use/Land Cover/Land Loss

6.5.1 No-Action Alternative

The current channel depth of the HNC would be maintained under the No-Action Alternative.

Land Use - Under the No-Action Alternative, land use is not expected to change.
Land Cover - Wetlands would continue to be directly and indirectly impacted by the present natural and manmade factors. The operation of the HNC Lock and Floodgates is expected to reduce salinities and reduce the conversion between marsh types or conversion to open water (USACE, 2013).

Land Loss - Subsidence and erosional land loss would continue at the present rate. The overall habitat value and acreage of the remaining wetlands would decline with the No-Action Alternative. According to the WVA model, vast acreages of wetlands would continue to be lost (Table 6-1). Under the No-Action Alternative (current dredging conditions), approximately 1,570 acres of waterbottom could be converted into marsh with the placement of over 12.2 mcy of dredged material at the Inland Reach placement sites over the life of the project. Intermediate marshes may shift to more salt tolerant vegetation. Without substantial sediment input, these fresher marshes would not be able to maintain elevations capable of supporting salt marsh vegetation. Coastal marshes and ridges protect inland plant communities from marine conditions. The continued conversion of coastal wetlands to open water would profoundly affect plant communities that require such protection. The operation of the HNC Lock and Floodgates is expected to reduce salinities and reduce the conversion between marsh types or conversion to open water (USACE, 2013).

The without project wetland loss in the placement sites and along the existing bankline is shown in Table 6-1. A total of 155 acres of bottomland hardwood, 36 acres of swamp, and 532 acres of intermediate, brackish, and salt marsh would be lost due to shoreline retreat.

6.5.2 Alternative 1A

Land Use - Under Alternative 1A, deepening the HNC could result in significant and long term effects due to the expansion of existing facilities and construction of new facilities.

Table 6-1. Without Project Wetland Losses (acres)

Existing Habitat	Without Project Change Target Year 50
Total Bottomland Hardwood	-155
Total Swamp	-36
Total Intermediate Marsh	-46
Total Brackish Marsh	-238
Total Salt Marsh	-248

Land Cover and Land Loss - Wetlands would continue to be directly and indirectly impacted by the present natural and manmade factors. The operation of the HNC Lock and Floodgates is expected to reduce salinities and reduce the conversion between marsh types or conversion to open water (USACE, 2013). Approximately 1,793 acres of waterbottom could be converted into marsh with the placement of nearly 13.9 mcy of dredged material at the Inland Reach placement sites over the life of the project. Foreshore protection and rock retention dikes would reduce shoreline erosion along the HNC. The operation of the HNC Lock and Floodgates is expected to reduce salinities that could potentially be increased during storms due to the deepening and decrease land loss (USACE, 2013).

6.5.3 Alternatives 1B, 1C

Land Use - Direct and indirect effects of Alternatives 1B and 1C on land use would be similar to effects of Alternative 1A.

Land Cover and Land Loss - Direct and indirect effects of Alternatives 1B and 1C on land cover and land loss would be similar to effects of Alternative 1A, except additional land would be created within Terrebonne Bay and Cat Island Pass. Nearly 20.2 mcy of Terrebonne Bay and Inland Reach dredged material would be placed over up to 2,086 acres of primarily waterbottom in the lung to create marsh. Over 12.0 mcy of Terrebonne Bay and Inland Reach dredged material would be placed over up to 1,234 acres of waterbottom on the bay side of East Island to create marsh. Nearly 18.2 mcy of Cat Island Pass dredged material would be placed on the Gulf side of East Island for beach nourishment.

6.5.4 Alternative 2A (TRP)

Land Use - Under Alternative 2A, deepening the HNC could result in significant and long-term effects due to the expansion of existing facilities and construction of new facilities.

Land Cover and Land Loss - Direct and indirect effects of Alternative 2A on land cover and land loss would be similar to effects of Alternative 1A. Under Alternative 2A, approximately

2,114 acres of waterbottom could be converted into marsh with the placement of nearly 16.3 mcy of dredged material at the inland placement sites over the life of the project.

6.5.5 Alternatives 2B, 2C

Land Use - Direct and indirect effects of Alternatives 2B and 2C on land use would be similar to effects of Alternative 2A.

Land Cover and Land Loss - Direct and indirect effects of Alternatives 2B and 2C on land cover and land loss would be similar to effects of Alternative 2A. Nearly 21.4 mcy of Terrebonne Bay and Inland Reach dredged material would be placed over up to 2,209 acres of primarily waterbottom in the lung to create marsh. Over 12.7 mcy of Terrebonne Bay and Inland Reach dredged material would be placed over up to 1,317 acres of waterbottom on the bay side of East Island to create marsh. Nearly 20.8 mcy of Cat Island Pass dredged material would be placed on the Gulf side of East Island for beach nourishment.

6.6 Prime and Unique Farmland

6.6.1 No-Action Alternative

The current channel depth of the HNC would be maintained under the No-Action Alternative. There would be direct effects to prime and unique farmland as the conversion of land to open water in the area would continue.

6.6.2 Alternatives 1A, 1B, 1C, 2A (TRP), 2B, 2C

Under the deepening alternatives (1A, 1B, 1C, 2A, 2B, 2C), there would be direct impacts to prime and unique farmland. The loss of prime and unique farmland and conversion of land to open water in the area would continue; however, material placement, and construction of foreshore protection and retention dikes would help to reduce some of the loss of prime and unique farmland. Prime farmland in the Houma region may be converted to other commercial uses as facilities along the HNC expand due to the deepening.

6.7 Rare Plant Communities and Natural Communities

6.7.1 No-Action Alternative

The current channel depth of the HNC would be maintained under the No-Action Alternative. Under the No-Action Alternative, rare plant species and natural communities (including coastal dune grassland, cypress-tupelo swamp, freshwater marsh, and salt marsh) would continue to be impacted by natural and manmade factors. Although salinity intrusion would be expected to increase minimally, the operation of the HNC Lock and Floodgates is expected to reduce impacts to vulnerable areas (USACE, 2013). Subsidence and erosional land loss would continue at the present rate. The overall habitat value and acreage of the remaining wetlands would continue to decline.

6.7.2 Alternatives 1A, 1B, 1C, 2A (TRP), 2B, and 2C

The deepening alternatives (1A, 1B, 1C, 2A, 2B, 2C) would have similar effects on rare plant species and natural communities as the No-Action Alternative, although effects during construction would be direct and moderate due to the initially greater amount of dredged material from the deepening. Foreshore protection and rock retention dikes would reduce shoreline erosion along the HNC.

6.8 Geology and Soils

6.8.1 No-Action Alternative

The current channel depth of the HNC would be maintained under the No-Action Alternative. The No-Action Alternative would have no direct effects on geology. O&M dredging would continue to relocate material from the channel bottom to disposal areas (54.6 million cubic yards [mcy] over 50 years). The loss of soils, including erosion of the channel banks, and conversion of land to open water in the area would continue.

6.8.2 Alternatives 1A, 1B, 1C

The 18-foot deepening alternatives (1A, 1B, 1C) would have no direct effects on geology. Deepening would dredge 4.8 mcy [52 acres of HNC waterbottom to increase the top width of the channel (35 acres Inland Reach and 17 acres Terrebonne Bay Reach)]. O&M dredging would continue to relocate material from the channel bottom to disposal areas (59.47 mcy over 50 years). The loss of soils would be a long-term and unavoidable impact. Erosion of the channel banks and conversion of land to open water in the area would continue; however, foreshore protection and retention dikes would reduce bank erosion and the material placement would create additional marsh and barrier island habitat.

6.8.3 Alternatives 2A (TRP), 2B, 2C

The 20-foot deepening alternatives (2A, 2B, 2C) would have no direct effects on geology. Deepening would dredge 7.5 mcy [102 acres of HNC waterbottom to increase the top width of the channel (73 acres Inland Reach, 24 acres Terrebonne Bay Reach, and 5 acres Cat Island Pass Reach)]. O&M dredging would continue to relocate material from the channel bottom to disposal areas (63.1 mcy over 50 years). The loss of soilswould be a long-term and unavoidable impact. Erosion of the channel banks and conversion of land to open water in the area would continue; however, foreshore protection and retention dikes would reduce bank erosion and the material placement would create additional marsh and barrier island habitat.

6.9 Shoaling and Maintenance Dredging

6.9.1 No-Action Alternative

The current channel depth of the HNC would be maintained under the No-Action Alternative. Bank erosion and other land loss mechanisms would continue to convert land to open water in the area and would continue to contribute to shoaling and the need for maintenance dredging.

6.9.2 Alternatives 1A, 1B, 1C

The 18-foot deepening alternatives (1A, 1B, and 1C) would significantly affect shoaling and maintenance dredging requirements in the HNC. The addition of foreshore protection and rock retention within the Inland Reach would decrease shoaling rates and the effects of increased vessel traffic on bank erosion would be somewhat mitigated. After the initial deepening, effects of O&M dredging would be similar to the No-Action Alternative.

6.9.3 Alternatives 2A (TRP), 2B, 2C

The channel will be lengthened from Mile -3.5 to -3.7 to reach the -20 contour. Since Cat Island Pass is already authorized to -18 feet, the deepening and lengthening of the offshore reach will increase the maintenance dredging from approximately 250,000 to 290,000 cy per year, or about a 15 percent increase (Rosati 2008). This maintenance dredging is likely to increase in the future due to the migration of Timbalier Island to the west unless the channel is realigned further to the west (Rosati 2008). The effects of increased vessel traffic on bank erosion and shoaling would be somewhat mitigated by the construction of foreshore protection and retention dikes on the Inland Reach.

6.10 Barrier Islands

6.10.1 No-Action Alternative

The current channel depth of the HNC would be maintained under the No-Action Alternative. Under the No-Action Alternative, without nourishment, East Island would continue to narrow and beach erosion would continue at its current pace. Estimates for migration of Cat Island Pass range from 26 ft/yr (1980s–2006) to 42 ft/yr (1930s –1980s) to the west. It is likely that channel position after 1967 was controlled by dredging; thus, the better estimate for natural channel migration is approximately 40 ft/yr. Timbalier Island is migrating west at 250 ft/yr. The Gulf side of East Island is estimated to be eroding at 65,000 cy/yr (Rosati 2008). Dredged material from the Cat Island Pass Reach would be placed in SPDs under the No-Action Alternative. Presently, fine sand dredged from Cat Island Pass is placed at either of two SPDs approximately 2500-ft west of the channel, located at Mile −1.7 and at Mile –2.5. With the complex sediment transport pathways in Cat Island Pass, it is likely that the present location of these disposal sites returns sediment to the channel.

6.10.2 Alternative 1A

Effects of Alternative 1A on barrier islands would be the same as the No-Action Alternative. Dredged material from the Cat Island Pass Reach would be placed in SPDs under Alternative 1A. With channel deepening, it is anticipated that transport pathways will continue, although the deeper channel will intercept natural sand presently bypassing the channel.

6.10.3 Alternatives 1B, 1C

Under Alternatives 1B and 1C, dredged material would be pumped onto the Gulf surf zone of East Island west of the nodal point for transport by the longshore current. Material would also be placed in the back bay area of East Island for wetland creation. The initial construction would be followed by maintenance quantities every two years. The beach nourishment would help to protect marsh habitat. This dredged material would augment the beach, and protect the island by buffering wave action. The dredged material would eventually be eroded by wave action and swept westward by prevailing currents. Some of this material would likely be deposited on beaches and islands west of East Island, indirectly benefiting these areas. Material placed on East Island would allow the continuation of the normal sand transport system. There would be no direct negative effects on vegetation or wildlife since the material would be placed in the surf zone and the back bay area.

6.10.4 Alternative 2A (TRP)

Direct and indirect effects of Alternative 2A would be similar to effects of Alternative 1A. The initial quantity of dredged material placed in SPDs in the Cat Island Pass Reach would be greater due to the initially greater amount of dredged material from the deepening. Following the deepening, effects of maintenance dredging placement on barrier islands would be the same as Alternative 1A. With channel deepening, it is anticipated that sediment transport pathways east of the channel will continue, although the deeper channel will intercept natural sand presently bypassing the channel and increase shoaling by 40,000 cy/yr. It is likely that this maintenance dredging rate will increase in the future due to migration of Timbalier Island to the west unless the channel is realigned further to the west (Rosati 2008).

6.10.5 Alternatives 2B and 2C

Direct and indirect effects of Alternatives 2B and 2C would be similar to effects of Alternatives 1B and 1C. The initial quantity of dredged material pumped into the Gulf surf zone of East Island and placed in the back bay area of East Island for wetland creation in the Cat Island Pass Reach would be greater due to the initially larger amount of dredged material from the deepening. Placement on the bayside has several advantages as compared to Gulf side deposition: it is less likely to experience energetic wave conditions; it will provide a platform on which the island can overwash and thus maintain its form; and fine sediment will not erode as rapidly and may eventually become vegetated, thereby creating new marsh. Following the deepening, effects of maintenance dredging placement on barrier islands would be the same as

Alternatives 1B and 1C. Sediment placed on East Island would continue the natural bypassing process across Cat Island Pass that will be disrupted by the deepened and lengthened channel.

6.11 Wildlife Resources

6.11.1 No-Action Alternative

The current channel depth of the HNC would be maintained under the No-Action Alternative. Wildlife resources would continue to be affected by changing coastal conditions and loss of land which would continue to reduce foraging areas for some birds and mammals. Amphibian populations would continue to decline and be limited by the lack of fresh water. Most reptile populations would also continue to decline. With barrier island retreat and coastal erosion, habitat for the diamondback terrapin would continue to decline. Alligator populations would continue to be stable due to management efforts. Many mammal species would continue to experience habitat loss due to the transformation of swamps, bottomland hardwood and fresh marsh into areas that are more saline or open water. Wetlands would continue to be directly and indirectly impacted by the present natural and manmade factors. The operation of the HNC Lock and Floodgates is expected to reduce salinities and reduce the conversion between marsh types or conversion to open water (USACE, 2013). The conversion of fresh habitat to open water or more saline marshes would alter the bird community to a more open water saline community with diving ducks, rails, coots, and gallinules. The current rate of land loss, erosion, and subsidence indicates a continued decline in wildlife resources in the project area. Over the long-term, wildlife resources could be significantly affected as their habitat and that of their prey disappears.

Maintenance dredging and placement could cause minor direct effects due to avoidance of maintenance areas by wildlife. Undocumented eagle nests would be surveyed prior to initiation of construction. Maintenance dredging or placement would not encroach within 1,500 feet of an eagle nest during the nesting season (October through mid-May) or within 2,000 feet of a brown pelican nest during April to mid-September.

6.11.2 Alternative 1A

Alternative 1A would have similar direct and indirect effects on wildlife resources in the project area as the No-Action Alternative, although effects could be initially greater due to the additional dredged material from the deepening.

6.11.3 Alternative 1B, 1C

Alternatives 1B and 1C would have similar direct and indirect effects on wildlife resources in the project area as Alternative 1A, but effects would be more positive due to the additional marsh creation from the deepening.

6.11.4 Alternative 2A (TRP)

Alternative 2A would have similar direct and indirect effects on wildlife resources in the project area as Alternative 1A, although effects could be initially greater due to the additional dredged material from the deepening.

6.11.5 Alternative 2B, 2C

Alternatives 2B and 2C would have similar direct and indirect effects on wildlife resources in the project area as Alternative 2A, but effects would be more positive due to the additional marsh creation from the deepening.

6.12 Invasive Wildlife Species

6.12.1 No-Action Alternative

The current channel depth of the HNC would be maintained under the No-Action Alternative. The No-Action Alternative is not expected to affect invasive wildlife species.

6.12.2 Alternatives 1A, 1B, 1C, 2A (TRP), 2B, 2C

The deepening alternatives (1A, 1B, 1C, 2A, 2B, 2C) are not expected to affect invasive wildlife species.

6.13 Threatened and Endangered Species

6.13.1 No-Action Alternative

The current channel depth of the HNC would be maintained under the No-Action Alternative. Maintenance dredging and placement could cause minor direct effects due to avoidance of construction areas by threatened and endangered species. Threatened and endangered species would continue to be affected by changing coastal conditions and loss of land which would reduce foraging areas for some birds and mammals. With barrier island retreat and coastal erosion, foraging habitat for the piping plover would continue to decline. Wetlands would continue to be directly and indirectly impacted by the present natural and manmade factors. The operation of the HNC Lock and Floodgates is expected to reduce salinities and reduce the conversion between marsh types or conversion to open water (USACE, 2013). The current rate of land loss, erosion, and subsidence indicates a continued decline in habitat for threatened and endangered species in the project area. Over the long-term, threatened and endangered species could be greatly affected as their habitat and that of their prey disappears.

Despite precautions, significant impacts could occur if sea turtles were taken during dredging operations. Dredging with hopper dredges for Gulf navigation channel projects may occasionally kill sea turtles, mainly loggerheads and Kemp's ridleys. Observers aboard dredge vessels and relocation trawling will be used to minimize the potential for incidental turtle takes. Collisions with service vessels can pose a threat to sea turtles; however, sea turtles in the project area would be migratory and not year-round residents. Any sea turtles in the project area would likely be present during the spring and summer. Collisions with vessels are a concern because sea turtles and manatee frequent the surface. Most collisions involved propeller and boat strikes by commercial transport and recreational boat traffic. Mitigation measures such as turtle observers and relocation trawling will minimize the potential for collisions with sea turtles. Possible indirect impacts include interference with underwater resting habitats, disturbance to benthic foraging habitats, and disruption of the prey base. Sea turtles feed on benthic invertebrates, fish, crabs, jellyfish, sponges, and sea grasses. Dredging in shallow areas can destroy foraging habitat for sea turtles. Other factors affecting sea turtles include discarded trash and debris from dredge or service vessels. Effects from sediment plumes created by dredge operations would be minor and short-term. Sea turtles can consume plastic bags, tar balls, and other discarded trash or litter. Littering regulations reduce the accumulation of plastic and other debris in the marine environment.

The No-Action Alternative of continued maintenance dredging and disposal would not have any direct or indirect effects on piping plover. Existing conditions would persist and the erosion of piping plover roosting and foraging habitat would continue. The No-Action Alternative would not have any direct impacts on the Florida manatee or whales. Existing conditions would persist. Florida manatees and whales are unlikely to be present in the project area. The proposed project would be expected to have negligible effects on manatees and whales. Standard manatee protection procedures would be followed to decrease the chances of injury.

6.13.2 Alternative 1A

Alternative 1A would have similar direct and indirect effects on threatened and endangered species in the project area as the No-Action Alternative, although effects could be initially greater due to the additional dredged material from the deepening and utility relocation.

6.13.3 Alternatives 1B, 1C

Alternatives 1B and 1C would have similar direct and indirect effects on threatened and endangered species in the project area as Alternative 1A. Effects would be more positive due to the additional marsh and beach creation from the deepening, which could provide foraging areas for some species of endangered birds and mammals and prey species. Over the long-term, there could be an impact to threatened and endangered species as loss rates of their habitat and the habitat of their prey habitat naturally stabilizes. Sea turtles may be adversely impacted during actual dredging operations of the channel. The incidence of unavoidable taking of these sea turtles would be minimized by the use of hydraulic dredges. No direct impact to threatened and endangered species should occur if these guidelines are followed. Dredging and material placement would indirectly benefit piping plover by placing the heavy material from the bar reach in the surf zone on the Gulf side of East Island. Maintenance dredging and disposal is not likely to affect any piping plovers since the birds are highly mobile and can quickly move out of harm's way. Disposal activities on East Island may lead to temporarily diminished quantity and quality of intertidal foraging and roosting habitats on East Island, resulting in temporary adverse affects to critical habitat. However, there are suitable habitats nearby. The proposed action would introduce sediment into that system that would be reworked and redistributed through natural processes, thus maintaining and/or enhancing the features of critical habitat. The additional sediment would be re-worked by wind and wave action and storm events to allow for natural shoreline nourishment and repair along East Island, which should result in the natural reformation of optimal piping plover habitat in the form of overwash areas, sand flats, mud flats, and sand spits. The restoration and maintenance of intertidal habitat is important for the restoration of the piping plover population to healthy levels.

6.13.4 Alternative 2A (TRP)

Alternative 2A would have similar direct and indirect effects on threatened and endangered species in the project area as Alternative 1A, although effects could be initially greater due to the additional dredged material from the deepening and additional utility relocations.

Because this project will not be constructed in the next year, an updated threatened and endangered species review and coordination with USFWS and NMFS will be necessary no more than a year before construction begins. A Biological Assessment was submitted to the NMFS and is currently under review.

6.13.5 Alternatives 2B and 2C

Alternatives 2B and 2C would have similar direct and indirect effects on threatened and endangered species in the project area as Alternatives 1B and 1C, although effects could be initially greater due to the additional dredged material from the deepening.

AQUATIC ENVIRONMENT

6.14 Benthos

6.14.1 No-Action Alternative

The current channel depth of the HNC would be maintained under the No-Action Alternative. The No-Action Alternative would directly impact the ecology of the benthos in the project area. Approximately 36.3 miles of 150-ft wide canal would be maintenance dredged about every 10 years, and 3.5 miles of 300-ft wide canal would be maintenance dredged about every 2 years. Potentially, 932 acres of HNC waterbottom could be disturbed. Approximately 1,570 acres of waterbottom could be converted into marsh with the placement of over 12.2 mcy of dredged material at the inland placement sites over the life of the project. An additional nearly 31.7 mcy of Terrebonne Bay and Inland Reach dredged material and 12.5 mcy of Cat Island Pass dredged material would be placed over waterbottom in SPDs over the life of the project. The amount of waterbottom this material would disturb is unknown.

Most members of the benthic communities are sessile or very slow moving. The dredging of material would directly and adversely impact them by digging up organisms, moving them through a pipeline, and placing them in a new location. The likelihood of an organism surviving would be extremely slim. The newly exposed sediment would be quickly recolonized from adjacent areas. Oyster reefs and other benthos would be destroyed directly in the placement process. The composition of the species that make up the benthos would change in most of the placement areas since the habitat would be converted from open water to marsh. These organisms would be disturbed during maintenance cycles; hence, a climax community may never be reached.

