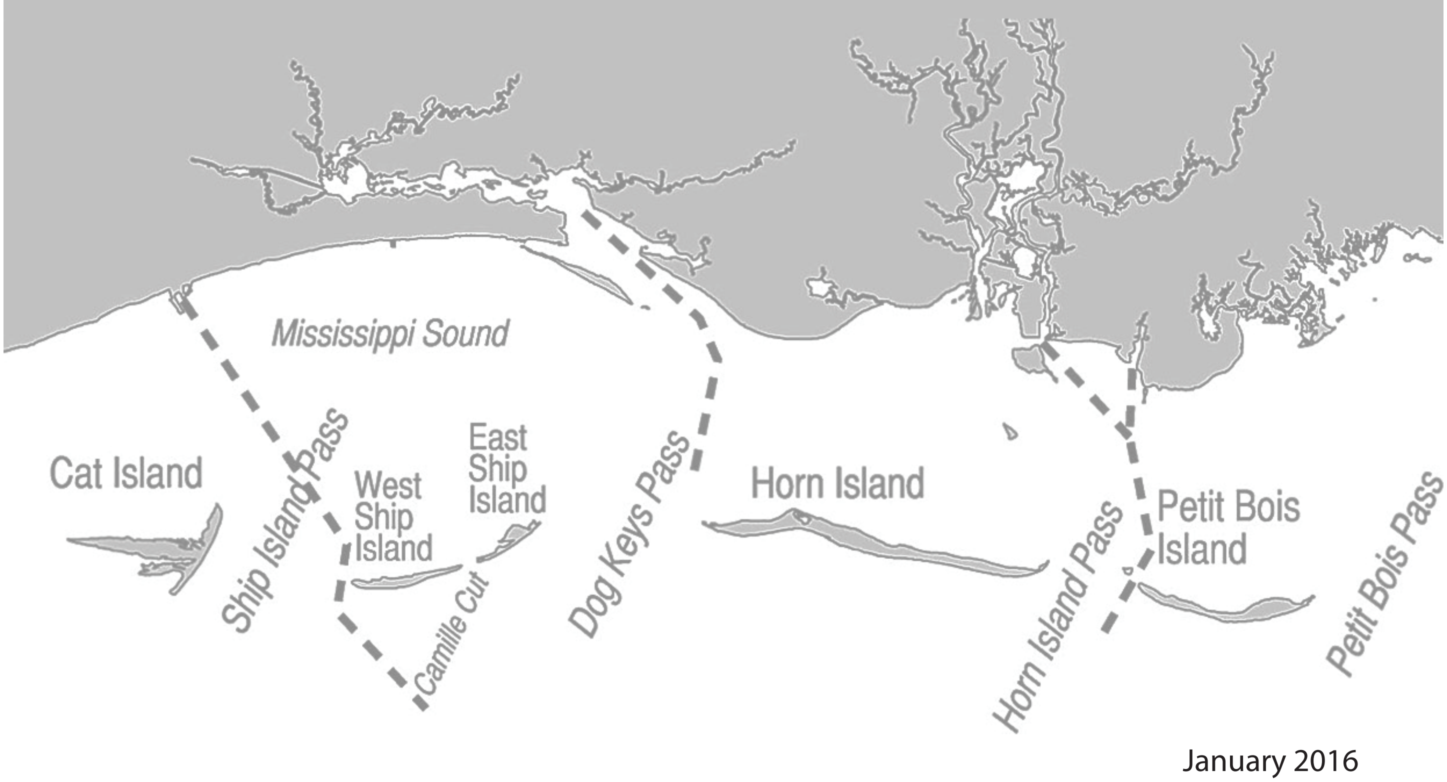
Mississippi Coastal Improvements Program (MsCIP)
Comprehensive Barrier Island Restoration
Hancock, Harrison, and Jackson Counties, Mississippi

Final Supplemental Environmental Impact Statement

Prepared for
U.S. Army Corps of Engineers
Mobile District

US Army Corps
of Engineers ®
Mobile District



January 2016

Executive Summary

Project Background

The U.S. Army Corps of Engineers (USACE), Mobile District, proposes to restore a portion of the Mississippi barrier islands in the Gulf of Mexico. This action is related to the consequences of Hurricane Katrina, other hurricanes in the Gulf of Mexico in 2005, and past navigational dredging and disposal activities that have altered sediment availability and transport along the islands. The Mississippi Coastal Improvements Program (MsCIP) Comprehensive Plan and Integrated Programmatic Environmental Impact Statement (PEIS) (USACE, 2009a) was developed to support the long-term recovery of Hancock, Harrison, and Jackson Counties from the devastation caused by these hurricanes, as well as to make the coast more resilient against damage from future storms. The MsCIP PEIS was prepared under the authority of the Department of Defense Appropriations Act of 2006 (Public Law 109-148), dated December 30, 2005 and was completed in June 2009. The Report of the Chief of Engineers dated September 15, 2009, and the Record of Decision (ROD) signed by the Assistant Secretary of the Army for Civil Works dated January 14, 2010, were submitted to Congress on January 15, 2010. The MsCIP PEIS evaluated an array of measures to address cost-effective solutions for hurricane and storm damage risk reduction, saltwater intrusion, shoreline erosion, preservation of fish and wildlife, and other water-related issues (USACE, 2009a).

The MsCIP PEIS evaluated an array of measures to promote the recovery of coastal Mississippi from damages caused by the hurricanes of 2005 and to increase the resilience of the coast against damage from future storms. The ROD for the MsCIP PEIS recommended a number of key elements for phased implementation over the next 30–40 years. The Comprehensive Plan, as evaluated in the MsCIP PEIS, includes the comprehensive restoration of the Mississippi barrier islands; restoration of over 3,000 acres of wetland and coastal forest habitat; acquisition of approximately 2,000 parcels, with relocation of residents, within the high hazard area; improvement of a levee at the Forest Heights community in Gulfport, Mississippi; a flood-proofing demonstration in Waveland, Mississippi; and the study of 53 other hurricane and storm damage risk reduction and ecosystem restoration options across the coastal area.

This Supplemental Environmental Impact Statement (SEIS) evaluates alternatives designed to accomplish the purpose of and need for the barrier island restoration elements as recommended in the MsCIP Comprehensive Plan and authorized by Congress, as well as the potential environmental impacts and benefits associated with the USACE final design for the plan to implement the authorized construction action in compliance with the National Environmental Policy Act (NEPA) and applicable regulations. The action alternatives considered in this SEIS include potential sand borrow locations and site-specific options for implementing restoration at the sand placement locations authorized for construction. Alternatives considered are tiered from the MsCIP PEIS (40 Code of Federal Regulations [C.F.R.] 1508.28). Thus, those alternatives that were evaluated and rejected under the MsCIP PEIS are not carried forward for analysis in this document.

Project Area

The project area includes the mainland coast of Mississippi (Hancock, Harrison, and Jackson Counties), the Mississippi Sound, the Mississippi-Alabama barrier islands, and the northern Gulf of Mexico to about 8 miles seaward of the barrier islands (Figure ES-1). A chain of sandy barrier islands located from 6 to 12 miles offshore separates the Mississippi Sound from the northern Gulf of Mexico. From east to west, the islands are Dauphin Island in Alabama and Petit Bois, Horn, East Ship, West Ship, and Cat Islands in Mississippi. In addition, Sand Island, which has been created through the deposition of dredged material within Disposal Area 10 (DA-10) of the Pascagoula Harbor Federal Navigation project, lies between Petit Bois and Horn Islands.

Dauphin, Petit Bois, Horn, East Ship, and West Ship Islands are located along the modern littoral drift zone that moves sand westward across the islands, resulting in their elongated shapes and westward migration over time (Figure ES-1). The westernmost island, Cat Island, is believed to have originated as part of the Alabama-Mississippi barrier chain (Saucier, 1963; Frazier, 1967; Otvos, 1978, 1981; Kindinger et al., in press). However, wave climate altered by the growth of the St. Bernard Delta into the northern Gulf of Mexico significantly sheltered the island from south and southeast waves that supplied sediment to the island around 4,000 years ago (Frazier, 1967; Penland et al., 1985; Otvos and Giardino, 2004; Twichell et al., 2011; Kindinger et al., in press). Due to the change in oceanic conditions, Cat Island is not part of the modern littoral drift system that supplies sand along the Alabama-Mississippi barrier island chain (Byrnes et al., 2012; Walstra et al., 2012). Thus, Cat Island has experienced more limited migration. Ship Island currently exists as two island segments, East Ship and West Ship, separated by Camille Cut. In 1969, Hurricane Camille substantially breached a part of Ship Island that had been historically vulnerable to breaching. This breach remains today as a 3.5-mile-wide shallow sandbar between the two small islands.

All of Petit Bois, Horn, East Ship, West Ship Islands, and portions of Cat Island are located within the boundaries of the Gulf Islands National Seashore (GUIS) Mississippi unit under the jurisdiction of the National Park Service (NPS). Petit Bois and Horn Islands also have been designated by the U.S. Congress as the Gulf Islands Wilderness under the Wilderness Act. The remainder of Cat Island is currently under State and private ownership. The project area offshore of the islands includes portions of the Outer Continental Shelf (OCS), which are under the Bureau of Ocean Energy Management (BOEM) jurisdiction for leasing and regulating the recovery of minerals. BOEM jurisdiction extends to the subsoil and seabed of all submerged lands seaward of State-owned waters to the limits of the OCS.

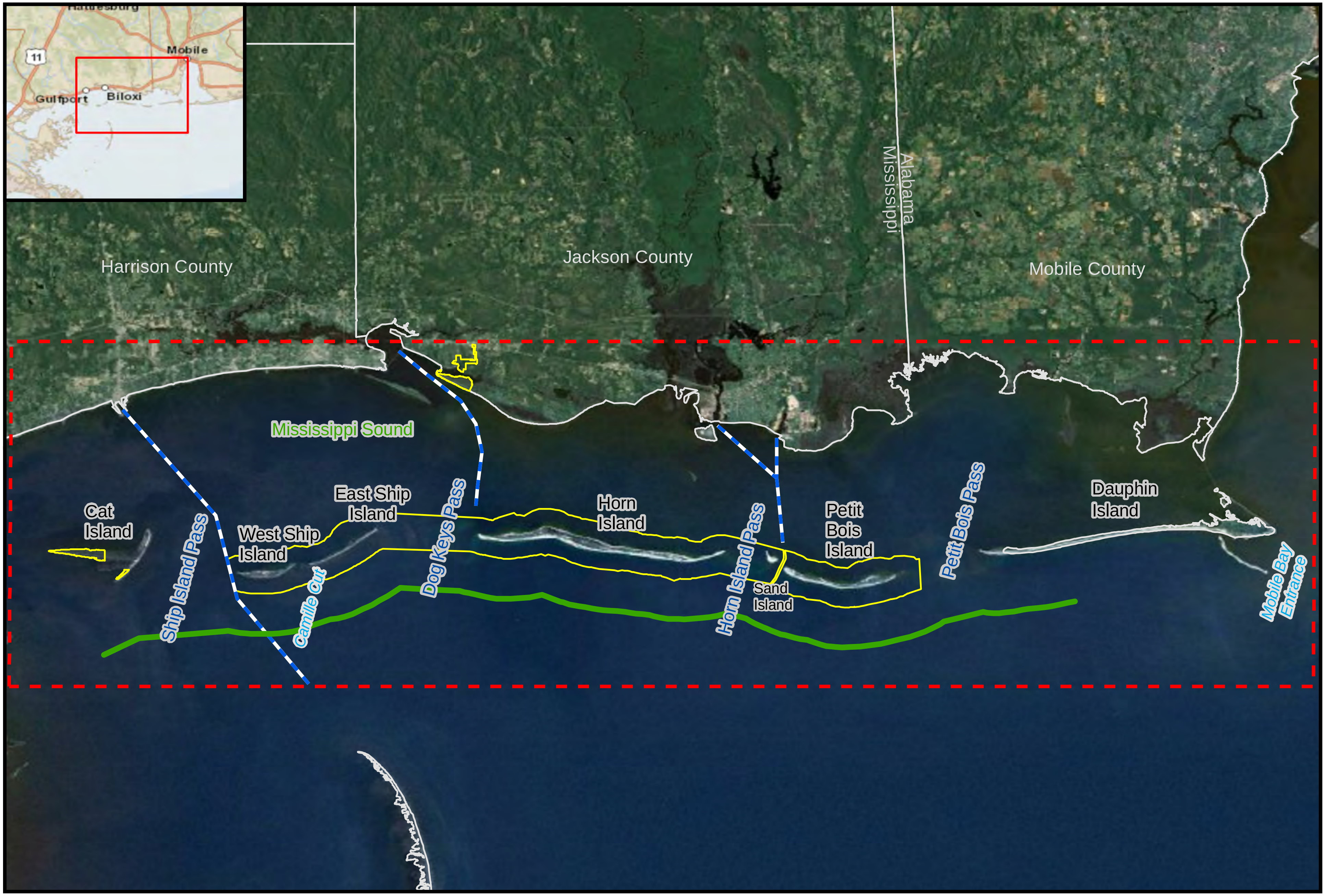
Purpose and Need

The MsCIP PEIS evaluated the need for restoring the Mississippi Barrier Islands as part of a comprehensive plan to increase the resiliency of the coast to future storm events. The PEIS recommended a general plan that included the placement of up to 22 million cubic yards to restore islands within the GUIS Mississippi unit and an undetermined quantity of sand in the vicinity of Cat Island. The PEIS also discussed the need to evaluate refinements to the barrier island restoration plan, including locating additional borrow sites and specific design options. This SEIS has been prepared to evaluate and document the impacts of specific alternatives for sand borrow areas, placement options, engineering and design alternatives, and construction methods.

This SEIS will be used to support the NEPA compliance requirements for the federal agencies with jurisdiction over parts of the tentatively selected plan, including USACE, the NPS, and the BOEM. As a federal agency with jurisdiction to manage the resources available on OCS, BOEM was invited by USACE to participate as a cooperating agency in the preparation of the SEIS. BOEM's connected, though separate, proposed action is to issue a negotiated agreement pursuant to its authority under the Outer Continental Shelf Lands Act for use of sand, gravel, and shell resources for Coastal Storm Damage Reduction (CSDR) projects from the OCS. It also serves to support BOEM's connected, though separate, proposed action to issue a negotiated agreement pursuant to its authority under the Outer Continental Shelf Lands Act for use of sand, gravel, and shell resources for CSDR projects from the OCS. Additionally, consultations and coordination with the USFWS and NMFS were completed under the Endangered Species Act and the Biological Assessment (BA) and Biological Opinion (BO) were updated for the Final SEIS to evaluate potential protected species impacts at the OCS borrow sites. Consultation and/or coordination for cultural resources under the National Historic Preservation Act, Archaeological Resources Protection Act, Abandoned Shipwreck Act, and Sunken Military Craft Act has occurred between USACE, Mobile District, and the State Historic Preservation Offices of Mississippi and Alabama, the National Park Service, the Bureau of Energy Management, and interested Federally Recognized Tribes throughout the development of the barrier island restoration program.

The need for the Proposed Action remains the same as that described in the MsCIP PEIS, which is that implementation of the recommended comprehensive restoration of the barrier islands is required to achieve the goals outlined in the MsCIP PEIS. The restoration of the Mississippi barrier island system is needed to:

- Protect and maintain the estuarine ecosystem of the Mississippi Sound and to reduce storm damage incurred along the mainland coast of Mississippi;
- Preserve and protect the Mississippi barrier islands and their natural and cultural resources;
- Reduce erosion and land loss of the barrier islands, especially East and West Ship Islands, and Cat Island to the west; and
- Enhance the long-term sand supply to the littoral drift system, which historically has maintained the Mississippi barrier islands through natural processes.



Deep Draft Shipping Channel

Federal-State Waters Boundary

Project Area

Gulf Islands National Seashore

N

0 4 8 16 Miles

FIGURE ES-1
PROJECT AREA MAP
MsCIP COMPREHENSIVE BARRIER ISLAND RESTORATION SEIS

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Proposed Action, Programmatic Environmental Impact Statement of June 2009

The USACE's initial plan for restoration under the PEIS serves as the basis for development of alternative actions in this SEIS. The proposed Comprehensive Barrier Island Restoration element as described in the MsCIP PEIS includes restoration of the Mississippi barrier islands through the placement of up to 22 million cubic yards (mcy) of sand within the GUIS Mississippi unit and an undetermined quantity of sand in the vicinity of Cat Island. In the MsCIP PEIS, the overall recommendation to return sand to the system included:

- Filling Camille Cut, the 3.5-mile breach in Ship Island;
- Adding sand to the littoral system on the east end of Petit Bois Island;
- Adding sand to the littoral system on the east end of East Ship Island; and
- Adding sand to the Littoral System on the East End of Cat Island.

Tentatively Selected Plan, Supplemental Environmental Impact Statement of 2013

The original MsCIP PEIS evaluated a general restoration plan that included the placement of material between East and West Ship Islands to fill Camille Cut and placement of sand within the littoral zones of Cat, East Ship, and Petit Bois Islands, with preliminary estimates of the volume of fill material required. The PEIS also recommended that additional analyses be completed prior to implementation of restoration to identify the most effective plan(s) for restoring the barrier island system. The alternatives evaluated for this SEIS are based on this additional information including geophysical and geotechnical evaluations, revised sediment budget analysis, and a suite of hydrodynamic, sediment transport, and morphological modeling efforts. These updated alternatives are based on differing design configurations using varying quantities and multiple sources of sand with different median grain sizes and include:

- Restoration of Ship Island, including Sand Placement in Camille Cut and Replenishment of the Southern Shoreline of East Ship Island;
- Beach-front Placement of Sand Along Cat Island; and
- Management of Future Dredged Material from Pascagoula Ship Channel.

From the updated evaluations, a Tentatively Selected Plan (TSP) has been developed which fulfills the goals identified in the MsCIP PEIS for restoration of the Mississippi barrier islands to sustain the Mississippi Sound's productive ecological system while also providing the first line of defense, resulting in a more resilient coast. Additionally, a Monitoring and Adaptive Management (MAM) Plan was developed to determine progress toward restoration success and to increase the likelihood of achieving desired project outcomes in the face of uncertainty. The MAM Plan is a living document and will be regularly updated to reflect monitoring-acquired and other new information as well as resolution of and progress on resolving key uncertainties and discovering lessons learned to help with management of coastal resources.

The following paragraphs provide details on each of the TSP components.

Ship Island Restoration

The restoration of Ship Island includes the closure of Camille Cut and restoration of the shoreline of the current East Ship Island. This restoration would be accomplished in five phases over an approximately 2.5-year period and is summarized below, by component. The combined Camille Cut and East Ship Island equilibrated fill would encompass approximately 1,500 acres, of which roughly 800 acres would be above mean high water level (MHWL). The placement on Ship Island would be a one-time event.

Direct Sand Placement in Camille Cut

To restore East Ship Island and West Ship Island to a single elongated barrier island, the approximately 3.5-mile-long Camille Cut would be filled with approximately 13.5 mcy of sand. The newly formed island segment would be constructed as a low-level dune system connecting existing West Ship and East Ship Islands. Under the proposed design template, the constructed Camille Cut closure would be approximately 1,100 feet wide. The fill would tie into the existing island shoreline just below the frontal dune line at an elevation of approximately +7 feet North American Vertical Datum of 1988 (NAVD88) with a 1V:12H (vertical:horizontal) slope to the MHWL and an approximate 1V:20H slope below the MHWL. The fill at its western and eastern ends would tie into the existing berm along the eastern end of West Ship Island and transition into the proposed East Ship Island placement.

As sand placement in Camille Cut progresses, the newly created island segment would be stabilized with sand fencing and planted with native dune vegetation, including sea oats and/or other grasses and forbs, to restore stable dune habitat. The planting would include dune grasses in groupings along the newly created beach.

Replenishment of East Ship Island

The restoration of East Ship Island would consist of the placement of approximately 5.5 mcy of sand along the southern shoreline. In addition to restoring the southern shoreline, placement of sand in this area would add material to the newly restored Camille Cut fill and therefore support the overall replenishment of the system as identified in the sediment budget analysis and sediment transport modeling. The construction template for the restored southern shoreline would consist of an average berm crest width of approximately 1,200 feet at an elevation of +6 feet NAVD88 with a 1V:12H to 1:20 slope from the seaward edge of the berm to the toe of the fill (intersection with the existing bottom).

Borrow Site Option 4

- Ship Island restoration would involve use of sand from five borrow areas (referred to as Borrow Site Option 4, based on multiple alternatives being initially considered). A total of approximately 19.0 mcy of in-placed sand based on 2012 surveys, would be required to fill Camille Cut and to restore East Ship Island. The term “in-placed” refers to the actual volume of sand material on the beach, assuming that some fraction above this net volume might be lost in the process. Available borrow areas with total volumes of required and allowable sand available before factoring construction losses and inefficiencies include:

- Ship Island (2.7 mcy);
- Horn Island Pass (4.9 mcy);
- Petit Bois Pass–Alabama (PBP-AL) (19.8 mcy);
- Petit Bois Pass-Mississippi (PBP-MS) (2.0 mcy); and
- Petit Bois Pass–Outer Continental Shelf (PBP-OCS) (19.6 mcy).

Sand from borrow sites would likely be dredged with a hopper dredge or hydraulic cutterhead dredge, loaded into scows, hauled to the placement vicinity, and then pumped directly onto the site. Placement of the material would be concurrent with the fill of Camille Cut.

The five borrow sites listed above include sub-areas, several of which are outside, or partially outside, waters of the State of Mississippi. These include Petit Bois-AL (PBP-AL East and PBP-AL West) and Petit Bois Pass-OCS (PBP-OCS East 1-5, PBP-OCS West 1, and PBP-OCS West 3-6). PBP-AL East and PBP-AL West are located within Alabama state waters, PBP-OCS West 1 and 3 are located within Mississippi state waters, and the OCS and PBP-OCS West 2, 4, 5, and 6 as well as PBP-OCS East 1 through 5 are located completely within OCS waters. Use of material from these sites requires additional coordination as described below.

The State of Alabama owns the title to lands underlying coastal waters to a line 3 geographical miles distant from its coastline (see 43 U.S.C. § 1301, et seq.). The United States has paramount rights in these waters for purposes of commerce, navigation, national defense, and international affairs, none of which apply to the removal of sand for the purposes of beach or island restoration. The State's position is removal of sand within the state boundaries will be done in accordance with State Law (AL Code 9-15-52) and either a direct sale or royalty payment may be charged for removal.

Discussions with the current State of Alabama officials indicate what the State's position is toward the acquisition of sand that may be necessary to complete implementation of the restoration. Per these discussions the State has indicated that sand will be offered at a royalty rate of $7.00 per cubic yard measured at the borrow site with a minimum quantity of 3 million cubic yards from the sites designated as PB-AL East 3 or PB-AL West 2 and 3 as discussed in the SEIS. Payment would be requested 60 days in advance of the advertisement of a contract for the removal of sand from these sites. The United States right to remove sand from the designated sites would begin upon payment for the 3 million cubic yards and the United States would have 30 months to complete removal of this sand from the Alabama sites. Should the United States need any additional quantity of sand above the 3 million cubic yards discussions would be renewed with the then current State officials.

The BOEM is the agency of the Department of the Interior tasked with managing the extraction of offshore minerals from the OCS. While the largest component of this management is related to exploration for and development of oil and gas resources, the BOEM is also responsible for what are loosely referred to as "non-energy minerals" (primarily sand and gravel) obtained from the ocean floor. BOEM jurisdiction for leasing and regulating the recovery of minerals extends to the subsoil and seabed of all submerged lands seaward of State-owned waters to the limits of the OCS. 43 U.S.C. 1337(k)(2) allows the BOEM to negotiate, on a noncompetitive basis, the rights to OCS sand, gravel, or shell resources for shore protection, beach or wetlands restoration projects, or for use in construction projects funded in whole or part by or authorized by the Federal Government, without payment of fees. Any sand removed from the OCS requires review and an agreement from the BOEM.

Cat Island Restoration

Dune and beach restoration on Cat Island, including revegetation, would be implemented through the direct placement of approximately 2 mcy of sand on the eastern beach fronting Cat Island. The recommended design is largely based on restoring the eastern shoreface of Cat Island to 1998 conditions. The construction template would include an average dune crest width of 40 feet at an elevation of approximately +7.5 feet NAVD88. The construction berm would have an average constructed crest width of approximately 250 feet at an elevation of approximately +5 feet NAVD88 with a 1V:12H to 1V:20H slope from the seaward side of the berm to the toe of the fill. Direct placement of sand on the eastern beach would restore the island habitats, thereby enhancing the island's ability to absorb energy from westward-propagating waves. The construction profile would be expected to adjust rapidly through the erosion of the upper profile and mimic the natural nearshore profile once it reaches equilibrium. The equilibrium design berm width averages 175–200 feet. The total equilibrated fill area encompasses approximately 305 acres.

Sand used in the restoration of Cat Island would come from an approximately 429-acre sand deposit in an area about 2 miles long and 0.2-mile wide centered about 1.25 miles off the eastern shoreline of Cat Island (Figure 3-14). The proposed borrow site is located east of the placement area and outside of the GUIS boundaries. The borrow site would be dredged to a depth of approximately 6 feet, which includes 4 feet for required dredging plus an additional 2 feet of allowable overdepth.

The proximity of the borrow area to the eastern shoreline of Cat Island in relatively shallow water would allow for the rapid placement of sand on the beach, likely using a hydraulic cutterhead pipeline dredge. The material would be pumped directly onto the beach and reworked (shaped) by land-based equipment. Following placement, the area would be revegetated with native grasses. Restoration would occur over approximately 6 months. The placement of sand would be a one-time event.

Management of Littoral Placement of Future Dredged Material from Pascagoula Federal Navigation Channel

The TSP includes revisions to the dredged material placement practices within the littoral zone of the Horn Island Pass portion of the Pascagoula Federal Navigation Channel. The intent of the revisions is to ensure that placement of future dredged material within the littoral zone best replicates natural sediment pathways in the system and minimizes potential adverse impacts to the surrounding area while not increasing costs to operation of the Pascagoula Federal Navigation Channel. The TSP includes placement of suitable sandy material dredged from the Horn Island Pass portion of the Pascagoula Federal Navigation Channel along the shallow shoals exposed to the open Gulf waves with the greatest sand transport potential. These shoals are located in the south and west portions of the existing specified DA-10 and the northern portion of the existing specified Littoral Zone disposal site. The total area for potential direct placement would encompass approximately 1,600 acres, including a portion of the existing DA-10 and the existing Littoral Zone placement site, with existing depths generally between 5 and 30 feet. The optimum dredge placement location for hydraulic cutterhead pipeline dredges is in the shallow waters just southwest of Sand Island. This area is preferred from the standpoint of both sediment transport potential and operations to minimize unnecessary pumping distances. The deeper waters are required for hopper dredges that cannot operate on the shallow shoals.

No-Action Alternative

The No-Action Alternative represents the future without-project conditions that would occur in the project area without comprehensive restoration of the Mississippi barrier islands. The MsCIP PEIS (USACE, 2009a), from which this SEIS is tiered, describes future without-project conditions and evaluates the environmental effects of the No-Action Alternative. The No-Action Alternative serves in this SEIS as the baseline against which potential environmental impacts and benefits associated with site-specific implementation aspects of the barrier island restoration are compared.

The No-Action Alternative would involve continuing erosion of the barrier islands, increasing salinity of the Mississippi Sound, and continuing degradation and loss of estuarine habitats and productive fisheries (USACE, 2009a). The No-Action Alternative assumes that net land loss and morphological changes would continue along the barrier islands into the future, primarily as a result of storms. Historical analysis of barrier island change provided by Morton (2008) and recent analysis by Byrnes et al. (2013) indicate that East Ship Island would continue to narrow and lose land area under this alternative. Sand available for transport from East Ship Island would be depleted in a matter of decades, as storm and normal transport processes reduce the island to a shoal. Dog Keys Pass would become wider as East Ship Island evolves to a shoal, and natural sediment bypassing to West Ship Island would be greatly diminished. In addition, Cat Island would continue to lose land area from persistent erosion due to increased exposure to southeast waves from the Gulf.

Under the No-Action Alternative, loss of coastal ecotone habitat would continue. Barrier islands and beaches along eroding margins of the islands would transition to open-water habitat. These changes would alter and reduce the integrity of existing beach and nearshore habitats for use by communities of terrestrial and benthic invertebrates, fish, wetland plants, submerged aquatic vegetation, marine mammals, and marine and coastal birds (USACE, 2009a). Beach and littoral habitats for threatened and endangered species such as Gulf sturgeon, sea turtles, and piping plover would also diminish. Loss of the barrier structure provided by the presence of the barrier islands would allow for the free exchange of higher-salinity Gulf waters into the Mississippi Sound in an area which has historically been impacted by a reduction in the quantity and timing of freshwater flows from river systems entering the Sound. This alteration of water quality in the Mississippi Sound as a result of increasing salinity would threaten commercial and recreational fishing as well as essential fish and shellfish habitats for estuarine species. In addition, unprotected significant cultural resource sites along eroding shorelines of the barrier islands could be lost.

Under the No-Action Alternative, the loss of the barrier islands would threaten the estuarine ecosystem of the Mississippi Sound and expose the mainland coast and its associated wetlands and coastal habitats to increasing saltwater intrusion and damage from future storms. In addition, the structural integrity and efficacy of the barrier islands as a first line of defense of mainland habitats would continue to diminish, reducing the resilience of the coast against damage from future storms.

As documented in the MsCIP PEIS (USACE, 2009a), the No-Action Alternative would fail to address the need for comprehensive improvements in the coastal area of Mississippi in the interest of hurricane and storm damage risk reduction, prevention of saltwater intrusion, preservation of fish and wildlife, prevention of erosion, and other related water resource purposes. Although it was determined not to meet the purpose and need for implementing barrier island restoration, the No-Action Alternative is considered herein to meet the requirements of NEPA and to serve as the baseline for evaluating the effects of the TSP.

Impacts Summary

Implementation of the TSP to restore the Mississippi barrier island system would result in both negative and beneficial impacts to placement and borrow areas and to the users of these areas. Negative impacts include the permanent loss of open water habitat at Camille Cut, construction-related short- to long-term disruptions to birds and other wildlife on Ship and Cat Islands, and construction-related disruptions to public use of borrow and placement areas.

However, the overall significant long-term system-wide benefits to the ecosystem and associated losses outweigh the negative impacts. Restoration would provide for additional nesting habitat for threatened and endangered sea turtles and over-wintering critical habitat for the piping plover as well as habitat for neotropical migrants and waterfowl. Closure of Camille Cut would help to maintain the salinity regime in the Sound and the habitat conditions for oysters and numerous estuarine dependent fish and crustacean species that are essential for commercial and recreational fishing. In addition, the barrier island restoration would help to continue to protect the significant historical and cultural sites within the GUIS. The anticipated reduction in storm surges would also help to protect unique coastal mainland habitats and wetlands.

Environmental Compliance and Commitments

To satisfy environmental compliance laws and regulations for this project, the status of the determinations, coordination, and consultations pertaining to the environmental compliance with the cooperating agencies is summarized below.

A BA was prepared and submitted on November 12, 2012 to USFWS and NOAA Fisheries also known as National Marine Fisheries Service, Protected Resources Division (NMFS-PRD). An amended BA was prepared on September 16, 2014 and January 2015 to include updates and changes in the plans, and resubmitted to USFWS and NMFS-PRD. The USFWS and NMFS-PRD issued a draft BO on the action identifying reasonable and prudent measures to minimize impacts in June and July 2015. After review, the Corps provided comments suggesting minor changes in quantities and acreages, updating borrow site and fill language in the long-term monitoring, and clarifying requirements for escarpment removal. The USFWS concurred with comments and submitted a final BO on September 8, 2015. NMFS-PRD also concurred with comments and submitted their final BO (SER-2012-09304) on September 14, 2015. The BA, USFWS BO, and NMFS-PRD BO are included in Appendix N.

Clean Water Act, Sec 401 Water Quality Certifications have not been received, but will be requested from the Mississippi Department of Environmental Quality and Alabama Department of Environmental Management (ADEM) during the release of the Final SEIS for public comment. The Coastal Zone Consistency determination has been coordinated with the Mississippi Department Marine Resources (MDMR) via the SEIS and Notice of Intent and final coordination will be completed prior to the signing of the Record of Decision. A 404(b)(1) evaluation of dredged and fill material has been prepared and is included as an Appendix in the SEIS.

Coordination with NMFS-Habitat Conservation Division has been initiated via the SEIS, and the USACE is preparing to submit an Essential Fish Habitat (EFH) Assessment letter. Pending receipt of the Essential Fish Habitat (EFH) Assessment from the USACE, NMFS-HCD will issue conservation measures to minimize impacts on EFH.

Effects determinations under Section 106 of the National Historic Preservation Act have been coordinated with the State Historic Preservation Offices, and letters of consultation have been received for the project from the State of Mississippi on October 7, 2014 and the State Alabama on October 17 and 20, 2014. All coordination letters received to date are located in Appendix T and consultations are anticipated to be completed prior to the signing of the Record of Decision but will be completed not later than the initiation of any land-disturbing activities.

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Acronyms and Abbreviations

ACHP	Advisory Council on Historic Preservation
APE	Area of Potential Effects
ARPA	Archaeological Resources Protection Act
ASA	Abandoned Shipwreck Act
BA	biological assessment
BMP	best management practice
BOEM	Bureau of Ocean Energy Management
BP	BP Exploration and Production, Inc.
CAA	Clean Air Act
CBRA	Coastal Barriers Resources Act
CEQ	Council on Environmental Quality
C.F.R.	Code of Federal Regulations
CO	carbon monoxide
CSDR	Coastal Storm Damage Reduction
CSLC	California State Lands Commission
CWA	Clean Water Act
cy/yr	cubic yards per year
CZMA	Coastal Zone Management Act
D50	median particle diameter
DA	disposal area
dB	decibel
dBA	A-weighted decibel scale
DO	dissolved oxygen
EA	environmental assessment
EFH	essential fish habitat
EIFS	economic impact forecasting system
EIS	environmental impact statement
EJ	Environmental Justice
ERDC	Engineer Research and Development Center
ESA	Endangered Species Act
FEMA	Federal Emergency Management Agency
FNU	formazin nephelometric units
Fed. Reg.	*Federal Register*
FWCAR	Fish and Wildlife Coordination Act Report
GIWW	Gulf Intracoastal Waterway
GMFMC	Gulf of Mexico Fishery Management Council
GRBO	Gulf of Mexico Regional Biological Opinion
GSCH	Gulf sturgeon critical habitat
GSMFC	Gulf States Marine Fisheries Commission

GUIS	Gulf Islands National Seashore
HAB	harmful algal bloom
Hz	hertz
IMMS	Institute for Marine Mammal Studies
IPCC	Intergovernmental Panel on Climate Change
KCS	Kansas City Southern
kHz	kilohertz
km	kilometer
lb/Mgal	pounds per million gallons
µm	microns
µPa/m	microPascal per meter
µPa2sec	microPascal over a 1-second period
MAM	Monitoring and Adaptive Management
MBTA	Migratory Bird Treaty Act
MCA	Mississippi Coastal Assessment Program
MCP	Mississippi Coastal Program
mcy	million cubic yards
MDEQ	Mississippi Department of Environmental Quality
MDMR	Mississippi Department of Marine Resources
MDOT	Mississippi Department of Transportation
MDWFP	Mississippi Department of Wildlife, Fisheries, and Parks
mgd	million gallons per day
mg/L	milligrams per liter
mg/m^2	milligrams per square meter
MHWL	mean high water level
MHHW	mean higher high water
MHT	mean high tide
MLT	mean low tide
MLLW	mean lower low water
mm	millimeters
MMPA	Marine Mammal Protection Act
MMS	Minerals Management Service
MPA	marine protected area
MPRSA	Marine Protection, Research, and Sanctuaries Act
MSAAS	"Benthic Macroinfauna Community Characterizations in the Mississippi Sound and Adjacent Areas" study
MsCIP	Mississippi Coastal Improvements Program
MSEMA	Mississippi Emergency Management Agency
MSU	Mississippi State University
NAAQS	National Ambient Air Quality Standards
NAGPRA	Native American Graves Protection and Repatriation Act
NAVD88	North American Vertical Datum of 1988

NCA	National Coastal Assessment
NEP	National Estuary Program
NEPA	National Environmental Policy Act
NERR	National Estuarine Research Reserve
NHPA	National Historic Preservation Act
NOAA	National Oceanic and Atmospheric Administration
NOAA Fisheries	formerly National Marine Fisheries Service (NMFS)
NOI	Notice of Intent
NOx	nitrogen oxides
NPS	National Park Service
NRHP	National Register of Historic Places
NTUs	nephelometric turbidity units
NWI	National Wetlands Inventory
OCS	Outer Continental Shelf
OSAT3	Operational Science Agency Team
PBP-AL	Petit Bois Pass-Alabama
PBP-MS	Petit Bois Pass-Mississippi
PBP-OCS	Petit Bois Pass-Outer Continental Shelf
PEIS	Programmatic Environmental Impact Statement
P.L.	Public Law
PM	particulate matter
ppm	parts per million
ppt	parts per thousand
PTS	permanent threshold shift
re	relative to
rms	root-mean-square
ROD	Record of Decision
ROI	Region of Influence
SAV	submerged aquatic vegetation
SEIS	Supplemental Environmental Impact Statement
SHPO	State Historic Preservation Office
SIP	State Implementation Plan
SMCA	Sunken Military Craft Act
SOx	sulfur oxides
SPL	sound pressure level
SRCC	Southeast Regional Climate Center
THC	total hydrocarbons
TOC	total organic carbon
TOG	total organic gases
TPH	total petroleum hydrocarbons
TSP	Tentatively Selected Plan
TTS	temporary threshold shift
USACE	U.S. Army Corps of Engineers

U.S.C.	U.S. Code
USCG	U.S. Coast Guard
USDOC	U.S. Department of Commerce
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WSOF	Wetland Statement of Findings

1. Introduction

In response to the devastation caused by Hurricane Katrina, the Secretary of the Army was directed to prepare a comprehensive plan for improvements in the coastal area of Mississippi in the interest of hurricane and storm damage risk reduction, prevention of saltwater intrusion, preservation of fish and wildlife, prevention of erosion, and other related water resource purposes (Department of Defense Appropriations Act of 2006 [Public Law (P.L.) 109-148]). The Mississippi Coastal Improvements Program (MsCIP) Comprehensive Plan and Integrated Programmatic Environmental Impact Statement, hereafter referred to as the MsCIP Programmatic Environmental Impact Statement (PEIS) (U.S. Army Corps of Engineers [USACE], 2009a) was completed in June 2009 to support the long-term recovery of Hancock, Harrison, and Jackson Counties in Mississippi with the goal of enhancing the resilience of the coastal area and its communities against future events, including storms. The Report of the Chief of Engineers dated September 15, 2009, and the Record of Decision (ROD) signed by the Assistant Secretary of the Army for Civil Works dated January 14, 2010, were submitted to Congress on January 15, 2010 (USACE, 2009b; USACE, 2010a).

The MsCIP PEIS evaluated an array of measures to promote the recovery of coastal Mississippi from the hurricanes of 2005 and to increase the resilience of the coast against damage from future storms. The ROD for the MsCIP PEIS recommended several key elements for phased implementation over the next 30–40 years. The Comprehensive Plan, as evaluated in the MsCIP PEIS, includes the comprehensive restoration of the Mississippi barrier islands; restoration of more than 3,000 acres of wetland and coastal forest habitat; acquisition of approximately 2,000 parcels, with relocation of residents, within the high hazard area; improvement of a levee at the Forest Heights community in Gulfport, Mississippi; a flood-proofing demonstration in Waveland, Mississippi; and the study of 53 other hurricane and storm damage risk reduction and ecosystem restoration options across the coastal area.

The Supplemental Appropriations Act, 2009 (P.L. 111-32), provided funds and direction to the Secretary of the Army to restore historical levels of storm damage risk reduction to the Mississippi Gulf Coast through barrier island and ecosystem restoration. The MsCIP PEIS addressed the general plan for comprehensive barrier island restoration, but the final design was not complete at the time because specific sand borrow sources and the placement templates had not been determined. To ensure full compliance with the National Environmental Policy Act (NEPA), the USACE's Mobile District prepared this Supplemental Environmental Impact Statement (SEIS) in cooperation with other federal, state, and local agencies. This SEIS is tiered from the MsCIP PEIS (USACE, 2009a), which evaluated a full range of barrier island ecosystem restoration alternatives, from very limited restoration of East Ship Island and West Ship Island to massive restoration of the islands' historical dimensions (USACE, 2009a). The ROD for the MsCIP PEIS recommended a comprehensive restoration plan that combined two of these alternatives (USACE, 2010a). Therefore, new alternatives to barrier island restoration and protection of the Mississippi Sound are not considered in this SEIS. Rather, the alternatives considered herein are focused specifically on site-specific borrow areas, placement area design, and construction methods for implementing the barrier island restoration plan.

The USACE is serving as the lead federal agency during preparation of the SEIS. The following agencies have participated in the development of the Tentatively Selected Plan (TSP) and have agreed to participate as cooperating agencies:

- U.S. Environmental Protection Agency (USEPA);
- U.S. Department of the Interior—National Park Service (NPS), U.S. Fish and Wildlife Service (USFWS), Bureau of Ocean Energy Management (BOEM), and U.S. Geological Survey (USGS);
- U.S. Department of Commerce (USDOC)—National Oceanic and Atmospheric Administration (NOAA) and National Marine Fisheries Service (NOAA Fisheries);
- Mississippi Department of Marine Resources (MDMR);
- Mississippi Department of Environmental Quality (MDEQ);
- Mississippi Department of Archives and History;
- Mississippi Museum of Natural Science; and
- Alabama Department of Conservation and Natural Resources.

As a federal agency with jurisdiction to manage the resources available on the outer continental shelf (OCS), BOEM was invited by USACE to participate as a cooperating agency in the preparation of the SEIS. This partnership was developed to fulfill BOEM's mandatory statutory environmental and leasing requirements for the completion of a Memorandum of Agreement, which will serve as a negotiated lease agreement for the designated OCS borrow. As a cooperating agency, with respect to NEPA, BOEM:

- Participated in the NEPA process;
- Participated in the consultation process;
- Assumed, at the request of USACE, responsibility for developing information and preparing environmental analyses for which BOEM has special expertise; and
- Made available staff support at the lead agency's request to enhance the interdisciplinary capability of USACE.

BOEM also agreed to participate in the required Endangered Species Act (ESA) Section 7 consultation, the Magnuson-Stevens Fishery and Conservation Management Act Essential Fish Habitat consultation (Section 305), the National Historic Preservation Act of 1966 (NHPA) Section 106 process, and the Coastal Zone Management Act Section 307 consistency determination. As the lead federal agency for ESA Section 7 and the Essential Fish Habitat (EFH) consultations, USACE notified USFWS and NMFS of its lead role and BOEM's cooperating status. Through this partnership, USACE jointly submitted, with BOEM, the ESA Section 7 and EFH assessments to USFWS and NMFS. USACE also acted as the lead federal agency for Section 106 compliance in accordance with 36 Code of Federal

Regulations (C.F.R.) Part 800.2(2) while BOEM acted as a cooperating agency for Section 106 compliance, offering input and consultation as needed.

The USACE conducted extensive public involvement during development of the MsCIP PEIS. Those efforts, along with public involvement associated with development of this SEIS, are summarized in Section 7.

1.1 Mississippi Coastal Improvements Program Comprehensive Plan

The Mobile District, in partnership with the State of Mississippi, developed the MsCIP PEIS to address cost-effective solutions for hurricane and storm damage risk reduction, saltwater intrusion, shoreline erosion, and preservation of fish and wildlife (USACE, 2009a). The MsCIP PEIS uses a systemwide approach linking structural and nonstructural hurricane and storm damage risk reduction elements with ecosystem restoration elements, all with the goal of providing a coastal community that is more resilient against hurricanes and storms. The plan used a “Lines of Defense” concept incorporating a group of alternative measures that function together as a comprehensive approach to addressing problems and opportunities. The grouping of alternative measures integrates structural, nonstructural, and ecosystem restoration measures. This concept progresses geographically from the offshore barrier islands to what could be considered the inland surge extent of the worst possible theoretical storm (USACE, 2009a). The MsCIP PEIS identified, screened, evaluated, prioritized, and optimized a broad array of alternatives. Comprehensive barrier island restoration, as a first line of defense against hurricane and storm damage, was one of several key elements recommended in the MsCIP PEIS (USACE, 2009a). Restoration of the Mississippi barrier island system would provide significant systemwide benefits to the habitats of the Gulf Islands National Seashore (GUIS) and other ecosystems, as well as economic benefits associated with damage and fishery losses avoided and other regional benefits (USACE, 2009a). Most notably, comprehensive barrier island restoration would help maintain the fragile Mississippi Sound ecosystem with its economic, recreational, environmental, and aesthetic benefits, and provide additional habitat for federally protected species of sea turtles and birds. The analyses provided in the MsCIP PEIS indicate that the comprehensive barrier island restoration would result in the restoration of 1,150 acres of critical coastal zone habitats and improvement to the water quality of the Mississippi Sound by maintaining the salinity regime in the Sound. In addition, some level of protection would be afforded to cultural sites on East Ship Island and West Ship Island, which are listed on the National Register of Historic Places (NRHP). Other benefits would include annual hurricane and storm damage risk reduction of $20 million to mainland Mississippi, $470,000 in average annual recreation benefits, and $43 million in average annual fishery losses avoided.

Given the chronic erosion processes along the barrier islands and their threat to natural and cultural resources, NPS—in collaboration with USACE, USGS, NOAA Fisheries, USEPA, NOAA, USFWS, MDEQ, and MDMR—concluded in the MsCIP PEIS that specific emergency actions and long-term habitat restoration are crucial for preserving and protecting the Mississippi barrier islands and their natural and cultural resources. As such, this SEIS for Mississippi barrier island restoration reflects extensive interagency consultation and collaboration.

1.2 Barrier Island Restoration Project Area

The project area for the comprehensive restoration of the Mississippi barrier islands extends from the mainland coast of Mississippi (Hancock, Harrison, and Jackson Counties) to the south across the Mississippi Sound and the Mississippi-Alabama barrier islands into the northern Gulf of Mexico to a distance about 8 miles seaward of the barrier islands (Figure 1-1). The Mississippi Sound is a shallow, estuarine body of water ranging 6 to 12 miles wide, extending approximately 90 miles along the coast from the juncture with Mobile Bay, Alabama, west to the mouth of Lake Borgne, Louisiana. Several navigation channels traverse the Mississippi Sound. The Gulf Intracoastal Waterway (GIWW) provides a shallow-draft channel for navigation that parallels the mainland coast through the entire length of the Mississippi Sound. Three Federal navigation channels—Gulfport, Biloxi, and Pascagoula—extend into the Mississippi Sound from the Mississippi mainland, and one channel, Bayou La Batre, extends into the Sound from the Alabama mainland. The USACE actively maintains these five channels.