6.14.2 Alternative 1A

Alternative 1A would have similar direct impacts on the ecology of the benthos in the project area as the No-Action Alternative but the adverse impacts would be slightly greater. Approximately 36.3 miles of 150-ft wide canal would be deepened and then maintenance dredged about every 10 years, and 3.5 miles of 300-ft wide canal would be maintenance dredged about every 2 years. Potentially, 984 acres of HNC waterbottom could be disturbed from dredging. Approximately 1,793 acres of waterbottom could be converted into marsh with the placement of nearly 13.9 mcy of dredged material at the inland placement sites over the life of the project. Alternative 1A would dredge an additional 52 acres along the HNC to increase the top width of the channel (35 acres Inland Reach and 17 acres Terrebonne Bay Reach).

Approximately 1.6 miles of rock retention dikes to contain the inland disposal sites and 13.1 miles of foreshore protection would be constructed or refurbished; approximately 80-ft wide flotation canals would be necessary for rock placement. An additional nearly 37.3 mcy of Terrebonne Bay and Inland Reach dredged material and nearly 13.2 mcy of Cat Island Pass dredged material would be placed over waterbottom in SPDs over the life of the project. The amount of waterbottom this dredged material would disturb is unknown.

6.14.3 Alternatives 1B and 1C

Alternatives 1B and 1C would have direct impacts on the ecology of the benthos in the project area would be similar to the 1A Alternative, but the adverse impacts would be slightly greater. Quantities of dredged material that would be placed in the inland placement sites and areas of rock retention dikes and foreshore protection would be the same as Alternative 1A. Nearly 20.2 mcy of Terrebonne Bay and Inland Reach dredged material would be placed over up to 2,086 acres of primarily waterbottom in the lung to create marsh. Over 12 mcy of Terrebonne Bay and Inland Reach dredged material would be placed over up to 1,234 acres of waterbottom on the bay side of East Island to create marsh. Nearly 18.2 mcy of Cat Island Pass dredged material would be placed on the Gulf side of East Island for beach nourishment. The amount of waterbottom this dredged material would disturb is unknown. The increase in top width of the channel would be the same as Alternative 1A.

6.14.4 Alternative 2A (TRP)

Alternative 2A would have direct impacts on the ecology of the benthos in the project area similar to the 1A Alternative, but greater. Potentially 1,046 acres of waterbottom could be disturbed from dredging. Approximately 2,114 acres of waterbottom could be converted into marsh with the placement of nearly 16.3 mcy of dredged material at the inland placement sites over the life of the project. Alternative 2A would dredge an additional 102 acres along the HNC to increase the top width of the channel (73 acres Inland Reach, 24 acres Terrebonne Bay Reach, and 5 acres Cat Island Pass Reach). An additional over 39.4 mcy of Terrebonne Bay and Inland Reach dredged material and over 13.9 mcy of Cat Island Pass dredged material would be placed over waterbottom in SPDs over the life of the project. The amount of waterbottom this dredged material would disturb is unknown.

6.14.5 Alternatives 2B and 2C

Alternatives 2B and 2C would have direct impacts on the ecology of the benthos in the project area, similar to the 2A Alternative. Quantities of dredged material that would be placed in the inland placement sites and areas of rock retention dikes and foreshore protection would be the same as Alternative 2A. Nearly 21.4 mcy of Terrebonne Bay and Inland Reach dredged material would be placed over up to 2,209 acres of primarily waterbottom in the lung to create marsh. Over 18.0 mcy of Terrebonne Bay and Inland Reach dredged material would be placed over up to 1,317 acres of waterbottom on the bay side of East Island to create marsh. Nearly 15.6 mcy of Cat Island Pass dredged material would be placed on the Gulf side of East Island for beach nourishment. The amount of waterbottom this dredged material would disturb is unknown. The increase in top width of the channel would be the same as Alternative 2A.

6.15 Plankton

6.15.1 No-Action Alternative

The current channel depth of the HNC would be maintained under the No-Action Alternative. The No-Action Alternative would directly impact the ecology of the plankton in the project area. During dredging, there would be short-term minor adverse impacts to plankton populations due to increases in turbidity, low dissolved oxygen, and the introduction of sediments into shallow open water areas. There would be a permanent loss of some shallow water habitat as it is filled with dredged material. The operation of the HNC Lock and Floodgates is expected to reduce salinities to mitigate increases in saline water flows and associated nutrients that could change plankton abundance and species composition (USACE, 2013). Maintaining existing habitat characteristics could limit conversions of plankton communities to those of higher salinity habitats. Wetland loss would eventually result in a decrease of available nutrients and detritus, which could lead to the conversion of primarily estuarine-dependent plankton species assemblages to more marine and open water plankton species assemblages.

6.15.2 Alternatives 1A, 1B, 1C, 2A (TRP), 2B, 2C

The deepening alternatives (1A, 1B, 1C, 2A, 2B, 2C) would have similar effects on plankton communities as the No-Action Alternative, although effects during construction would be slightly greater due to the initially greater amount of dredged material from the deepening.

6.16 Fisheries

6.16.1 No-Action Alternative

The current channel depth of the HNC would be maintained under the No-Action Alternative. The No-Action Alternative would have a positive indirect effect on fisheries resources through the creation of marsh. This positive effect would not offset the long-term negative effect on aquatic resources due to land loss. Many fisheries species use the marsh as a nursery or feeding area. Land loss increases areas of open water and marsh edge habitat, increasing the available fisheries habitat; this would have a short-term positive indirect effect on aquatic resources. However, as marsh is lost, marsh edge habitat eventually disappears, negatively affecting aquatic species. Salinity intrusion would continue, creating a landward shift in marine habitat; however, the operation of the HNC Lock and Floodgates is expected to reduce salinities (USACE, 2013). Freshwater aquatic habitat would shrink; however, marshes would convert to different marsh types or open water. Populations of most major commercially important fish and invertebrate species are expected to decline in the study area over the next 50 years.

Fish are transient and mobile by nature; this would allow them to avoid the construction area during the dredging and placement operations. The primary effect to fisheries would result from the disturbance of benthic and epibenthic communities. Benthos and epibenthos smothered during dredged material placement would temporarily disrupt the food chain. Pumping of the dredged material would also create a short-term local increase in turbidity. The turbidity may decrease the hunting capacity of visual predators and clog the gills of filter feeders.

Invertebrates would be affected differently, depending on the species. Blue crabs and shrimp are mobile and could avoid the dredging and placement areas, although some burial may occur. Juveniles recruit to the marsh from offshore, so recolonization would not be affected. Oyster reefs in placement areas would be buried. Any oysters present could be smothered by fill. The turbidity may clog the gills of oysters and other filter feeding bivalves. The recruitment of new oysters would be minimal due to lack of hard substrate. One oyster lease in Disposal Site 21 may be affected by fill placement; these effects would be assessed and mitigated prior to construction.

6.16.2 Alternative 1A

Alternative 1A would have similar direct effects on fisheries resources in the project area as the No-Action Alternative but slightly greater due to the initially larger quantities of dredged material from the deepening and relocation of utilities. One oyster lease in Disposal Site 21 would be directly and significantly impacted. Compensation for this loss would be required and these effects would be assessed and mitigated prior to construction.

6.16.3 Alternatives 1B, 1C

Alternatives 1B and 1C would have similar direct effects on fisheries resources in the project area as Alternative 1A but could be slightly greater due to the placement locations in the Terrebonne Bay and Cat Island Pass Reaches. Sixty one oyster leases in Disposal Site 21 (1) and the lung (60) would be directly impacted. Compensation for this loss would be required and these effects would be assessed and mitigated prior to use. The use of earthen or rock dikes could prevent fish access to portions of the study area. Dikes would be breached by year 3 to allow tidal flow and fish access.

6.16.4 Alternative 2A (TRP)

Alternative 2A would have similar direct effects on fisheries in the project area as Alternative 1A, but slightly greater initially due to the larger quantities of dredged material from the deepening and additional utility relocation. One oyster lease in one placement area would be directly impacted. Compensation for this loss would be required and these effects would be assessed and mitigated prior to use.

6.16.5 Alternatives 2B, 2C

Alternatives 2B and 2C would have similar direct effects on fisheries in the project area as Alternative 2A, but could be slightly greater due to the placement locations in the Terrebonne Bay and Cat Island Pass Reaches. Sixty one oyster leases in Disposal Site 21 (1) and the lung (60) would be directly impacted. Compensation for this loss would be required and these effects would be assessed and mitigated prior to use.

6.17 Invasive Aquatic Species

6.17.1 No-Action Alternative

The current authorized channel depth of the HNC would be maintained under the No-Action Alternative. The no-action alternative is not expected to have an effect of invasive aquatic species. Vegetative invasive species will be discussed in Section 6.23.

6.17.2 Alternatives 1A, 1B, 1C, 2A (TRP), 2B, 2C

The deepening alternatives (1A, 1B, 1C, 2A, 2B, 2C) are not expected to affect invasive aquatic species.

6.18 Essential Fish Habitat

6.18.1 No-Action Alternative

The current channel depth of the HNC would be maintained under the No-Action Alternative. The No-Action Alternative would have positive direct and indirect effects on emergent marsh EFH in the long term through the creation of marsh. This positive effect would not offset the long-term negative effect on EFH due to land loss. Land loss increases areas of open water and initially increases marsh edge habitat. This increases these types of EFH and would have a short-term positive indirect effect on EFH. However, as additional marsh is lost, marsh edge habitat eventually disappears, adversely affecting emergent marsh EFH.

Salinity intrusion would continue, creating a landward shift in EFH. Altered freshwater inflow has a significant effect on emergent marshes, oyster bars, and nearshore mangroves; a moderate effect on estuarine and nearshore seagrasses, estuarine mangroves, estuarine hard bottom, nearshore sand/shell, soft, and hard bottoms; and some effect on estuarine sand/shell and soft bottom. However, the operation of the HNC Lock and Floodgates is expected to reduce salinities and the associated shift in EFH (USACE, 2013).

Maintenance dredging under the No-Action Alternative would have short-term direct and indirect adverse effects. Estuarine water column and water bottom designated as EFH would be temporarily affected through the disturbance and removal of bottom sediments in the navigation channel. Turbidity from the dredging operations could compromise water quality. The beneficial use of dredged material to create marsh could help to offset the effects of dredging and placement. The creation of wetlands would provide EFH for many aquatic species; including Federally managed species or species groups.

6.18.2 Alternative 1A

Alternative 1A would have similar direct and indirect effects on EFH in the project area as the No-Action Alternative, although effects could be moderate due to the additional dredged material from the deepening. The creation of earthen or rock dikes could indirectly impact EFH over the short-term. These dikes would be breached by year three to allow tidal flow and fish access to mitigate for long-term impacts to EFH. Shoreline hardening has a negative effect on estuarine and nearshore mangroves, emergent marshes, and nearshore sand/shell, soft, and hard bottoms; a moderate effect on oyster bars, and nearshore seagrasses; and some effect on estuarine seagrasses and sand/shell, soft, and hard bottoms. However, direct negative impacts to EFH would be offset by the long-term protection (reduced land loss rate) these hard structures would have by protecting emergent marsh.

6.18.3 Alternatives 1B and 1C

Alternatives 1B and 1C would have similar direct and indirect effects on EFH in the project area as Alternative 1A, but effects on emergent marsh EFH would be more positive due to the additional marsh creation.

6.18.4 Alternative 2A (TRP)

Alternative 2A would have similar direct, positive effects on EFH in the project area as Alternative 1A, but slightly greater initially due to the larger quantities of dredged material from the deepening.

6.18.5 Alternatives 2B and 2C

Alternatives 2B and 2C would have similar direct and indirect effects on EFH in the project area as Alternative 2A, but effects on emergent marsh EFH would be more positive due to the additional marsh creation.

WATER ENVIRONMENT

6.19 Hydrology

6.19.1 No-Action Alternative

The current channel depth of the HNC would be maintained under the No-Action Alternative. The continued maintenance of the HNC would have limited or no direct or indirect impact on the hydrology of the area. The tidal prism through Cat Island Pass increased 21 percent from the 1930s to 2006 due to natural deepening of the pass, possibly changes in dynamics between adjacent inlets, and an increase in bay area due to beach erosion and wetland loss (Rosati 2008). This trend would likely continue. Wind-generated waves would continue to erode the shoreline of the tidal ponds in the area.

6.19.2 Alternatives 1A, 1B, 1C

Similar to the No-Action Alternative, the 18-foot deepening alternatives (1A, 1B, and 1C) would have limited or no direct or indirect effects on the hydrology of the area. The slightly deeper channel could increase the potential of salinity during storms. However, operation of the lock and floodgates would mitigate potential effects of the HNC on salinity (USACE, 2013). The tidal prism will likely increase by an insignificant amount due to the increase in channel area as a result of deepening.

6.19.3 Alternatives 2A (TRP), 2B, 2C

The 20-foot deepening alternatives (2A, 2B, and 2C) would have similar effects as the 18-foot deepening alternatives, although the slightly deeper channel could increase the potential of salinity during storms. However, operation of the lock and floodgates would mitigate potential effects of the HNC on salinity (USACE, 2013). The tidal prism will likely increase by an insignificant amount, approximately 0.01 percent, due to the increase in channel area as a result of deepening (Rosati 2008).

6.20 Groundwater

6.20.1 No-Action Alternative

The current channel depth of the HNC would be maintained under the No-Action Alternative. The No-Action Alternative would have no direct or indirect impacts on groundwater.

6.20.2 Alternatives 1A, 1B, 1C, 2A (TRP), 2B, 2C

Similar to the No-Action Alternative, the deepening alternatives (1A, 1B, 1C, 2A, 2B, 2C) would have no direct or indirect impacts to groundwater.

6.21 Water Quality and Salinity

6.21.1 No-Action Alternative

The current channel depth of the HNC would be maintained under the No-Action Alternative. The Inland Reach of the HNC is maintenance dredged approximately every 10 years and the Terrebonne Bay and Cat Island Pass Reaches are maintenance dredged approximately every 2 to 3 years to maintain the currently authorized depth.

The placement of dredged material into the upland CDFs, including Sites 1 and 3 would result in the discharge of effluent into the HNC, except Site 1, which would discharge into Short Cut Canal. The mixing zone requirements would be met for all upland CDFs with the installation of appropriately sized and placed weirs. The placement of Inland Reach dredged material in Sites 7E, 12, 12B, A-07-A, 14A, 15, 15A, 16, 19C, 19D, 20C, 21, and 24 would not result in point source discharges into the HNC. Dredged material would discharge into the site, and the suspended material would settle out in the receiving area with the probable runoff of the supernatant into adjoining water bodies and marsh/wetland areas. Dredged material from the Terrebonne Bay and Cat Island Pass Reaches would be placed in SPDs in open water.

Dredging and dredged material placement could potentially have direct and indirect surface water runoff effects on water quality of the HNC and adjacent water bodies. The resulting effects would be a factor of the concentration of contaminants, if any, in the sediments to be displaced. Resuspension of sediments during dredging activities varies according to the type of dredge, dredge operator skills, hydrodynamics and sediment characteristics. Dredging of sediments (clean or contaminated) destroys benthic habitat and creates adverse impacts to aquatic, terrestrial, and avian food webs; and degraded water quality. The suspension and dispersal of contaminated sediments could have ecological impacts extending beyond the return of water column turbidity to baseline conditions, particularly if persistent and bioaccumulative chemicals are involved (Su *et al*. 2002). However, mechanical dredging minimizes water column impacts from placement, and includes dewatering, and dredging activities are not anticipated to have significant long-term impacts on the receiving aquatic environment.

Ambient water analyses of elutriates from sediments within some of the sample sites exceeded water quality criteria for lead, copper, and cyanide. Resuspension of dissolved metals would likely increase dissolved concentrations of some metals above the water quality criteria that were not previously exceeded, increasing the potential for bioaccumulation. Metals have a high affinity for organic particulates and do not generally demonstrate significant food chain bioaccumulation. The standard elutriate test used is a conservative indicator of expected contaminant release at the point of dredging. Therefore, contaminant concentrations during dredging activities could be lower than those reported from laboratory analyses. Biological effects data collected for one station identified no cause for concern.

Metals bound to the sediments prior to dredging could remain bound, potentially increasing metal concentrations of the sediments downstream of the disposal area. Bound metals do not generally demonstrate significant food chain bioaccumulation, and the concentrations in the HNC are not relatively high with respect to the reference sites. Therefore, there does not appear to be cause for concern. The dissolved metal concentrations in the elutriate analyses potentially could migrate into the adjacent water bodies, causing bioaccumulation in aquatic life within the water column. Mercury and copper concentrations increased up to seven fold after dredging, but declined to background concentrations within 48 hours (Edwards *et al.* 1995). However, the exposure of aquatic life to metals in the water column would probably be limited. The aquatic life in the upper HNC areas, which correspond to the marsh creation sites, are already exposed to elevated levels of some metals (copper and zinc) and arsenic.

The elutriate concentration for arsenic exceeded the current water quality standard and the LDEQ human health protection criteria for a drinking water supply water body. The HNC from Houma to Bayou Pelton (Subsegment LA120509) is a designated drinking water supply and the operation of the Houma Drinking Water Plant could potentially be affected. The plant has been informed of the potential for contaminants and would be coordinated with during the project. The appropriate dredging operations/techniques, such as dredging this subsegment during high water flows, would help to avoid the migration of potential contaminants toward the drinking water intake.

Increased salinity could result in the release of some metals from disturbed sediments. However, saline water does not cause significant increases in contaminant release (specifically mercury, copper, manganese, and iron) from sediments to the water column over that observed for fresh water (Edwards *et al.* 1995). As a precaution, it is recommended that the HNC be dredged from north to south to reduce saltwater intrusion during dredging.

Salinities in the semi-confined and unconfined disposal areas are not expected to change significantly due to the proposed dredge disposal. The CDFs could experience slightly elevated salinity levels during pumping; however, when the material dries, salinities would return to pre-pumping conditions in wet areas. The operation of the lock and floodgates would mitigate potential effects of the HNC on salinity (USACE, 2013).

Storm Water Pollution Prevention Plans (SWPPPs) would be prepared and implemented. Dredging contractors would prevent oil, fuel, or other hazardous substances from entering the air or water by design and procedural controls. Wastes and refuse generated by project construction would be removed and properly disposed. The contractor would implement a spill contingency plan for hazardous, toxic, or petroleum material. Compliance with EPA Vessel General Permits would be ensured, as applicable.

Activities that could potentially have negative effects on water quality would continue to occur, including industrial, commercial, and residential development along the coast and in the vicinity of Houma and the HNC. Point and nonpoint source pollution in the HNC and surrounding water bodies can come from sources including wastewater treatment facilities and urban runoff from new and existing development. Additional water quality issues may have occurred with the BP Oil Spill of 2010. The construction of flood-damage reduction projects could alter the hydrology of the coast, potentially leading to areas of degraded water quality. However, the Morganza to the Gulf project is incorporating resource-sustainable design features that may aid in protecting significant resources, including surface waters. Ongoing erosion/subsidence or land loss in the coastal areas would continue to unearth oil and gas infrastructure and wastewater collection systems and other commercial-industry related systems making it more vulnerable to storm events and navigation.

6.21.2 Alternative 1A

Construction dredging, dredged material placement, and subsequent maintenance dredging activities under Alternative 1A would have similar direct and indirect effects on water quality as the No-Action Alternative. Effects would be slightly greater due to the initially greater amount of dredged material from the deepening and the relocation of utilities. Following the deepening, effects of maintenance dredging on water quality would be the same as the No-Action Alternative.

The increased boat traffic due to the deepening could potentially increase the amount of bank erosion and small amounts of contaminants, such as oil and diesel; however, the construction of foreshore protection would reduce bank erosion, thereby reducing maintenance dredging quantities.

The deeper channel could potentially allow more saline water into the area, particularly during storms. However, the operation of the lock and floodgates would mitigate potential effects of the deepening on salinity (USACE, 2013).

The LDEQ TMDL program would be indirectly impacted by the proposed deepening project. Section 303(d) of the CWA requires the state to identify, list, and rank waters for development of TMDLs to correct impaired or threatened waters or eliminate the threat and restore waters that do not meet applicable water quality standards after implementation of technology-based controls. LDEQ would be coordinated with regarding any proposed changes to the hydrodynamics to aid in planning and implementation of TMDLs in the HNC.

6.21.3 Alternatives 1B, 1C

Construction dredging, dredged material placement, and subsequent maintenance dredging activities under Alternatives 1B and 1C would have similar direct and indirect effects on water quality in the Inland Reach as Alternative 1A. In the Terrebonne Bay and Cat Island Pass Reaches, the placement of dredged material for beneficial use in the lung, and the bay and Gulf sides of East Island would not result in point source discharges into the HNC.

6.21.4 Alternatives 2A (TRP)

Direct and indirect effects of Alternative 2A on water quality would be similar to the effects of Alternative 1A. Effects would be slightly greater due to the initially greater amount of dredged material from the deepening and relocation of additional utilities. Following the deepening, effects of maintenance dredging on water quality would be the same as Alternative 1A.

6.21.5 Alternatives 2B, 2C

Effects of Alternatives 2B and 2C on water quality would be similar to the effects of Alternatives 1B and 1C. Effects would be slightly greater due to the initially greater amount of dredged material from the deepening. Following the deepening, effects of maintenance dredging on water quality would be the same as Alternatives 1B and 1C.

COASTAL ENVIRONMENT

6.22 Coastal Vegetation and Wetlands

6.22.1 No-Action Alternative

The current channel depth of the HNC would be maintained under the No-Action Alternative. Under the No-Action Alternative, wetlands would continue to be impacted by natural and manmade factors. Although salinity intrusion would be expected to increase minimally, the operation of the HNC Lock and Floodgates is expected to reduce impacts to vulnerable areas (USACE, 2013). Subsidence and erosional land loss would continue at the present rate. The overall habitat value and acreage of the remaining wetlands would continue to decline. Reduced salinities could allow cypress swamps in the project area to recover.

The HET used the WVA model to predict the net change in the placement sites at Target Year 50 under the No-Action Alternative (Table 6-2).

Table 6-2. Alternative 0 (No-Action) at Target Year 50

Wetland Type	FWOP TY 50 Acres
Bottomland Hardwood*	-61.8
Swamp	-36
Intermediate Marsh	314.4
Brackish Marsh	699.0
Salt Marsh	378.4

*Site 3 only; Site 1 has already been mitigated

Bottomland Hardwoods - Boat traffic is assumed to remain the same and much of the shoreline recession is assumed to be caused by boat wakes. Shoreline recession in the Inland Reach would remain the same. Dredged material would be placed in Sites 1 and 3 in the Inland Reach for the No-Action Alternative (continued maintenance); these areas were classified by the HET as bottomland hardwood habitats. Wetland loss in Site 1 has been previously mitigated. Both sites are designated as existing upland disposal areas. A total of 61.8 acres of bottomland hardwood habitat would be directly converted to uplands by the placement of dredged material in Site 3 (Table 6-2). An additional 36 acres of bottomland hardwood habitat would be lost along the channel banks due to erosion.