A chain of six sandy barrier islands 6 to 12 miles offshore of Mississippi and Alabama separate the Mississippi Sound from the northern Gulf of Mexico. From east to west, the islands are Dauphin Island in Alabama and Petit Bois, Horn, East Ship, West Ship, and Cat Islands in Mississippi (Figure 1-1). The barrier island chain includes dynamic and diverse habitats that are part of a complex integrated system of beaches, dunes, marshes, maritime forest, bays, tidal flats, and inlets. The five eastern barrier islands (Dauphin, Petit Bois, Horn, and East Ship Island, and West Ship Island) are within a littoral drift zone that moves sand westward along the islands, resulting in their elongated shapes and westward migration over time. The westernmost island, Cat Island, is believed to have originated as part of the Alabama-Mississippi chain (Saucier, 1963; Frazier, 1967; Otvos, 1978; Kindinger et al., in press). However, wave climate altered by the growth of the St. Bernard Delta into the northern Gulf of Mexico significantly sheltered the island from south and southeast waves that supplied sediment to the island around 4,000 years ago (Frazier, 1967; Penland et al., 1985; Otvos and Giardino, 2004; Twichell et al., 2011; and Kindinger et al., in press). Due to the change in oceanic conditions, Cat Island is not part of the modern littoral drift system that supplies sand along the Alabama-Mississippi barrier island chain (Byrnes et al., 2012; Walstra et al., 2012). Thus, Cat Island has experienced more limited migration.

Ship Island exists as two island segments—East Ship Island and West Ship Island—separated by Camille Cut (Figure 1-1). In 1969, Hurricane Camille breached a portion of Ship Island that historically had been vulnerable to breaching. Hurricane Katrina substantially changed the area of Camille Cut, and caused significant erosion of East Ship Island. Although these breaches have partially healed naturally over time in the past, studies by Morton (2008) and Byrnes et al. (2013) indicate that the current breach would not heal as in the past. The breach remains today as a 3.5-mile-wide shallow submerged sandbar between the two small islands.

Two maintained navigation channels extend through passes in the Mississippi barrier islands. The Pascagoula Federal Navigation project extends through Horn Island Pass near the west end of Petit Bois Island. The Gulfport Federal Navigation project Bar Channel segment extends through Ship Island Pass near the west end of West Ship Island.

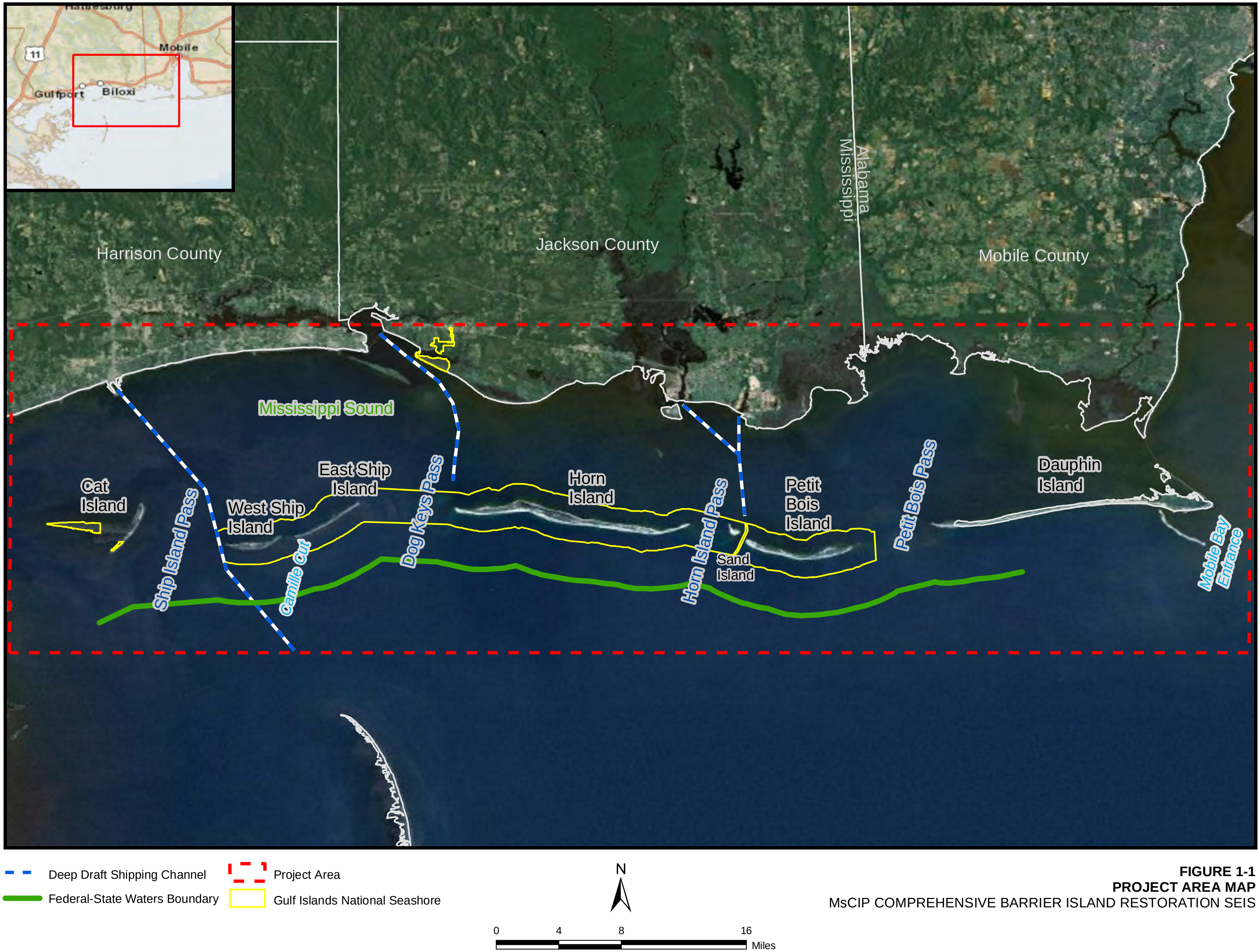

FIGURE 1-1
PROJECT AREA MAP
MsCIP COMPREHENSIVE BARRIER ISLAND RESTORATION SEIS

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All of Petit Bois, Horn, East Ship, and West Ship Islands, and parts of Cat Island, are within the boundaries of the GUIS Mississippi unit under the jurisdiction of the NPS (Figure 1-1). The U.S. Congress has designated Petit Bois and Horn Islands as the Gulf Islands Wilderness under the Wilderness Act. The designation affords additional significance and protection to the islands. The project area south of the islands includes portions of the OCS, which are under the BOEM jurisdiction for leasing and regulating the recovery of minerals. BOEM jurisdiction extends to the subsoil and seabed of all submerged lands seaward of State-owned waters to the limits of the OCS.

1.3 Gulf Islands National Seashore

GUIS is a unit of NPS that includes natural, cultural, and recreational resources along the northern Gulf of Mexico coasts of Mississippi and Florida. These resources include several coastal defense forts spanning more than 2 centuries of military activity, with archaeological features, coastal barrier islands, salt marshes, bayous and submerged seagrass beds, complex terrestrial communities, emerald green water, and white sand beaches. The barrier islands within GUIS are nationally significant for several reasons. Specifically, the islands:

- Contain an extensive collection of publicly accessible seacoast defense structures in the U.S., representing a continuum of development from early French and Spanish exploration and colonization through World War II;
- Provide for public recreational opportunities on natural and scenic island, beach, and water areas that possess the rare combination of remaining undeveloped land in a wilderness state, yet being close to major population centers;
- Provide habitat for several endangered species in diverse ecosystems, stopover habitat for migratory birds, and critical nursery habitat for marine flora and fauna; serve as an enclave for the complex terrestrial and aquatic plant and animal communities that characterize the northern Gulf Coast; and illustrate the natural processes that shape these unique areas;
- Contain land and marine archaeological resources that represent a continuum of human occupation in a coastal environment and are important in enhancing the knowledge of the past, including knowledge of the original inhabitants of this area of the Gulf Coast and, later, their interactions with the earliest settlers; and
- Provide a benchmark to compare conditions in developed areas of the Gulf Coast to natural areas within the park.

The Mississippi barrier islands within GUIS are Petit Bois, Horn, East Ship Island, West Ship Island, and parts of Cat Island (Figure 1-1). In most cases, their boundaries extend 1 mile from the shore. The exception is Cat Island, where the boundary between GUIS and state waters is the mean high tide line. Also within the boundary is the manmade (subaerial, or above the water surface) part of Disposal Area 10 (DA-10) of the Pascagoula Harbor project, locally known as Sand Island. This island is located west of the Pascagoula Ship Channel and north and east of the eastern end of Horn Island. In addition, NPS administers the 401-acre Davis Bayou area on the mainland near Ocean Springs, Mississippi.

The GUIS has the following purposes:

- Preserving, protecting, and interpreting the Gulf Coast barrier island and bayou ecosystems and the system of historic coastal defense fortifications; and
- Providing for public use and enjoyment of these resources to the extent possible.

1.4 Additional Engineering and Design Studies

Preconstruction engineering and design studies relative to comprehensive barrier island restoration began in July 2009. The purpose of the studies was to support the final engineering and design for implementation of the project. Detailed studies provided data on the site-specific aspects of proposed sand borrow locations and placement areas, and procedures for construction of barrier island restoration elements. The following additional studies were conducted on hydrodynamics, sediment transport, cultural resources, and biological conditions within the project area to evaluate impacts of specific alternatives:

- Geophysical surveys to locate and quantify potential sand borrow locations that could be useful in replenishing the sediment budget for the barrier islands (Appendix A);
- Sediment transport assessment to update the sediment budget for the barrier islands (Appendix B);
- Site-specific modeling of sand transport, wave propagation, and geomorphic change resulting from proposed sand placement and potential impacts of proposed nearshore borrow areas (Appendix C);
- Hydrodynamic and water quality numeric modeling to refine the restoration alternatives based on analysis of waves, currents, circulation, water quality, and sediment transport (Appendix D);
- Analysis of littoral and shoreline impacts associated with borrow activities at the Cat Island borrow area (Appendix E);
- Analysis of circulation and sediment transport potential associated with borrow activities at DA-10 (Appendix F);
- Pipeline impact assessment, to simulate the potential impacts of borrow site excavation on sediment transport along the Gulfstream Pipeline (Appendix G);
- Biological survey to characterize seagrass communities occurring in or adjacent to potential borrow areas and littoral zone placement areas (Appendix H);
- Biological surveys to characterize benthic macroinvertebrate communities occurring in potential borrow areas and littoral zone placement areas (Appendix I);
- Weekly bird surveys in five locations (eastern and western East Ship Island, eastern and western West Ship Island, and Sand Island within DA-10) to characterize bird communities (Appendix J);
- Summary of Gulf sturgeon (*Acipenser oxyrinchus desotoi*) telemetry monitoring at Ship Island (Appendix K);

- Engineering analysis of Camille Cut closure options (Appendix L);
- NPS Wetland Statement of Findings—analysis of potential wetland impacts within the GUIS based on NPS Director's Order 77-1 (Appendix M);
- Biological assessment—analysis of potential impacts on threatened and endangered species (Appendix N);
- Maps of essential fish habitat by species within the project area (Appendix O);
- Analysis of alternatives related to wetland impacts under Section 404(b)(1) of the Clean Water Act (CWA) (Appendix P);
- Fish and Wildlife Coordination Act report evaluating impacts to wildlife resources from water resource programs (Appendix Q);
- Public involvement and agency correspondence (Appendix R);
- Monitoring and Adaptive Management (MAM) Plan (Appendix S). The MAM Plan, was developed to determine progress toward restoration success and to increase the likelihood of achieving desired project outcomes in the face of uncertainty. The MAM Plan is a living document and will be regularly updated to reflect monitoring-acquired and other new information as well as resolution of and progress on resolving key uncertainties and/or discovering lessons learned to help with management of coastal resources; and
- Maritime cultural resource surveys to identify potential cultural resources were conducted of all borrow and placement areas. Terrestrial cultural resource surveys were conducted to identify potential cultural resources in all placement areas or areas where ground disturbance may occur related to placement (staging and access) (Appendix T).

2. Purpose and Need

In 2005, Hurricanes Cindy, Katrina, and Rita caused an unprecedented level of destruction within the Gulf Region of the U.S., most notably in Texas, Louisiana, and Mississippi. During Hurricane Katrina, coastal Mississippi was the point of impact of the greatest tidal surge that has hit the mainland U.S. in its recorded history (USACE, 2009a). Katrina affected more than 90,000 square miles of the Gulf Coast region, caused almost complete destruction of several large coastal communities, and seriously damaged numerous others. The tremendous storms devastated the physical, natural, and human environments of the region.

In response, the U.S. Congress directed the USACE in 2005 to initiate two important and related comprehensive planning efforts to address the devastation caused by the coastal storms of 2005: the MsCIP and the Louisiana Coastal Protection and Restoration. Together, these two planning efforts were intended to develop systemwide solutions to assist the multi-state region of the U.S. Gulf Coast in recovering from the devastation caused by storms and providing greater resilience against future storms.

The MsCIP was authorized by the Department of Defense Appropriations Act, 2006 (P.L. 109-148), enacted December 30, 2005. The law directed the Secretary of the Army to conduct an analysis and design for comprehensive improvements or modifications to existing improvements in the coastal area of Mississippi in the interest of hurricane and storm damage risk reduction, prevention of saltwater intrusion, preservation of fish and wildlife, prevention of erosion, and other related water resource purposes.

The comprehensive vision for the MsCIP is a coastal Mississippi that is more resilient and less susceptible to risk from hurricane and storm surge. The MsCIP PEIS evaluated an array of near- and long-term strategies intended to render the region more resilient and less susceptible to damage resulting from a variety of future coastal storms, including those equaling or exceeding the 2005 hurricanes (USACE, 2009a). The pursuit of resilience for coastal Mississippi led to the development of the Lines of Defense approach as described in Section 1.1 of the MsCIP PEIS, beginning with the offshore barrier islands and moving inland to the extent of the maximum probable surge. Within this zone both natural and manmade features are linked in a comprehensive storm damage risk reduction plan. The MsCIP PEIS further identified systemwide opportunities to promote the long-term sustainability of physical, human, and natural resources. These include restoring barrier island and mainland environments, protecting coastal environments, and reducing saltwater intrusion within the Mississippi Sound coastal environment (USACE, 2009a).

The ROD for the MsCIP PEIS included a recommendation for implementing comprehensive barrier island restoration to provide a first line of defense for reducing the vulnerability and increasing the resilience of the coastal Mississippi region against future hurricanes, storms, and storm surges; to improve barrier island habitat; and to protect the estuarine nature of water in the Mississippi Sound. P.L. 111-32, enacted June 24, 2009, authorized and funded barrier island and ecosystem restoration elements, to restore historical levels of storm damage risk reduction to the Mississippi Gulf Coast.

2.1 Purpose of Proposed Action

Per the MsCIP PEIS, the purpose of the Proposed Action is to evaluate options to implement comprehensive restoration of the Mississippi barrier island system through the placement of sand to restore barrier islands and to supply sand for littoral transport. This SEIS has been prepared to evaluate the specific alternatives for sand borrow areas, placement options, engineering and design alternatives, and construction methods.

This SEIS will be used to support the NEPA compliance requirements for the federal agencies with jurisdiction over parts of the TSP project area, including USACE, the NPS, and the BOEM. As a federal agency with jurisdiction to manage the resources available on OCS, BOEM was invited by USACE to participate as a cooperating agency in the preparation of the SEIS. BOEM's connected, though separate, proposed action is to issue a negotiated agreement pursuant to its authority under the Outer Continental Shelf Lands Act for use of sand, gravel, and shell resources for Coastal Storm Damage Reduction (CSDR) projects from the OCS.

2.2 Need for Proposed Action

As described in the MsCIP PEIS and ROD, implementation of the recommended comprehensive restoration of the barrier islands is required to achieve the goals outlined in the MsCIP PEIS. The restoration of the Mississippi barrier island system is needed to:

- Protect and maintain the estuarine ecosystem of the Mississippi Sound and to reduce storm damage incurred along the mainland coast of Mississippi;
- Preserve and protect the Mississippi barrier islands and their natural and cultural resources;
- Reduce erosion and land loss of the barrier islands, especially East and West Ship Islands, and Cat Island to the west; and
- Enhance the long-term sand supply to the littoral drift system, which historically has maintained the Mississippi barrier islands through natural processes.

The Proposed Action evaluates various alternative means of achieving these goals.

3. Description of the Tentatively Selected Plan and Alternatives

This chapter describes the range of alternatives considered for site-specific implementation of Comprehensive Barrier Island Restoration, including an evaluation of reasonable alternatives to meet the project objective, per Council on Environmental Quality (CEQ) regulations implementing NEPA (40 C.F.R. Parts 1500 - 1508). Alternatives considered in this SEIS are tiered from the MsCIP PEIS; thus alternatives that were evaluated and rejected under the MsCIP PEIS are not carried forward for analysis in this document. The action alternatives considered include potential sand borrow locations and site-specific options for implementing restoration at sand placement locations authorized for construction. For each alternative carried forward for further consideration, a discussion of the affected environment (Section 4) and potential environmental effects (Section 5) provides a clear basis for decision-makers and the public to make an informed decision for the identification of the TSP.

Since much of the proposed project is located within the boundaries of the GUIS Mississippi unit, the alternatives are also evaluated for compliance with NPS policies. Restoration of barrier islands that have been impacted by human activities, such as dredging, is consistent with such policies. In addition, several borrow sites are outside or partially outside waters of the State of Mississippi, including Petit Bois-AL (PBP-AL East and PBP-AL West) and Petit Bois Pass-OCS (PBP-OCS East 1-5, PBP-OCS West 1 and PBP-OCS West 3-6). PBP-AL East and PBP-AL West are located within Alabama state waters, PBP-OCS West 1 and 3 are located within Mississippi state waters, and the OCS and PBP-OCS West 4, 5, and 6 as well as PBP-OCS East 1 through 5 are located completely within OCS waters. Evaluation of these borrow alternatives for compliance with requirements that may be imposed by the State of Alabama or the BOEM in consideration of:

- The State of Alabama owns the title to lands underlying coastal waters to a line 3 geographical miles distant from its coastline (see 43 U.S.C. § 1301, et seq.). The United States has paramount rights in these waters for purposes of commerce, navigation, national defense, and international affairs, none of which apply to the removal of sand for the purposes of beach or island restoration. The State's position is removal of sand within the state boundaries will be done in accordance with State Law (AL Code 9-15-52) and either a direct sale or royalty payment may be charged for removal.
- Discussions with the current State of Alabama officials indicate what the State's position is toward the acquisition of sand that may be necessary to complete implementation of the restoration. Per these discussions the State has indicated that sand will be offered at a royalty rate of $7.00 per cubic yard measured at the borrow site with a minimum quantity of 3 million cubic yards from the sites designated as PB-AL East 3 or PB-AL West 2 and 3 as discussed in the SEIS. Payment would be requested 60 days in advance of the advertisement of a contract for the removal of sand from these sites. The United States right to remove sand from the designated sites would begin upon payment for the

3 million cubic yards and the United States would have 30 months to complete removal of this sand from the Alabama sites. Should the United States need any additional quantity of sand above the 3 million cubic yards discussions would be renewed with the then current State officials.

- BOEM is the agency of the Department of the Interior tasked with managing the extraction of offshore minerals from the OCS. While the largest component of this management is related to exploration for and development of oil and gas resources, the BOEM is also responsible for what are loosely referred to as "non-energy minerals" (primarily sand and gravel) obtained from the ocean floor. Dredging of sediment resources within the OCS requires authorization by the BOEM for use during construction and maintenance. P.L. 102-426 [43 United States Code (U.S.C.) 1337(k)(2)], enacted October 31, 1994, gave BOEM the authority to negotiate, on a noncompetitive basis, the rights to OCS sand, gravel, and shell resources for CSDR projects; beach or wetlands restoration projects; or for use in construction projects funded in whole or part by or authorized by the federal government. BOEM jurisdiction for leasing and regulating the recovery of minerals extends to the subsoil and seabed of all submerged lands seaward of State-owned waters to the limits of the OCS. Any sand removed from the OCS requires review and an agreement from the BOEM.
- Recognizing the potential for borrow area resources to be identified within the OCS, BOEM has agreed to serve as a cooperating federal agency on this study and may undertake a connected action (i.e., authorize use of the OCS borrow area) that is related to, but unique from the USACE proposed action. BOEM's proposed action is to issue a negotiated agreement pursuant to its authority under the Outer Continental Shelf Lands Act.
- BOEM also agreed to participate in the required ESA Section 7 consultation, the Magnuson-Stevens Fishery and Conservation Management Act EHF consultation (Section 305), the NHPA Section 106 process, and the Coastal Zone Management Act Section 307 consistency determination. As the lead federal agency for ESA Section 7 and the EFH consultations, USACE notified USFWS and NMFS of its lead role and BOEM's cooperating status. Through this partnership USACE jointly submitted, with BOEM, the ESA Section 7 and EFH assessments to USFWS and NMFS. USACE also acted as the lead federal agency for Section 106 compliance in accordance with 36 C.F.R. Part 800.2(2) while BOEM acted as a cooperating agency for Section 106 compliance, offering input and consultation as needed.
- Section 3.1 describes the TSP from the MsCIP PEIS. The TSP represents USACE's initial plan for restoration. It serves as the basis for development of the final design for implementing the authorized construction project as determined through additional detailed studies conducted under the Mississippi Barrier Island Restoration component of the MsCIP Comprehensive Plan.

Section 3.2 describes the detailed engineering and design evaluations, and alternatives analysis, conducted for three key components of restoration: sand borrow sites; sand placement sites and design; and construction methodology. Potential borrow sites were screened as part of extensive geophysical and hydrodynamic studies according to their technical feasibility, potential impacts, and efficacy for providing sand of sufficient quality and quantities required to meet the purpose of and need for the proposed project. Potential sand placement locations and designs were evaluated as part of site-specific geomorphologic, sediment transport, and hydrodynamic studies. Engineering designs were evaluated based on project stability and lifespan considerations, as well as characteristics of available sand sources. Construction method options were evaluated based on their ability to provide sufficient quantities of compatible sand of the proper mix to achieve the longest stable restoration without future maintenance. As part of the evaluation process, each construction method was screened for environmental concerns to avoid or minimize potential adverse impacts.

Section 3.3 summarizes the alternatives that were considered but were not carried forward for further analysis based on the findings of the detailed studies in Section 3.2.

Section 3.4 describes the alternatives retained for further analysis in this SEIS. Two primary alternatives are carried forward: No Action and the TSP with Borrow Site Option 4. Three additional borrow site options in support of the proposed restoration are also analyzed (Borrow Site Options 1, 2, and 3). These alternatives are evaluated in the remainder of the document.

3.1 Proposed Action, Programmatic Environmental Impact Statement of June 2009

As noted, the USACE's initial plan for restoration under the PEIS serves as the basis for development of alternative actions in this SEIS. The proposed Comprehensive Barrier Island Restoration as described in the MsCIP PEIS includes the restoration of the Mississippi barrier islands through the placement of up to 22 million cubic yards (mcy) of sand within the GUIS Mississippi unit and an undetermined quantity of sand near Cat Island. In the MsCIP PEIS, the overall recommendation to return sand to the system (Figure 3-1) included:

- Filling Camille Cut, the 3.5-mile breach in Ship Island;
- Adding sand to the littoral system on east end of Petit Bois Island;
- Adding sand to the littoral system on the east end of East Ship Island; and
- Adding sand to the littoral system on the east end of Cat Island.

The overarching goal of the barrier island restoration component of the MsCIP is to enhance sediment transport among the islands to mimic a natural state as much as possible given the realities of navigation channel dredging, climate change (sea level change), and other anthropogenic activities. Initial planning with the NPS indicated that support of the project could be obtained if restoration were limited to an initial sand placement, to compensate for anthropogenic activities, with no additional maintenance thereafter, thus allowing natural coastal processes to shape the islands in the future. This complies with the NPS Management Policies (2006) and Director's Order 12 (2011), which allows restoration of lands disturbed by human activities and protection of significant cultural resources in NPS units.

The following sections detail the development of alternatives for barrier island restoration. These alternatives are tiered from the MsCIP PEIS and are intended to serve the original project goals while meeting the NPS Management Policies (2006) and Director's Order 12 mentioned above.

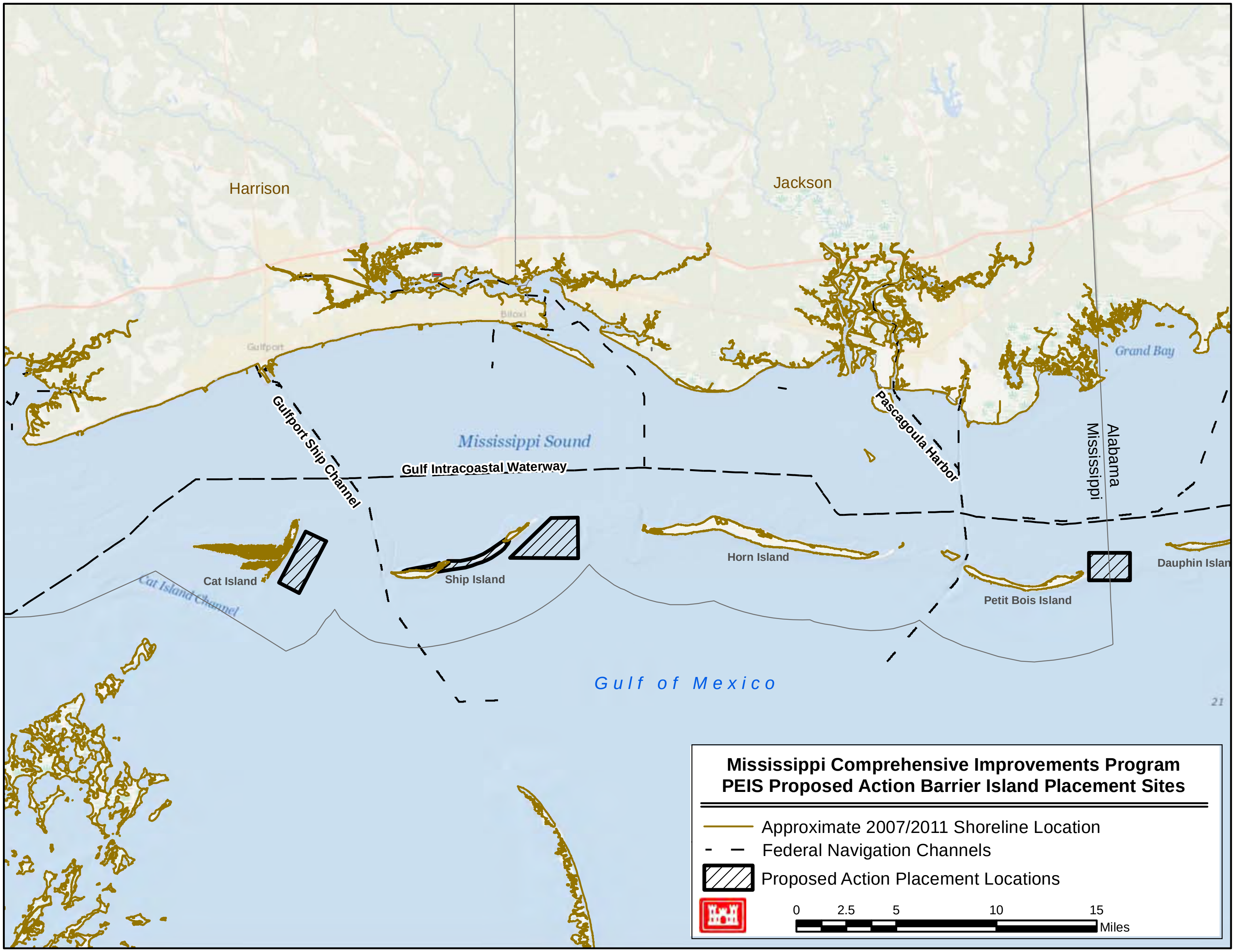

FIGURE 3-1
PEIS PROPOSED SAND PLACEMENT AREAS
MsCIP COMPREHENSIVE BARRIER ISLAND RESTORATION SEIS

3.2 Detailed Engineering and Design Evaluations and Alternatives Analysis

All of the alternatives considered in this SEIS are based on the information presented in the Comprehensive Barrier Island Restoration Plan of the MsCIP PEIS, which included the placement of up to 22 mcy of sand within the GUIS Mississippi unit and an undetermined quantity of sand to be placed near Cat Island. These volumes of material were based on an analysis of historical dredging records between 1897 and 2007.

Based on an updated evaluation of historical dredging records from the period of initial authorization and construction of the Pascagoula Harbor navigation channel in 1897 to the present day (specified as 2010), it was determined that approximately 25 mcy of new work and maintenance material has been dredged from the channel within the active littoral zone (Appendix B). This amount is 3 mcy more than the 22 mcy specified in the authorizing MsCIP documents, which analyzed dredging records between 1897 and 2007.

Horn Island Pass dredging and survey data for the period 1917 to 2009 were compared to determine the amount of dredged material potentially placed outside the littoral zone through anthropogenic actions. It was determined that 13.1 mcy were placed outside the active littoral cell of the barrier island chain near Horn Island Pass between 1917 to 1920 and 2005 to 2010 (Appendix B).

The original MsCIP PEIS evaluated a general restoration plan that included the placement of material between East and West Ship Islands to fill Camille Cut, with preliminary estimates of the volume of fill material required. For this analysis, a more detailed design was completed to identify the most effective plan for restoring the barrier island system. The options evaluated included various design configurations using varying quantities and multiple sources of sand with different median grain sizes based on historical topographic surveys, bathymetric surveys, dredging records, and a suite of morphological modeling efforts.

Development of options is organized into three key elements required for implementation of the Comprehensive Barrier Island Restoration: potential borrow sites (Section 3.2.1), sand placement evaluations (3.2.2), and construction methodology (Section 3.2.3.). A series of design and modeling steps were completed, including field data collection, a preliminary desktop analysis to generally define volume and grain size of material needed, an analysis of the effects of multiple storm events on the design and sediment pathways in the system, and an evaluation of alternatives with a coarser fill material and lower berm elevations. Lastly, additional modeling was conducted to estimate future morphological response of the island with and without restoration. The following sections contain a summary of the detailed engineering and design evaluations.

The MsCIP PEIS compared several barrier island restoration alternatives based on contributions of each alternative to elements comprising the System of Accounts (National Economic Development, Regional Economic Development, Other Social Effects, and Environmental Quality), risk and uncertainty, and stakeholder preference (Engineer Regulation 1105-2-100). At the programmatic level, the initial analysis of alternatives assumed that borrow areas would be available within the immediate area and that the studies conducted for this SEIS would be used to further evaluate potential sources.

3.2.1 Potential Borrow Sites

To identify specific potential borrow sites for barrier island restoration, alternative locations were evaluated in this SEIS based on the following criteria:

- Sufficient sand quantity and compatibility with placement areas in terms of grain size, shape, color, and other physical characteristics;
- Location outside of the active littoral transport system;
- No significant adverse wave focusing or negative impact to the transport system following removal;
- Cost-effective to obtain and transport sand to the placement site; and
- Compatible with NPS management policies and objectives.

Sand texture (grain size, percent fines, angularity) and color characteristics were carefully considered during project design based on the stability expected in the restored areas, project longevity without future maintenance, and aesthetic qualities of the restoration. Ideally, sand used for island restoration would have essentially the same physical characteristics as the sand on the islands, so it would have nearly the same gradation, particle shape, and color. Thus, the sand added would become part of the natural transport system and enhance the barrier island habitat.

Borrow site analysis focused on maintaining the natural littoral drift by identifying sites outside of the littoral transport system. Removal of sand from the littoral zone could accelerate erosion on the islands within the system, which would be contrary to the goal of the barrier island restoration. Impacts to wave propagation also were considered when identifying borrow sites.

The cost-effectiveness of borrow sites was evaluated based on the estimated site-specific costs of dredging and transporting material. Borrow sites were evaluated based on the likelihood of impacts on biological resources, including essential fish habitat (EFH) and critical habitat for threatened or endangered species.

Identification of potential borrow sites involved two primary investigations: beach sand compatibility investigations as described in Section 3.2.1.1, and sand borrow site investigations as described in Section 3.2.1.2. Beach sand samples were collected to quantify and qualify native sand material on the barrier islands. The results of these samples were compared to data from sediment surveys of potential sand borrow areas to identify suitable sources of sand for restoration.

3.2.1.1 Beach Sand Compatibility Investigations

The initial step in identifying sand borrow areas was to characterize the beach sand on the barrier islands for comparison with sand from the prospective borrow sites. To determine compatibility requirements for any sand placed within GUIS boundaries, samples of beach sand were taken at several locations in 2006, 2009, and 2010 (Appendix A). The samples were analyzed for color, angularity, grain size (based on diameter), and gradation

(Table 3-1). In addition, transects were sampled across two of the islands and composite samples were taken to depths of several feet in 2010 (Table 3-2 and Appendix A). The samples were collected to determine the variability of grain sizes across the islands and variability with depth.

Most of the sand on the Mississippi barrier island beaches is light gray, and subangular to rounded in shape, with a median particle diameter (D50) ranging from 0.30 to 0.51 millimeter (mm) (Table 3-1). Sand distributed across the islands tends to exhibit greater variation in D50 grain size with depth, ranging from 0.21 to 0.48 mm as indicated by sampling below the surface at West Ship Island (Table 3-2). Composite samples to depths of -4 or -5 feet at West Ship Island have D50 grain size ranging from 0.27 to 0.37 mm.

TABLE 3-1
Summary of Beach Sediment Surface Sampling for Compatibility Comparisons

Locations[a]	Years[b]	Description	Typical Color[c]	D50 Grain Size (mm)[d] Range
Cat Island				
East shore of north spit; east shore of south spit	2009	Fine-grained sands; Subangular to rounded	Light gray	0.31–0.33
West Ship Island				
North beach at pier; central portion of island; south beach; boat dock on north shore; end of boardwalk, south shore; east end on north shore; east end on south shore	2006, 2009	Medium poorly graded sand; subangular to rounded; some dark particles on central part of island and south beach	Light gray; gray; dark gray; light brownish gray	0.30–0.47
Island Transect	2010	Poorly graded sand		0.21–0.45
East Ship Island				
North beach; south beach; west tip; east end on north shore; east end on south shore	2006, 2009	Medium poorly graded sand; subangular to rounded; some organic peat on south beach	Light gray; black (peat)	0.32–0.32
Horn Island				
North beach; south beach; boat dock on north shore; end of path from boat dock on south shore; eastern end on north shore; eastern end on south shore; sand spit east of eastern end of island	2006, 2009	Medium poorly graded sand; subangular to rounded	Light gray; gray; olive gray; white	0.33–0.51
Island Transect	2010	Poorly graded sand		0.28–0.48
DA-10/Sand Island				
South shore	2009	Subangular to rounded	Light gray	0.33
Eastern side, center, western side	2011	Medium to fine sand; subangular to rounded	NA	0.30–0.39

TABLE 3-1
Summary of Beach Sediment Surface Sampling for Compatibility Comparisons

Locations[a]	Years[b]	Description	Typical Color[c]	D50 Grain Size (mm)[d] Range
Petit Bois Island				
North beach; south beach; north shore in center of island; south shore in center of island; east end on north shore; east end on south shore	2006, 2009	Medium poorly graded sand; subangular to rounded	Light gray	0.34–0.39

Source: Appendix A

[a] See sample location maps in Appendix A of the Geophysical Report, which is Appendix A of this SEIS.

[b] 2006 samples collected by USACE analyzed for color and angularity; 2009 samples collected by USACE and NPS analyzed for color and angularity, and tested for grain size at a contract engineering laboratory; 2010 samples tested for grain size.

[c] Munsell color of wet or dry sediment; if more than one color, presented in decreasing frequency of observation.

[d] Range and average provided if more than one sample; sample value provided if single sample.

TABLE 3-2
Summary of Beach Sediment Profile Sampling at West Ship Island

Depths from 0.0–5.0 feet	Depth of Sample (ft)	D50 Grain Size (mm)
West Ship Island (WSI-5-10) [a]	0.0–1.5	0.37
	1.5–3.0	0.34
	3.0–4.5	0.32
West Ship Island (WSI-12-10)	1.0–2.0	0.33
	2.0–3.0	0.27
	3.0–4.0	0.28
West Ship Island (WSI-13-10)	1.0–2.0	0.34
	2.0–3.0	0.27
	3.0–4.0	0.27
	4.0–5.0	0.32

Source: Appendix A

[a] See Figure 3.2.3.3 in Appendix A of Appendix A to this SEIS

For compatibility with the native material on the island and fill stability, well sorted to poorly sorted subangular sands, light gray to gray in color, with median grain size greater than 0.28 mm and percent fines less than 10 percent were considered to be optimum for barrier island restoration efforts. Placed sands with up to 10 percent fine sediment content were considered acceptable, while 15 percent fines content was considered the maximum allowable content for dredging. The dredging process typically winnows out fine sediments when the sand is being mined, transported, and placed because these sediments tend to remain suspended in the slurry water. Therefore, sands containing up to 15 percent silts or clays are expected to have a percentage closer to 10 percent following placement as compared to their in situ condition. Natural coastal processes further winnow out fine sediments over time following placement. Other material was considered provided that the overfill ratio, which is a function of grain size compatibility of the composite fill, was within acceptable limits.

3.2.1.2 Borrow Sites Investigation and Analysis

Identifying and delineating borrow areas is a multi-step, iterative process. It begins with researching available literature from federal and state entities, published academic and private sector research papers, and consultation with subject matter experts. The results from this research direct the field work for the next phase. Borrow area delineation is based in part on the results of geophysical surveys, vibracore sampling, bathymetric surveys, and cultural resource surveys. Modeling of a potential borrow area's effects on wave action is also a consideration, but mostly for areas in shallower water or near natural or man-made structures that may be adversely affected by the removal of the sediment. Other external factors, as discussed previously in Section 3.2.1, contribute to the complexity of the task. Quality control of dredged material is difficult and a 2-foot buffer between the bottom of cut elevations and the top of any significant clay or silt stratum was implemented during planning. In general, the process to delineate a borrow area, following the research phase, consists of the following steps, which are usually iterative and not necessarily chronological:

- Geophysical surveys are conducted to provide a large-scale view of the geology in a particular study area and can identify potential sand bodies. They provide a subsurface view of a potential borrow area and can indicate the areal extent, thickness, and orientation of a sand deposit. The surveys assist with identifying the horizontal and vertical boundaries of a delineated borrow site. They are somewhat limited in that they do not always "see" clay or silt layers and sediment sampling is necessary to physically validate the models.

- Vibracore samples are used to validate and improve the geophysical survey's stratigraphic model and provide grain size, color, angularity, and fine sediment content data for the sediments in the various strata. They provide the ground-truth of what sediments are actually there and determine whether a sand body meets the established textural requirements for borrow material. The surveys assist with data gaps when the geophysical survey cannot see certain stratigraphy due to the material type, e.g., clays.

- Bathymetric surveys provide the actual seafloor surface elevations for use in shaping the borrow area and determining dredge cut elevations and borrow quantities. These surveys are especially important for areas of varied relief, such as the area south of Petit Bois Island, where suitable sand deposits are contained mostly within the boundaries of shoals and the borrow area must be confined to the shape and orientation of the shoal. The bathymetry is also useful in understanding the effects the borrow area's side slopes will have on the areas adjacent to them.

- Cultural resource surveys identify potential objects of historical significance that must be avoided within the proposed borrow area. This can result in the borrow area either being reconfigured with a buffer around the object, or complete elimination of the site if the buffer proves too large for the area to be economically feasible to mine.

- Areal boundaries are drawn to best fit the extent of the suitable sand deposit, given the constraints identified by the geophysical survey, the vibracores, and the bathymetric and cultural resource surveys. Subareas, or cells, are designed, as necessary, to optimize the dredgeable quantity within these boundaries by altering cut elevations to fit the deposit's thicknesses. After the boundaries are established, volumes of the sand can be calculated for each area and subarea using end-area calculations. The textural characteristics of the sediment can then be calculated for each borrow area to ensure they meet the fill requirements established at the beginning of the investigation.

Under an interagency agreement, the USGS conducted an extensive geophysical investigation program to locate and quantify potential sand borrow locations (Twichell et al., 2011). The first and second series of surveys occurred in 2010 and 2013, respectively. Review of geophysical survey documents and records led to identification of areas deemed geologically conducive to the presence of large sand deposits. The USGS, in collaboration with USACE, surveyed much of the inner shelf offshore of the Mississippi barrier islands to define the shallow stratigraphy of the region and assess the distribution and extent of sediment deposits that could be dredged for the large volume of material needed for restoration. Geophysical and bathymetric surveys collected by the USGS and vibracores collected by USACE in 2010 and 2011 were integrated to help identify potential sand sources. The core samples, collected using a vibracore sampler with a 20-foot core barrel, allowed geologists to verify the stratigraphy identified by the geophysical surveys, identify sand deposits, and make initial observations of sediment textural and color characteristics.

Vibracore locations were selected in nine areas identified near the barrier islands, from Cat Island eastward to Petit Bois Pass (Figure 3-2):

- Gulfport Channel;
- Mississippi Sound;
- Cat Island;
- Ship Island Pass;
- Ship Island;
- Dog Keys Pass;
- Horn Island Pass;
- DA-10/Sand Island; and
- Petit Bois Pass.

In addition to the nine potential borrow locations investigated as part of the 2010 and 2011 geotechnical sampling events, sand from upland disposal sites in the Lower Tombigbee River was evaluated. The upland borrow source was included in the evaluation because initial studies during the PEIS found significant quantities of sand available from several disposal areas along the river. Furthermore, these sites are close to their disposal capacity, so the beneficial reuse options were considered. Initial concerns about use of the material focused on the potential color of the material and grain size compatibility with the placement areas. The St. Bernard Shoals were another area initially considered as a possible source of sand. They consist of two major shoal fields located approximately 25 kilometer (km) southeast of the Chandeleur Islands. While the shoals contain significant quantities of sand, several studies indicated that the grain size would be smaller and the color darker than needed for this project. The distance from the project site (approximately 40 miles south-southeast of Ship Island) was also considered too far. Therefore, this area was not sampled by USACE during the geotechnical investigation (*Note:* These sites are not shown in Figure 3-2 because of distance from restoration sites).

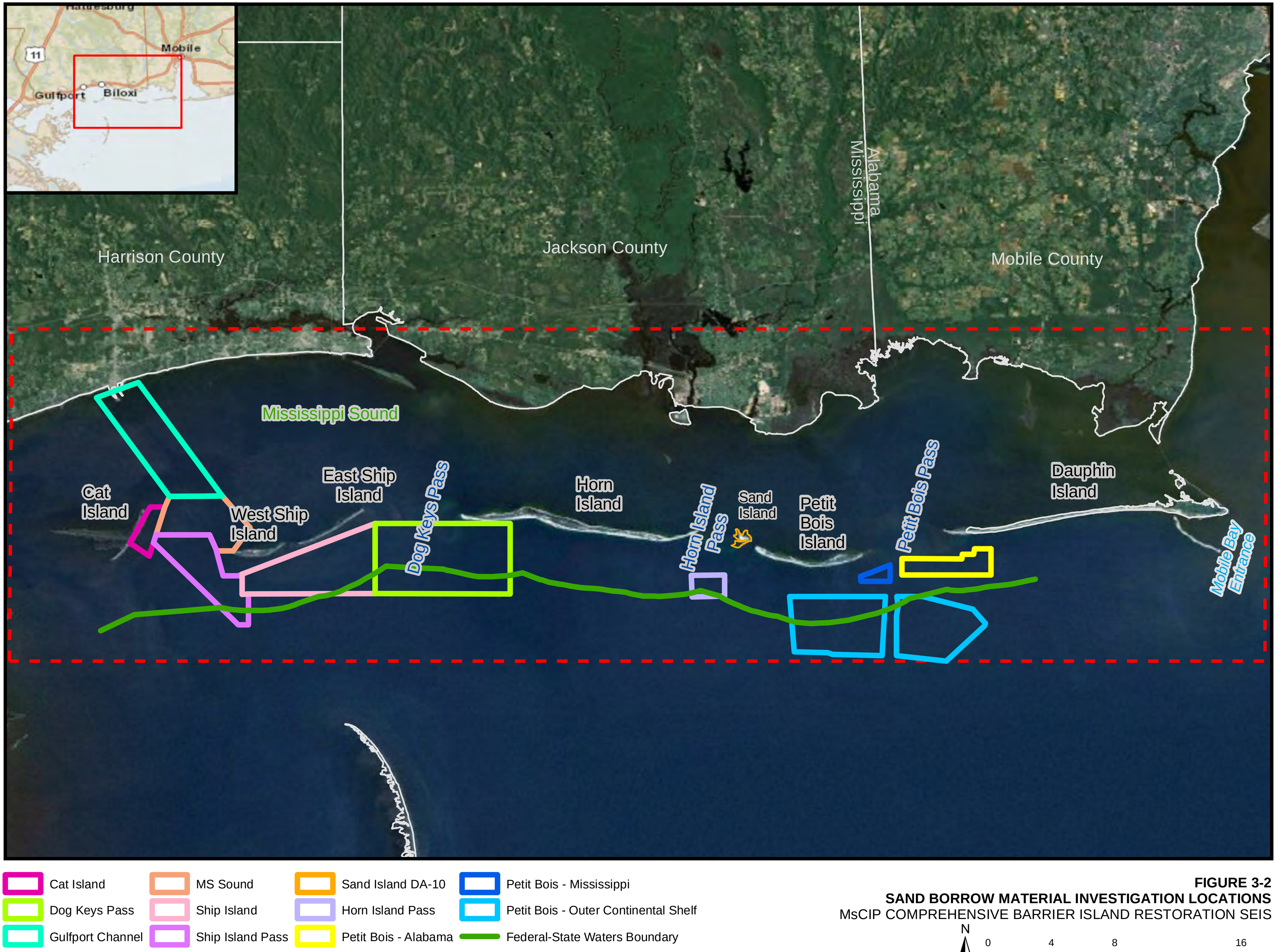

FIGURE 3-2
SAND BORROW MATERIAL INVESTIGATION LOCATIONS
MsCIP COMPREHENSIVE BARRIER ISLAND RESTORATION SEIS

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In 2012 and early 2013, USACE conducted more investigations to further evaluate potential sand quality in the Petit Bois Pass (including Petit Bois Alabama [PBP-AL], Petit Bois Mississippi [PBP-MS], and Petit Bois Outer Continental Shelf [PBP-OCS]) and the Horn Island sites. Field sampling events were completed using vibracores, and samples were again analyzed for grain size, percent fines, and color. Results of these investigations (see Appendix A and Table 3-3) provide the basis for evaluating the compatibility of sand in potential borrow area locations (in terms of color, shape, percent fines, and size characteristics) with sands on barrier island beaches (Tables 3-1 and 3-2).