Intermediate Marsh - Dredged material would be placed in Sites 12, 12B, A-07-A, and 14A for the No-Action Alternative; based on field knowledge, these areas were classified by the HET as intermediate marsh. The total net change in intermediate marsh is positive with 314.4 acres added.

Brackish Marsh - Dredged material would be placed in Sites 7E, 15, 15A, 16, 19C, 19D, and 20C for the No-Action Alternative; these areas were classified by the HET as brackish marsh. The total net change in brackish marsh is positive with 699 acres added.

Salt Marsh - Dredged material would be placed in Sites 21, and 24 for the No-Action Alternative; these areas were classified by the HET as salt marsh. The total net change in salt marsh is positive with 378.4 acres added.

Submerged Aquatic Vegetation - There is a small potential for the indirect enhancement of submerged aquatic vegetation habitat in Sites A-07-A, 7E, 12, 12B, 14A 15, 15A, 16, 19C, and 19D due to the reduction in fetch and the increase in shallow open water (less than 1.5 feet). The predicted direct and indirect impacts to submerged aquatic vegetation are captured in Variable V2 of the WVA for each placement area.

6.22.2 Alternative 1A

Direct and indirect effects of Alternative 1A on wetlands would be similar to effects of the No-Action Alternative. Although vessel traffic would increase due to the deepening, the rock dikes that would be constructed, as needed, for foreshore protection (erosion control) along Miles 36.3 to 11.0 would protect the existing shoreline of the HNC to prevent further land loss due to boat wakes. The overall habitat value and acreage of the remaining wetlands would continue to decline, but at a slower rate. Reduced salinities resulting from operation of the lock could allow cypress swamps in the project area to recover (USACE, 2013).

The HET used the WVA model to predict the net change in the placement sites at Target Year 50 for Alternative 1A (Table 6-3).

Table 6-3. Alternative 1A at Target Year 50

Wetland Type	FWOP TY 50 Acres	TY 50 Alt 1A Acres	TY 50 Alt 1A Net Acres	Alt 1A Net AAHUs Over 50 Years
Bottomland hardwood	-61.8	-73.5	-11.7	-3.95
Swamp	-36	-38	-2	-0.72
Intermediate Marsh	314.4	386.8	72.4	19.1
Brackish Marsh	699.0	810.2	111.2	48.8
Salt Marsh	378.4	473.4	95.0	80.2

*Site 3 only; Site 1 has already been mitigated

Bottomland Hardwoods and Swamp - Dredged material would be placed in Sites 1 and 3 in the Inland Reach for Alternative 1A; these areas were classified by the HET as bottomland hardwood habitats. Wetland loss in Site 1 has been previously mitigated. Both sites are designated as existing upland disposal areas. A total of 73.5 acres of bottomland hardwood habitat would be directly converted to uplands due to the placement of dredged material in Site 3 (Loss of 38 acres of swamp habitat). The lost value of bottomland hardwood and swamp habitat in Site 3 (−4.67 AAHUs; Table 6-3) would require compensatory mitigation.

Intermediate Marsh - Dredged material would be placed in Sites 12, 12B, A-07-A, and 14A for Alternative 1A; these areas were classified by the HET as intermediate marsh. The total net changes in AAHUs for the intermediate marsh is positive (19.1 AAHUs remain). The placement of shoreline protection with Alternative 1A would bank stability, but the increase in erosion rate resulting from the channel deepening and widening would result in the indirect loss of 2 acres of intermediate marsh.

Brackish Marsh - Dredged material would be placed in Sites 7E, 15, 15A, 16, 19C, 19D, and 20C for Alternative 1A; these areas were classified by the HET as brackish marsh. This would result in a net increase of 111.2 acres of brackish marsh habitat. In addition, the placement of shoreline protection indirectly protects 63 acres of brackish marsh. The total net changes in AAHUs for the brackish marsh is positive (48.8 additional AAHUs).

Salt Marsh - Dredged material would be placed in Sites 21 and 24 for Alternative 1A; these areas were classified by the HET as salt marsh. This would result in a net increase of 95 acres of salt marsh habitat. The placement of shoreline protection with Alternative 1A would indirectly protect 161 acres of salt marsh. The total net changes in AAHUs for the salt marsh is positive (80.2 additional AAHUs).

Submerged Aquatic Vegetation - There is a small potential for the indirect enhancement of submerged aquatic vegetation habitat in Sites A-07-A, 7E, 12, 12B, 14A 15, 15A, 16, 19C, and 19D due to the reduction in fetch and the increase in shallow open water (less than 1.5 feet). The predicted direct and indirect impacts to submerged aquatic vegetation are captured in Variable V2 of the WVA for each placement area.

6.22.3 Alternative 1B

Direct and indirect effects of Alternative 1B on wetlands would be similar to effects of Alternative 1A for all habitat types except salt marsh habitat.

The HET used the WVA model to predict the net change in the placement sites at Target Year 50 for Alternative 1B (Table 6-4).

Table 6-4. Alternative 1B at Target Year 50

Wetland Type	FWOP TY 50 Acres	TY 50 Alt 1B Acres	TY 50 Alt 1B Net Acres	Alt 1B Net AAHUs Over 50 Years
Bottomland hardwood*	-61.8	-73.5	-11.7	-3.95
Swamp	-36	-38	-2	-0.72
Intermediate Marsh	314.4	386.8	72.4	19.1
Brackish Marsh	699.0	810.23	111.2	48.8
Salt Marsh	378.4	3,793.4	3,415	660.2

*Site 3 only; Site 1 has already been mitigated

Salt Marsh - Dredged material would be placed in Sites 21, 24, the lung, the bay side of East Island, and nearshore of East Island; these areas were classified by the HET as salt marsh. Salt marsh would be created directly with the dredged material (3,793 acres), and 161 acres of salt marsh would be protected indirectly with the shoreline protection. The total net gain for salt marsh would be 660.2 AAHUs (Table 6-4).

6.22.4 Alternative 1C

Direct and indirect effects of Alternative 1C on wetlands would be similar to effects of Alternatives 1A and 1B for all habitat types except salt marsh habitat.

The HET used the WVA model to predict the net change in the placement sites at Target Year 50 for Alternative 1C (Table 6-5).

Table 6-5. Alternative 1C at Target Year 50

Wetland Type	FWOP TY 50 Acres	TY 50 Alt 1C Acres	TY 50 Alt 1C Net Acres	Alt 1C Net AAHUs Over 50 Years
Bottomland hardwood*	-61.8	-73.5	-11.7	-3.95
Swamp	-36	-38	-2	-0.72
Intermediate Marsh	314.4	386.8	72.4	19.08
Brackish Marsh	699.0	810.23	111.2	48.84
Salt Marsh	378.4	3,793.4	3,415	716.9

*Site 3 only; Site 1 has already been mitigated

Salt Marsh - Dredged material would be placed in Sites 21, 24, the lung, the bay side of East Island, and nearshore of East Island; these areas were classified by the HET as salt marsh. Salt marsh would be created directly with the dredged material (3,793 acres), while 161 acres of salt marsh would be protected indirectly with the shoreline protection. The total net gain for salt marsh would be 716.9 AAHUs (Table 6-5).

6.22.5 Alternative 2A (TRP)

Direct and indirect effects of Alternative 2A on wetlands would be similar to effects of Alternative 1A.

The HET used the WVA model to predict the net change in the placement sites at Target Year 50 for Alternative 2A (Table 6-6).

Table 6-6. Alternative 2A at Target Year 50

Wetland Type	FWOP TY 50 Acres	TY 50 Alt 2A Acres	TY 50 Alt 2A Net Acres	Alt 2A Net AAHUs Over 50 Years
Bottomland Hardwood*	-61.8	-101.9	-40.1	-9.71
Swamp	-36	-38	-2	-0.72
Intermediate Marsh	314.4	461.5	147.1	39.3
Brackish Marsh	699.0	954.9	255.9	103.0
Salt Marsh	378.4	551.2	172.8	103.0

*Site 3 only; Site 1 has already been mitigated

Bottomland Hardwoods and Swamp - Under Alternative 2A, 101.9 acres of bottomland hardwood habitat would be directly converted to uplands due to the placement of dredged material in Site 3. Due to bank erosion in the northern portion of this project, there would be a loss of 38 acres of swamp habitat. The lost value of bottomland hardwood and swamp habitat in Site 3 (-9.71 AAHUs; Table 6-6) would require compensatory mitigation.

Intermediate Marsh - The total net changes in AAHUs for the intermediate marsh is positive (39.3 AAHUs; Table 6-6). The placement of shoreline protection with Alternative 1A would bank stability, but the increase in erosion rate resulting from the channel deepening and widening would result in the indirect loss of 2 acres of intermediate marsh.

Brackish Marsh - Dredged material would be placed in Sites 7E, 15, 15A, 16, 19C, 19D, and 20C for Alternative 2A; these areas were classified by the HET as brackish marsh. This would result in a net increase of 255.9 acres of brackish marsh habitat (Table 6-6). In addition, the placement of shoreline protection indirectly protects 63 acres of brackish marsh. The total net changes in AAHUs for the brackish marsh is positive (103 additional AAHUs).

Salt Marsh - Dredged material would be placed in Sites 21 and 24 for Alternative 1A; these areas were classified by the HET as salt marsh. This would result in a net increase of 172.8 acres of salt marsh habitat (Table 6-6). The placement of shoreline protection with Alternative 1A would indirectly protect 161 acres of salt marsh. The total net changes in AAHUs for the salt marsh is positive (103 additional AAHUs).

Submerged Aquatic Vegetation - Direct and indirect effects of Alternative 2A on submerged aquatic vegetation would be similar to effects of Alternative 1A.

6.22.6 Alternative 2B

Direct and indirect effects of Alternative 2B on wetlands would be similar to effects of Alternative 2A for all habitat types except salt marsh habitat.

The HET used the WVA model to predict the net change in the placement sites at Target Year 50 for Alternative 2B (Table 6-7).

Salt Marsh - Alternative 2B would create salt marsh directly with the dredged material, while 161 acres of salt marsh would be protected indirectly with the shoreline protection. The total net gain for salt marsh would be 756.7 AAHUs (Table 6-7).

Table 6-7. Alternative 2B at Target Year 50

Wetland Type	FWOP TY 50 Acres	TY 50 Alt 2B Acres	TY 50 Alt 2B Net Acres	Alt 2B Net AAHUs Over 50 Years
Bottomland Hardwood*	-61.8	-101.9	-40.1	-9.71
Swamp	-36	-38	-2	-0.72
Intermediate Marsh	314.4	461.5	147.1	39.3
Brackish Marsh	699.0	954.9	255.9	103.0
Salt Marsh	378.4	4,077.3	3,699	756.7

*Site 3 only (Site 1 has already been mitigated)

6.22.7 Alternative 2C

Direct and indirect effects of Alternative 2B on wetlands would be similar to effects of Alternative 2A for all habitat types except salt marsh habitat.

The HET used the WVA model to predict the net change in the placement sites at Target Year 50 for Alternative 2C (Table 6-8).

Table 6-8. Alternative 2C at Target Year 50

Wetland Type	FWOP TY 50 Acres	TY 50 Alt 2C Acres	TY 50 Alt 2C Net Acres	Alt 2C Net AAHUs Over 50 Years
Bottomland Hardwood*	-61.8	-101.9	-40.1	-9.71
Swamp	-36	-38	-2	-0.72
Intermediate Marsh	314.4	461.5	147.1	39.3
Brackish Marsh	699.0	954.9	255.9	103.0
Salt Marsh	378.4	4,077.3	3,699	825.4

*Site 3 only; Site 1 has already been mitigated

Salt Marsh - Alternative 2C would create salt marsh directly with the dredged material, while 161 acres of salt marsh would be protected indirectly with the shoreline protection. The total net gain for salt marsh would be 825.4 AAHUs (Table 6-8).

6.23 Vegetative Invasive Species

6.23.1 No-Action Alternative

The current channel depth of the HNC would be maintained under the No-Action Alternative. Under the No-Action Alternative, invasive vegetation species would continue to be directly and indirectly impacted by natural and manmade factors. Although salinity intrusion would be expected to increase minimally, the operation of the HNC Lock and Floodgates is expected to reduce impacts to vulnerable areas (USACE, 2013). Subsidence and erosional land loss would continue at the present rate. The growth of undesirable vegetation and invasive plant species is an important consideration. Where this occurs, a control strategy, along with an invasive species survey, may need to be implemented. Invasive plants thrive on bare soil and disturbed ground where the native plant community has been displaced. Placement of dredged material would disturb land already present in disposal areas and could increase the potential for invasive species.

6.23.2 Alternatives 1A, 1B, 1C, 2A (TRP), 2B, 2C

The deepening alternatives (1A, 1B, 1C, 2A, 2B, 2C) would have similar effects on invasive vegetation species as the No-Action Alternative, although effects during construction would be temporarily more adverse due to the initially greater amount of dredged material from the deepening. Foreshore protection and rock retention dikes would reduce shoreline erosion along the HNC.

ADDITIONAL RESOURCES

6.24 Historical and Cultural Resources

6.24.1 No-Action Alternative

The current channel depth of the HNC would be maintained under the No-Action Alternative. The No-Action Alternative would have no direct impacts on historic or cultural resources. Maintenance dredging activities along the canal and marsh areas would continue, potentially exposing buried cultural resources. Subsidence and erosional land loss would continue at the present rate. Channel bank erosion is apparent in many locations along the Inland Reach. Most shoreline retreat is caused by erosion due to boat wakes. Losses of other marsh types generally result from the internal loss rate and subsidence. Erosion and natural subsidence are the primary causes for cultural resource site destruction within the study area. The No-Action alternative would have and indirect impact on historical and cultural resources due to oil and gas exploration, extraction, and pipeline construction continuing. These activities would likely continue, further risking disturbance, damage, and potential destruction of any cultural resources in these areas.

6.24.2 Alternatives 1A, 1B, 1C

The 18-foot deepening alternatives (1A, 1B, and 1C) would have similar direct and indirect effects on cultural resources in the project area as the No-Action Alternative, although effects could be initially greater due to the increased top width and the additional initial dredged material from the deepening. The increased boat traffic due to the deepening could potentially increase the amount of bank erosion; however, foreshore protection would be constructed to reduce bank erosion, reducing exposure of cultural resources from erosion.

Indirect impacts of implementing the 18-foot deepening alternatives would be the protection of existing cultural resources located further inland and along the bank line in the HNC area. There is a very high probability that archaeological sites are present on natural levees in the northern portion of the project area and along the entire length of the project area. The HNC and the proposed disposal areas often bisect natural levee landforms along the canal as well as natural waterways and lakes, including Bayou LaCarpe, Bayou Grand Caillou, and Bayou Petit Caillou, as well as Lake Quitman and Lake Boudreaux. Natural levee areas currently exposed along the canal bankline could be subjected to increased erosion from wave action from larger vessel and also damage from the initial placement of foreshore protection. Proposed disposal area construction and use, which includes berm construction and dredged material placement, could also impact these high probability locations. However, there are no submerged cultural resources at the proposed disposal areas.

In addition, watercraft from all historic periods could be present within the project area. Project activities associated with channel deepening, bankline protection, berm construction, and dredged material placement could result in the disturbance of significant historic watercraft, if present in the area. Two magnetic anomalies, located outside of the proposed project area along Bayou Grand Caillou, were discovered during remote-sensing surveys but would not be directly impacted by the proposed project as Bayou Grand Caillou has since been removed from project consideration.

The CEMVN plans to conduct additional archaeological investigations in the project area during the next project study phase. Section 106 consultation with the SHPO is ongoing and would be concluded prior to project construction. Remote sensing surveys are generally effective at identifying submerged cultural resources; however, the possibility of encountering an unidentified and unanticipated submerged cultural resource, however unlikely, is always present during construction and dredging activities. In the event that significant cultural resources are encountered in the construction site, work at that location will be halted, and a CEMVN archeologist and SHPO will be notified for further consultation. An Unanticipated Discovery Plan will be included in the construction and dredging plans and specifications.

In addition, if any unrecorded cultural resources are determined to exist within the proposed project boundaries once project construction begins, then no work will proceed in the area containing these cultural resources until a CEMVN archeologist has been notified and final coordination with the SHPO has been completed.

With implementation of the proposed action, natural levee areas currently exposed along the canal bankline could be subjected to increased erosion from larger vessel wave action and also damaged from the initial placement of riprap bank protection. Proposed disposal area construction and use, which includes berm construction and dredged material placement, can also impact these high probability locations.

6.24.3 Alternatives 2A (TRP), 2B, 2C

The 20-foot deepening alternatives (2A, 2B, and 2C) would have similar direct and indirect effects on cultural resources in the project area as the 18-foot deepening alternatives, although effects could be initially greater due to the increased top width and the additional initial dredged material from the deepening.

6.25 Air Quality

6.25.1 No-Action Alternative

Under the No-Action Alternative, there would be minor short-term direct impacts to air quality that would result from the maintenance dredging of the HNC. The air quality impacts would be limited to those produced by heavy equipment. Ambient air quality would be temporarily degraded, but emission controls and limited duration would aid in minimizing the effects. No long-term significant direct or indirect impacts to the local air quality would be anticipated. Emissions attributable to deepening of the HNC would result in no significant impact to air quality in the parish, and would not affect the attainment status of Terrebonne Parish. Therefore, an air emissions conformity determination would not be required.

6.25.2 Alternatives 1A, 1B, 1C

The 18-foot deepening alternatives (1A, 1B, 1C) would have similar effects on air quality as the No-Action Alternative, although effects during construction would be slightly greater due to the initially greater amount of dredged material from the deepening. Direct impacts to ambient air quality would be temporary and localized, resulting primarily from the emissions of construction equipment within the study area. Direct impacts to air quality, specifically emission levels for nitrous oxide (NOx) and volatile organic compounds (VOCs) are quantified in Tables 6.9 and 6.10.

6.25.3 Alternatives 2A (TRP), 2B, 2C

The 20-foot deepening alternatives (2A, 2B, 2C) would have similar effects on air quality as the 18-foot Alternatives, although effects during construction would be slightly greater due to the initially prolonged dredging duration during deepening of the channel.

Table 6-9. Air Quality Emission Analysis for Nitrous Oxide

Air Quality Emission Analysis for Volatile Organic Compounds										
Units	Equipment Item	Total Work Hours	Work Hours Per Unit	Fuel Type Gas	Diesel	hp	Multiplying Factor %hp	Time	Total hp Hours	Annual hp Hours
1	Crane (25 Ton, 80' Boom)	5,475	5,475		D	130	130	0.7	413526.75	413526.75
1	Directional Driller (50,000 LB Thrust)	8,400	8,400		D	200	200	0.7	976080	976080
1	Welding Generator (300 AMP)	4,140	4,140	G		48	48	0.7	115456.32	115456.32
1	Hydraulic Excavator 1.75 CY, 60,700 LB	360	360		D	168	168	0.7	35138.88	35138.88
1	Crew Boat, 47-foot	4,408	4,408		D	874	874	0.8	2558121.09	2558121.09
1	Air Compressor 450 CFM, 125 PSI	3,144	3,144		D	170	170	0.7	310532.88	310532.88
1	Welding Generator (300 AMP)	4,438	4,438	G		48	48	0.7	123766.944	123766.944
1	Dredging Generator	8,013	8,013	G		314	314	0.7	1461843.64	1461843.64
1	Cutterhead Dredge (27 in.)	6,091	6,091		D	4,700	4,700	0.7	16632693.7	16632693.7
1	Cutterhead Dredge (30 in.)	1,922	1,922		D	9,200	9,200	0.7	10273474.4	10273474.4
1	Crane, Dragline, 100 Ton, 100' Boom5,734	5,734	5,734		D	284	284	0.7	946132.936	946132.936
1	Crane, Dragline, 100 Ton, 100' Boom (4.0 CY Bucket)	3,337	3,337		D	284	284	0.7	550618.348	550618.348
1	Crane, Dragline, 7.0 CY, 100 Ton, 140' Bo13,585om	13,585	13,585		D	400	400	0.7	3157154	3157154
1	Crane, Dragline, 50 Ton, 100' Boom	5,734	5,734		D	150	150	0.7	499718.1	499718.1
1	Crane (25 Ton, 80' Boom)	600	600		D	130	130	0.7	45318	45318
1	Marsh Backhoe, 1.9 CY	9,647	9,647		D	222	222	0.7	1244289.35	1244289.35
1	Marsh Crane 1.9 CY	6,269	6,269		D	222	222	0.7	808588.158	808588.158
1	Hydraulic Excavator 55,000 LB, 1.5 CY	7,953	7,953		D	176	176	0.7	813241.968	813241.968
1	Hydraulic Excavator 60,700 LB, 1.75 CY	4	4		D	168	168	0.7	390.432	390.432
1	Loader/Backhoe 1.4 CY	38	38		D	91	91	0.7	2009.098	2009.098
1	90 HP Dozer	1,768	1,768		D	90	90	0.7	92448.72	92448.72

Air Quality Emission Analysis for Volatile Organic Compounds										
Units	**Equipment Item**	**Total Work Hours**	**Work Hours Per Unit**	**Fuel Type Gas**	**Diesel**	**hp**	**Multiplying Factor %hp**	**Time**	**Total hp Hours**	**Annual hp Hours**
1	Log Skidder, 43,000 LB Pull	1,768	1,768		D	160	160	0.7	164353.28	164353.28
1	1,200 HP Tug	7,173	7,173		D	1,200	1,200	0.8	5715446.4	5715446.4
1	900 HP Tug Rental	7,489	7,489		D	900	900	0.8	4475426.4	4475426.4
1	600 HP Tug Rental	1,958	1,958		D	600	600	0.8	780067.2	780067.2
1	Tug Boat 55 Ft	628	628		D	870	870	0.8	362783.04	362783.04
1	Tug Boat 70 Ft	436	436		D	1,350	1,350	0.8	390830.4	390830.4
1	Directional Driller (50,000 LB Thrust)	600	600		D	200	200	0.7	69720	69720
1	23' Little Giant w/ Cabin, 3,400 LB Outboard	8,316	8,316		D	250	250	0.8	1380456	1380456
									54,399,626.44	54,399,626.44
	VOC Emission Factors (lbs/hp hours)	Gas	Diesel							
	Exhaust	0.015	0.00247							
	Evaporation	0.000661	0				Emissions			Tons
	Crankcase	0.00485	0.0000441				Gas			4.13
	Refueling	0.00108	0				Diesel			1.16
	Total	**0.021591**	**0.0025141**				**Subtotal**			**5.29**

[1]Nox emission factors were obtained per guidance AP 42. Additional information may be obtained at www.epa.gov/ttnchie1/ap42/.
[2]Estimated Nox emissions were calculated by multiplying total diesel hp hours by the diesel Nox emission factor (lbs/hp hours), divided by 2000 to obtain tons (874129.44*0.031/2000).