In August 2013, the USGS conducted a geophysical survey of the Mississippi inner shelf area south of Petit Bois Island. This survey helped to fill data gaps from the first survey regarding the near-surface stratigraphy. This survey collected the same data types as the original 2010 survey and identified several large shoals and subsurface features containing sandy deposits. The USGS provided USACE with isopach maps and proposed vibracore locations to gain further information about the features.

From November 2013 through February 2014, USACE conducted vibracore sampling of the area surveyed by the USGS. Additional samples were also collected in the Horn Island Pass area to augment information gathered in the 2010 and 2012 sampling events. Field sampling was completed using vibracores, and samples were again analyzed for grain size, percent fines, and color. Results of these investigations (see Appendix A and Table 3-3) provide the basis for evaluating the compatibility of sand in potential borrow area locations (in terms of color, shape, percent fines, and size characteristics) with sands on barrier island beaches (Tables 3-1 and 3-2).The sampling did not identify any additional Horn Island Pass borrow material. However, it did identify several large deposits in the Petit Bois-OCS sampling area potentially capable of being used as borrow areas. Several sites contain sand acceptable for barrier island restoration, whereas others lack suitable material of desired grain size, fine sediment content, shape, or color. Mean grain size of material at some potential borrow sites generally is finer than existing island sand. However, mixing sand of different grain sizes from otherwise suitable borrow sites can achieve the compatibility and stability of fill required for restoration, as noted in the discussion of construction alternatives in Section 3.2.3.2.

For reasons provided in Table 3-3, six borrow sites (St. Bernard Shoals, Gulfport Channel, Mississippi Sound, Ship Island Pass, Dog Keys Pass, and Lower Tombigbee River Upland disposal sites) were evaluated as not feasible, and seven (Cat Island, Ship Island, DA-10/ Sand Island, Petit Bois Pass–MS, Petit Bois Pass–AL, Petit Bois Pass-OCS, and Horn Island Pass) were evaluated as feasible. These are shown on Figure 3-3 and described in Table 3-3.

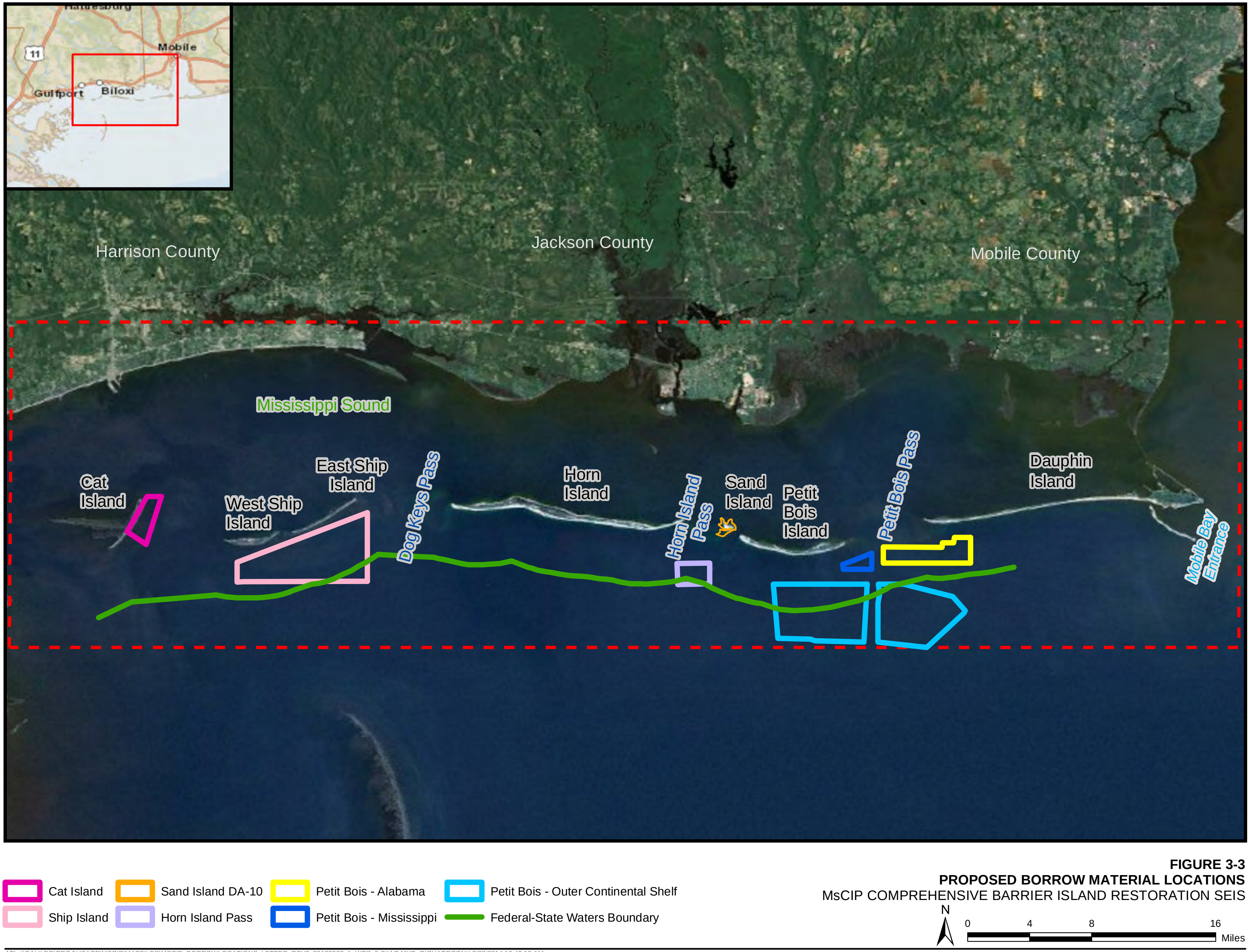

FIGURE 3-3
PROPOSED BORROW MATERIAL LOCATIONS
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TABLE 3-3
Summary of Potential Borrow Material Locations

Survey Area	Sand Availability	Sediment Characteristics	Environmental Considerations	Summary of Feasibility as Borrow Source
Locations Not Carried Forward				
St. Bernard Shoals	Sufficient quantities available.	Too dark gray in color and fine-grained.	Area crossed by numerous pipelines, which would restrict dredging.	Site too distant from placement sites; incompatible color and grain size.
Gulfport Channel	Very limited amounts of sand over scattered areas.	Silts or clays not project compatible.	Areas outside actual shipping channel located within GSCH.	Not feasible because of lack of suitable material (predominantly silt and clay).
Mississippi Sound	Some areas near West Ship Island with large sand deposits.	Grain size (0.16–0.21 mm, with mixed silts and clay) too fine, clay overburden.	Entire deposit located within GSCH.	Not feasible because of fine grain size; located in GSCH.
Ship Island Pass	Limited sand deposits; located in northern portion of pass in shoals.	Grain size (0.13–0.19 mm) too fine; 8 to up to 20 feet of muddy overburden.	Entire deposit located within GSCH.	Not feasible because of fine grain size; would affect GSCH.
Dog Keys Pass	Sand deposits located within active littoral transport zone of barrier islands.	Grain size (0.16–0.23 mm) too fine.	Located within GSCH.	Not feasible because of fine grain size; would affect GSCH; location in active littoral zone.
Lower Tombigbee River Upland Disposal Sites	Approximately 2 mcy available from two upland disposal sites.	Grain size acceptable (D50 of 0.30 mm); incompatible color (reddish-pink hue).	Located in existing upland disposal area.	Not feasible because of transport distances (78 and 92 miles from the mouth of the Mobile River) and sand color.
Locations Carried Forward				
Cat Island	4.3 mcy of sand deposits located off the east beach.	Grain size suitable for placement (D50 of 0.20 mm); predominant color light gray.	Some potential for focusing of waves from the north and northeast; located within Gulf sturgeon critical habitat (GSCH) on the West Bank platform; and outside of the active littoral transport zone	Feasible because of adequate sand volume; possibility of shallow excavation; could avoid Gulf sturgeon impacts and minimize wave focusing.
Ship Island	22 mcy of sand available (Ship Island Borrow Area Option 1) south of the island; 2 subareas identified: Ship Island Borrow Area Option 2 includes 8.7 mcy of sand; and Ship Island Borrow Area Option 3 includes 2.7 mcy of sand.	Grain size D50 = 0.21 mm); predominant color light gray.	Moderate potential for adverse shoreline impacts due to wave refraction; part of the 22 mcy is within GSCH; area located southeast of Loggerhead Shoal and outside of the active littoral transport zone.	Feasible; close to placement areas; grain size is finer than desired; Ship Island Borrow Area Option 3 avoids GSCH, and minimizes wave focusing.

TABLE 3-3 CONTINUED
Summary of Potential Borrow Material Locations

Survey Area	Sand Availability	Sediment Characteristics	Environmental Considerations	Summary of Feasibility as Borrow Source
DA-10/Sand Island	5.1 mcy of sand deposits associated with historical dredged material disposal area available for use. Sand deposits located outside the most active littoral system.	DA-10/Sand Island Borrow Area Option 1 includes 6.2 mcy of light gray sand, with D50 = 0.33 mm. DA-10/Sand Island Borrow Area Option 2 includes 4.7 mcy of light gray sand, with D50 = 0.32 mm.	Within Gulf sturgeon and piping plover designated critical habitat; upland portion of the area (Sand Island) is used by nesting shore birds; contains 26.69 acres of palustrine emergent and estuarine intertidal wetlands, and offers significant recreational opportunities; site is located within the Horn Island Pass shoal complex.	Feasible; within Gulf sturgeon and piping plover critical habitat; active dredged material disposal site DA-10/Sand Island Borrow Area Option 1 would eliminate or adversely affect the hydrology and functionality of the palustrine emergent wetlands and some of the estuarine intertidal wetlands, and some piping plover habitat would remain; this option would reduce wave energy penetrating the Sound by keeping in place the southern shoreline. DA-10/Sand Island Borrow Area Option 2 would avoid the palustrine emergent wetlands.
Petit Bois Pass-Alabama East (PBP-AL East)	Up to 14.7 mcy of sand available, south of Petit Bois Pass.	PBP-AL East Option 1 has 13.3 mcy of light gray to white sand, with D50 = 0.33 mm. PBP-AL East Option 2 has 14.7 mcy light gray to white sand, with D50 = 0.33 mm.	Moderate potential for adverse shoreline impacts due to wave refraction; outside (south of) GSCH; area located south and southeast of the Petit Bois Pass shoal system and outside the active littoral transport zone.	Both options feasible; PBP-AL East Option 2 offers more sand volume.
Petit Bois Pass-Alabama West (PBP-AL West)	6.2 mcy of sand initially identified south of Petit Bois Pass; 5.1 mcy of sand identified as feasible for use.	PBP-AL West Option 1 has 6.2 mcy of light gray to white sand, with D50 = 0.32 mm. PBP-AL West Option 2 has 5.1 mcy light gray to white sand, with D50 = 0.31 mm	Moderate potential for adverse shoreline impacts due to wave refraction; outside (south of) GSCH; area located south and southeast of the Petit Bois Pass shoal system and outside the active littoral transport zone.	PBP-AL West Option 2 feasible; avoids pipeline crossings and reduces potential impacts of bathymetric changes along the pipeline as a result of wave focusing.
Petit Bois Pass—Mississippi (PBP-MS)	2.0 mcy of sand available west of Petit Bois Pass	Sand is light gray in color with grain size of D50 = 0.31 mm.	Moderate potential for adverse shoreline impacts due to wave refraction; mainly outside (south of) GSCH, 32.0 acres of GSCH; area located south of the Petit Bois Pass shoal system and outside the active littoral transport zone.	Feasible; optimum grain size; outside GSCH.

TABLE 3-3 CONTINUED
Summary of Potential Borrow Material Locations

Survey Area	Sand Availability	Sediment Characteristics	Environmental Considerations	Summary of Feasibility as Borrow Source
Petit Bois Pass—Outer Continental Shelf East (PBP-OCS East)	4.3 mcy of sand available.	Sand is light gray in color; D50 grain size ranges from 0.27–0.33 mm.	Located outside (south of) GSCH and outside the active littoral transport zone.	Feasible due to adequate sand volume, optimum grain size; outside GSCH.
Petit Bois Pass—Outer Continental Shelf West (PBP-OCS-West)	15.5 mcy of sand available.	Sand is light gray in color; D50 grain size ranges from 0.26–0.30 mm.	Located outside (south of) GSCH and outside the active littoral transport zone.	Feasible due to adequate sand volume, optimum grain size; outside GSCH.
Horn Island Pass	Sand disposal mound from historical bar channel dredging located south of pass; about mcy4.9 of sand available.	D50 ranges from 0.25–0.31 mm; predominant color gray.	Located outside (south of) GSCH; area located south of the Horn Island Pass ebb tidal shoal and outside the active littoral transport zone.	Feasible due to adequate sand volume, optimum grain color and size, outside GSCH.

Source: Appendix A.

Cat Island Borrow Area

Potential borrow sites were investigated to the east of Cat Island. Geophysical surveys indicated the availability of extensive sand deposits in this area (the Cat Island shoal and the buried Ship Island Pass shoal) that could provide the 2 mcy of sand needed for placement at Cat Island. The two shoals are estimated to contain more than 32 million cubic meters of sediment, with greater than 90 percent sand content (Twichell et al., 2011). The proposed borrow area overlaps the south-southwest side of the Cat Island shoal and is west of the Ship Island Pass shoal. USACE vibracores indicate that the seafloor surface is predominantly poorly graded, fine-grained sand-sized quartz (SP), with some siltier sand (SP-SM) in the northern half of the borrow area. Average grain size in the borrow area (D50 of 0.20 mm) is smaller than in the native beach but deemed suitable for the placement site. The material is predominantly light gray in color and contains an average of less than 5percent fines. The borrow area is approximately 429 acres in size and material is an average of 6 feet thick, which includes 4 feet for required dredging plus an additional 2 feet of allowable overdepth.

Water depth over the area ranges from -12 to -14 feet North American Vertical Datum of 1988 (NAVD88) (Figure 3-4). Although the area is within designated critical habitat (Unit 8) for the federally threatened Gulf sturgeon and has a smaller grain size than desired, it is near the placement area on Cat Island, and the volume necessary for restoration would be small relative to the widespread availability of sand in this area. East and West Ship Islands and the shoal system to the south help to shelter the area from stronger, more energetic waves coming from the south and southeast, but there is the potential for moderate focusing of waves from the north and northeast along Cat Island. Because of the shallow (< 30 feet) nearshore location of the potential borrow areas, hydrodynamic modeling studies were conducted to determine whether disruption of the deposits would cause adverse wave focusing or adversely affect the transport system. Additional evaluations of the impact to GSCH were also conducted. The borrow area design is configured to prevent significant adverse impacts to the transport system and the use of this site would not impact or adversely modify critical habitat or threaten the continued existence of the protected species.

Ship Island Borrow Area(s)

Geophysical surveys and vibracores identified an initial deposit (Loggerhead shoal and tidal delta) of 29 million cubic meters of sediment with 92-95 percent sand content (Twichell et al., 2011). From this quantity, a 22-mcy subset of the area south of Ship Island was identified, with an average cut thickness of 8 feet. Within the Ship Island borrow site, three potential borrow areas were identified: Ship Island Borrow Area Option 1, Ship Island Borrow Area Option 2, and Ship Island Borrow Area Option 3 (Figure 3-5). Ship Island Borrow Area Option 1 is located 1.5 miles south of Camille Cut and East Ship Island at a depth of approximately -28 feet NAVD88. The proximity of the sand deposit to Camille Cut and East Ship Island makes the borrow area highly favorable for the placement of sand at East and West Ship Islands. However, the sand is finer than desired (D50 of 0.21 mm), which would limit its potential use. The predominant sand color is light gray.

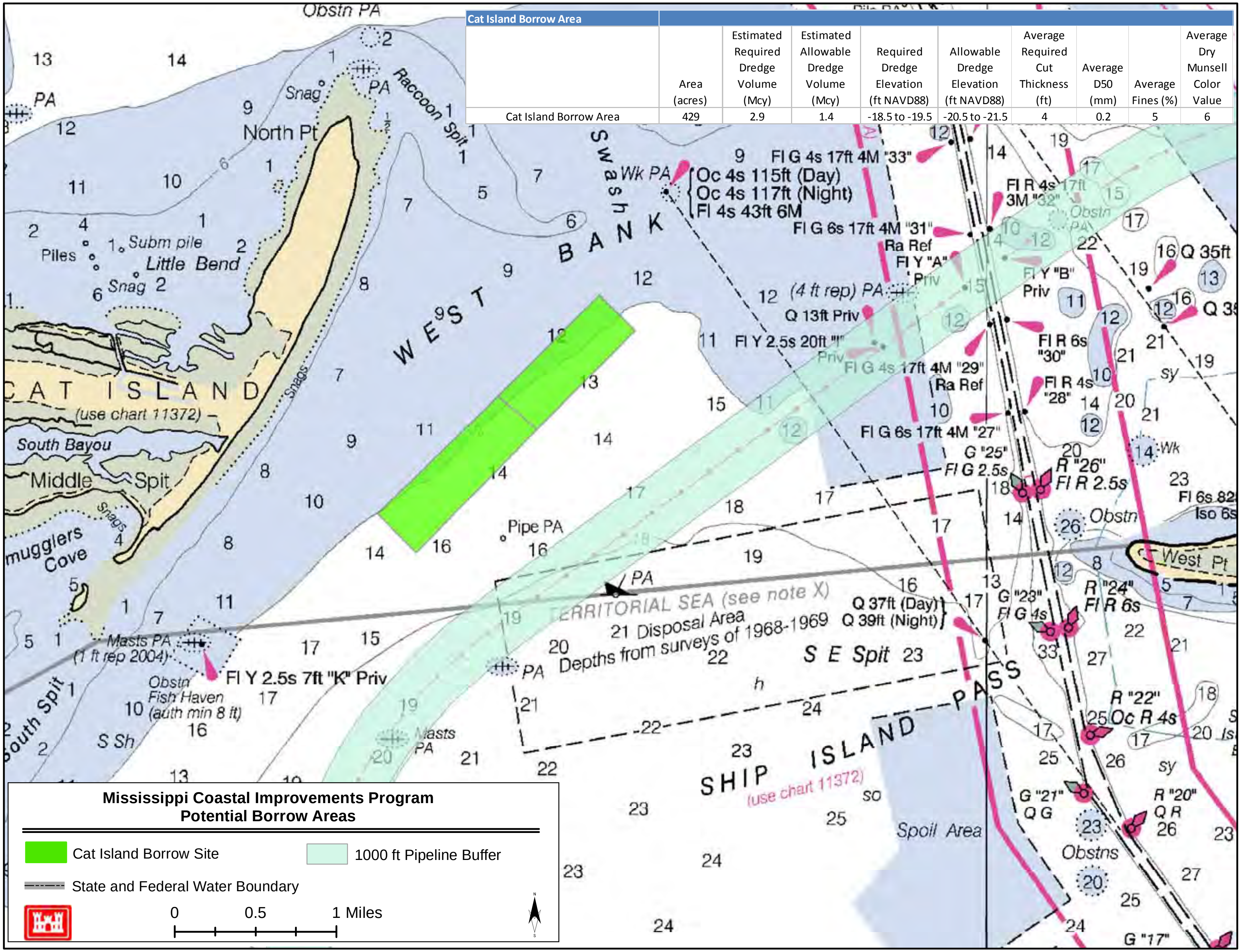
Further investigations identified two sub-areas of Ship Island Borrow Area Option 1 (Figure 3-5): Ship Island Borrow Area Option 2 and Ship Island Borrow Area Option 3. Ship Island Borrow Area Option 2 is 634 acres in size and contains approximately 8.7 mcy of suitable sand. Ship Island Borrow Area Option 3 is 183 acres in size and contains 2.7 mcy of sand. Ship Island Borrow Area Option 3 is entirely outside GSCH. Because of the shallow (< 30 feet), nearshore location of the potential borrow sites in the area, hydrodynamic modeling studies were conducted to determine whether use of this material would cause adverse wave focusing or adversely affect the transport system. The borrow area design was configured to prevent significant adverse impacts to the transport system. Appendix C contains details of these studies. The modeling evaluation indicated that using a subset of the entire 22 mcy of sand available would not adversely affect the long-term overall morphological development of Ship Island.

Based on the proximity of the site, potential sand volume and grain size, and limited potential for impact on critical habitat, Ship Island Borrow Area Option 3 is considered the most feasible of the Ship Island borrow areas.

Horn Island Pass Borrow Area(s)

The Horn Island Pass borrow site lies immediately west of the Pascagoula Harbor entrance channel (Figure 3-6) and has ambient water depths ranging from 27 to 40 feet. Horn Island Pass contains mounds created by the disposal of dredged material from the bar channel section of the Pass. Much of this material was sand naturally transported from Petit Bois Island and deposited in the channel. Because the sediment mounds are man-made, they contain discontinuous sandy layers atop the in-situ seafloor comprised mostly of sandy silts and clays. As a result, the mounds' sandy veneer pinches off at the lateral margins of the mounds. In general, vibracore borings that intersected the tops of the mounds recovered poorly graded, medium- to fine-grained, sand-sized quartz (SP) with very little fines and trace shell fragments throughout. Sand thicknesses on the mounds ranged from 1 foot to 11.8 foot, with an average thickness of 6.1-foot D50 grain size for samples in the mounds ranged from 0.15 mm to 0.34 mm, with an average D50 of 0.28 mm.

Cat Island Borrow Area	Area (acres)	Estimated Required Dredge Volume (Mcy)	Estimated Allowable Dredge Volume (Mcy)	Required Dredge Elevation (ft NAVD88)	Allowable Dredge Elevation (ft NAVD88)	Average Required Cut Thickness (ft)	Average D50 (mm)	Average Fines (%)	Average Dry Munsell Color Value
Cat Island Borrow Area	429	2.9	1.4	-18.5 to -19.5	-20.5 to -21.5	4	0.2	5	6



NOAA Chart 11373
Source Data: NOS surveys 1970 to 1989

FIGURE 3-4
CAT ISLAND BORROW AREA
MsCIP COMPREHENSIVE BARRIER ISLAND RESTORATION SEIS

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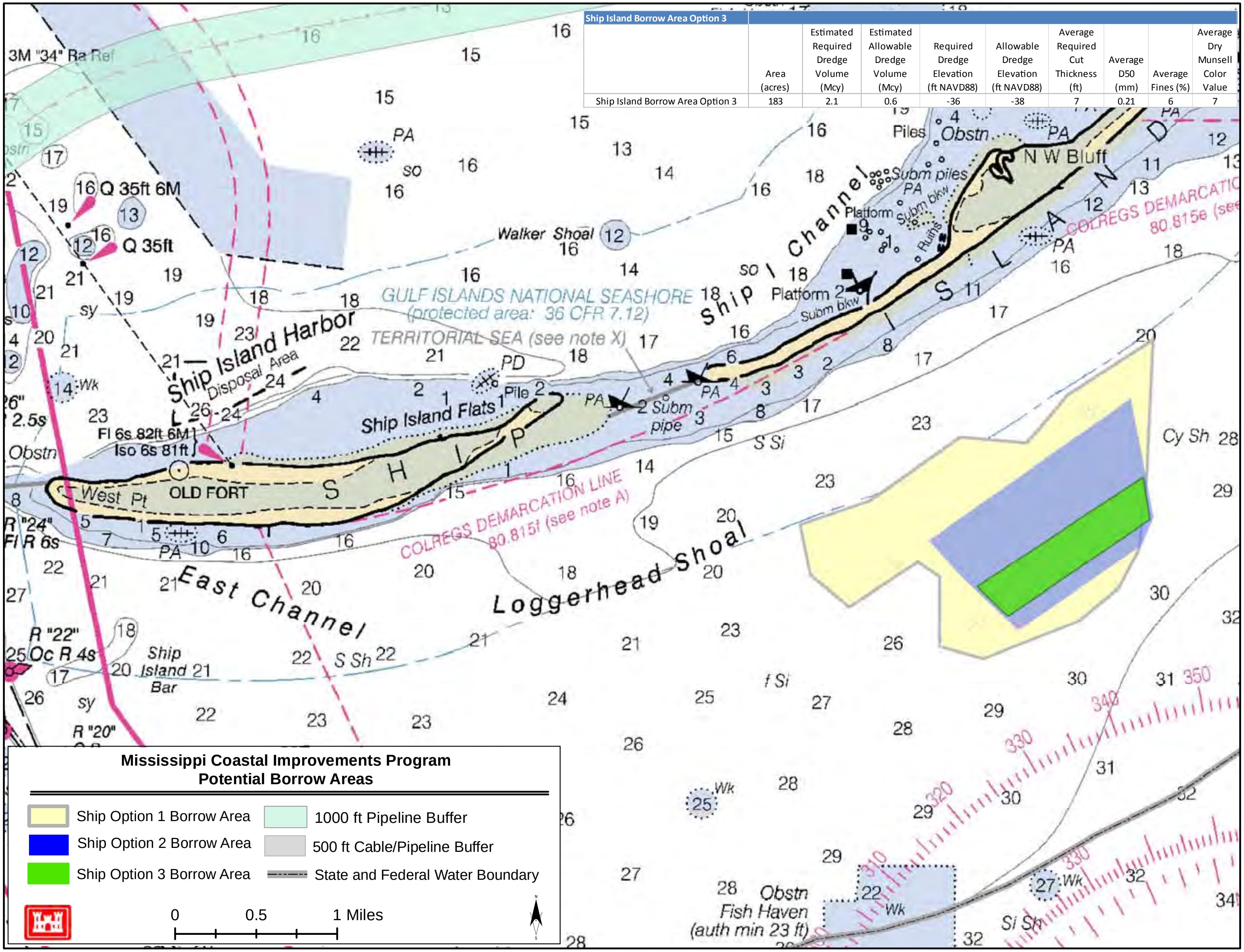
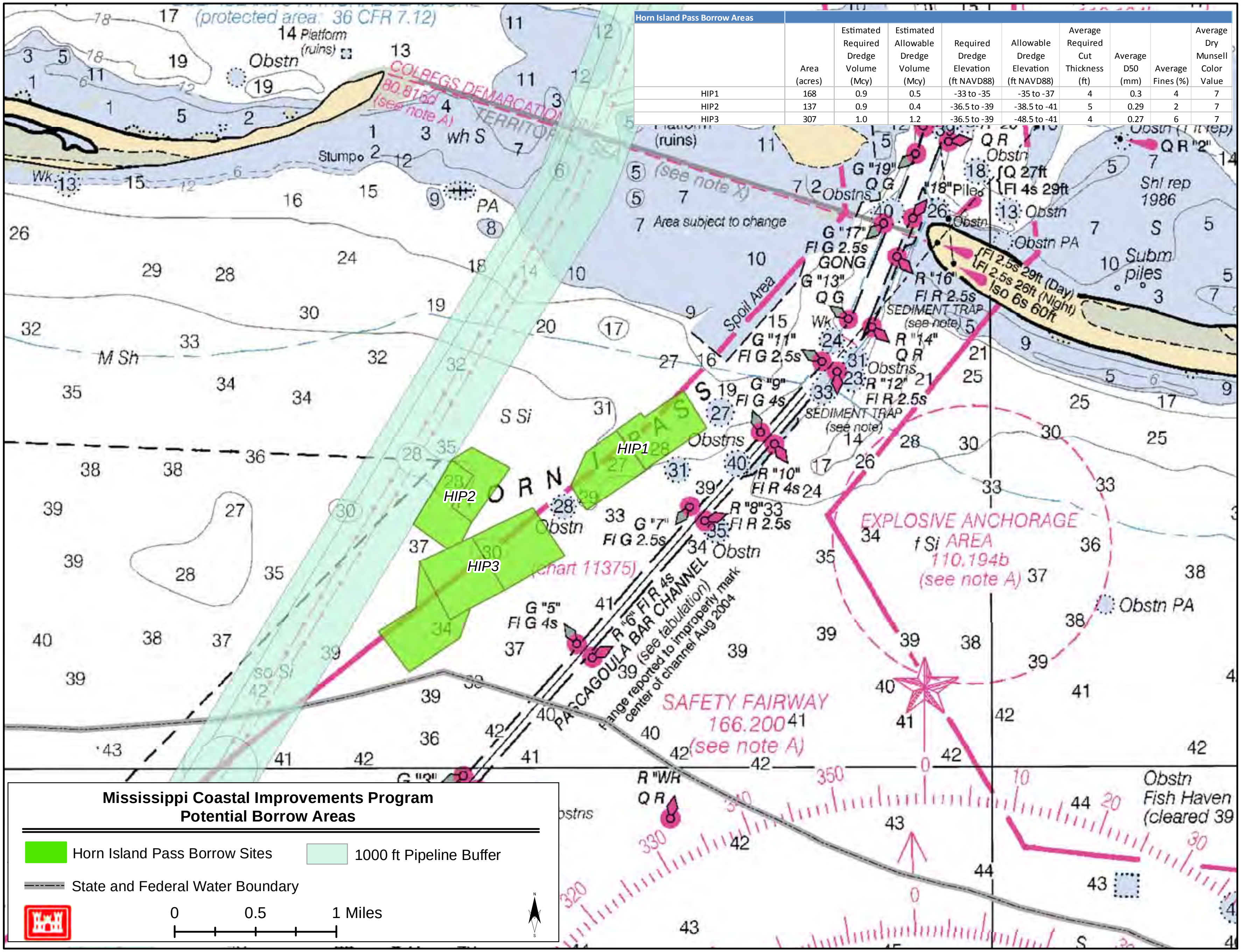


Ship Island Borrow Area Option 3	Area (acres)	Estimated Required Dredge Volume (Mcy)	Estimated Allowable Dredge Volume (Mcy)	Required Dredge Elevation (ft NAVD88)	Allowable Dredge Elevation (ft NAVD88)	Average Required Cut Thickness (ft)	Average D50 (mm)	Average Fines (%)	Average Dry Munsell Color Value
Ship Island Borrow Area Option 3	183	2.1	0.6	-36	-38	7	0.21	6	7

NOAA Chart 11373
Source Data: NOS surveys 1970 to 1989

FIGURE 3-5
SHIP ISLAND BORROW AREA OPTIONS
MsCIP COMPREHENSIVE BARRIER ISLAND RESTORATION SEIS



Horn Island Pass Borrow Areas

	Area (acres)	Estimated Required Dredge Volume (Mcy)	Estimated Allowable Dredge Volume (Mcy)	Required Dredge Elevation (ft NAVD88)	Allowable Dredge Elevation (ft NAVD88)	Average Required Cut Thickness (ft)	Average D50 (mm)	Average Fines (%)	Average Dry Munsell Color Value
HIP1	168	0.9	0.5	-33 to -35	-35 to -37	4	0.3	4	7
HIP2	137	0.9	0.4	-36.5 to -39	-38.5 to -41	5	0.29	2	7
HIP3	307	1.0	1.2	-36.5 to -39	-48.5 to -41	4	0.27	6	7

NOAA Chart 11373
Source Data: NOS surveys 1970 to 1989

FIGURE 3-6
HORN ISLAND PASS BORROW AREA
MsCIP COMPREHENSIVE BARRIER ISLAND RESTORATION SEIS

Percent fines ranged from 2 percent to 14 percent, with an average of 5 percent. Typical dry Munsell Color Value was 7, with a Munsell Color of Light Gray. Overburden was virtually non-existent on the tops of the mounds. Below the initial top sand layer, the sediments quickly grade to silty and clayey sands (SM and SC), usually underlain by intermittent layers of clay (CL or CH) and silt (ML or MH). Dry Munsell Color Value typically decreases with increasing depth. D50 grain size also typically decreases with depth.

The estimated available volume from the Horn Island Pass borrow area is 4.9 mcy in a combined area of 612 acres with cut elevations of -33 to -41 feet NAVD88 and average cut thicknesses ranging between 4 and 5 feet. Three obstructions near the borrow sites are marked on NOAA charts. The sites were buffered with 150 feet in addition to the specified buffer, as indicated on the latest NOAA map. In addition, two known pipelines are located to the east. An approximately 1,000-foot buffer was maintained around the known pipelines. Excavation would consist of removing disposal mounds to surrounding depths; therefore, any potential wave focusing would likely be minor.

DA-10/Sand Island Borrow Area(s)

This potential borrow area, within the GUIS NPS boundary, is a dredged material placement site used for material dredged from the Pascagoula Harbor Federal Navigation Project between Horn and Petit Bois Islands. DA-10/Sand Island is on the west side of the channel. Because the island is man-made, it contains mostly poorly graded, medium-grained, sand-sized quartz (SP) placed in thick deposits atop the in-situ seafloor, which is comprised mostly of sandy silts and clays. The area-weighted average D50 grain size is 0.32 mm, the percentage of fine sediments is less than 5, and dry Munsell color is predominantly light gray with an average dry Munsell value of 7. This sandy deposit is mostly a veneer which pinches off at the island’s lateral margins and quickly becomes unsuitable material for the project. Although this area is within the active littoral zone, material has been placed in the northern part of the specified placement area such that transport is not conducive to providing a sand source to the natural barrier islands. The specified disposal area is 940 acres in size, including the 165-acre island locally known as Sand Island. Sand Island, which has been created through the placement of dredged material, is a NPS resource that includes recreational area for NPS visitors, approximately 26.7 acres of scattered vegetated wetland habitats, and shorebird habitat.

Elevations at the site range from +18 to -10 feet NAVD88. Geotechnical investigations have identified 5.1 mcy of suitable quality sand, with favorable grain size (D50 = 0.33 mm) to remove from this location. DA-10/Sand Island is within the area designated as critical habitat for the Gulf sturgeon and the piping plover, but it is an active dredged material placement site.

Two potential borrow options within DA-10/Sand Island were identified.

DA-10/Sand Island Borrow Area Option 1 is 357 acres in size, including 105 acres of Sand Island. Sand would be removed to a depth of approximately -12 feet NAVD88 (Figure 3-7). Because of the shallow (< 30 feet) nearshore location of the potential borrow material in the area, hydrodynamic and sediment transport modeling studies were conducted to determine whether disruption of the deposits would cause adverse wave focusing or affects to the transport system. The borrow area design was configured to prevent significant wave focusing or adverse impact to the transport system. Details of these studies are included in

Appendices B, D, E, and F. The southern part of Sand Island is proposed to be left in place to minimize potential changes to waves on the leeward side of the island and to continue to provide shorebird habitat (see Sections 4 and 5).

DA-10/Sand Island Borrow Area Option 2 (Figure 3-8) was developed to avoid removal of a 7.9-acre ponded wetland inadvertently created through dredged disposal practices at the Pascagoula Harbor navigation channel. Use of Option 2 would involve using approximately 58 acres of the eastern part of Sand Island above mean lower low water (MLLW) while seeking to keep 125 acres of the western segment above MLLW in place. This area includes the lower berm elevation (+5 feet NAVD88) along the southern shoreline for bird habitat and the higher vegetated elevations upwards of +18 feet NAVD88 associated with an existing ponded wetland. Option 2 is approximately 304 acres in size, of which 58 acres are above MLLW and 246 acres are below MLLW. Approximately 3.7 mcy of sand would be removed to a depth of -14 feet, including 2 feet of allowable overdepth**.**

Even with using a smaller area of Sand Island, it is anticipated that removal of this sand would adversely affect all wetlands on Sand Island through dredged-material removal or damage to the hydrologic conditions that currently support any remaining wetlands.

Petit Bois Pass Borrow Areas

Within the Petit Bois Pass borrow site (Figure 3-9), the inshore PBP-AL (PBP-AL East and PBP-AL West) and PBP-MS locations and the PBP-OCS (PBP-OCS East 1-5 and PBP-OCS West 1-6) location were investigated. Each is discussed below.

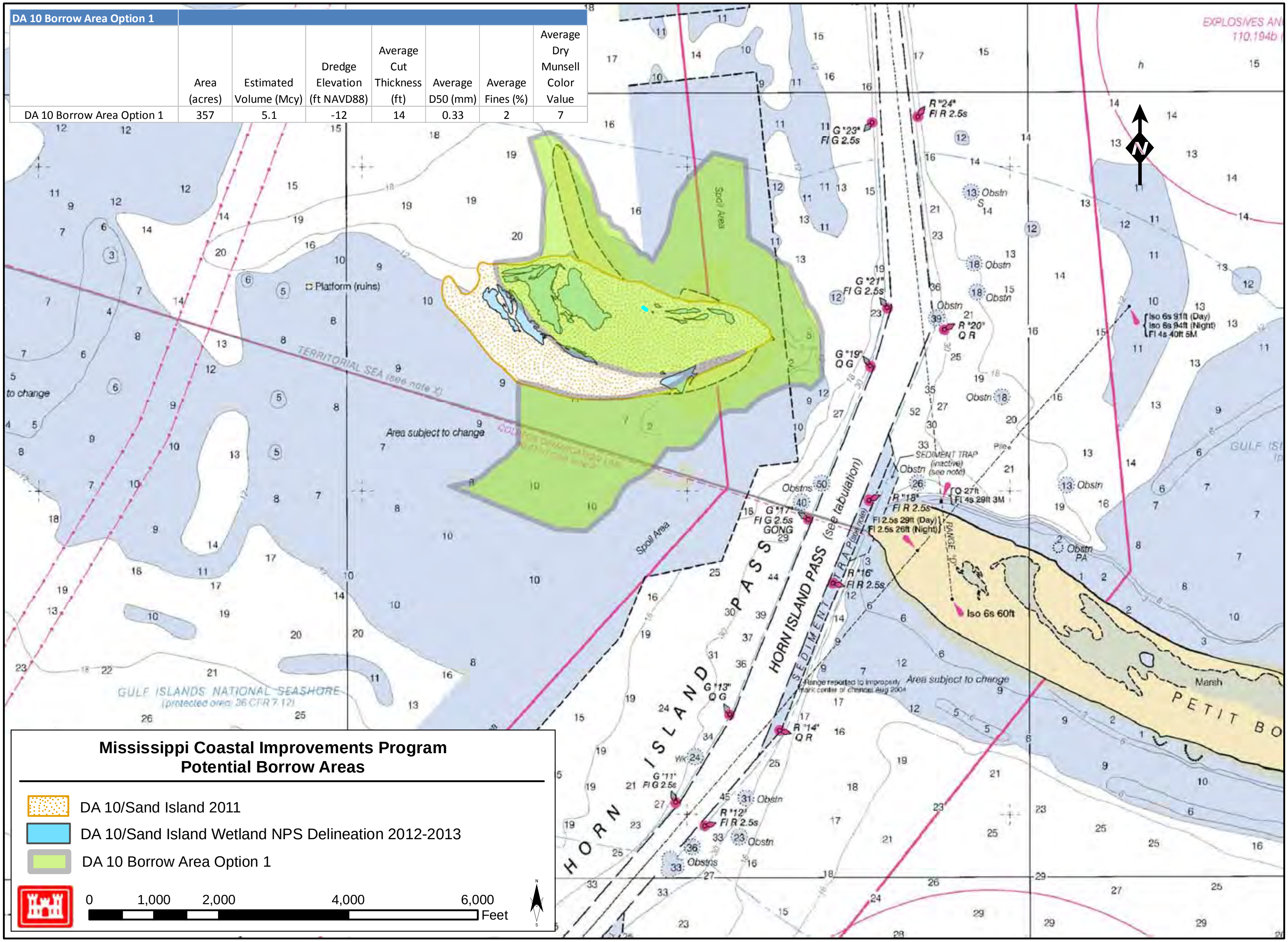
PBP-AL Borrow Areas

The initial PBP-AL location extends from Petit Bois Island in Mississippi, east to Dauphin Island in Alabama. Geophysical surveys indicated that large deposits of sand are present in the area south of the main pass extending 3 miles offshore (Figure 3-10). Based on the results of vibracores, 167 mcy of suitable sand were delineated in two separate zones: PBP-AL West Option 1 and PBP-AL East Option 1. PBP-AL West Option 1 is approximately 587 acres in size and contains 6.2 mcy of sand (Figure 3-10). PBP-AL East Option 1 is approximately 753 acres in size and contains 13.3 mcy of sand (Figure 3-10).

Both PBP-AL West Option 1 and PBP-AL East Option 1 contain high-quality sand, with compatible grain size (D50 = 0.32 mm) and color ranging from light gray to white, but PBP-AL West Option 1 contains a higher percentage of shell fragments. The extent of the sand appears to be continuous with a shallow bar to the north that is within the littoral zone of one of the barrier islands, but its characteristics suggest it may be of fluvial origin associated with a relict river channel. This area is located outside (southeast of) GSCH. It is in water with an average depth of approximately -31 feet NAVD88 and is 2-2.5 miles southwest of Dauphin Island.

Because of the shallow (< 30 feet) nearshore location of the area, hydrodynamic modeling studies were conducted to determine whether disruption of the deposits would cause adverse wave focusing or affects to the transport system. The borrow area design was configured to prevent significant adverse impacts to the transport system. Appendix D contains details of these studies. Given the extensive shoal system to the north, most wave focusing would be broken up by the shoal.

DA 10 Borrow Area Option 1	Area (acres)	Estimated Volume (Mcy)	Dredge Elevation (ft NAVD88)	Average Cut Thickness (ft)	Average D50 (mm)	Average Fines (%)	Average Dry Munsell Color Value
DA 10 Borrow Area Option 1	357	5.1	-12	14	0.33	2	7



NOAA Chart 11375
Source Data: NOS surveys 1970 to 1989

FIGURE 3-7
DA-10/SAND ISLAND BORROW SITE OPTION 1
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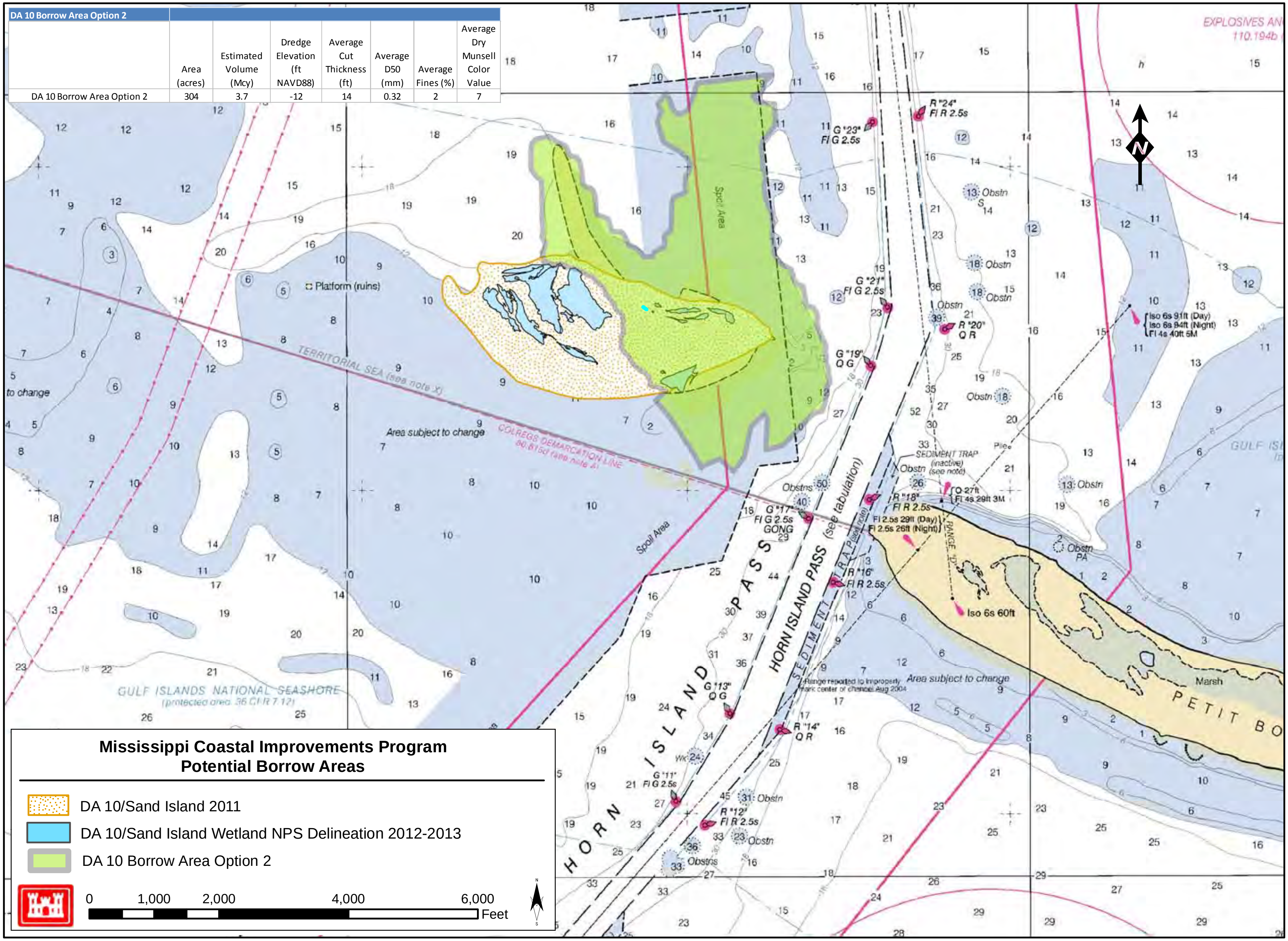
DA 10 Borrow Area Option 2	Area (acres)	Estimated Volume (Mcy)	Dredge Elevation (ft NAVD88)	Average Cut Thickness (ft)	Average D50 (mm)	Average Fines (%)	Average Dry Munsell Color Value
DA 10 Borrow Area Option 2	304	3.7	-12	14	0.32	2	7