Table 6-10. Air Quality Emission Analysis for Volatile Organic Compounds

Air Quality Emission Analysis for Volatile Organic Compounds										
Units	Equipment Item	Total Work Hours	Work Hours Per Unit	Fuel Type Gas	Diesel	hp	Multiplying Factor %hp	Time	Total hp Hours	Annual hp Hours
1	Crane (25 Ton, 80' Boom)	5,475	5,475		D	130	130	0.7	413526.75	413526.75
1	Directional Driller (50,000 LB Thrust)	8,400	8,400		D	200	200	0.7	976080	976080
1	Welding Generator (300 AMP)	4,140	4,140	G		48	48	0.7	115456.32	115456.32
1	Hydraulic Excavator 1.75 CY, 60,700 LB	360	360		D	168	168	0.7	35138.88	35138.88
1	Crew Boat, 47-foot	4,408	4,408		D	874	874	0.8	2558121.09	2558121.09
1	Air Compressor 450 CFM, 125 PSI	3,144	3,144		D	170	170	0.7	310532.88	310532.88
1	Welding Generator (300 AMP)	4,438	4,438	G		48	48	0.7	123766.944	123766.944
1	Dredging Generator	8,013	8,013	G		314	314	0.7	1461843.64	1461843.64
1	Cutterhead Dredge (27 in.)	6,091	6,091		D	4,700	4,700	0.7	16632693.7	16632693.7
1	Cutterhead Dredge (30 in.)	1,922	1,922		D	9,200	9,200	0.7	10273474.4	10273474.4
1	Crane, Dragline, 100 Ton, 100' Boom5,734	5,734	5,734		D	284	284	0.7	946132.936	946132.936
1	Crane, Dragline, 100 Ton, 100' Boom (4.0 CY Bucket)	3,337	3,337		D	284	284	0.7	550618.348	550618.348
1	Crane, Dragline, 7.0 CY, 100 Ton, 140' Bo13,585om	13,585	13,585		D	400	400	0.7	3157154	3157154
1	Crane, Dragline, 50 Ton, 100' Boom	5,734	5,734		D	150	150	0.7	499718.1	499718.1
1	Crane (25 Ton, 80' Boom)	600	600		D	130	130	0.7	45318	45318
1	Marsh Backhoe, 1.9 CY	9,647	9,647		D	222	222	0.7	1244289.35	1244289.35
1	Marsh Crane 1.9 CY	6,269	6,269		D	222	222	0.7	808588.158	808588.158
1	Hydraulic Excavator 55,000 LB, 1.5 CY	7,953	7,953		D	176	176	0.7	813241.968	813241.968
1	Hydraulic Excavator 60,700 LB, 1.75 CY	4	4		D	168	168	0.7	390.432	390.432
1	Loader/Backhoe 1.4 CY	38	38		D	91	91	0.7	2009.098	2009.098
1	90 HP Dozer	1,768	1,768		D	90	90	0.7	92448.72	92448.72

Air Quality Emission Analysis for Volatile Organic Compounds										
Units	**Equipment Item**	**Total Work Hours**	**Work Hours Per Unit**	**Fuel Type Gas**	**Diesel**	**hp**	**Multiplying Factor %hp**	**Time**	**Total hp Hours**	**Annual hp Hours**
1	Log Skidder, 43,000 LB Pull	1,768	1,768		D	160	160	0.7	164353.28	164353.28
1	1,200 HP Tug	7,173	7,173		D	1,200	1,200	0.8	5715446.4	5715446.4
1	900 HP Tug Rental	7,489	7,489		D	900	900	0.8	4475426.4	4475426.4
1	600 HP Tug Rental	1,958	1,958		D	600	600	0.8	780067.2	780067.2
1	Tug Boat 55 Ft	628	628		D	870	870	0.8	362783.04	362783.04
1	Tug Boat 70 Ft	436	436		D	1,350	1,350	0.8	390830.4	390830.4
1	Directional Driller (50,000 LB Thrust)	600	600		D	200	200	0.7	69720	69720
1	23' Little Giant w/ Cabin, 3,400 LB Outboard	8,316	8,316		D	250	250	0.8	1380456	1380456
									54,399,626.44	54,399,626.44
	VOC Emission Factors (lbs/hp hours)	Gas	Diesel							
	Exhaust	0.015	0.00247							
	Evaporation	0.000661	0				Emissions			Tons
	Crankcase	0.00485	0.0000441				Gas			4.13
	Refueling	0.00108	0				Diesel			1.16
	Total	**0.021591**	**0.0025141**				**Subtotal**			**5.29**

[1]Nox emission factors were obtained per guidance AP 42. Additional information may be obtained at www.epa.gov/ttnchie1/ap42/.
[2]Estimated Nox emissions were calculated by multiplying total diesel hp hours by the diesel Nox emission factor (lbs/hp hours), divided by 2000 to obtain tons (874129.44*0.031/2000).

6.26 Aesthetic and Visual Resources

6.26.1 No-Action Alternative

The current channel depth of the HNC would be maintained under the No-Action Alternative. Under the No-Action Alternative, direct and indirect effects to aesthetics would be minor and temporary. O&M dredging activities would be visible; however, much of the HNC is generally remote except for the city of Houma and the towns of Dulac and Cocodrie. The continued conversion of marsh to open water could reduce the aesthetics of the area.

6.26.2 Alternative 1A

Direct and indirect effects of Alternative 1A on aesthetics would be similar to the No-Action Alternative.

6.26.3 Alternatives 1B, 1C

Direct and indirect effects of Alternatives 1B and 1C on aesthetics would be similar to Alternative 1A. Beneficial use of the dredged material could help to improve the aesthetics of the area by creating new marsh and barrier island habitat.

6.26.4 Alternative 2A (TRP)

Direct and indirect effects of Alternative 2A on aesthetics would be similar to Alternative 1A.

6.26.5 Alternatives 2B, 2C

Direct and indirect effects of Alternatives 2B and 2C on aesthetics would be similar to Alternative 2A. Beneficial use of the dredged material could help to improve the aesthetics of the area by creating new marsh and barrier island habitat.

6.27 Hazardous, Toxic, and Radioactive Waste (HTRW)

6.27.1 No-Action Alternative

The current channel depth of the HNC would be maintained under the No-Action Alternative. Other than several areas of concern, no significant Hazardous, Toxic, and Radioactive Waste (HTRW) should be encountered during the course of project-related activities. There is a low risk of encountering HTRW within the proposed dredged material disposal sites. Should the construction methods change or the area of construction increase, the HTRW risk would require re-evaluation. Caution is recommended during dredging and construction activities in the vicinity of pipelines and orphan wells. An updated HTRW review will be necessary no more than a year before construction begins.

Because of the number of oil and gas pipelines present in the HNC corridor, a significant issue arises with respect to the possibility of contacting a submerged pipeline during dredging activities or construction of dikes and/or levees associated with the disposal sites. The pipeline owners would be contacted and notified regarding proposed dredging and construction activities. In addition, all pipelines traversing the HNC or disposal sites, or in the areas adjacent to the disposal sites would be located and clearly marked. Operation of heavy equipment in the disposal sites should avoid crossing the lines to the maximum extent practicable. Caution should be exercised during construction of retention dikes and levees, and during the operation of heavy equipment in the vicinity of any orphan wells. Construction near the debris pile and abandoned vessel adjacent to the access corridor for Sites 12 and 12B should be approached with caution.

There is a remote likelihood that oil from the Deepwater Horizon spill could be contained in the dredged material from the Cat Island Pass Reach. Surface and buried oil have been observed throughout the intertidal and supratidal zones of the Gulf shorelines of the barrier islands in the area. Cleanup activities have included both manual (e.g., rakes and shovels) and mechanical (e.g., excavators) methods to remove surface and buried oil. As of December 2012, patrolling and maintenance activities with manual removal of surface oil continue in some areas, while other areas continue to be monitored and surveyed.

6.27.2 <u>Alternatives 1A, 1B, 1C</u>

The 20-foot deepening alternatives (1A, 1B, 1C) would have similar HTRW effects as the No-Action Alternative, although due to the initially greater amount of dredged material from the deepening, there would be a greater likelihood of HTRW effects during construction.

6.27.3 <u>Alternatives 2A (TRP), 2B, 2C</u>

The 20-foot deepening alternatives (2A, 2B, 2C) would have similar HTRW effects as the 18-foot Alternatives, although due to the initially greater amount of dredged material from the deepening, there would be a greater likelihood of HTRW effects HTRW during construction.

6.28 Recreation Resources

6.28.1 <u>No-Action Alternative</u>

The current channel depth of the HNC would be maintained under the No-Action Alternative. During O&M dredging activities, recreation in and around the HNC would experience limited short-term direct disruption imposed by the physical size and working activities of the floating dredge facility. Dredging activities would temporarily increase the turbidity in the area of work and in the vicinity of the discharge pipes. Turbidity would have disrupt and displace water-oriented recreational activity within the area of dredging and dredged material placement; however, these indirect adverse effects would be temporary and short-lived. In time, recreational use of the area would return to its pre-dredging condition. Placement of dredged material to create marsh in the Inland Reach would have indirect positive impact on consumptive recreation uses.

The operation of the lock and floodgates would mitigate potential effects of the HNC on salinity (USACE, 2013). The continued conversion of existing freshwater wetland/marsh areas to saltwater marsh, and subsequently to open water, would alter recreational opportunities. With the continued conversion of marsh to open water, fishery productivity would be expected to peak and then decline. Opportunities for consumptive recreation would decline, including fishing, recreational shrimping, crawfishing, crabbing, and oyster harvesting. Populations of migratory birds and other wildlife directly dependent on the marsh and swamp would decrease significantly; this would affect populations of migratory species in other areas of North America. The general trend in wildlife abundance has been a decrease in areas experiencing high land loss and an increase of wildlife abundance in areas of freshwater input or land building due to restoration projects. As populations of migratory birds are negatively affected, opportunities for bird watching would decline. Hunting would be affected in areas where populations of game species flux.

6.28.2 Alternative 1A

Direct and indirect effects of Alternative 1A on recreation would be similar to the No-Action Alternative, although effects would be slightly greater due to the initially greater amount of dredged material from the deepening. Following the deepening, effects of maintenance dredging on the recreation would be similar to the No-Action Alternative.

6.28.3 Alternatives 1B, 1C

Direct and indirect effects of Alternatives 1B and 1C on recreation would be similar to Alternative 1A. Placement of dredged material for marsh creation and beach nourishment would benefit non-consumptive recreation such as bird watching by protecting essential bird habitat. Consumptive recreation uses such as hunting and fishing would benefit from marsh creation and beach nourishment by providing additional fish and wildlife habitat.

6.28.4 Alternative 2A (TRP)

Direct and indirect effects of Alternative 2A on recreation would be similar to Alternative 1A, although effects would be slightly greater due to the initially greater amount of dredged material from the deeper channel. Following the deepening, effects of maintenance dredging on recreation would be similar to the No-Action Alternative.

6.28.5 Alternatives 2B, 2C

Direct and indirect effects of Alternatives 2B and 2C on recreation would be similar to Alternative 2A. Following the deepening, effects of maintenance dredging on recreation would be the same as the No-Action Alternative. Placement of dredged material for marsh creation and beach nourishment would benefit non-consumptive recreation such as bird watching by protecting essential bird habitat. Consumptive recreation uses such as hunting and fishing would benefit from marsh creation by providing additional fish and wildlife habitat.

6.29 Unavoidable Adverse Environmental Effects

The Alternatives and the No-Action Alternative would convert open water habitat into marsh habitat; this would have an unavoidable adverse effect on some benthic organisms. These alternatives would completely convert waterbottom from soil type substrate to rocks. Open water habitat is not limited in this area, and is actually expanding. This trade off in habitat types would be overall beneficial to the complete ecosystem. Oyster reefs could be destroyed directly in the placement of dredged material to create marsh. Existing oyster leases in the placement sites would have to be compensated for. The shell cultch could be moved to a new lease site, which would reduce impacts on oyster reefs.

6.30 Irreversible and Irretrievable Commitments of Resources

Approximately 140 acres of water bottom would be converted from soil type substrate to rocks. This is an irreversible commitment of benthic resources. The deepening of the channel is an irretrievable commitment of marsh ecosystem, EFH, wildlife habitat, which could exist if navigation interests were removed. The energy used to construct and maintain the project is an irreversible commitment of that resource.

6.31 Relationship of Short-Term Uses and Long-Term Productivity

There would be short-term localized and minor impacts to water quality due to turbidity. There would also be short-term impacts to aquatic resources, EFH, wildlife, and T&E species. Some of the affected species would avoid the area during construction, while others would be indirectly impacted by turbidity, which could disrupt their feeding. The conversion of open water habitat into marsh habitat would have a long-term positive impact on species that use the created wetlands. This trade off in habitat types would be overall beneficial to the complete ecosystem, but would also be a trade off in short-term uses for long-term productivity. Air quality, recreation, and noise, would also have short-term impacts. Both the energy and the navigation resources would show long-term productivity in the trade-off.

6.32 Mitigation

The appropriate application of mitigation is to formulate an alternative that first avoids adverse impacts, then minimizes adverse impacts, and lastly, compensates for unavoidable impacts. During the planning process, this methodology was followed where practicable. This helped avoid adverse impacts to wetlands. The following design commitments would minimize adverse impacts. The dredged material placed within the shallow open water areas would be placed to an initial elevation that would be conducive to the development of long-term wetlands. Any earthen or rock dikes constructed for this project would be breached three years after construction (approximately every 1,000 feet with a 20 to 25 foot bottom width at –2 feet NAVD88) to allow for fisheries access.

Through coordination with the facility, CEMVN would utilize appropriate dredging operations/techniques, such as dredging the northern water quality subsegment, LA120509, during high water flows, to avoid potential contaminant migration toward the drinking water intake causing the plant to potentially fail regulated contaminant levels in the drinking water. Also, as an operational measure to reduce salinity effects, the channel would be dredged from the northern to the southern reaches to reduce saltwater intrusion during dredging. The mixing zone requirements would be met for all Confined Disposal facilities (CDFs) with appropriately sized weirs. For CDFs 1 and 3, an initial plume width of a minimum of 30 feet would be required to meet applicable Water Quality Standards. The weirs for each CDF would be designed to meet these minimum requirements. The weirs would be placed to ensure no overlapping of the mixing zones as required by LDEQ.

If work occurs during the bald eagle nesting season (i.e., October through mid-May), the USFWS (email dated January 15, 2004) recommends that a survey be conducted for the presence of undocumented eagle nests prior to initiation of construction. Construction or operational activities associated with the proposed project would not encroach within 1,500 feet of an eagle nest during that period. If placement of material is planned for the barriers islands the nesting time frames for gulls and terns (approximately mid-April to mid-September) and brown pelicans (approximately May to mid-September) should be avoided. Consultation with USFWS would be conducted to develop a plan to prevent impacts to these species.

Depending on the alternative that is chosen, the WVA analysis of the alternative plans show there would be a need for compensatory mitigation for the value of the wetland habitat lost and for impacted oyster leases. The compensatory mitigation would be accomplished through the purchase of credits from a mitigation bank in the area.

6.33 Systems/Watershed Context

The Louisiana Coastal Area (LCA) team was coordinated with throughout the study process. The LCA near-term course of action does not have any restoration features in the immediate vicinity of the project. The goals associated with the LCA Ecosystem Restoration Plan (LCA Plan) are to reverse the current trend of degradation of the coastal ecosystem. The LCA Plan maximizes the use of restoration strategies throughout coastal Louisiana:

- Ecological restoration of healthy, productive, and diverse coastal habitats within critical, high-priority coastal areas.
- Enhanced sustainability of critical, high-priority areas within the LCA that are essential for the function of the natural ecosystem.
- Integrated restoration program that results in multiple benefits not solely for wetlands, but for communities, industries, and natural resources of the coast.

The 2017 Coastal Master Plan is charged with providing a sustainable long-term solution for coastal protection and restoration. The objectives reflect the key issues affecting people in and around Louisiana's coast. These objectives seek to improve flood protection for families and businesses, recreate the natural processes that built the Louisiana delta, and ensure that the coast continues to be suitable for recreation, commerce, and industry. Objectives include:

- **Flood Protection:** Reduce economic losses from storm surge based flooding to residential, public, industrial, and commercial infrastructure.
- **Natural Processes:** Promote a sustainable coastal ecosystem by harnessing the natural processes of the system.
- **Coastal Habitats:** Provide habitats suitable to support an array of commercial and recreational activities coast wide.
- **Cultural Heritage:** Sustain, to the extent practicable, the unique cultural heritage of coastal Louisiana by protecting historic properties and traditional living cultures and their ties and relationships to the natural environment.
- **Working Coast:** Promote a viable working coast to support regionally and nationally important businesses and industries.

The impacts to the LCA and Coastal Master Plan from the HNC TRP would be a positive impact resulting from:

- Using bank protection and retention dikes in the Inland Reach to prevent increases in erosion of marsh and other areas resulting from deeper vessel wake impacts that would result from deepening the existing channel;
- Using dredge material from Inland Reach to be placed in containment areas to restore and increase marsh habitat adjacent to HNC areas.

6.34 Cumulative Impacts Summary

Cumulative effects are defined in 40 CFR 1508.7 as those effects that result from:

> *...the incremental impacts of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or nonfederal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.*

Cumulative environmental effects for the proposed project were assessed in accordance with guidance provided by the President's Council on Environmental Quality (CEQ).

Methodology

A six-step process was followed to assess cumulative effects on resources affected by the TRP. The first step was to identify which resources to consider in this analysis. All impacts on affected resources can be considered cumulative. However, according to CEQ guidance, *the role of the analyst is to narrow the focus of the cumulative effects analysis to important issues of* *national, regional, or local significance* (CEQ 1997, p. 12). In addition to this *significance* criterion, only those resources expected to be directly or indirectly affected by the deepening alternatives, as well as by other actions within the same geographic scope and time frame, were chosen for the analysis. Based on these criteria, the following natural resources were identified as targets for the cumulative effects analysis:

- Water quality
- Wetlands
- Benthos
- Fishery resources, including oysters

The temporal boundaries for the assessment were established as follows:

- Past: Starting with the Flood Control Act of 1928, when flood control projects of the Mississippi River and its tributaries were first authorized. Since that time, the HNC; Atchafalaya Basin Floodway; GIWW; Atchafalaya River; Bayous Chene, Boeuf, and Black Navigation Channel; and Houma-area levees, pump systems, drainage canals, and access canals have altered the hydrology of the project area.
- Present: Continued Maintenance of the Houma Navigation Canal, Louisiana Project; 2028 - When construction of project features are expected to be completed.
- Future: 2077. Fifty years is considered a reasonable period of assessment given the indefinite life of the project.

The next steps of the cumulative effects analysis included:

- Describing the historical context and existing condition of each resource. Descriptions of affected resources are summarized in more detail in Section 5 of this report.
- Summarizing the direct and indirect effects of the deepening alternatives on each identified resource. Environmental effects of the deepening alternatives are presented in more detail in Section 6.
- Identifying the accumulated effects on each resource from the deepening alternatives and other past, present, and reasonably foreseeable actions.
- Summarizing the magnitude of the cumulative effects of the projects and actions on the affected resources.

The information derived from these steps of the cumulative effect assessment is presented below for each resource.

Water Quality

The 2010 LDEQ IR indicates that 27 water bodies in Terrebonne Basin did not fully support their designated uses. The primary causes of impairment included low dissolved oxygen, fecal coliform, solids/sedimentation, and turbidity. Potential sources include wastewater treatment plants, minor point sources, septic tanks, and agricultural runoff. Salinity increases have resulted from expanding open water, loss of marsh vegetation, and storms trapping salt water behind levees and natural ridges.

The HNC lock complex is anticipated to be constructed and operated as part of the Morganza to the Gulf project before the HNC is deepened. The lock complex would be operated to restrict the entry of salt water into the HNC and interior water bodies, thereby having a beneficial impact on water quality (USACE, 2013). Additional beneficial impacts on water quality would result from coastal restoration projects under the LCA, CWPPRA, and CIAP programs that include the redistribution of freshwater, such as the Convey Atchafalaya River Water to Northern Terrebonne Marshes project.

Deepening the channel may allow more saline water into the area, particularly during storms, and construction and maintenance activities would result in localized increases in turbidity and suspended solids at the dredging and placement sites. However, the operation of the proposed HNC lock and floodgates is expected to mitigate potential effects of deepening the channel on salinity (USACE, 2013). While the proposed project, combined with other actions in the project area, including coastal restoration programs, may have a net improvement of water quality, these benefits may be attenuated by potential future increases in sea level rise.

Wetlands

The land loss rate in the study area between 1985 and 2008 was approximately 2,500 acres per year which equates to nearly 60,000 acres, primarily marsh, lost over that time period. Causes of these losses include development, oil and gas activities, lack of sediment input, natural subsidence, and sea level rise.

The construction of foreshore protection is expected to reduce bank erosion and the loss of adjacent wetland habitat. Wetlands would be filled to construct some of the placement sites; however these losses would be compensated through the establishment of vegetated wetlands. Additionally, vegetated wetlands in the project area are anticipated to be improved through CIAP, LCA, CWPPRA, and other Federal, state, and local restoration programs.

When combined with LCA, CWPPRA, and other Federal, state, and local restoration efforts, the net cumulative effects would be beneficial to wetland resources of the study area.

Benthos

The project area contains a variety of aquatic habitats, including ponds, lakes, bayous, canals, shallow open water areas, and bays. Development, oil and gas activities, loss of sediment input, saltwater intrusion, natural subsidence, and sea level rise have converted estuarine habitat to marine habitat in the Terrebonne Basin. The benthic community that supports the estuarine system has been adversely affected. However, the diversity of marine benthic species has increased as a result of marsh loss and expanding open water areas.