NOAA Chart 11375
Source Data: NOS surveys 1970 to 1989

FIGURE 3-8
DA-10/SAND ISLAND BORROW SITE OPTION 2
MsCIP COMPREHENSIVE BARRIER ISLAND RESTORATION SEIS

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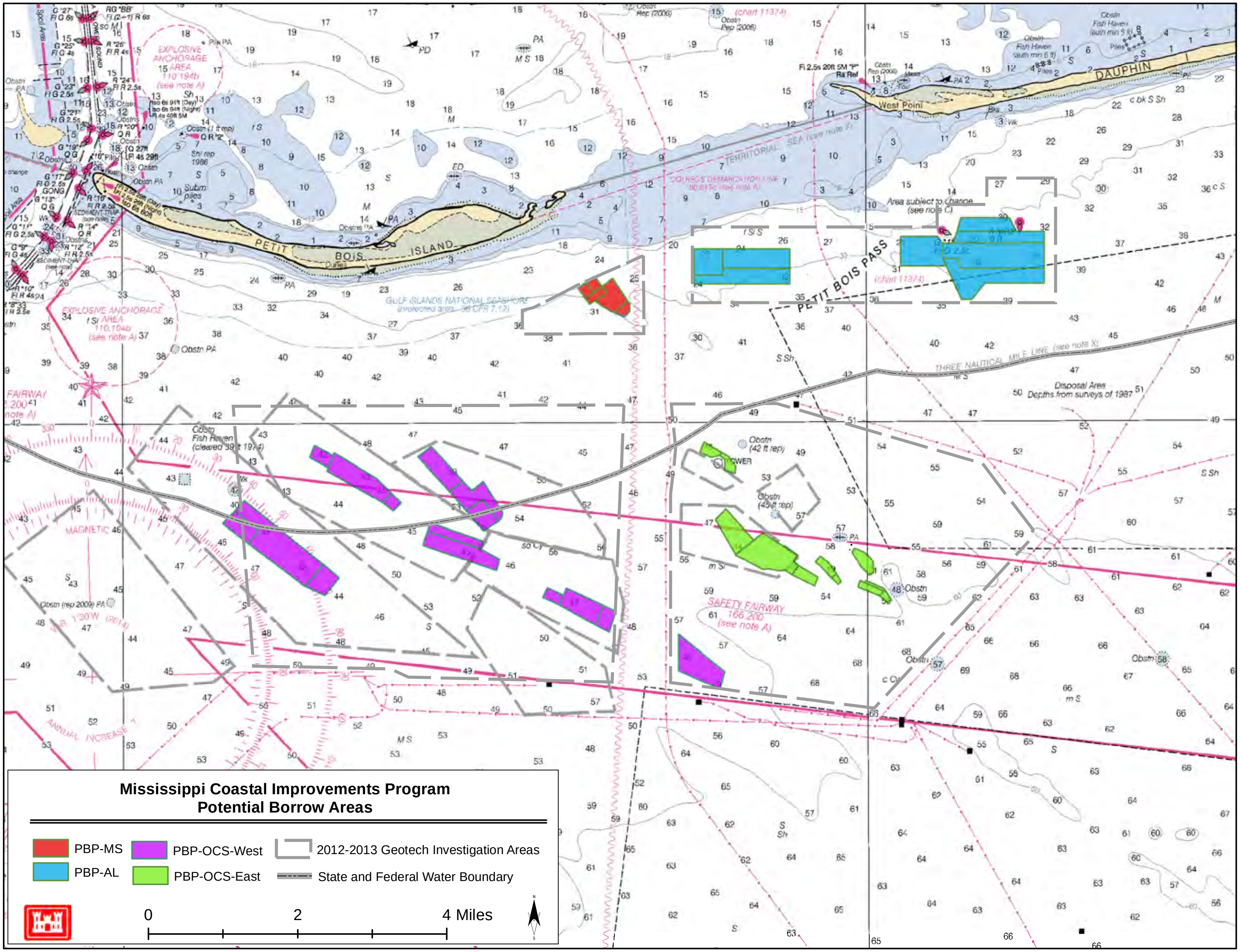


NOAA Chart 11373
Source Data: NOS surveys 1970 to 2012

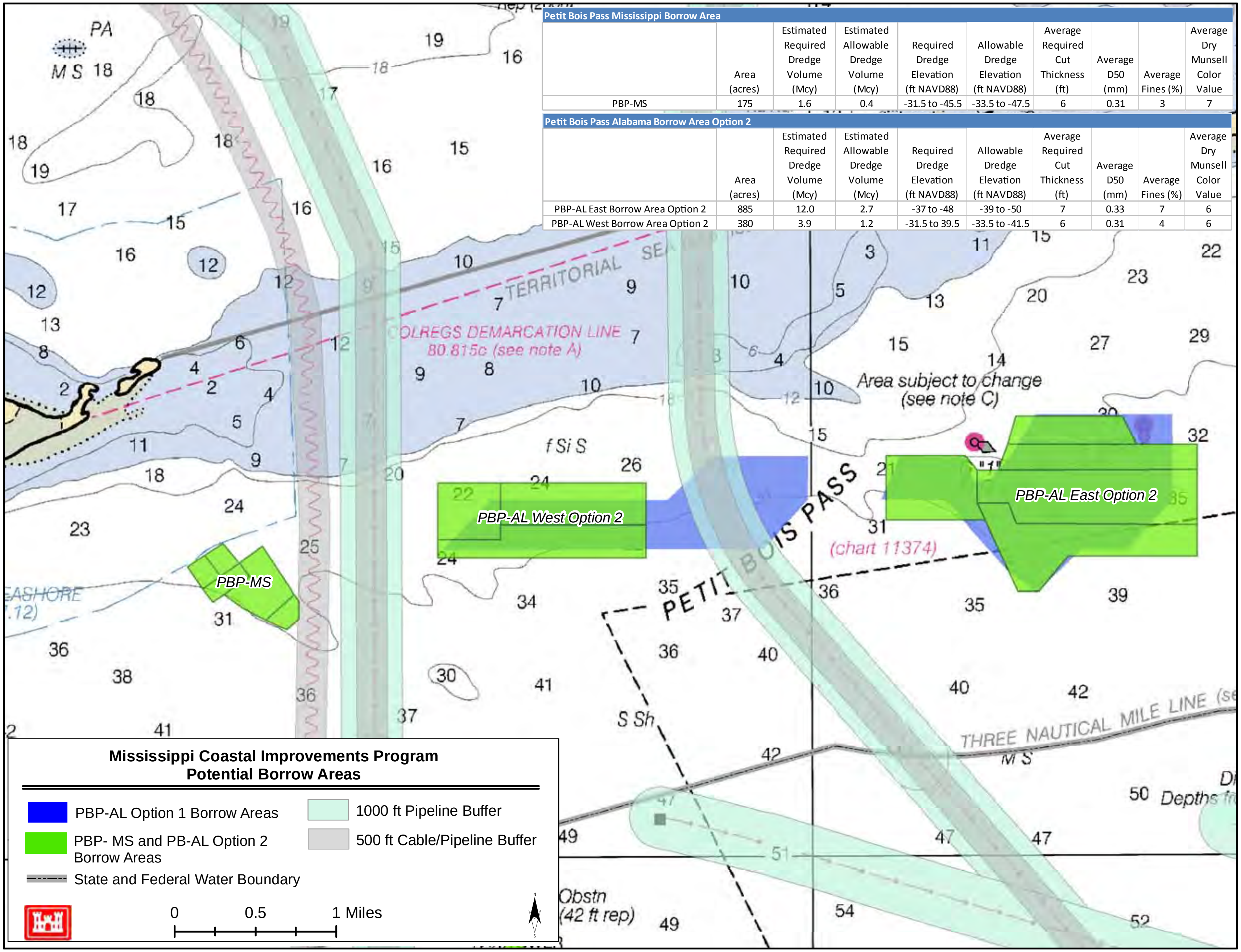
FIGURE 3-9
PETIT BOIS PASS BORROW AREAS
MsCIP COMPREHENSIVE BARRIER ISLAND RESTORATION SEIS

Petit Bois Pass Mississippi Borrow Area

	Area (acres)	Estimated Required Dredge Volume (Mcy)	Estimated Allowable Dredge Volume (Mcy)	Required Dredge Elevation (ft NAVD88)	Allowable Dredge Elevation (ft NAVD88)	Average Required Cut Thickness (ft)	Average D50 (mm)	Average Fines (%)	Average Dry Munsell Color Value
PBP-MS	175	1.6	0.4	-31.5 to -45.5	-33.5 to -47.5	6	0.31	3	7

Petit Bois Pass Alabama Borrow Area Option 2

	Area (acres)	Estimated Required Dredge Volume (Mcy)	Estimated Allowable Dredge Volume (Mcy)	Required Dredge Elevation (ft NAVD88)	Allowable Dredge Elevation (ft NAVD88)	Average Required Cut Thickness (ft)	Average D50 (mm)	Average Fines (%)	Average Dry Munsell Color Value
PBP-AL East Borrow Area Option 2	885	12.0	2.7	-37 to -48	-39 to -50	7	0.33	7	6
PBP-AL West Borrow Area Option 2	380	3.9	1.2	-31.5 to 39.5	-33.5 to -41.5	6	0.31	4	6



NOAA Chart 11373
Source Data: NOS surveys 1900 to 1989

FIGURE 3-10
PETIT BOIS PASS-MISSISSIPPI AND ALABAMA BORROW AREAS
MsCIP COMPREHENSIVE BARRIER ISLAND RESTORATION SEIS

Based on results from hydrodynamic and morphological modeling of potential impacts to adjacent pipelines, PBP-AL East Option 2 and PBP-AL West Option 2 were defined and are more feasible than PBP-AL East Option 1 and PBP-AL West Option 1 (Figure 3-10). The boundary for PBP-AL West Option 2 was established to maintain a buffer of at least 1,000 feet around known pipelines. To offset the smaller volume of sand available from PBP-AL West Option 2, compared to PBP-AL West Option 1, additional geotechnical investigations were performed in 2012 along the margins of the borrow areas. Therefore, the boundary of PBP-AL East Option 2 is larger than that of PBP-AL East Option 1, to include suitable material located further away from the pipelines. The estimated combined available volume of PBP-AL East Option 2 and PBP-AL West Option 2 is 19.8 mcy, and the combined area is 1,265 acres. Allowable cut elevations vary between -31 to -50 feet NAVD88 and average cut thicknesses range between 4 and 5 feet.

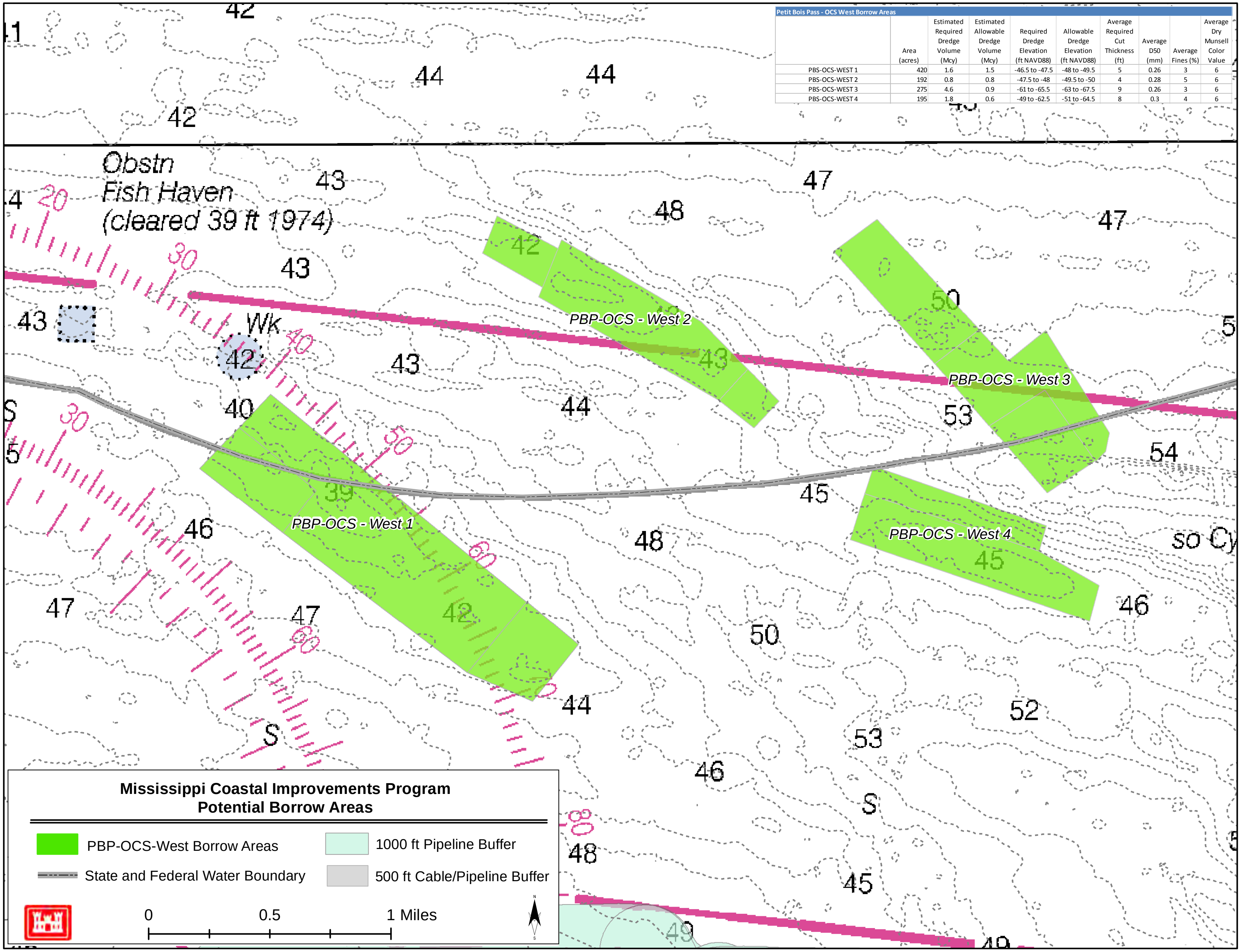
PBP-MS Borrow Areas

The PBP-MS borrow site is located about 1 mile southeast of the eastern tip of Petit Bois Island (Figure 3-10). It is situated along the northern third of a shoal approximately 1.6 miles long. Sand in this location has a favorable grain size (D50 = 0.31 mm). The ambient water depths range from -25 to -32 feet. Available volume is approximately 2.0 mcy. The site consists of 175 acres with cut elevations of -31 to -48 feet NAVD88 and average cut thicknesses of 4 feet. The site is bounded to the north and west by the NPS limits and to the east by a submerged cable and a pipeline. The cable is about 500 feet from the eastern limits of the proposed borrow area, the pipeline about 2,500 feet.

PBP-OCS Borrow Areas

The PBP-OCS West location is over 2 miles offshore of Petit Bois Island, near the safety fairway (Figures 3-11 and 3-12). The borrow area consists of several different sites, each with cells of varying cut elevations, mostly located along 2 major shoals of the area. The sand within the area is acceptable size (D50 = 0.26–0.30 mm), and the ambient water depths range from -40 to -55 feet. Estimated combined available volume is approximately 15.5 mcy. The site consists of 1,385 acres with cut elevations of -46 to -68 feet NAVD88 and average cut thicknesses ranging between 4 and 8 feet. The site contains a cable and pipeline in the vicinity PBP-OCS West 5 and 6. As with the PBP-AL sites, minimum buffers of 500 feet and 1,000 feet were applied around the cable and the pipeline, respectively.

The PBP- OCS East location is approximately 3.5 miles offshore of Petit Bois Island, near the safety fairway (Figure 3-12). The borrow area consists of several different sites, each with cells of varying cut elevations, mostly located along the major shoals of the area. The sand is an acceptable size (D50 = 0.28–0.33 mm), and the ambient water depths range from -45 to -60 feet. Estimated combined available volume is approximately 4.2 mcy. The site consists of 464 acres with cut elevations of -49 to -64 feet NAVD88 and average cut thicknesses ranging between 4 and 5 feet. A telecommunication tower is located on the shoal to the northwest in the lee of PBP-OCS East 1. An approximately 500-foot buffer was maintained around the telecommunication tower to provide adequate buffering for dredging equipment and side slope adjustments from borrow area excavation. In addition, a 150-foot buffer was applied to an obstruction located on the latest NOAA chart off the shoal to the southeast of PBP-OCS East 4.

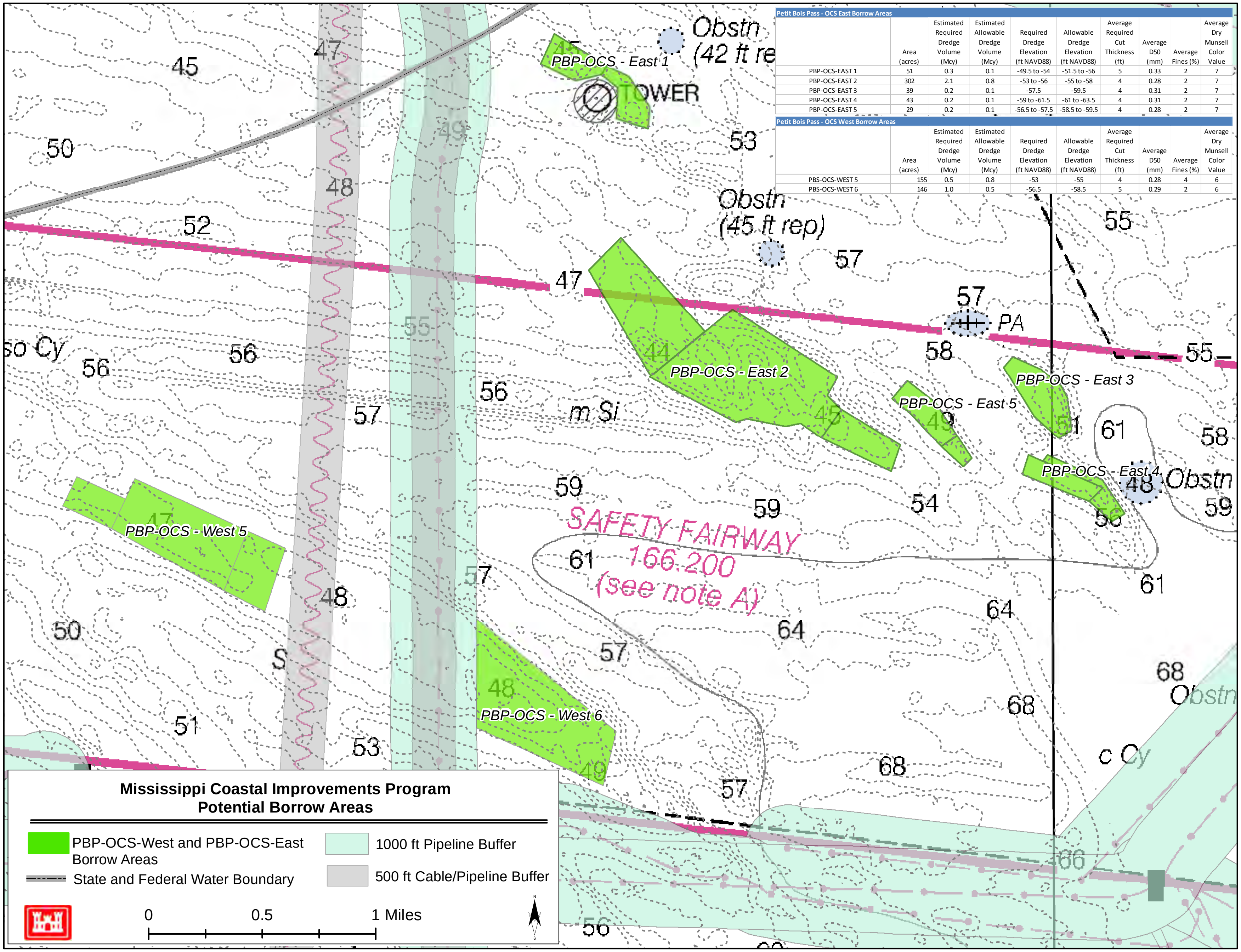


Petit Bois Pass - OCS West Borrow Areas

	Area (acres)	Estimated Required Dredge Volume (Mcy)	Estimated Allowable Dredge Volume (Mcy)	Required Dredge Elevation (ft NAVD88)	Allowable Dredge Elevation (ft NAVD88)	Average Required Cut Thickness (ft)	Average D50 (mm)	Average Fines (%)	Average Dry Munsell Color Value
PBS-OCS-WEST 1	420	1.6	1.5	-46.5 to -47.5	-48 to -49.5	5	0.26	3	6
PBS-OCS-WEST 2	192	0.8	0.8	-47.5 to -48	-49.5 to -50	4	0.28	5	6
PBS-OCS-WEST 3	275	4.6	0.9	-61 to -65.5	-63 to -67.5	9	0.26	3	6
PBS-OCS-WEST 4	195	1.8	0.6	-49 to -62.5	-51 to -64.5	8	0.3	4	6

NOAA Chart 11373
Source Data: NOS surveys 1970 to 2012

FIGURE 3-11
PETIT BOIS PASS - OUTER CONTINENTAL SHELF BORROW AREA WEST 1-4
MsCIP COMPREHENSIVE BARRIER ISLAND RESTORATION SEIS



Petit Bois Pass - OCS East Borrow Areas

	Area (acres)	Estimated Required Dredge Volume (Mcy)	Estimated Allowable Dredge Volume (Mcy)	Required Dredge Elevation (ft NAVD88)	Allowable Dredge Elevation (ft NAVD88)	Average Required Cut Thickness (ft)	Average D50 (mm)	Average Fines (%)	Average Dry Munsell Color Value
PBP-OCS-EAST 1	51	0.3	0.1	-49.5 to -54	-51.5 to -56	5	0.33	2	7
PBP-OCS-EAST 2	302	2.1	0.8	-53 to -56	-55 to -58	4	0.28	2	7
PBP-OCS-EAST 3	39	0.2	0.1	-57.5	-59.5	4	0.31	2	7
PBP-OCS-EAST 4	43	0.2	0.1	-59 to -61.5	-61 to -63.5	4	0.31	2	7
PBP-OCS-EAST 5	29	0.2	0.1	-56.5 to -57.5	-58.5 to -59.5	4	0.28	2	7

Petit Bois Pass - OCS West Borrow Areas

	Area (acres)	Estimated Required Dredge Volume (Mcy)	Estimated Allowable Dredge Volume (Mcy)	Required Dredge Elevation (ft NAVD88)	Allowable Dredge Elevation (ft NAVD88)	Average Required Cut Thickness (ft)	Average D50 (mm)	Average Fines (%)	Average Dry Munsell Color Value
PBS-OCS-WEST 5	155	0.5	0.8	-53	-55	4	0.28	4	6
PBS-OCS-WEST 6	146	1.0	0.5	-56.5	-58.5	5	0.29	2	6

NOAA Chart 11373
Source Data: NOS surveys 1940 to 2009

FIGURE 3-12
PETIT BOIS PASS OUTER CONTINENTAL SHELF BORROW AREA WEST 5-6 AND EAST 1-5
MsCIP COMPREHENSIVE BARRIER ISLAND RESTORATION SEIS

Table 3-4 summarizes potential borrow volumes from sites carried forward for further analysis, including the terrestrial and submerged habitat in each. DA-10/Sand Island is the only borrow site that includes both terrestrial and submerged habitat.