The dredging of material would directly impact benthic communities by digging up organisms, moving them through a pipeline, and placing them in a new location. Most organisms would not survive and oyster reefs and other benthos being destroyed directly in the placement process. It is expected that the newly exposed sediment would be quickly recolonized from adjacent areas.

The creation of marsh habitat through the beneficial use of dredged material would support aquatic vegetation and likely change the relative abundance and species composition of benthic communities.

The introduction of freshwater flows from proposed restoration programs and features of the proposed Morganza to the Gulf project that alter salinity regimes are also likely to change benthic abundance, species composition, and species distribution. Marsh restoration programs would benefit benthic communities that support the estuarine system.

Cumulative impacts would include the shifting of benthic abundance, species composition, and species distribution toward those characteristic of fresher habitats. The beneficial use of dredged material would provide long-term significant benefits to aquatic organisms and the fisheries that depend on them.

Fishery Resources, Including Oysters

Coastal marshes provide protection and an abundant food source and are critical to the growth and production of species including blue crab, white shrimp, brown shrimp, Gulf menhaden, Atlantic croaker, red drum, spotted seatrout, black drum, sand seatrout, spot, southern flounder, and striped mullet. Future commercial and recreational fishery harvests could be adversely impacted by the high rates of marsh loss throughout the project area. The conversion of marsh to open water could create temporary new oyster habitat. However, as surrounding marshes erode, oyster reefs would become increasingly vulnerable to storm damage.

Alternatives 1B, 1C, 2B, and 2C could adversely affect 61 oyster leases in Disposal Site 21 (1) and the lung (60). Alternatives 1A and 2A (TRP) could adversely affect one oyster lease in Disposal Site 21. Compensation for these losses would be required. The use of earthen or rock dikes would prevent fish access to portions of the study area. Dikes would be breached by year three to allow tidal flow and fish access. The project would partially offset the loss of aquatic habitats through the beneficial use of dredged material for the restoration of marsh habitat, thereby benefiting fishery species dependent on these habitats.

Adverse effects on oyster leases in the project area as a result of the proposed project would be assessed and mitigated prior to construction. When combined with LCA, CWPPRA, and other restoration efforts, the net effects associated with the proposed project would benefit fishery resources of the project area as aquatic habitats are anticipated to improve through other restoration programs.

6.35 Environmental Quality (EQ) Section

The environmental quality account is another means of evaluating the alternatives to assist in making a plan recommendation. The EQ account is intended to display the long-term effects that the alternative plans may have on significant environmental resources. Significant environmental resources are defined by the Water Resources Council as those components of the ecological, cultural and aesthetic environments, which, if affected by the alternative plans, could have a material bearing on the decision-making process. A summary of the environmental consequences, environmental commitments, and mitigation for the alternative plans is presented below and in Table 6-11. Details can be found below.

Table 6-11. Comparison of Environmental Consequences, Environmental Commitments, and Mitigation for Each Alternative

Significant Resource	Alternative 0 No-Action Alternative (Maintain Existing 15-foot Channel)	Deepening Alternatives					
		Alternative 1A 18-foot Adjacent Disposal	Alternative 1B 18-foot BU Earthen Containment	Alternative 1C 18-foot BU Rock Containment	Alternative 2A 20-foot Adjacent Disposal (TRP)	Alternative 2B 20-foot BU Earthen Containment	Alternative 2C 20-foot BU Rock Containment
Navigation	Current channel depth constraints limit vessel size and growth around the HNC. Little use by vessels drafting more than 12-13 feet. Increased transportation costs for larger vessels. Only smaller ocean or inland tugs can be used. Larger vessels requiring repairs or cleaning must travel to more distant ports, incur significant travel costs, additional trips, diverted cargo, additional barges, oversize/overweight permitted highway vehicles with multiple trucks, and/or dry docks. Minor short-term impacts during operation and maintenance (O&M) dredging; no significant impact on navigation.	Would only serve the periphery of the demands of oil and gas offshore industry. No fabrication benefits. NED present value benefits of $223.933 million. Benefit/cost ratio (BCR) for transportation cost savings is 1.19. Little change in the projected annual O&M costs from No-Action Alternative. Minor short-term impacts during construction and maintenance dredging operations; no significant impact on navigation.	Similar to Alternative 1A.	Similar to Alternative 1A.	Allows rerouting to be avoided. Larger vessels would be able to navigate the HNC using only a light tug for steering assistance. Reduces need for costly additional tug assistance and navigation aids. Reduces diversions to more distant ports and increases shipyard business in Houma, creating jobs and contributing benefits to the regional economy. Rig setup and takedown costs would decline. Greater use of existing facilities and no need to maintain satellite facilities on deeper channels. NED and fabrication benefits ranging from $1,207.8 million (100 percent market share) to $1,099.7 million (25 percent market share). Total present value benefits (NED and fabrication) for the 50 percent market share would be $1,135.8 million. Total benefits (transportation cost savings) are $1,063.761 million, nearly four times greater than those for Alternative 1A ($1,063 million versus $223 million). BCR for transportation cost savings is 4.96. Little change in the projected annual O&M costs over No-Action Alternative.	Similar to Alternative 2A.	Similar to Alternative 2A.
Socioeconomics (Excluding Navigation)	Current navigation limits growth in the area, affecting local economy. One oyster lease would be directly impacted and would require compensatory mitigation.	Deepening could improve growth and local economy. One oyster lease in one placement area would be directly impacted and mitigated for.	Similar to Alternative 1A. Sixty-one oyster leases in two disposal areas would be directly impacted and mitigated for.	Similar to Alternative 1B.	Similar to Alternative 1A, although deepening to 20 feet would improve growth and local economy over Alternative 1A.	Similar to Alternative 2A. Sixty-one oyster leases in two disposal areas would be directly impacted.	Similar to Alternative 2B.
Recreation	During O&M dredging, limited short-term direct disruption of recreation in and around operations. Increased turbidity in the area of work and near the discharge pipes would disrupt and displace water-oriented recreational activity within the area of dredging and placement; however, these indirect adverse effects would be temporary and short-lived. Marsh creation in Inland Reach indirect positive impact on consumptive recreation uses. In time, recreational use of the area would return to its pre-project conditions. Long-term recreation reduction possible with loss of habitat for recreationally important species.	Direct and indirect effects similar to the No-Action Alternative, although effects would be slightly greater due to the initially greater amount of dredged material from the deepening. Following the deepening, effects of maintenance dredging would be similar to the No-Action Alternative.	Similar to Alternative 1A. Placement of dredged material for marsh creation and beach nourishment would benefit non-consumptive and consumptive recreation.	Similar to Alternative 1B.	Similar to Alternative 1A, although effects would be slightly greater due to the initially greater amount of dredged material from the deeper channel. Following the deepening, effects of maintenance dredging would be similar to the No-Action Alternative.	Similar to Alternative 2A. Placement of dredged material for marsh creation and beach nourishment would benefit non-consumptive and consumptive recreation.	Similar to Alternative 2B.
Noise, Health, and Safety	Short-term, and minor, direct and indirect noise impacts during maintenance dredging. Noise during maintenance dredging would likely affect relatively few people other than those employed at or near the maintenance sites. Much of the HNC is generally remote except	Similar to No-Action Alternative, although effects would be slightly greater due to the initially greater amount of dredged material from the deepening. Following deepening, the noise impacts due to maintenance dredging would be the same as the No-Action Alternative. Due to the	Similar to Alternative 1A.	Similar to Alternative 1A.	Similar to Alternative 1A, although effects would be slightly greater due to the initially greater amount of dredged material from the deepening. Following deepening, the noise impacts due to maintenance dredging would be the same as the No-Action Alternative. Due to the deepening, the frequency of	Similar to Alternative 1A.	Similar to Alternative 1A.

Table 6-11. Comparison of Environmental Consequences, Environmental Commitments, and Mitigation for Each Alternative

Significant Resource	Alternative 0 No-Action Alternative (Maintain Existing 15-foot Channel)	Deepening Alternatives					
		Alternative 1A 18-foot Adjacent Disposal	Alternative 1B 18-foot BU Earthen Containment	Alternative 1C 18-foot BU Rock Containment	Alternative 2A 20-foot Adjacent Disposal (TRP)	Alternative 2B 20-foot BU Earthen Containment	Alternative 2C 20-foot BU Rock Containment
	for the city of Houma and the towns of Dulac and Cocodrie. Frequency and level of noise produced by navigation traffic would remain as current conditions. In some instances, noise may directly affect fish and wildlife species. The implementation of appropriate buffer zones and activity windows could be used to mitigate for potential impacts.	deepening, the frequency of noise produced by navigation traffic would increase, but the level of noise would likely remain the same.			noise produced by navigation traffic would increase, but the level of noise would likely remain the same.		
Environmental Justice	No minority and/or low-income communities would be directly adversely affected. No disproportionately high or adverse human health or environmental direct or indirect effects on minority or low-income populations. Children would not be directly adversely affected.	Similar to No-Action Alternative.	Similar to No-Action Alternative.	Similar to No-Action Alternative.	Similar to No-Action Alternative.	Similar to No-Action Alternative.	Similar to No-Action Alternative.
Aesthetics	Minor and temporary direct and indirect effects to aesthetics. Maintenance dredging activities would be visible, but much of the HNC is generally remote except for the city of Houma and the towns of Dulac and Cocodrie. The continued conversion of marsh to open water could reduce the aesthetics of the area.	Similar to No-Action Alternative.	Similar to Alternative 1A. Beneficial use of the dredged material could help to improve the aesthetics of the area by creating new marsh and barrier island habitat.	Similar to Alternative 1B.	Similar to Alternative 1A.	Similar to Alternative 2A. Beneficial use of the dredged material could help to improve the aesthetics of the area by creating new marsh and barrier island habitat.	Similar to Alternative 2B.
Energy	No direct effects on energy. Channel maintenance would indirectly help to maintain the energy infrastructure. Erosion of oil and gas infrastructure would be prevented by material placement.	Estimated 23 utilities, including oil and gas pipelines, electrical and communication lines, and public utilities (water and sewer), would have to be relocated. Channel deepening would indirectly enhance the energy infrastructure of the region by enabling larger vessels and infrastructure to be constructed and used. Erosion of oil and gas infrastructure would be prevented by foreshore protection and retention dikes and material placement, including beneficial use.	Similar to Alternative 1A.	Similar to Alternative 1A.	Similar to Alternative 1A. Estimated 27 utilities would have to be relocated. Channel deepening would indirectly enhance the energy infrastructure of the region by enabling larger vessels and infrastructure to be constructed and used. Erosion of oil and gas infrastructure would be prevented by foreshore protection and retention dikes and material placement, including beneficial use.	Similar to Alternative 2A.	Similar to Alternative 2A.
Geology and Soils	No direct effects on geology. O&M dredging would continue to relocate material from the channel bottom to disposal areas (54.6 mcy over 50 yrs). The loss of soils, including erosion of the channel banks, and conversion of land to open water in the area would continue.	Similar to No-Action Alternative, but deepening would dredge 4.8 mcy [52 acres of HNC waterbottom to increase the top width of the channel (35 acres Inland Reach and 17 acres Terrebonne Bay Reach)]. O&M dredging 60.9 mcy over 50 yrs. Foreshore protection and retention dikes would reduce bank erosion and the material placement would create additional marsh and barrier island habitat.	Similar to Alternative 1A.	Similar to Alternative 1A.	Similar to Alternative 1A, but deepening would dredge 7.5 mcy [102 acres of HNC waterbottom to increase the top width of the channel (73 acres Inland Reach, 24 acres Terrebonne Bay Reach, and 5 acres Cat Island Pass Reach)]. O&M dredging 63.7 mcy over 50 yrs.	Similar to Alternative 2A.	Similar to Alternative 2A.

Table 6-11. Comparison of Environmental Consequences, Environmental Commitments, and Mitigation for Each Alternative

Significant Resource	Alternative 0 No-Action Alternative (Maintain Existing 15-foot Channel)	Deepening Alternatives					
		Alternative 1A 18-foot Adjacent Disposal	Alternative 1B 18-foot BU Earthen Containment	Alternative 1C 18-foot BU Rock Containment	Alternative 2A 20-foot Adjacent Disposal (TRP)	Alternative 2B 20-foot BU Earthen Containment	Alternative 2C 20-foot BU Rock Containment
Prime and Unique Farmland	No direct effects to prime and unique farmland. The loss of prime and unique farmland and conversion of land to open water in the area would continue; however, material placement would help to reduce some of the loss of prime and unique farmland. Prime farmland in the Houma region may be converted to other commercial uses as facilities along the HNC expand.	Similar to No-Action Alternative except further expansion of HNC facilities due to deepening may convert prime and unique farmland. The loss of prime and unique farmland and conversion of land to open water in the area would continue; however, material placement, and construction of foreshore protection and retention dikes would help to reduce some of the loss of prime and unique farmland.	Similar to Alternative 1A.	Similar to Alternative 1A.	Similar to Alternative 1A except additional expansion of HNC facilities due to deepening may convert more prime and unique farmland.	Similar to Alternative 2A.	Similar to Alternative 2A.
Relative Subsidence	No direct or indirect effects on relative subsidence.	Similar to No-Action Alternative.	Similar to Alternative 1A.	Similar to Alternative 1A.	Similar to Alternative 1A.	Similar to Alternative 1A.	Similar to Alternative 1A.
Shoaling and Maintenance Dredging	Bank erosion and other land loss mechanisms would continue to convert land to open water in the area and would continue to contribute to shoaling and the need for maintenance dredging.	Similar to No-Action Alternative. After the initial deepening, maintenance dredging would occur similarly to the No-Action Alternative. The effect of increased vessel traffic on bank erosion and shoaling would be somewhat mitigated by the construction of foreshore protection and retention dikes on the Inland Reach.	Similar to Alternative 1A.	Similar to Alternative 1A.	Similar to Alternative 1A, although the initial dredge quantities would be slightly greater and increased vessel traffic due to the deepening may cause additional bank erosion, thus increasing maintenance dredging. Deepening and lengthening Cat Island Pass will increase the maintenance dredging by about 15 percent.	Similar to Alternative 2A.	Similar to Alternative 2A.
Hydrology	Limited or no direct or indirect impact on the hydrology of the area. Natural increase tidal prism over time would likely continue. Wind-generated waves continue to erode the shoreline of tidal ponds in the area. Saltwater intrusion would continue to cause marsh along the HNC to be lost and potentially affect the Houma water supply. The operation of the lock would mitigate potential effects of the HNC on salinity.	Similar to No-Action Alternative, although the slightly deeper channel could increase the potential of salinity during storms. The tidal prism will likely increase by an insignificant amount due to the increase in channel area as a result of deepening. The lock would mitigate potential effects of the HNC on salinity.	Similar to Alternative 1A. .	Similar to Alternative 1A.	Similar to Alternative 1A, although the slightly deeper channel could increase the potential of salinity during storms. The lock would mitigate potential effects of the HNC on salinity.	Similar to Alternative 2A.	Similar to Alternative 2A. .
Groundwater	No direct or indirect impacts to groundwater.	Similar to No-Action Alternative.	Similar to Alternative 1A.	Similar to Alternative 1A.	Similar to Alternative 1A.	Similar to Alternative 1A.	Similar to Alternative 1A.
Relative Sea Level Rise	No direct or indirect impacts to relative sea level rise.	Similar to No-Action Alternative.	Similar to Alternative 1A.	Similar to Alternative 1A.	Similar to Alternative 1A.	Similar to Alternative 1A.	Similar to Alternative 1A.
Water Quality	Dredged material placement into upland CDFs would discharge effluent into HNC, (except Site 1 into Short Cut Canal). Mixing zone requirements would be met for upland CDFs by installing weirs. Placement of Inland Reach dredged material for habitat creation in Sites 7, 12, 12A, 13B, 14, 15, 16, 19C, 19D, 20C, 21, and 24 would not result in point source discharges into the HNC. Suspended material would settle out in the receiving area with the probable runoff of the supernatant into adjoining water bodies and marsh/wetland	Similar to No-Action Alternative. Effects slightly greater due to the initially greater amount of dredged material from the deepening. Following the deepening, effects of maintenance dredging on water quality would be the same as the No-Action Alternative. Increased boat traffic due to deepening could potentially increase the amount of bank erosion, but construction of foreshore protection would reduce bank erosion and maintenance dredging quantities. Deeper channel could allow more saline water into the area, particularly during storms, but the operation of the	Similar in the Inland Reach to Alternative 1A. In the Terrebonne Bay and Cat Island Pass Reaches, the placement of dredged material for beneficial use in the lung, and the bay and Gulf sides of East Island would not	Similar to Alternative 1B.	Similar to the effects of Alternative 1A. Effects slightly greater due to the initially greater amount of dredged material from the deepening. Following the deepening, effects of maintenance dredging on water quality would be the same as Alternative 1A.	Similar to Alternative 1B. Effects slightly greater due to the initially greater amount of dredged material from the deepening. Following the deepening, effects of maintenance dredging on water	Similar to Alternative 2B.

Table 6-11. Comparison of Environmental Consequences, Environmental Commitments, and Mitigation for Each Alternative

Significant Resource	Alternative 0 No-Action Alternative (Maintain Existing 15-foot Channel)	Deepening Alternatives					
		Alternative 1A 18-foot Adjacent Disposal	Alternative 1B 18-foot BU Earthen Containment	Alternative 1C 18-foot BU Rock Containment	Alternative 2A 20-foot Adjacent Disposal (TRP)	Alternative 2B 20-foot BU Earthen Containment	Alternative 2C 20-foot BU Rock Containment
	areas. Marsh creation sites would be semi-confined or unconfined. Protective dikes would reduce the long-term effects of erosion of the material back into the water column. Dredged material from the Terrebonne Bay and Cat Island Pass Reaches would be placed in SPDs in open water. Dredging and dredged material placement could potentially have direct and indirect surface water runoff effects on water quality of HNC and adjacent water bodies.	lock would mitigate potential effects. Would indirectly impact the LDEQ's TMDL program.	result in point source discharges into the HNC.			quality would be the same as Alternative 1B.	
Barrier Island	Without nourishment, East Island would continue to narrow and beach erosion would continue. Timbalier Island and Cat Island Pass would continue to migrate westward. Dredged material from the Cat Island Pass Reach would be placed in SPDs under the No-Action Alternative.	Similar to the No-Action Alternative. Transport pathways will continue, although the deeper channel will intercept natural sand presently bypassing the channel.	Material placed in the back bay area of East Island would create marsh. The beach nourishment would help to protect the marsh and beach habitat. Continuation of the normal sand transport system.	Similar to Alternative 1B.	Similar to Alternative 1A.	Similar to Alternatives 1B and 1C, although the quantity of dredged material would be greater. Deeper channel will intercept natural sand presently bypassing the channel and increase shoaling by 40,000 cy/yr. Continuation of the normal sand transport system.	Similar to Alternative 2B.

Table 6-11. Comparison of Environmental Consequences, Environmental Commitments, and Mitigation for Each Alternative

Significant Resource	Alternative 0 No-Action Alternative (Maintain Existing 15-foot Channel)	Deepening Alternatives					
		Alternative 1A 18-foot Adjacent Disposal	**Alternative 1B 18-foot BU Earthen Containment**	**Alternative 1C 18-foot BU Rock Containment**	**Alternative 2A 20-foot Adjacent Disposal (TRP)**	**Alternative 2B 20-foot BU Earthen Containment**	**Alternative 2C 20-foot BU Rock Containment**
Land Use/ Land Cover/ Land Loss	Land use is not expected to change. Wetlands would continue to be directly and indirectly impacted by natural and manmade factors. Operation of the HNC lock is expected to reduce salinities and reduce the conversion between marsh types or conversion to open water. Subsidence and land loss would continue at the present rate. The overall habitat value and acreage of the remaining wetlands would decline. Vast acreages of wetlands would continue to be lost. Approximately 1,570 acres of waterbottom could be converted into marsh with the placement of over 12.2 mcy of dredged material at the Inland Reach placement sites over the life of the project due to continued maintenance dredging.	Wetland loss trends would be similar to No-Action Alternative. Deepening could result in expansion of existing facilities and construction of new facilities, affecting land use. Approximately 1,792 acres of waterbottom could be converted into marsh with the placement of nearly 13.9 mcy of dredged material at the Inland Reach placement sites over the life of the project. Rock retention dikes and foreshore protection dikes would reduce shoreline erosion along the HNC. The operation of the HNC lock is expected to reduce salinities that could potentially be increased during storms due to the deepening and decrease land loss.	Land use, land loss, and land cover similar to Alternative 1A. Same quantities in Inland Reach placement sites as Alternative 1A. Nearly 19.2 mcy of Terrebonne Bay and Inland Reach dredged material would be placed over 2,100 acres of primarily waterbottom in the lung to create marsh. Over 11.7 mcy of Terrebonne Bay dredged material would be placed over up to 1,234 acres of waterbottom on the bay side of East Island to create marsh. Nearly 18 mcy of Cat Island Pass dredged material would be placed on the Gulf side of East Island for beach nourishment.	Similar to Alternative 1B.	Land use, land loss, and land cover similar to Alternative 1A. Approximately 2,114 acres of waterbottom could be converted into marsh with the placement of nearly 16.3 mcy of dredged material at the Inland Reach placement sites over the life of the project.	Land use, land loss, and land cover similar to Alternative 2A. Same quantities in Inland Reach placement sites as Alternative 2A. Nearly 21.4 mcy of Terrebonne Bay and Inland Reach dredged material would be placed over up to 2,210 acres of primarily waterbottom in the lung to create marsh. Over 12.7 mcy of Terrebonne Bay and Inland Reach dredged material would be placed over up to 1,317 acres of waterbottom on the bay side of East Island to create marsh. Nearly 20.3 mcy of Cat Island Pass dredged material would be placed on the Gulf side of East Island for beach nourishment.	Similar to Alternative 2B.
Coastal Vegetation and Wetlands	Wetlands would continue to be impacted by natural and manmade factors. Salinity intrusion expected to increase minimally, but the operation of the HNC lock is expected to reduce impacts to vulnerable areas. Subsidence and land loss would continue at the present rate. The overall habitat value and acreage of the remaining wetlands would continue to decline. Reduced salinities due to the lock could allow cypress swamps in the project area to recover.	Direct and indirect impacts. Net gain of wetland acres and value (143 AAHUs assuming intermediate sea level rise). BLH (−3.95 AAHUs) and swamp (−0.72 AAHUs) would require compensatory mitigation. Impacts to SAV.	Similar to Alternative 1A. Earthen protection of new placement areas in the SM area (3,320 acres) would increase total created wetland acres and value (580 AAHUs assuming intermediate sea level rise). BLH and swamp loss would require compensatory	Similar to Alternative 1A. Rock protection in the SM area (3,320 acres) would increase total created wetland acres and value (637 AAHUs assuming intermediate sea level rise). The same	Similar to Alternative 1A. Increase in created wetland acres and value (235 AAHUs assuming intermediate sea level rise). BLH (−9.71 AAHUs) and swamp (−0.72 AAHUs) would require compensatory mitigation.	Similar to Alternative 2A. Earthen protection of new placement areas in the SM (3,526 acres) area would increase total created wetland acres and value (654 AAHUs assuming intermediate sea level rise). BLH and swamp loss	Similar to Alternative 2A. Rock protection in the SM (3,526 acres) area would increase created wetland acres and value (722 AAHUs assuming intermediate sea level rise). The

Table 6-11. Comparison of Environmental Consequences, Environmental Commitments, and Mitigation for Each Alternative

Significant Resource	Alternative 0 No-Action Alternative (Maintain Existing 15-foot Channel)	Deepening Alternatives					
		Alternative 1A 18-foot Adjacent Disposal	Alternative 1B 18-foot BU Earthen Containment	Alternative 1C 18-foot BU Rock Containment	Alternative 2A 20-foot Adjacent Disposal (TRP)	Alternative 2B 20-foot BU Earthen Containment	Alternative 2C 20-foot BU Rock Containment
			mitigation.	compensatory mitigation would be required as Alternative 1A.		would require compensatory mitigation.	same compensatory mitigation would be required as Alternative 1A.
Rare Plant Species and Natural Communities	Rare plant species and natural communities (including coastal dune grassland, cypress-tupelo swamp, freshwater marsh, and salt marsh) would continue to be impacted by natural and manmade factors. Salinity intrusion expected to increase minimally, but the operation of the HNC lock expected to reduce impacts to vulnerable areas. Subsidence and erosional land loss would continue at the present rate. The overall habitat value and acreage of the remaining wetlands would continue to decline. Reduced salinities could allow cypress swamps in the project area to recover.	Similar to No-Action Alternative, although effects during construction would be slightly greater due to the initially greater amount of dredged material from the deepening.	Similar to Alternative 1A.	Similar to Alternative 1A.	Similar to Alternative 1A, although effects during construction would be slightly greater due to the initially greater amount of dredged material from the deepening.	Similar to Alternative 2A.	Similar to Alternative 2A.
Invasive Species – Vegetation	Invasive vegetation species would continue to be directly and indirectly impacted by natural and manmade factors. A control strategy may need to be implemented to reduce growth of undesirable and invasive plant species. Placement of dredged material would disturb land already present in disposal areas and could increase the potential for invasive species.	Similar to No-Action Alternative, although effects during construction would be slightly greater due to the initially greater amount of dredged material from the deepening.	Similar to Alternative 1A.	Similar to Alternative 1A.	Similar to Alternative 1A, although effects during construction would be slightly greater due to the initially greater amount of dredged material from the deepening.	Similar to Alternative 2A.	Similar to Alternative 2A.
Benthos	Would directly impact ecology of the benthos in the project area. Approximately 36.3 miles of 150-ft wide canal would be maintenance dredged about every 10 years, and 3.5 miles of 300-ft wide canal would be maintenance dredged about every 2 years. Potentially, 932 acres of HNC waterbottom could be disturbed. Approximately 1,570 acres of waterbottom could be converted to marsh with the placement of over 12.2 mcy of dredged material at the inland placement sites over the project life. Nearly 32 mcy of Terrebonne Bay and Inland Reach dredged material and 12.5 mcy of Cat Island Pass dredged material would be placed over waterbottom in SPDs over project life; amount of waterbottom disturbed unknown. Composition of benthic species could change in most of the placement areas.	Similar to No-Action Alternative but slightly greater. Approximately 36.3 miles of 150-ft wide canal would be deepened and then maintenance dredged about every 10 years, and 3.5 miles of 300-ft wide canal would be maintenance dredged about every 2 years. Potentially, 984 acres of HNC waterbottom could be disturbed. Approximately 1,792 acres of waterbottom could be converted to marsh with the placement of nearly 13.9 mcy of dredged material at the Inland Reach sites over the project life. Additional 52 acres to increase channel top width (35 acres Inland Reach and 17 acres Terrebonne Bay Reach). Approximately 14.7 miles of rock retention dikes and/or foreshore protection would be constructed; approximately 80-ft wide flotation canals would be necessary for rock placement. Nearly 34.5 mcy of Terrebonne Bay and Inland Reach dredged material and nearly 12.5 mcy of	Similar to the 1A Alternative, but greater. Nearly 19.2 mcy of dredged material would be placed on waterbottom in the lung to create marsh. Over 11.7 mcy of Terrebonne Bay and Inland Reach dredged material would be placed over up to 1,234 acres of waterbottom on the bay side of East Island to create marsh. Nearly 18 mcy of Cat Island	Similar to Alternative 1B.	Similar to Alternative 1A, but greater. Potentially 769 acres of waterbottom could be disturbed. Approximately 1,046 acres of waterbottom could be converted to marsh with the placement of nearly 16.3 mcy of dredged material at the inland placement sites over the life of the project. Would dredge 102 acres along the HNC to increase the top width of the channel (73 acres Inland Reach, 24 acres Terrebonne Bay Reach, and 5 acres Cat Island Pass Reach). Approximately 14.7 miles of rock retention dikes and/or foreshore protection would be constructed; approximately 80-ft wide flotation canals would be necessary for rock placement. Additional over 35.9 mcy of Terrebonne Bay and Inland Reach dredged material and over 14.5 mcy of Cat Island Pass dredged material would be placed over waterbottom in SPDs over the life of the project. The amount of waterbottom this dredged material would disturb is unknown.	Similar to Alternative 2A. Nearly 21.4 mcy of Terrebonne Bay and Inland Reach dredged material would be placed over waterbottom in the lung to create marsh. Over 12.7 mcy of dredged material would be placed over up to 1,317 acres of waterbottom on the bay side of East Island to create marsh. Nearly 20.3 mcy of Cat Island	Similar to Alternative 2B.

Table 6-11. Comparison of Environmental Consequences, Environmental Commitments, and Mitigation for Each Alternative

Significant Resource	Alternative 0 No-Action Alternative (Maintain Existing 15-foot Channel)	Deepening Alternatives Alternative 1A 18-foot Adjacent Disposal	Alternative 1B 18-foot BU Earthen Containment	Alternative 1C 18-foot BU Rock Containment	Alternative 2A 20-foot Adjacent Disposal (TRP)	Alternative 2B 20-foot BU Earthen Containment	Alternative 2C 20-foot BU Rock Containment
		Cat Island Pass dredged material would be placed over waterbottom in SPDs over project life; amount of waterbottom disturbed unknown. Composition of benthic species could change in most of the placement areas.	Pass dredged material would be placed on the Gulf side of East Island for beach nourishment. The amount of waterbottom this dredged material would disturb is unknown. The increase in channel top width same as Alternative 1A.			Pass dredged material would be placed on the Gulf side of East Island for beach nourishment. The amount of waterbottom this dredged material would disturb is unknown. The increase in channel top width same as Alternative 2A.	
Plankton	Direct impacts on ecology of plankton. Short-term minor adverse impacts to plankton populations from dredging due to increases in turbidity, low dissolved oxygen, and introduction of sediments into shallow open water areas. Permanent loss of some shallow water habitat from dredged material. Operation of the HNC Lock would mitigate increases in salinities water flows and associated nutrients that could change plankton abundance and species composition. Maintaining existing habitat characteristics could limit conversions of plankton communities to those of higher salinity habitats. Wetland loss eventually decreases available nutrients and detritus and could convert primarily estuarine-dependent plankton species assemblages to marine and open water assemblages.	Similar to No-Action Alternative, although effects during construction would be slightly greater due to the initially greater amount of dredged material from the deepening.	Similar to Alternative 1A.	Similar to Alternative 1A.	Similar to Alternative 1A, although effects during construction would be slightly greater due to the initially greater amount of dredged material from the deepening.	Similar to Alternative 1B.	Similar to Alternative 1B.
Fisheries	Positive indirect effect on fisheries resources through marsh creation. This positive effect would not offset the long-term negative effect on aquatic resources due to land loss. Land loss increases areas of open water and marsh edge habitat, increasing the available fisheries habitat, a short-term positive indirect effect. Loss of marsh edge habitat negatively affects aquatic species. Salinity intrusion would continue, creating a landward shift in marine habitat; however, operation of the HNC Lock is expected to reduce salinities. Freshwater aquatic habitat would shrink; however,	Similar to No-Action Alternative but slightly greater due to the initially larger quantities of dredged material from the deepening.	Similar to Alternative 1A but greater due to the placement locations in the lower reaches. Impacts to 61 oyster leases in Site 21 and the lung would be mitigated. Use of earthen or rock dikes could prevent fish access to portions of the study area. Dikes would be	Similar to Alternative 1B.	Similar to Alternative 1A, but greater initially due to the larger quantities of dredged material from the deepening.	Similar to Alternative 2A, but greater due to the placement locations in the lower reaches. Impacts to 61 oyster leases in Site 21 and the lung would be mitigated.	Similar to Alternative 2B.

Table 6-11. Comparison of Environmental Consequences, Environmental Commitments, and Mitigation for Each Alternative

Significant Resource	Alternative 0 No-Action Alternative (Maintain Existing 15-foot Channel)	Deepening Alternatives					
		Alternative 1A 18-foot Adjacent Disposal	**Alternative 1B 18-foot BU Earthen Containment**	**Alternative 1C 18-foot BU Rock Containment**	**Alternative 2A 20-foot Adjacent Disposal (TRP)**	**Alternative 2B 20-foot BU Earthen Containment**	**Alternative 2C 20-foot BU Rock Containment**
	marshes would convert to different types or open water. Populations of most major commercially important fish and invertebrate species are expected to decline in the study area over the next 50 years. Disturbance of benthic and epibenthic communities would temporarily disrupt the food chain. Short-term local increase in turbidity may decrease the hunting capacity of visual predators and clog the gills of filter feeders. Blue crabs and shrimp are mobile and could avoid the dredging and placement areas, although some burial may occur; recolonization would not be affected. Oyster reefs in placement areas would be buried, smothered by fill, turbidity may clog gills, and recruitment of new oysters would be minimal due to lack of hard substrate. One oyster lease in Site 21 may be affected by fill placement; these effects would be assessed and mitigated prior to maintenance.		breached to allow tidal flow and fish access.				
Invasive Aquatic Species	No effect on invasive aquatic species.	Similar to No-Action Alternative	Similar to Alternative 1A.	Similar to Alternative 1A.	Similar to Alternative 1A.	Similar to Alternative 2A.	Similar to Alternative 2A.
Essential Fish Habitat	Positive direct and indirect effects on emergent marsh EFH over long term by marsh creation, but long-term negative effect from land loss. Land loss initially increases marsh edge habitat, but it eventually disappears, adversely affecting emergent marsh EFH. Salinity intrusion would continue, creating a landward shift in EFH, but operation of the HNC lock expected to mitigate salinities. Salinity shifts affect emergent marshes, oyster bars, mangroves, estuarine hard bottom, nearshore sand/shell, soft and hard bottoms, estuarine sand/shell and soft bottom. Maintenance dredging short-term direct and indirect negative effects. Estuarine water column and water bottom designated as EFH would be temporarily affected through the disturbance and removal of bottom. Turbidity from dredging could temporarily compromise water quality.	Similar to No-Action Alternative, although effects could be initially greater due to the additional dredged material from the deepening.	Similar to Alternative 1A, but effects on emergent marsh EFH could be initially greater due to the additional marsh creation. Earthen dike creation would impact EFH over short-term. Dikes would be breached to allow tidal flow and fish access to mitigate for long-term impacts to EFH. Shoreline hardening affects mangroves, emergent marshes, nearshore sand/shell, soft, and hard bottoms, oyster bars, sand/shell, soft, and hard bottoms. Direct negative impacts to EFH would be offset	Similar to Alternative 1B, except use of rock instead of earthen dikes.	Similar to Alternative 1A, but slightly greater initially due to the larger quantities of dredged material from the deepening.	Similar to Alternative 2A.	Similar to Alternative 2A.

Table 6-11. Comparison of Environmental Consequences, Environmental Commitments, and Mitigation for Each Alternative

Significant Resource	Alternative 0 No-Action Alternative (Maintain Existing 15-foot Channel)	Deepening Alternatives					
		Alternative 1A 18-foot Adjacent Disposal	Alternative 1B 18-foot BU Earthen Containment	Alternative 1C 18-foot BU Rock Containment	Alternative 2A 20-foot Adjacent Disposal (TRP)	Alternative 2B 20-foot BU Earthen Containment	Alternative 2C 20-foot BU Rock Containment
			by the long-term protection (reduced land loss rate) hard structures provide.				
Wildlife	Changing coastal conditions (transformation to more saline) and loss of land for foraging areas for many birds and mammals. Amphibian and reptile populations would continue to decline. Operation of the HNC lock would reduce salinities and conversion between marsh types or conversion to open water. Would alter bird community to a more open water saline community with diving ducks, rails, coots, and gallinules. Continued decline in wildlife resources over the long-term as habitat and prey habitat disappears. Maintenance dredging and placement could have minor direct effects due to avoidance. No direct impact to protected wildlife if brown pelican and bald eagle guidelines are followed.	Similar to No-Action Alternative, although effects could be initially greater due to the additional dredged material from the deepening.	Similar to Alternative 1A.	Similar to Alternative 1A.	Similar to Alternative 1A, although effects could be initially greater due to the additional dredged material from the deepening.	Similar to Alternative 2B.	Similar to Alternative 2B.
Invasive Wildlife Species	No effect expected.	Similar to No-Action Alternative.	Similar to No-Action Alternative.	Similar to No-Action Alternative.	Similar to No-Action Alternative.	Similar to No-Action Alternative.	Similar to No-Action Alternative.
Threatened and Endangered Species	O&M dredging and placement could cause minor direct effects due to avoidance of maintenance areas by T&E species. Continual effects by changing coastal conditions and loss of foraging areas and prey species habitat for some birds and mammals. Operation of the HNC lock would reduce salinities and the conversion between marsh types or conversion to open water. Continued decline in habitat of prey species. Observers and relocation trawling will be used to minimize potential for incidental turtle takes, but sea turtles, mainly loggerheads and Kemp's ridleys, could be killed or injured during dredging. Collisions with vessels possible, but turtles are migratory and not year-round residents, likely present during the spring and summer. Possible indirect impacts include interference with underwater resting habitats, disturbance to benthic foraging habitats, disruption of prey	Similar to No-Action Alternative, although effects could be initially greater due to the additional dredged material from the deepening. The USFWS Endangered Species Coordinator on X XX, 201X concurred with the determination that "*The proposed activities would not significantly affect listed or proposed threatened or endangered species*". This project will not be constructed in the next year, and an updated T&E species review and coordination with USFWS and NMFS will be necessary no more than a year before construction.	Similar to Alternative 1A. Effects would be more positive due to the additional marsh creation. Dredging and material placement would indirectly benefit piping plover and red knot by placing dredged material in the surf zone of East Island. Disposal unlikely to directly affect piping plover and red knot since the birds are migratory, but may temporarily diminish foraging habitat on	Similar to Alternative 1B.	Similar to Alternative 1A, although effects could be initially greater due to the additional dredged material from the deepening.	Similar to Alternative 1B, although effects could be initially greater due to the additional dredged material from the deepening.	Similar to Alternative 2B.

Table 6-11. Comparison of Environmental Consequences, Environmental Commitments, and Mitigation for Each Alternative

Significant Resource	Alternative 0 No-Action Alternative (Maintain Existing 15-foot Channel)	Deepening Alternatives					
		Alternative 1A 18-foot Adjacent Disposal	Alternative 1B 18-foot BU Earthen Containment	Alternative 1C 18-foot BU Rock Containment	Alternative 2A 20-foot Adjacent Disposal (TRP)	Alternative 2B 20-foot BU Earthen Containment	Alternative 2C 20-foot BU Rock Containment
	base, degradation of benthic feeding areas, and discarded trash and debris. Effects of sediment plumes minor and short-term. No direct or indirect effects on piping plover and red knot; erosion of foraging habitat would continue. No direct impacts on Florida manatee or whales; unlikely to be in the project area. Standard manatee protection procedures would be followed.		East Island, resulting in temporary adverse effects to critical habitat. However, suitable habitats are nearby. Introduced sediment would be reworked and redistributed through natural processes, maintaining and/or enhancing the features of critical habitat in the form of overwash areas, sand flats, mud flats, and sand spits.				
Air Quality	Minor short-term direct impacts to air quality from O&M dredging. Air quality impacts would be limited to those from heavy equipment. Ambient air quality would be temporarily degraded, but emission controls and limited duration would help minimize effects. No long-term significant direct or indirect impacts to the local air quality anticipated, and would not affect the attainment status of Terrebonne Parish.	Similar to No-Action Alternative, although effects during construction would be slightly greater due to the initially greater amount of dredged material from the deepening.	Similar to Alternative 1A.	Similar to Alternative 1A.	Similar to Alternative 1A, although effects during construction would be slightly greater due to the initially greater amount of dredged material from the deepening.	Similar to Alternative 2A.	Similar to Alternative 2A.
Cultural Resources	No direct impacts on historic or cultural resources. Maintenance dredging along the HNC and marsh areas would continue, potentially exposing buried cultural resources. Channel bank erosion would continue. Marsh loss would continue. Erosion and natural subsidence are the primary causes for cultural resource site destruction. Oil and gas exploration and extraction and pipeline maintenance would continue, further risking disturbance, damage and potential destruction of cultural resources in the area.	Similar to No-Action Alternative, although effects could be initially greater due to the increased top width and the additional initial dredged material from the deepening. Increased boat traffic and wave action due to larger vessels due to the deepening could potentially increase bank erosion, but construction of foreshore protection and retention dikes would reduce bank erosion, reducing exposure of cultural resources. Protection of existing cultural resources further inland and along the bank line. Potential damage from placement of foreshore protection. Disposal area use could also impact high probability locations. No submerged cultural resources at proposed disposal areas. Watercraft from all historic periods could be present and could be disturbed from deepening, shoreline protection, berm construction, and dredged material placement. Additional archaeological investigations in the project area may be necessary during the next	Similar to Alternative 1A.	Similar to Alternative 1A.	Similar to Alternative 1A, although effects could be initially greater due to the increased top width and the additional initial dredged material from the deepening.	Similar to Alternative 2A.	Similar to Alternative 2A.

Table 6-11. Comparison of Environmental Consequences, Environmental Commitments, and Mitigation for Each Alternative

Significant Resource	Alternative 0 No-Action Alternative (Maintain Existing 15-foot Channel)	Deepening Alternatives					
		Alternative 1A 18-foot Adjacent Disposal	Alternative 1B 18-foot BU Earthen Containment	Alternative 1C 18-foot BU Rock Containment	Alternative 2A 20-foot Adjacent Disposal (TRP)	Alternative 2B 20-foot BU Earthen Containment	Alternative 2C 20-foot BU Rock Containment
		project study phase. Section 106 consultation with the SHPO is ongoing and would be concluded prior to construction. If significant cultural resources are encountered during construction, work at that location will be halted, and a CEMVN archeologist and SHPO will be notified for further consultation. An Unanticipated Discovery Plan will be included in the plans and specifications.					
Hazardous, Toxic, and Radioactive Waste (HTRW)	Other than several areas of concern, no significant HTRW should be encountered during project-related activities. Low risk of encountering HTRW in the proposed disposal sites. If maintenance methods change or the area of maintenance increases, the HTRW risk would require re-evaluation. Caution is recommended during dredging and maintenance activities near pipelines and orphan wells. This project will not be constructed in the next year and an updated HTRW review will be needed no more than a year before maintenance. A number of oil and gas pipelines are in the project area, and there is a possibility of hitting a submerged pipeline during dredging or maintenance of levees associated with the disposal sites. Pipeline owners would be contacted and notified regarding proposed dredging and maintenance activities. All pipelines traversing the HNC or disposal sites, or in areas adjacent to the disposal sites would be located and clearly marked. Heavy equipment in disposal sites would avoid crossing pipelines to the maximum extent practicable. Maintenance near the debris pile and abandoned vessel adjacent to the access corridor for Sites 12 and 12B would be approached with caution. There is a remote likelihood that surface or buried oil from the Deepwater Horizon spill could be contained in the dredged material from the Cat Island Pass Reach.	Similar effects on HTRW as the No-Action Alternative, although due to the initially greater amount of dredged material from the deepening, there would be a greater likelihood of encountering HTRW during construction.	Similar to Alternative 1A.	Similar to Alternative 1A.	Similar effects on HTRW as Alternative 1A, although due to the initially greater amount of dredged material from the deepening, there would be a greater likelihood of encountering HTRW during construction.	Similar to Alternative 2A.	Similar to Alternative 2A.
Cumulative Impact (Section 4.7)	Project would not significantly increase cumulative impacts to hydraulics, water quality, prime and unique farmlands, wetlands, benthos, aquatic resources, EFH, wildlife, T&E, air quality, economics, recreation, noise, energy, cultural resources, environmental justice, and barrier islands if the lock is operated to reduce salinity intrusion. No	Project would not significantly increase cumulative impact to hydraulics, water quality, prime and unique farmlands, wetlands, benthos, aquatic resources, EFH, wildlife, T&E, air quality, economics, recreation, noise, energy, cultural resources, environmental justice, and barrier islands if the lock is operated to reduce salinity intrusion. No significant change to navigation	Same as Alternative 1A.	Same as Alternative 1A.	Same as Alternative 1A.	Same as Alternative 1A.	Same as Alternative 1A.

Table 6-11. Comparison of Environmental Consequences, Environmental Commitments, and Mitigation for Each Alternative

Significant Resource	Alternative 0 No-Action Alternative (Maintain Existing 15-foot Channel)	Deepening Alternatives					
		Alternative 1A 18-foot Adjacent Disposal	Alternative 1B 18-foot BU Earthen Containment	Alternative 1C 18-foot BU Rock Containment	Alternative 2A 20-foot Adjacent Disposal (TRP)	Alternative 2B 20-foot BU Earthen Containment	Alternative 2C 20-foot BU Rock Containment
	significant change to navigation nationally but some locally.	nationally but some locally.					
Environmental Commitments	Marsh creation in Inland Reach for long-term wetlands from O&M. Any new work not covered in this EIS would require appropriate NEPA and Permits.	Marsh creation in Inland Reach for long-term wetlands; HET determined height; dikes breached by TY3; foreshore protection and retention dikes; coordinate with HDWP before using CDFs; weirs in CDFs designed to allow mixing zones; avoidance of bald eagle nests and nesting season; mitigation constructed either before/concurrently; perpetual disposal material easement required; and HNC lock and floodgates constructed and operated before deepening. This project will not be constructed in the next year and an updated T&E review needed no more than a year before construction begins and be coordinated with USFWS and NMFS. An updated HTRW review needed no more than a year before construction begins.	Same as Alternative 1A.	Same as Alternative 1A.	Same as Alternative 1A.	Same as Alternative 1A.	Same as Alternative 1A.
Mitigation (after avoid and minimization) (Section 4.4.5.3)		BLH (−3.95 AAHUs) and swamp (−0.72 AAHUs) would require in-kind compensatory mitigation and one oyster lease. BLH and swamp mitigation would be accomplished with a use of a mitigation bank in the area.	BLH and swamp mitigation would be the same as Alternative 1A. An additional 60 oyster leases would require mitigation within the lung disposal area.	Same as Alternative 1B.	BLH (−9.71 AAHUs) and swamp (−0.72 AAHUs) would require in-kind compensatory mitigation and one oyster lease. BLH and swamp would be mitigated using a mitigation bank in the area.	BLH and swamp mitigation would be the same as Alternative 2A. An additional 60 oyster leases would require mitigation within the lung disposal area.	Same as Alternative 2B.

7.0 PUBLIC INVOLVEMENT

In compliance with USACE policies and NEPA, input on projects is solicited from the public and other government agencies. The public was invited to comment during the scoping process and during public meetings, and comments have been solicited for this document.

7.1 Notice of Intent and Scoping

The public was involved in the process, prior to report preparation and throughout the study. A Notice of Intent by the CEMVN to prepare an EIS for the Mississippi River and Tributaries-Morganza, Louisiana to the Gulf of Mexico Hurricane Protection--Houma Navigation Canal Deepening General Re-Evaluation appeared in the Federal Register on May 23, 2003 (GPO 2003).

A scoping meeting was held in Houma, Louisiana on May 21, 2003. Approximately 45 people attended the meeting and 18 people provided comments. During a 30-day comment period ending June 23, 2003, 19 written comments were received (Appendix J). There was general support for the project, provided the lock associated with the Morganza to the Gulf project was constructed and operated first.

7.2 Public Involvement

Public briefings were conducted to provide information and solicit concerns regarding the project. Two public presentations were given at Terrebonne Parish School Board meetings on January 29 and February 5, 2002. These presentations described the project and requested rights of entry for surveys and borings. A presentation was also given to the TPC on August 20, 2002. Monthly status meetings were held and key stakeholders, including the LADOTD, TCLD, and TPC regularly attended these meetings.

The team provided effective and transparent communication with the public and state and Federal agencies. Several public meetings have been held, and local stakeholders have been kept apprised of project status. State and Federal agencies, as an integral part of the project study team, have been involved in the development of the alternatives, and knowledgeable of the impacts of each alternative. The team collaborated with other government agencies, industry, and stakeholders to improve the project planning process.

7.3 Agency Coordination

An interagency habitat evaluation team (HET) was formed on November 15, 1995, for the Morganza to the Gulf Project. This HET was also engaged in the planning process of the HNC Deepening. This team selected the proposed disposal sites identified in this report. The HET included members from the U.S. Environmental Protection Agency (EPA), National Oceanic and Atmospheric Administration's-National Marine Fisheries Service (NOAA-NMFS), U.S. Fish and Wildlife Service (USFWS), National Resource Conservation Service (NRCS), Louisiana

Department of Natural Resources-Coastal Management Division (LADNR-CMD), Louisiana Coastal Protection and Restoration Authority (CPRA), Louisiana Department of Wildlife and Fisheries (LDWF), LADOTD, Terrebonne Levee and Conservation District (TLCD), TPC, and MVN. The USFWS conducted Wetland Value Assessments (WVAs) for the evaluation of the alternatives and prepared the Fish and Wildlife Coordination Act Report. Comments were solicited from the U.S. Coast Guard regarding navigation concerns. The LDEQ provided coordination for the Water Quality Certification.

7.4 Compliance with Laws and Executive Orders

This IFR/DEIS has been prepared in compliance with the following applicable laws and executive orders.

Abandoned Shipwreck Act
Archeological and Historic Preservation Act
Bald Eagle Protection Act
Clean Air Act
Clean Water Act
Coastal Barrier Resources Act
Coastal Zone Management Act consistency
Comprehensive Environmental Response, Compensation, and Liability Act
Endangered Species Act, Section 7 consultation
Estuary Protection Act
Farmland Protection Policy Act
Federal Environmental Pesticide Control Act
Federal Water Project Recreation Act
Fish and Wildlife Coordination Act
Floodplain Management (E.O. 11988)
Food Security Act
Intergovernmental Cooperation Act
Land and Water Conservation Fund Act
Marine Protection, Research, and Sanctuaries Act
Magnuson-Stevens Act
National Environmental Policy Act
National Historic Preservation Act
Noise Control Act
Noise Pollution and Abatement Act
Paperwork Reduction Act
Preservation of Historic and Archeological Data Act
Protection and Enhancement of Environmental Quality (E.O. 11991)
Protection and Enhancement of the Cultural Environment (E.O. 11593)
Protection of Wetlands (E.O. 11990)
Quiet Communities Act
Resource Conservation and Recovery Act
Rivers and Harbors Appropriation Act

Safe Drinking Water Act
Toxic Substances Control Act
Uniform Relocation Assistance and Real Property Acquisition Policies Act
Water Resource Development Acts
Wild and Scenic Rivers Act

Environmental compliance for the tentatively recommended plan (TRP) would be achieved upon: coordination of the report with appropriate agencies, organizations, and individuals for their review and the USFWS and NOAA-NMFS confirmation that the TRP would not be likely to adversely affect any endangered or threatened species; LDNR concurrence with the determination that the TRP is consistent, to the maximum extent practicable, with the Louisiana Coastal Resources Program; receipt of a Water Quality Certificate from the State of Louisiana; public review of the Section 404(b)(1) Public Notice; signature of the Section 404(b)(1) Evaluation; receipt of the Louisiana State Historic Preservation Officer's (SHPO) Determination of No Affect on cultural resources; receipt and acceptance or resolution of all USFWS Fish and Wildlife Coordination Act recommendations; receipt and acceptance or resolution of all LDEQ comments on the air quality impact analysis documented in the EIS; and receipt and acceptance or resolution of all NMFS Essential Fish Habitat recommendations. The record of decision would not be signed until the TRP achieves environmental compliance with applicable laws and regulations, as described above. The HNC Lock will need to be constructed and operated before the channel can be deepened.

7.5 Public Notice Comments on DEIS

Scoping comments primarily concerned: lock should be built and operated first; bank stabilization; saltwater intrusion; wetland loss; 20-foot depth; drinking water; importance of canal on local economy; socioeconomic; flooding; hurricane protection; maintenance of channel; indirect, secondary, and cumulative effects; wake-induced erosion; and beneficial use of material to create marsh. The scoping report is located in Appendix J.

8.0 COORDINATION AND COMPLIANCE

This section documents the coordination and compliance efforts regarding statutory authorities including: environmental laws, regulations, executive orders, policies, rules, and guidance. Consistency of the TSP with other Louisiana coastal restoration efforts is also described. Planning for this feasibility study has been conducted in accordance with the ER 1105-2-100 guidance. This report is an integrated feasibility study and EIS. Policy reviews have been conducted to ensure compliance with applicable USACE policies.

8.1 USACE Principles and Guidelines (P&G)

The guidance for conducting Civil Works planning studies (ER 1105-2-100) is based on the P&G adopted by the Water Resources Council. The P&G are composed of two parts: The Economic and Environmental Principles and Guidelines for Water and Related Land Implementation Studies and the Economic and Environmental Guidelines for Water and Related Land Resources Implementation Studies. The P&G require the systematic formulation of alternative plans to ensure all reasonable alternatives are evaluated. The P&G also include guidance on the development and structure of the studies and reports for projects requiring specific authorization.

Under the study guidance for projects requiring specific authorization, the feasibility study requirements include documentation of the planning process and environmental compliance. The feasibility report is required to document the planning process and all assumptions made during plan formulation along with the rationale for decision making. The report should culminate in a tentatively recommended plan along with documentation of how the plan relates to the NED, NER, or a combined NED/NER plan. If the project deviates from those plans, the degree and reasons for the deviation must be documented. The feasibility study is also required to document compliance with applicable environmental laws and regulations which can be included as an EA or EIS included with the feasibility study or an integrated feasibility study document with NEPA information.

8.2 Environmental Coordination and Compliance

Following completion of the final integrated report, the Assistant Secretary of the Army for Civil Works will issue a written Record of Decision (ROD) concerning the proposed action. The ROD will be issued within a framework of laws, regulations, executive orders, policies, rules, and other guidance. These authorities establish regulatory compliance standards for environmental resources pertaining directly to USACE management of water resources development projects, or provide planning guidance for the management of environmental resources. Relevant Federal statutory authorities and executive orders are listed in Table 8.1. Relevant State of Louisiana statutory authorities are listed in Table 8.2. Full compliance with statutory authorities will be accomplished upon review of the final integrated feasibility report and Supplemental Environmental Impact Statement by appropriate agencies and the public and the signing of a Record of Decision (ROD), in compliance with the Fish and Wildlife Coordination Act (1958).

Table 8.1. Relevant Federal Statutory Authorities and Executive Orders (Note: This list is not complete or exhaustive)

Abandoned Shipwreck Act of 1987	Marine Mammal Protection Act of 1972
American Indian Religious Freedom Act of 1978	Marine Protected Areas (EO 13158) of 2000
Anadromous Fish Conservation Act of 1965	Marine Protection, Research, and Sanctuaries Act of 1972
Archaeological Resources Protection Act of 1979	Migratory Bird Conservation Act of 1929
Archaeological and Historical Preservation Act of 1974	Migratory Bird Treaty Act of 1918
Bald Eagle Protection Act of 1940	Migratory Bird Habitat Protection (EO 13186) of 2001
Clean Air Act of 1970	National Environmental Policy Act of 1969
Clean Water Act of 1977	National Historic Preservation Act of 1966
Coastal Barrier Improvement Act of 1990	National Invasive Species Act of 1996
Coastal Barrier Resources Act of 1982	Native American Graves Protection and Repatriation Act of 1990
Coastal Wetlands Planning, Protection, and Restoration Act of 1990	Neotropical Migratory Bird Conservation Act of 2000
Coastal Zone Management Act of 1972	Noise Control Act of 1972
Coastal Zone Protection Act of 1996	Nonindigenous Aquatic Nuisance Prevention and Control Act of 1996
Comprehensive Environmental Response, Compensation, and Liability Act of 1980	North American Wetlands Conservation Act of 1989
Consultation and Coordination with Indian Tribal Governments (EO 13175) of 2000	Oil Pollution Act of 1990
Deepwater Port Act of 1974	Outer Continental Shelf Lands Act of 1953
Emergency Planning and Community Right-to-Know Act of 1986	Pollution Prevention Act of 1990
Emergency Wetlands Restoration Act of 1986	Prime or Unique Farmlands, 1980 CEQ Memorandum
Endangered Species Act of 1973	Protection and Enhancement of the Cultural Environment (EO 11593) of 1971
Environmental Quality Improvement Act of 1970	Protection and Enhancement of Environmental Quality (EO 11991) of 1977
Estuaries and Clean Waters Act of 2000	Protection of Children from Environmental Health Risks and Safety Issues (EO 13045) of 1997
Estuary Protection Act of 1968	Protection of Cultural Property (EO 12555) of 1986
Estuary Restoration Act of 2000	Protection of Wetlands (EO 11990) of 1977
Exotic Organisms (EO 11987) of 1977	Reclamation Projects Authorization and Adjustments Act of 1992
Farmland Protection Policy Act of 1981	Recreational Fisheries (EO 12962) of 1995
Federal Actions to Address Environmental Justice in Minority Populations & Low-Income Populations (EO 12898, 12948) of 1994, as amended	Resource Conservation and Recovery Act of 1976
Federal Compliance with Pollution Control Standards (EO 12088) of 1978	Responsibilities of Federal Agencies to Protect Migratory Birds (EO 13186) of 2001
Federal Emergency Management (EO 12148) of 1979	Rivers and Harbors Acts of 1899, 1956
Federal Water Pollution Control Act of 1972	Rivers and Harbors and Flood Control Act of 1970
Federal Water Project Recreation Act of 1965	Safe Drinking Water Act of 1974
Fish and Wildlife Conservation Act of 1980	Submerged Land Act of 1953
Fish and Wildlife Coordination Act of 1958	Sustainable Fisheries Act of 1996
Flood Control Act of 1944	Title VI, Section 601 of the Civil Rights Act of 1964
Floodplain Management (EO 11988) of 1977	Toxic Substances Control Act of 1976
Food Security Act of 1985	Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (Public Law 91-646)
Greening of the Government Through Leadership in Environmental Management (EO 13148) of 2000	Water Resources Development Acts of 1976, 1986, 1990, 1992, and 2007
Historic Sites Act of 1935	Water Resources Planning Act of 1965
Historical and Archaeological Data-Preservation Act of 1974	Watershed Protection & Flood Prevention Act of 1954
Indian Sacred Sites (EO 13007) of 1996	Water Pollution Control Act Amendments of 1961
Invasive Species (EO 13112) of 1999	Wild and Scenic River Act of 1968
Land & Water Conservation Fund Act of 1965	Wilderness Act of 1964
Magnuson-Stevens Fishery Conservation and Management Act of 1976, as amended	

Table 8.2. Relevant State Statutory Authorities
(Note: This list is not complete or exhaustive)

Air Control Act Archeological Treasury Act of 1974 Louisiana Coastal Resources Program Louisiana Natural and Scenic Rivers System	Louisiana Threatened and Endangered Species and Rare & Unique Habitats Protection of Cypress Trees Water Control Act

8.2.1 Clean Air Act of 1970

The Clean Air Act (CAA) sets goals and standards for the quality and purity of air. It requires the Environmental Protection Agency to set National Ambient Air Quality Standards (NAAQS) for pollutants considered harmful to public health and the environment. The project area is in Terrebonne Parish, which is currently in attainment of NAAQS. The Louisiana Department of Environmental Quality is not required by the CAA and Louisiana Administrative Code, Title 33 to grant a general conformity determination.

8.2.2 Clean Air Act of 1977 – Section 401

The Clean Water Act (CWA) sets and maintains goals and standards for water quality and purity. Section 401 requires a Water Quality Certification from the Louisiana Department of Environmental Quality that a proposed project does not violate established effluent limitations and water quality standards. Section 401 Water Quality Certification signed July 6, 2015.

8.2.3 Clean Water Act of 1972 – Section 404

The USACE administers regulations under Section 404(b)(1) of the CWA, which establishes a program to regulate the discharge of dredged and fill material into waters of the U.S., including wetlands. Potential project induced impacts subject to these regulations has been evaluated. Section 404(b)(1) signed XXXX, 2017.

8.2.4 Coastal Zone Management Act of 1972 (Coastal Zone Development)

The Coastal Zone Management Act provides for the management, beneficial use, protection and development of the nation's coastal resources by encouraging and assisting the states to exercise effectively their responsibilities in the coastal zone through the development and implementation of management programs to achieve wise use of the land and water resources of the coastal zone, giving full consideration to ecological, cultural, historic, and esthetic values as well as the needs for compatible economic development. A Consistency Determination for the National Economic Development (NED) Plans, dated XXXX, 2017, was provided to the Louisiana Department of Natural Resources (LDNR), Office of Coastal Management for concurrence. By letter dated June 30, 2014, the LDNR, Office of Coastal Management provided programmatic concurrence that the project, at that stage of development (i.e., at a programmatic level), was consistent with the Louisiana Coastal Resources Program, but future phases of the project which may have coastal impacts would need to be reviewed as they were developed.

A revised Consistency Determination for fully constructible NED Recommended Plans was provided to the LDNR, Office of Coastal Management on XXXX, 2017. By letter dated XXXX, 2017, the LDNR, Office of Coastal Management provided concurrence that the Southwest Coastal Louisiana project (application number C20160002) is consistent with the Louisiana Coastal Resources Program.

8.2.5 Farmland Protection Policy Act of 1981 (Farmland)

The Farmland Protection Policy Act (FPPA) is intended to minimize the impact of Federal programs on the unnecessary and irreversible conversion of farmland to nonagricultural uses. Projects are subject to requirements if they may irreversibly convert farmland to nonagricultural use and are completed by a Federal agency or with assistance from a Federal agency. There are approximately 20,724 acres of soils that are classified as prime farmlands in the study area (NED). The area surrounding the HNC consists mostly of undeveloped wetlands and few areas are currently being used for agriculture or pastureland. Approximately 514 acres of soils classified as prime farmlands are present on chenier ridges that could be removed from current or future agricultural use as a result of proposed reforestation activities. By letter dated XXXX, 2017 the NRCS concurs that impacts to prime and unique farmlands from the RP would not "irreversibly" impact prime farmland and is therefore exempt from the rules and regulations of Section 1539- 1549 of Farmland Protection Policy Act.

8.2.6 Fish and Wildlife Coordination Act Report (Fish & Wildlife)

The Fish and Wildlife Coordination Act (FWCA) provides authority for the USFWS involvement in evaluating impacts to fish and wildlife from proposed water resource development projects. It requires that fish and wildlife resources receive equal consideration to other project features. It requires Federal agencies that construct, license or permit water resource development projects to first consult with the USFWS, NMFS and state resource agencies regarding the impacts on fish and wildlife resources and measures to mitigate these impacts. Section 2(b) requires the USFWS to produce a Coordination Act Report (FWCAR) that details existing fish and wildlife resources in a project area, potential impacts due to a proposed project and recommendations for a project. The final FWCAR (XXXX 2017) includes the USFWS final positions and recommendations and are contained in Appendix H. The draft FWCAR is available upon request.

8.2.7 Endangered Species Act of 1973 (Threatened and Endangered Species)

The Endangered Species Act (ESA) is designed to protect and recover threatened and endangered (T&E) species of fish, wildlife and plants. The CEMVN is coordinating with the USFWS and the National Marine Fisheries Service (NMFS) to ensure for the protection of those T&E species under their respective jurisdictions. The USFWS identified in their September 20, 2013 email eleven listed T&E species, the Red-cockaded woodpecker, Piping plover, Red knot, Whooping crane, Gulf sturgeon, West Indian manatee, Green sea turtle, Hawksbill sea turtle, Kemp's Ridley sea turtle, Leatherback sea turtle and loggerhead sea turtle that are known to occur or occasionally occur in the project area. In addition, designated Piping plover critical habitat and Loggerhead critical habitat also occur within the project area. No plants were identified as being threatened or endangered in the project area. Based on review of existing data and preliminary field surveys, the MVN has determined that the proposed action "may affect but will not likely adversely affect" the piping plover or it's critical habitat, red knot, West Indian manatee, Gulf sturgeon, loggerhead and Kemps Ridley sea turtles; would have no effect on the green, leatherback, and hawksbill sea turtles or loggerhead critical habitat and would not adversely impact other species of concern that could potentially be found in the project area. As part of the 2017 Revised Draft EIS, a Biological Assessment (BA) for NER Recommended Plan was submitted to USFWS on XXXX, 2017; the USFWS concurred by letter on XXXX, 2017. A BA was submitted to USFWS for the NED Recommended Plan on XXXX, 2017; the USFWS concurred by letter on XXXX, 2017. A BA for the NER RP was submitted to the NMFS on XXXX, 2017 and NMFS provided their letter of concurrence dated XXXX, 2017.

8.2.8 Louisiana State Threatened and Endangered Species and Rare and Unique Habitat

The Louisiana Department of Wildlife and Fisheries Louisiana Natural Heritage Program lists T&E species, rare, unique, and imperiled habitats in the State of Louisiana. Based on review of the LNHP online database, the following rare or unique habitats, animals and plants are found in the project area: Brackish marsh, coastal dune grassland, coastal live oak-hackberry forest, coastal prairie, freshwater marsh, red wolf, crested caracara, snowy plover, piping plover, Wilson's plover, common ground-dove, sandhill crane, diamondback terrapin, brown pelican, roseate spoonbill, glossy ibis, paddlefish, eastern spotted skunk, ornate box turtle, manatee, Gregg's amaranth, A milk-vetch, golden canna, dune sandbur, sand dune spurge, wedge-leaf prairie-clover, wedge-leaf whitlow-grass, slim spike-rush, punctuate cupgrass, narrow-leaved puccoon, grapefruit primrose willow, saltflat-grass, blue water lily, roundleaf scarf-pea, Correll's false dragon-head, wand blackroot, Mexican hat, small's beaksedge, southern beaksedge, sand rose-gentian, brookweed, Elliott sida, Florida bully, powdery thalia, woolly honeysweet, sea oats (LDWF 2013). The CEMVN finds the NER RP would have long term beneficial impacts on these rare and unique habitats and Louisiana T&E species.

8.2.9 Louisiana State Rare, Threatened and Endangered Species and Natural Communities Coordination

The CEMVN Cultural Resources Representative reviewed the database maintained by the Louisiana Natural Heritage Program (LNHP) that provides the most recent listing and locations for rare, threatened and endangered species of plants and animals and natural communities within the State of Louisiana. The proposed action is not likely to adversely affect any rare, threatened or endangered species, or unique natural communities. The proposed action would increase the extent of bald cypress-tupelo swamp within portions of the study area, which are identified as rare natural communities for certain regions of the state (see also Section 5.10 Coastal Vegetation and Wetlands).

8.2.10 Magnuson-Stevens Fishery Conservation and Management Act of 1996 and the Magnuson-Stevens Act Reauthorization of 2006 (Essential Fish Habitat)

The law and its reauthorization govern marine fisheries management in the U.S. Essential Fish Habitat (EFH) would not intersect the proposed nonstructural NED Plan. The CEMVN has determined that the NED Plan would have significant impacts to EFH by shifting existing shallow open water EFH to marsh EFH and shoreline protection habitat which would protect marsh habitat. Hence, there would be a net positive gain and overall estuarine benefits of higher quality marsh EFH.

8.2.11 Migratory Bird Treaty Act of 1918 and Migratory Bird Conservation Act of 1929 (Migratory Birds)

The Migratory Bird Treaty Act (MBTA) and the Migratory Bird Conservation Act (MBCA) protect migratory birds and their habitat. Many important habitats in the project area provide migratory bird shelter, nesting, feeding and roosting habitat. All construction activities shall observe a buffer of 1,000 feet for any colonial nesting waterbird colonies (e.g., egrets, herons, ibis, pelicans, etc.), 1,300 feet for any shorebird nesting colonies (e.g., terns, gulls, plovers, skimmers, etc.), and 2,000 feet for any brown pelican nesting colonies near the project feature. Based upon a field survey conducted in June 2015 for active colonial-nesting waterbird colonies, one active colonial-nesting waterbird colony was observed within 1,000 feet of the proposed construction limits of marsh creation feature 3a1 within the HNC. Additionally, a shorebird nesting colony was recorded within 1,300 feet of the proposed construction limits of breakwater feature 6b2 within the Rockefeller restoration area. USFWS and CEMVN biologists will survey the area before construction to confirm active rookery locations. If colonial-nesting waterbird colonies exist within 1,000 feet, if shorebird colonies exist within 1,300 feet, or if brown pelican nesting colonies exist within 2,000 feet of the proposed action, this could be a project constraint. USFWS guidelines would be followed to avoid adverse impacts to these species.

8.2.12 National Historic Preservation Act of 1966 (Cultural and Historic Resources)

Section 106 of the National Historic Preservation Act (NHPA) and the implementing regulations (36 CFR part 800) require Federal agencies to take into account the effects of their undertakings on historic properties, including any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion on, the National Register of Historic Places, and to provide the Advisory Council on Historic Preservation a reasonable opportunity to comment. Federal agencies are required to consult with other parties throughout the Section 106 process, including the State Historic Preservation Officer (SHPO) and Indian Tribes that attach traditional religious and cultural significance to historic properties that may be affected by an undertaking. Taking into account the views of consulting parties and the public, the federal agency will determine how to resolve any adverse effects to historic properties prior to the final decision-making. Section 106 consultation has been initiated, and a programmatic agreement for the NED Recommended Plan has been executed and is contained in Appendix H.

8.2.13 Executive Order 11988, Flood Plain Management

EO 11988 directs agencies to avoid development in floodplains to the maximum extent feasible. The NED Plan would reduce the risk of storm surge flooding to existing structures within the floodplain. The CEMVN is also providing storm surge information to inform the Floodplain Administrators in Terrebonne Parish in their floodplain management implementation. Hence, the proposed action complies with EO 11988.

8.2.14 Executive Order 11514, Protection of the Environment

EO 11514 directs Federal agencies to "initiate measures needed to direct their policies, plans, and programs so as to meet national environmental goals." The RP complies with EO 11514.

8.2.15 Executive Order 11990, Protection of Wetlands

EO 11990 directs Federal agencies to avoid to the extent possible the long and short term adverse impacts associated with the destruction or modification of wetlands, and to avoid direct or indirect support of new construction in wetlands wherever there is a practicable alternative. Mitigation planning was integrated into the planning by considering, individually and collectively, each of the NEPA mitigation actions of avoiding, minimizing, reducing, and rectifying potential adverse impacts to wetlands to the extent practicable. Implementing the NED Plan would require compensatory mitigation. For the NED Plan, unavoidable project-induced impacts to wetlands, such as placement of shoreline protection features and others have been avoided or will be mitigated in-kind by the ecosystem restoration benefits generated. Hence, the proposed action complies with the EO 11990.

8.2.16 Executive Order 13186, Migratory Bird Habitat Protection

EO 13186 directs Federal agencies to take actions to further implement the MBTA. The NED RP has been evaluated for potential effects on migratory birds, with emphasis on species of concern. Many important habitats in the project area provide migratory bird shelter, nesting, feeding and roosting habitat. There are not expected to be any adverse effects to migratory birds from the NED Plan.

8.2.17 Executive Order 12898, Environmental Justice

EO 12898 requires agencies to make achieving environmental justice (EJ) part of their missions by identifying and addressing disproportionately high and adverse human health or environmental effects of programs, policies and activities on minority populations and low-income populations. Potential EJ issues have been considered throughout planning. As part of the NEPA process, attention was given to EJ issues. There are not expected to be any disproportionate EJ impacts from the NED RP. However, USACE encourages any interested parties to inform the agency of potential EJ concerns.

8.2.18 Executive Order 13112, Invasive Species

EO 13112 directs Federal agencies to prevent the introduction of invasive species; provide for their control; and minimize the economic, ecological, and human health impacts that invasive species cause. The NED RP is consistent with EO 13112 to the extent practicable and permitted by law and subject to the availability of appropriations, and within Administration budgetary limits. Relevant programs and authorities to prevent the introduction of invasive species would be used during construction. The CEMVN will not authorize, fund, or carry out actions likely to cause or promote the introduction or spread of invasive species in the United States or elsewhere unless the CEMVN has determined and made public its determination that for the Houma Navigation Canal Deepening Study Integrated Final XXXX 2017 Feasibility Report & EIS, the benefits of such actions clearly outweigh the potential harm caused by invasive species; and that all feasible and prudent measures to minimize risk of harm would be taken in conjunction with the actions.

8.3 Compliance to Laws and Policies

The degree to which the tentatively recommended plan complies with the applicable laws, policies, and plans is summarized in Table 8.3.

Table 8.3. Degree of Compliance with Environmental Requirements

Environmental Requirement	Status
Federal	
1. National Environmental Policy Act	
2. Clean Air Act	
3. Rivers and Harbors Act	
4. Clean Water Act, Section 404(b)	
5. CEQ Policy on Prime or Unique Farmlands	
6. Federal Water Project Recreation Act	
7. Land and Water Conservation Fund Act	
8. Marine Research and Sanctuaries Act	
9. Watershed Protection and Flood Prevention Act	
10. Wild and Scenic Rivers Act	
11. EO 11988, Floodplain Management	
12. Archeological and Historic Preservation Act	FC
13. EO 11593, Protection and Enhancement of the Cultural Environment	
14. National Historic Preservation Act	
15. Coastal Zone Management Act	
16. Fish and Wildlife Coordination Act	
17. Estuary Protection Act	
18. Endangered Species Act	
19. Executive Order 11990, Wetlands	
20. Chief of Engineers Wetlands Policy	
State	
21. State of Louisiana Master Plan	
Local	
22. Local Land Use Plans	N/A

Legend:
FC = Full Compliance. All requirements of the law, policy, or related regulations have been met.
PC = Partial Compliance. Some requirements of the law, policy, or related regulations have been met.
N/A = Not Applicable. The law, policy, or related regulations do not apply.

9.0 CONCLUSIONS AND DETERMINATIONS

9.1 Areas of Resolved Controversy

Estimates for Relative Sea-Level Rise (RSLR) were based on Engineering Circular (EC) 1165-2-212 *Sea-Level Change Considerations for Civil Works Projects, October 1, 2011*. RSLR is the combined rate of sea-level rise and rate of subsidence. According to the EC guidance, the RSLR is estimated for low (historic), intermediate, and high sea-level rise scenarios. The low (historic) rate of RSLR is based on the USACE Gage (82350) Bayou Lafourche at Leeville, Louisiana shows the RSLR is 7.79 mm/yr and the rate of subsidence is 6.09 mm/yr. The intermediate and high scenarios of RSLR use the eustatic sea-level rise derived from the National Research Council equations NRC I and NRC III, respectively, and the subsidence rate computed from the Leeville gage. Estimated values of low, intermediate, and high rates of RSLR are shown for the year that construction is expected to be completed (2027) and for the 50-year project life (2077) (Table 9-1).

Table 9-1. Relative Sea-Level Rise

Scenarios	Construction Completed (2027) RSLR (feet)	Project Life 50 years (2077) RSLR (feet)
Low (historic)	0.43	1.71
Intermediate	0.51	2.32
High	0.76	4.27

The historical rate was used during the project analysis and to select the TRP. Most of the economic benefits for a navigation project are on the front end, where there will be minimal change due to sea level rise. This project is not being analyzed as a NER project so there is no need to run the WVA at all three levels for all of the placement sites. Any site that has a negative impact or will be used as mitigation will be run at all three rates. RSLR would not affect future navigation on the HNC because RSLR will increase the channel depth when measured from the water surface. The requirements for safe navigation are based on the draft of the vessel and the depth of the channel.

Because this project will not be constructed in the next year, an updated threatened and endangered species review will have to occur no more than a year before construction begins and be coordinated with USFWS and NMFS. Due to the fact that this project will not be constructed in the next year, an updated HTRW review will have to occur no more than a year before construction begins.

A demonstration project could be recommended, based on WRDA Implementation Guidance dated 10 July 2009, for LCA, Sections 7001–7008, and 7011 of Title VII of WRDA 2007. This proposed demonstration project would comprise features for beneficial use of maintenance dredged material from the HNC. The demonstration would resolve an issue of engineering uncertainty regarding the efficacy of creating small cells as disposal locations within the open water environment of Terrebonne Bay and the bay side of East Island. The demonstration project could also verify conclusions on transport pathways from a 2007 study that would have direct impact on the selection of disposal location for the constructions of the HNC deepening and maintenance events in the future.

9.2 Areas of Unresolved Controversy

A scoping meeting and public comment period were held and no unresolved controversies were raised at that time. There are sufficient placement areas to provide for dredged material placement if land right issues should arise. This project assumes that the Houma Navigation Lock will be constructed and operated to mitigate for salinity effects prior to the construction of this project.

There do not appear to be any major issues of unresolved controversy. Generally, the HNC Deepening Project was not very controversial, mainly because operation of the MTG floodgate and lock would mitigate any potential salinity problems. The City of Houma's water supply would not be impacted. Additionally, since the tentatively recommended plan (TRP) provides for the most practicable and beneficial use of the dredged material, the resource agencies generally do not have any major issues with the project. One critical issue is that the MTG floodgate, lock, and levee must be built and operated before the HNC is deepened to avoid these impacts. Oyster leases within the disposal areas that may be affected by disposal activities would be assessed and mitigated in PED, prior to use.

The impacts of the Deepwater Horizon oil spill on coastal Louisiana are uncertain at this time. The impacts of the oil spill as well as the various emergency actions taken to address oil spill impacts (e.g., use of oil dispersants, creation of sand berms, use of Hesco baskets, rip-rap, sheet piling and other actions) could potentially impact USACE water resources projects and studies within the Louisiana coastal area, including the HNC Deepening Project. Potential impacts could include factors such as changes to existing, future without, and future with project conditions, as well as increased project costs and implementation delays.

The USACE will continue to monitor and closely coordinate with other Federal and State resource agencies and local sponsors in determining how to best address any potential problems associated with the oil spill that may adversely impact study implementation. Supplemental planning and environmental documentation may be required as information becomes available. If at any time petroleum or crude oil is discovered on Study lands, all efforts will be taken to seek clean up by the responsible parties, pursuant to the Oil Pollution Act of 1990 (33 U.S.C. 2701 *et seq.*).

The former Delta Shipyard on the HNC, located at 200 Dean Court in southeastern Houma, Terrebonne Parish, Louisiana, has been designated as a Superfund Site. The facility is located in a mixed industrial and residential area south of the city of Houma, Louisiana. Delta Shipyard was a cleaning and repair facility for small cargo boats, fishing boats, and oil barges. Oily waste from the cleaning process was stored in several unlined earthen pits used as evaporation ponds.

These pits were reportedly also used to dispose of oil field drilling material. Delta Shipyard was owned by Delta Ironworks, Inc. The entire property consisted of 165 acres and was home to seven divisions of Delta Ironworks, including Delta Shipyard. During the 1970s and 1980s, the property changed hands through several mergers and sales. In January 2012, the LDEQ asked the EPA for assistance in evaluating this site.

Wetlands are contaminated with arsenic, antimony, anthracene, barium, benzene, cadmium, chromium, ethylbenzene, fluorene, lead, manganese, mercury, 2-methylnaphthalene, naphthalene, phenanthrene, pyrene, o-xylene and m,p-xylene to the surface water pathway. In addition, three evaporation pits containing greater than 30,000 cubic yards of hazardous material are located in a wetland and may potentially release waste to nearby waterways. Large volumes of waste remain on site, and hazardous substances have been found in ground water, surface water and soil. The closest residential property is located approximately 400 feet west of the open pits. Without remediation of the site, additional releases to ground water, surface water and soil will continue to occur.

9.3 Recommendations

The District Commander has considered all the significant aspects of this study including the environmental, social, and economic effects, the engineering feasibility, and the comments received from other resource agencies, the non-Federal sponsors, and the public and have determined that the TRP presented in this report is in the overall public interest and a justified expenditure of Federal funds. As a comprehensive approach to restore and maintain ecological integrity, including habitats, communities, and populations of native species, and the processes that sustain them by reducing the trend of degradation and deterioration to the area, the District Commander recommends increasing the project depth of the Houma Navigation Canal, Louisiana, to the Gulf of Mexico, to 20 feet deep NAVD88, with such modifications thereof as in the discretion of the Commander, HQUSACE, may be advisable. The channels modified by the TRP would continue to be federally maintained.

The first cost is estimated at $218,897,000 (2017 price levels); Contingent on adequate funding, OMRR&R costs are estimated at $717,342,000 over a 50-yeard period. During construction, the first cost allocated to the Federal government is currently estimated at $157,989,000 (2017 price levels). The total non-Federal cost-share for implementing the project is estimated to be $60,908,000 (2017 price levels). In general, the navigation features up to 20 feet are cost shared with non-Federal interests providing prior to construction an initial 10 percent of the construction costs plus after construction an additional 10 percent of the construction cost, which can be paid over a 30-year period. The non-Federal interests are also required to provide certain project costs including Local Service Facilities, Removals, and LERRDs, which are credited towards the post construction 10 percent share. The TRP produces net excess benefits over costs and a positive benefit to cost ratio. Some of these benefits related to fabrication operations are not in accordance with the P&G, but have been measured in accordance with Congressionally mandated language.

The District Commander further recommends that construction of the proposed project be contingent on the project sponsor giving written assurances satisfactory to the Secretary of the Army that it will:

a. Enter into an agreement, which provides, prior to execution of the project cooperation agreement, 25 percent of design costs;

b. Provide, during construction, any additional funds needed to cover the non-Federal share of design costs;

c. Provide, during the period of construction, a cash contribution equal to 10 percent of the total cost of construction of the general navigation features (which include the construction of land-based and aquatic dredged material disposal facilities that are necessary for the disposal of dredged material required for project construction, operation, and maintenance, and, for which a contract for the Federal facility's construction or improvement was not awarded on or before October 12, 1996);

d. Construct and maintain, at its own expense, all project features other than those for general navigation, including dredged depths commensurate with those in related general navigation features in berthing areas and local access channels serving the general navigation features;

e. Provide and maintain adequate local service facilities including port facilities and berthing areas open to all on equal terms and provide necessary site development for the regional harbor;

f. Pay with interest, over a period not to exceed 30 years following completion of the period of construction of the project, up to an additional 10 percent of the total cost of construction of the general navigation features. The value of lands, easements, rights-of-way, and relocations provided by the non-Federal sponsor for the general navigation features, described below, may be credited toward this required payment. If the amount of credit exceeds 10 percent of the total cost of construction of the general navigation features, the non-Federal sponsor shall not be required to make any contribution under this paragraph, nor shall it be entitled to any refund for the value of lands, easements, rights-of-way, and relocations in excess of 10 percent of the total cost of construction of the general navigation features;

g. Accomplish all removals determined necessary by the Federal Government other than those removals specifically assigned to the Federal Government;

h. Provide all lands, easements, rights-of-way, and perform or ensure the performance of all relocations determined by the Federal Government to be necessary for the construction, operation, maintenance, repair, replacement, and rehabilitation of the general navigation features (including all lands, easements, and rights-of-way, and relocations necessary for dredged material disposal facilities);

i. Provide the non-Federal share of that portion of the costs of mitigation and data recovery activities associated with historic preservation, that are in excess of 1 percent of the total amount authorized to be appropriated for the project, in accordance with the cost sharing provisions of the agreement;

j. Do not use Federal funds to meet the non-Federal Sponsor's share of total project costs unless the Federal granting agency verifies in writing that the expenditure of such funds is authorized;

k. Give the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon property that the Non-Federal Sponsor, now or hereafter, owns or controls for access to the project for the purpose of inspecting, operating, maintaining, repairing, replacing, rehabilitating, or completing the project;

l. Hold and save the United States free from all damages arising from the construction and operation, maintenance, repair, replacement, and rehabilitation of the project, any betterments, and the local service facilities, except those damages due to the fault or negligence of the United States or its contractors;

m. Comply with all applicable provisions of the Uniform Relocations Assistance and Real Property Acquisition Policies Act of 1970, Public Law 9 1-646, as amended (42 U.S.C. 4601-4655), and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way necessary for the initial construction, operation and maintenance of the project, including those necessary for relocations, borrow materials, and dredged or excavated material disposal, and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act;

n. Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended (42 U.S.C. 1962d-5), and Section 103 of the Water Resources Development Act of 1986, Public Law 99-662, as amended (33 U.S.C. 2213), which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until the non-Federal sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element;

o. Perform, or cause to be performed, any investigations for hazardous substances as are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Public Law 96-5 10, as amended (42 U.S.C. 9601-9675), that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for the initial construction, operation, and maintenance of the project. However, for lands that the Federal Government determines to be subject to the navigation servitude, only the Federal Government shall perform such investigations unless the Federal Government provides the Non-Federal Sponsor with prior specific written direction, in which case the Non-Federal Sponsor shall perform such investigations in accordance with such written direction;

p. Assume, as between the Federal Government and the Non-Federal Sponsor, complete financial responsibility for all necessary cleanup and response costs of any CERCLA regulated materials located in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be necessary for the initial construction, operation, or maintenance of the project;

q. To the maximum extent practicable, operate, maintain, and repair the project in a manner that will not cause liability to arise under CERCLA;

r. Keep and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project, for a minimum of three years after completion of the accounting for which such books, records, documents, and other evidence is required, to the extent and in such detail as will properly reflect total costs of construction of the Project, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 32 Code of Federal Regulations (CFR) Section 33.20; and

s. Comply with all applicable Federal and State laws and regulations, including, but not limited to, Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d), and Department of Defense Directive 5500.11 issued pursuant thereto, as well as Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army," and all applicable Federal labor standards and requirements, including but not limited to 40 U.S.C. 3141–3148 and 40 U.S.C. 3701–3708 (revising, codifying and enacting without substantial change the provisions of the Davis-Bacon Act (formerly 40 U.S.C. 276a *et seq*.), the Contract Work Hours and Safety Standards Act(formerly 40 U.S.C. 327 *et seq*.) and the Copeland Anti-Kickback Act (formerly 40 U.S.C. 276c *et seq*.).

The recommendation contained herein reflects the information available at this time, 2017 price levels, and current Departmental policies governing the formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national civil works construction program, nor the perspective of higher levels of review within the Executive Branch. Consequently, the recommendation may be modified before they are transmitted to the Congress as proposals for authorization and/or implementation funding.

Michael Clancy
Colonel, U.S. Army
District Commander

10.0 LIST OF PREPARERS*

Table 10.1 List of Preparers

Name	Role in Preparation	Organization
Ator, Don	Economics	PBS&J
Balfour, Sharon	Sponsor	LADOTD
Blevins, Joshua	Technical Review	USACE
Boyle, Don	Project and Program Management	PBS&J
Brouillette, Rickey	Engineering	CPRA
Broussard, Rick	Engineering, project design	USACE
Brown, Jane	Operations	USACE
Butler, Richard	Engineering	USACE
Carlson, K.L.		CPRA
Carnes, Laura	Environmental	GEC
Carter, Eddy		GEC
Creef, Ed	Operations, Dredging	USACE
Daigre, Quinton	Environmental	GEC
Darville, Jennifer	Technical Editor	USACE
Dubois, Robert	HET	USFWS
Ducote, Greg	Coastal Zone Management	LDNR
Ettinger, John	Habitat Evaluations	USEPA
Ferdinand, F.	Economics	Terrebonne Econ. Dev. Auth.
Fine, Stephen	Plan Formulation	Fine Projects, Inc.
Francis, Robert	Economics	Gulf Island Fabricators, Inc.
Fuqua, Robert	Engineering	USACE
Glisch, Eric	Hydraulics	USACE
Haab, Mark	Project Management	USACE
Horn, Kevin	Economics	GEC
Hudson, George	Engineering	GEC
Jones, Ken	Coastal Engineering	PBS&J
Kaye, Scott	Economics	GEC
Kim, Sung-Chan	Hydraulic Modeling	USACE-ERDC-CHL
LeRoux, Patricia	Environmental	USACE
Leaumont, Brian	Engineering, Levees Section	USACE
Levron, Al	Navigation, Economics	TPCG

Name	Role in Preparation	Organization
Llewellyn, Dan	Habitat Evaluation	LDNR
Lucore, Marti	Project Management	USACE
Marceaux, Joey	Real Estate	USACE
Marcks, Brian	Habitat Evaluations	LDNR
Martin, Clyde	Sponsor	LADOTD
Mckown, Michael	Technical Review	USACE
McMenis, James	Sponsor	LADOTD
Merhi, Ismail		LDNR
Neubauer, James	Cost Engineering	USACE
Perry, Shelton	Economics	GEC
Popovich, George	Construction	USACE
Puls, Jonathan	Engineering	GEC
Rabelais, David	Navigation, Economics	TPCG
Risko, Tony	Coastal Engineering	PBS&J
Rogers, Barton	Planning, Project Management	Rogers, Barton
Rogers, Donna	Project Management, Environmental	GEC
Ruiz, Manuel	Habitat Evaluations	LDWF
Salamone, Eric	Engineering	USACE
Schneider, Donald	Navigation, Operations	USACE
Smith, Steve		T. Baker Smith
Vicidomina, Frank	Value Engineering	USACE
Whalen, Daniel	Economics	USACE
Williams, Patrick	Habitat Evaluations	NOAA-NMFS
Zachary, Andrea	Environmental	GEC

- USACE participation includes work conducted before the project was designated as a Section 203 project, through coordination with the Non-Federal sponsors, and for the use of proprietary CEDEP software.

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