TABLE 3-4
Summary of Potential Borrow Volumes from Sites Carried Forward

Borrow Areas	Terrestrial Habitat (ac.)	Submerged Habitat (ac.)	Total Acres	Estimated Total Available Borrow Volume (mcy)
Ship Island Borrow Area Option 3	0	183	831	2.7
DA-10/Sand Island Borrow Area Option 1	102	255	357	6.2
DA-10/Sand Island Borrow Area Option 2	58	246	304	4.7
Horn Island Pass	0	612	612	4.9
PBP-MS	0	175	175	2.0
PBP-AL East Option 2	0	885	885	14.7
PBP-AL West Option 2	0	380	380	5.1
PBP-OCS East	0	464	464	4.2
PBP-OCS West	0	1385	1385	15.5
Cat Island	0	429	429	4.3

3.2.2 Sand Placement Evaluations

The recommended plan identified in the MsCIP PEIS included placement locations at Camille Cut and at the littoral zones at East Ship Island, Petit Bois Island, and Cat Island (Figure 3-1). Through further analyses (discussed below), littoral zone placements were eliminated at East Ship Island, Petit Bois Island, and Cat Island and direct placements were added along the southern shoreline of East Ship Island and eastern shoreline of Cat Island. In general, at East Ship Island and Petit Bois Island, a one-time direct placement of sand in the littoral zone would be at risk of being displaced by the dominant long-shore transport mechanism. Analyses indicate that sand should be placed on the southern shoreline of East Ship Island to ensure re-establishment of the barrier island. At Cat Island, analyses indicate that cross-shore transport mechanisms are not dominant, and that material should be placed on the eastern shoreline to maintain the island and prevent land losses due to erosion.

3.2.2.1 Desktop Analysis of Camille Cut Closure Options

A desktop analysis was conducted to provide relative comparisons between borrow sources for Camille Cut (Appendix L). The analysis was intended as a screening tool to narrow the options for further detailed engineering analysis and hydrodynamic and sediment transport modeling. The desktop analysis assumed the following:

- Historical processes, inferred from the sediment budget as detailed in Byrnes et al. (2012) (Appendix B), would continue through time;

- Preferable fill designs are those that maintain a critical width of 500 feet or greater for a period of 30 years. The 500-foot width represents the smallest island width that minimizes net loss of sand from the barrier island over periods from decades to centuries;
- Preferable borrow sources would have a D50 greater than 0.28 mm to increase the stability of the fill and maximize the life of the sediment within the island system; and
- East Ship would continue to provide a source of sand for Camille Cut fill.

In general, results demonstrated that material placed in Camille Cut with a coarser median grain size would result in a more stable fill section with greater longevity. Also, a smaller footprint within Camille Cut with less volume could be constructed using coarser-grained material.

The desktop analysis did not include the potential effects of tropical storms, littoral zone placement, or offshore borrow sources. These were analyzed on a subset of selected designs in the hydrodynamic and sediment transport modeling work (Appendices C and D). The designs carried forward for further analysis based on results of the desktop assessment are described in the following sections. Appendix L contains the desktop analysis. Appendix D contains details of the predicted response of restoration designs to different synthetic storms.

3.2.2.2 Sediment Transport Modeling and Analysis

The original plan for restoration of the 3.5-mile-long Camille Cut (from the PEIS) consisted of placing approximately 13.5 mcy of sand obtained from an offshore borrow source at St. Bernard Shoals. The newly formed island segment would be constructed as a low-profile berm connecting West Ship Island and East Ship Island.

The initial restoration template evaluated in this SEIS for Camille Cut and East Ship Island consisted of a 1,000-foot-wide equilibrated berm with a crest elevation of +8 feet NAVD88 for Camille Cut and a nearshore feeder berm with sand placed between elevations +1 foot and -15 feet for East Ship Island. The recommended alignment was based largely on the West and East Ship Island orientation and historical island shoreline locations dating back to the late 1800s. The total quantity for the design was 22 mcy and three different grain sizes were considered to evaluate the resilience of the restored design using different potential borrow sources. The median grain sizes were fine 0.2 mm sand, an intermediate grain size of 0.26 mm, and a relatively coarse 0.3-mm sand corresponding to the native sand. The equilibrated crest width of 1,000 feet was held constant for all modeling scenarios.

The modeling results for this configuration showed no island breaching during the 1-year and 10-year events for all three grain size scenarios. Sediment transport rates, however, for the fine sand were about 20 percent higher than for the coarse sand. For the 500-year event, breaching occurred with all three grain sizes, with sediment transport rates for the fine sand about 40 percent higher. The coarse-grained sand (0.3 mm) was considered the best option, because it resulted in significantly less sediment transport into the surrounding environment. Based on modeling results that indicated potential cross-shore losses into the Sound because of overwash for all events simulated, placement of sand at a higher elevation on East Ship Island was determined to be more beneficial to the downdrift island and to provide more immediate protection to the severely eroding southern shoreline of East Ship Island. Appendix D contains additional details of this analysis.

The initial restoration template for Camille Cut and East Ship Island was refined to evaluate severe storm impacts on a reduced template using coarser material (median grain size of 0.32 mm). The reduced template consists of a 700-foot-wide equilibrated berm with a crest elevation of +7 feet NAVD88 for Camille Cut and a 1,000-foot-wide equilibrated berm with a crest elevation of +6 feet along East Ship Island. The 700-foot-wide berm for Camille Cut was the minimum configuration determined from the desktop analysis to provide a critical width over the 30-year design period. The design for East Ship Island was driven by the availability of a sufficient volume of sand (5–6 mcy) needed to supplement the littoral transport of the island for 20 to 30 years, based on the long-term sediment budget for the area. The elevation along Camille Cut was lowered by 1 foot to test the sensitivity of the design at a lower elevation, which is still consistent with natural frontal dune elevations on the barrier island. The revised configuration resulted in increased sediment transport around the island compared to existing condition, as was the case for the original restoration template, with breaching also occurring for the 500-year event. Breaching did not occur for the 1- and 10-year events. The results of the revised configuration showed better protection for East Ship Island and transport pathways that feed the downdrift segments of the island. The revised configuration was carried forward, because it performed better than the original restoration template and resulted in a reduced project cost through the use of a lower quantity of sand for this fill area. Appendix D contains details of the revised configuration analysis.

3.2.2.3 Long-Term Morphological Modeling for Camille Cut and East Ship Island

The revised configuration was modeled further to determine long-term impacts of the proposed project on the surrounding environment. The intent was to assess the project's morphological response over a period of years for average and storm conditions. The following key questions were answered by the modeling results:

1. How will the closing of Camille Cut and the nearshore sand placement at the southeast end of Ship Island affect sediment transport?
2. Will sand extracted from borrow sites adversely affect erosion and deposition on the barrier islands?
3. How will the closing of Camille Cut and sand placement at the southeast end of Ship Island affect operation and maintenance of the Gulfport Federal Navigation project at Ship Island Pass?

The results of the analysis showed that sediment transport would increase around the island because more sand would be introduced into the system for movement. However, the effects are expected to be localized to Ship Island, and impacts to the Gulfport Navigation Channel in Ship Island Pass should be minor under average conditions. There could be an increase in sedimentation in the navigation channel during hurricane events. The larger hurricanes considered (Katrina, Georges) resulted in a 10–30 percent increase in sedimentation in the entrance channel. The smaller hurricanes resulted in a 5–10 percent increase. No negative impacts would be expected from the extraction of sand from the proposed Ship Island borrow site. Appendix C contains further details of the long-term morphological modeling. The design that was developed from the results of the modeling efforts is described below.

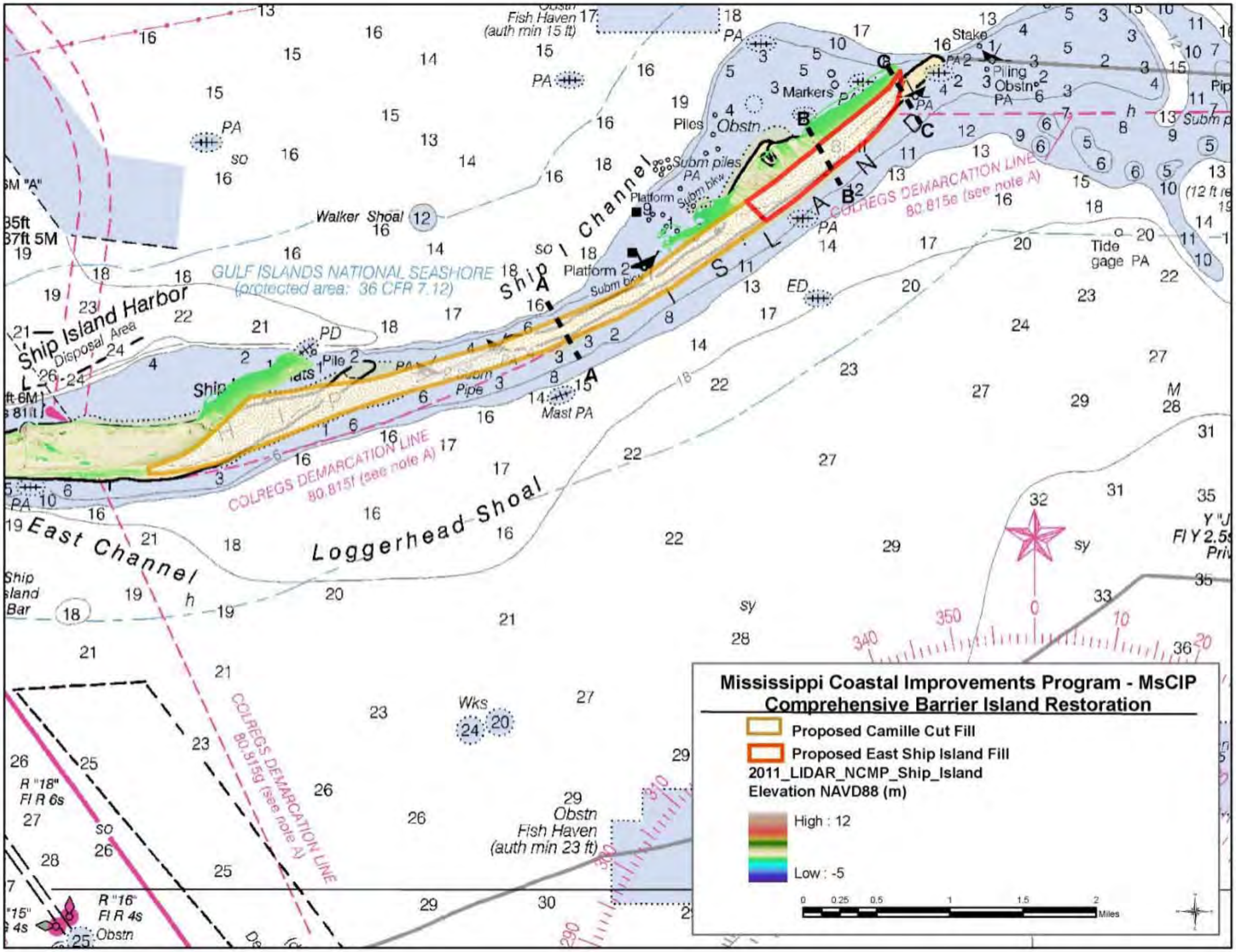
3.2.2.4 Optimal Design for Restoration of Ship Island

The original plan consisted of placing 5 mcy of sand from an offshore borrow site at St. Bernard Shoals in the subaqueous littoral zone east of East Ship Island. This was based on an initial analysis of historical survey data sets and numerical modeling, as discussed in the MsCIP PEIS. Additional studies conducted in support of final design, including the update of the initial analysis, indicated that placement of sand in the littoral zone would not be the direct benefit needed for the eastern portion of Ship Island due to the dynamics of the shoal system within Dog Keys Pass. To provide a more direct benefit to the islands, the littoral zone placement was eliminated in favor of options related to direct placement along the subaerial beach part of the littoral zone immediately adjacent to East Ship Island.

The final recommended design, described below, is based on the desktop analysis and subsequent hydrodynamic and morphological modeling. The constructed Camille Cut template would be approximately 1,100 feet wide (Figure 3-13). The fill would tie into the existing shoreline at the frontal dune line at an elevation of +7 feet (NAVD88) with a 1V:12H (vertical:horizontal) slope to the mean high water level (MHWL) and a 1V:20H slope below it. The fill at its western and eastern ends would tie into the existing berm along the eastern end of West Ship Island and transition into the East Ship Island placement, as described below.

As constructed, the seaward slope of the profile would be steeper than the natural slope (from 1:50 to 1:100); however, based on professional experience, the construction profile is expected to adjust typically over a 12-month period to mimic the island's nearshore slopes. This would occur through the erosion of the upper profile and subsequent deposition near the toe of the fill until its equilibrium profile mimics the natural nearshore profile shape. The construction and equilibrium beach profiles would contain essentially equal volumes of sand; the volume eroded from the upper profile during the adjustment process would equal the volume deposited at the toe of the fill. The equilibrium design width would average approximately 700 feet. The tie-in points of the fill area at both ends would grade into existing contours without substantial breaks in elevation. The fill configuration would preserve the spits protruding northward from West and East Ship Islands at either end of Camille Cut.

Assuming an average water depth of about 5 feet in the existing breach, approximately 13.5 mcy of sand would be required to fill Camille Cut in this manner. Sand used to fill Camille Cut would come from a combination of offshore borrow areas (see Section 3.2.1), including Horn Island Pass, PBP-AL, PBP-MS, PBP-OCS, and Ship Island. Coarser sand from the Horn Island Pass, PBP-MS, PBP-OCS, and PBP-AL, sites would be placed first as fill within Camille Cut and then capped with the finer sand from the Ship Island borrow area (1 mcy). The coarser sand would provide greater stability for the project, while the finer sand deposits would better facilitate the establishment of native dune vegetation. The direct placement of sand to fill Camille Cut would be a one-time event.



NOAA Chart 11373
Source Data: NOS surveys 1970 to 2012

FIGURE 3-13
PROPOSED RESTORATION AREAS AT CAMILLE CUT AND EAST SHIP ISLAND
MsCIP COMPREHENSIVE BARRIER ISLAND RESTORATION SEIS

The newly created island segment would be planted with native dune vegetation, including sea oats (*Uniola paniculata)*, gulf bluestem (*Schizachyrium maritimum*), and/or other grasses and forbs, to restore stable dune habitat. Planting would include vegetation similar to that found in the existing coastal habitats (Section 4.5.1). The planting would include dune grasses in groupings within the newly created beach. These planting of Camille Cut would be expected to trap windblown sand, forming naturally shaped sand contours similar to those of other dunes on the Mississippi barrier islands.

The restoration of East Ship Island would consist of placing approximately 5.5 mcy of sand along the southern shoreline. In addition to restoring the southern shoreline, sand placed in that area would migrate with the littoral drift to support the overall replenishment of the system as identified in the sediment budget analysis and transport modeling. The construction template for the restored southern shoreline would consist of an average berm crest width of approximately 1,200 feet at an elevation of +6 feet NAVD88 with a 1V:12H to 1:20 slope from the seaward edge of the berm to the toe of the fill (intersection with the existing bottom).

Sand used to restore East Ship Island would come from a combination of offshore borrow areas (see Section 3.2.1), including Horn Island Pass, PBP-MS, PBP-AL, PBP-OCS, and Ship Island. Placement of the material would be concurrent with the fill of Camille Cut.

The combined Camille Cut and East Ship Island equilibrated fill would encompass approximately 1,500 acres, of which 800 acres would be above the MHWL. The activities USACE is undertaking as part of the Comprehensive Barrier Island Restoration of West and East Ship Islands, including filling Camille Cut, restoring the southern shore of East Ship Island, and the proposed planting of native vegetation, are collectively a one-time event, as described in the MsCIP Comprehensive Plan and PEIS (USACE, 2009a). No future operations or maintenance activities would be conducted.

3.2.2.5 Analysis and Design for Restoration of Cat Island

Sand placement in the Cat Island littoral zone was conceptually identified in the MsCIP PEIS. Further investigation was recommended to define the exact placement location and quantity applicable for restoration of the eastern shoreface of the island. Restoration of Cat Island through direct placement was strongly supported in the public comments received on the PEIS, as it is generally believed that a robust Cat Island is a necessary element of risk reduction for the western Harrison and Hancock County mainland shorelines. The use of littoral placement as an indirect means of restoration was eliminated in favor of direct placement based on the comments and on extensive sediment budget analysis.

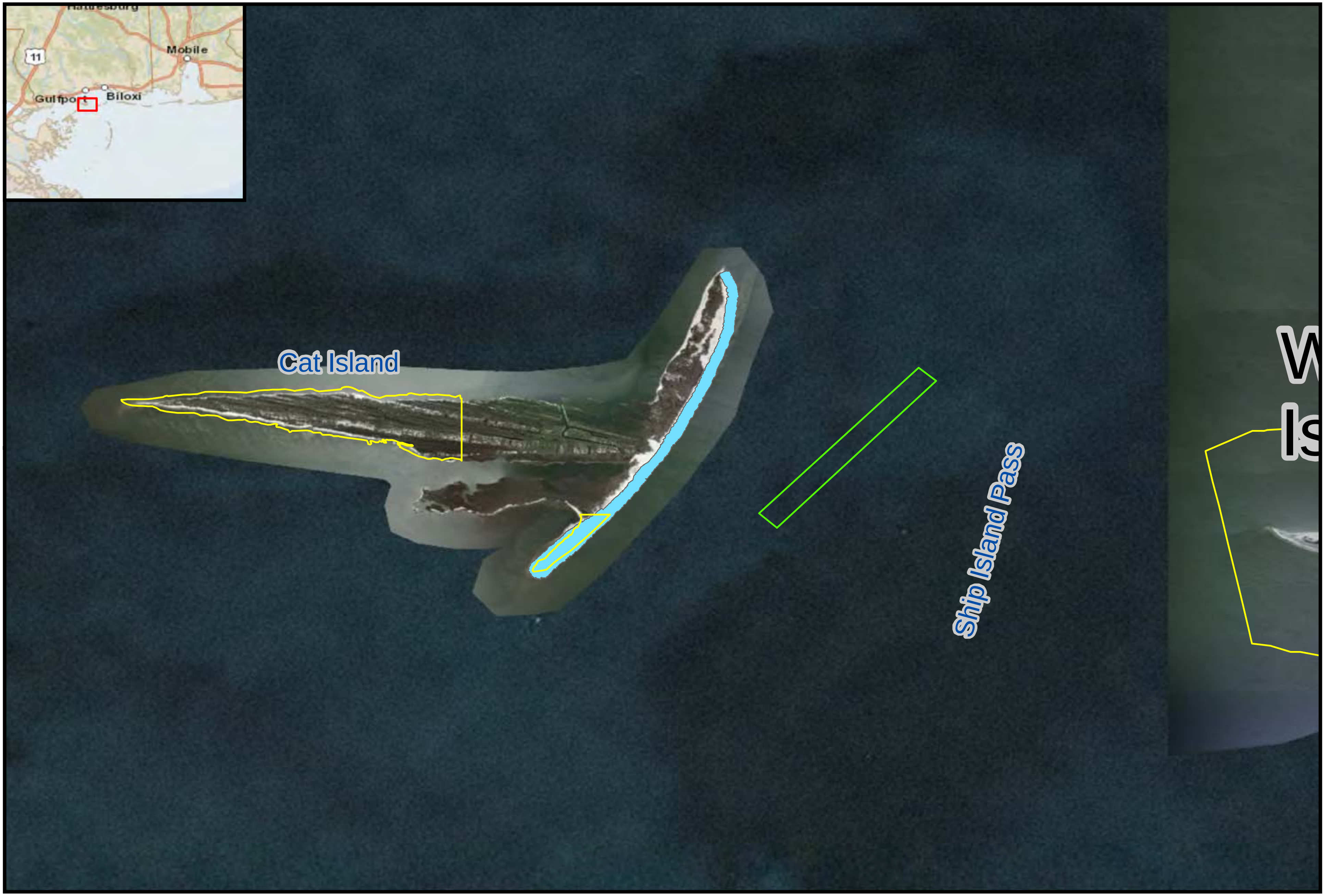
The restoration of Cat Island was developed through analyses of long-term sediment transport processes, the littoral sediment budget, shoreline change, sediment compatibility, and potential impacts due to the removal of material from identified borrow sources. To ensure replication of natural sediment transport pathways and minimization of potential adverse impacts, historical topographic and bathymetric surveys were compared to quantify past and present changes in the sand flux throughout the littoral system. The analysis indicated that littoral sand transported along Cat Island is reworked from the progradational beach ridge complex with no natural migration of sand across Ship Island Pass. This finding was further validated by hydrodynamic and sediment transport modeling (Appendix C). Therefore, it was determined that habitat restoration on Cat Island would benefit most from the direct placement of sand on the beach rather than from placing sand in the littoral zone. Placement directly on the beach at Cat Island is expected to reduce land loss of the island.

Additional studies as documented in Appendix B and Byrnes et al. (2013) determined that the end of longshore transport along the Mississippi barrier islands is at Ship Island Pass. These findings were based on the results of no measurable bathymetric changes between Ship and Cat Islands in survey records spanning between 1848 and 2010. Byrnes et al. (2013) concluded that Cat Island had been segregated from west-directed sand transport along the barrier islands and that changes in dominant wave orientation have promoted reworking of the beach ridge complex that had developed prior to the formation of the St. Bernard Delta and shoals. This study as well as wave and shoreline change modeling indicates the longshore transport along the island is bidirectional, causing sand deposition north and south of the primary beach ridge (Appendices B and E).

The recommended design for Cat Island involves direct placement of 2 mcy of sand on the eastern beach of the island. The design was largely based on restoring the eastern shoreface of Cat Island to 1998 conditions. These conditions were determined to be the best conditions that would be feasible to implement, given the availability of sand for restoration and the anticipated project funding budget. The portion of the shoreline of Cat Island proposed for restoration is currently owned by BP Exploration and Production, Inc. (BP). Once the appropriate fee title conveyance to the State of Mississippi occurs, USACE will require a Right-of-Entry for Authorization for Construction to all lands within the project area, in addition to evidence supporting said legal authority to grant rights-of-way to said lands. If subject lands are not conveyed to the State of Mississippi, any portion of land remaining under private ownership will be excluded from the project limits or will need to be acquired by the Federal Government, in accordance with appropriate policies and laws.

The planning-level construction template includes an average dune width of 40 feet at an elevation of approximately +7.5 feet NAVD88. The construction berm would have an average constructed width of about 250 feet at an elevation of +5 feet with a 1V:12H to 1V:20H slope from the seaward side of the berm to the toe of the fill. Direct placement of sand on the eastern beach would provide area to restore the island habitats, thereby enhancing the island’s ability to absorb energy from westward-propagating waves. The steeper construction profile is expected to adjust rapidly through erosion to mimic the milder natural nearshore profile once it reaches equilibrium. The equilibrium design berm width averages approximately 175 to 200 feet. The total equilibrated fill area encompasses approximately 305 acres.

Sand used in the restoration of Cat Island would come from a 429-acre sand deposit in an area about 2 miles long and 0.2 mile wide centered about 1.25 miles off the eastern shoreline of Cat Island (Figure 3-14). The borrow site would be east of the placement area and outside the GUIS boundaries. Geophysical survey data indicate that extensive sand deposits are available in the area (Appendix A). The borrow site would be dredged to a depth of 3 to 5 feet to minimize disruption of habitat and to minimize the effects of wave refraction over the site after excavation. The borrow area design is configured to prevent significant adverse impacts to the transport system, and use of this site would not affect or adversely modify critical habitat or threaten the continued existence of protected species.



Gulf Islands National Seashore

Cat Island Area 4 Borrow Area

Proposed Sand Placement Area

N

0 0.25 0.5 1 Miles

FIGURE 3-14
PROPOSED RESTORATION AREA AT CAT ISLAND
MsCIP COMPREHENSIVE BARRIER ISLAND RESTORATION SEIS

ES041513031852KNV Restoration_Cat 4/15/13 lk

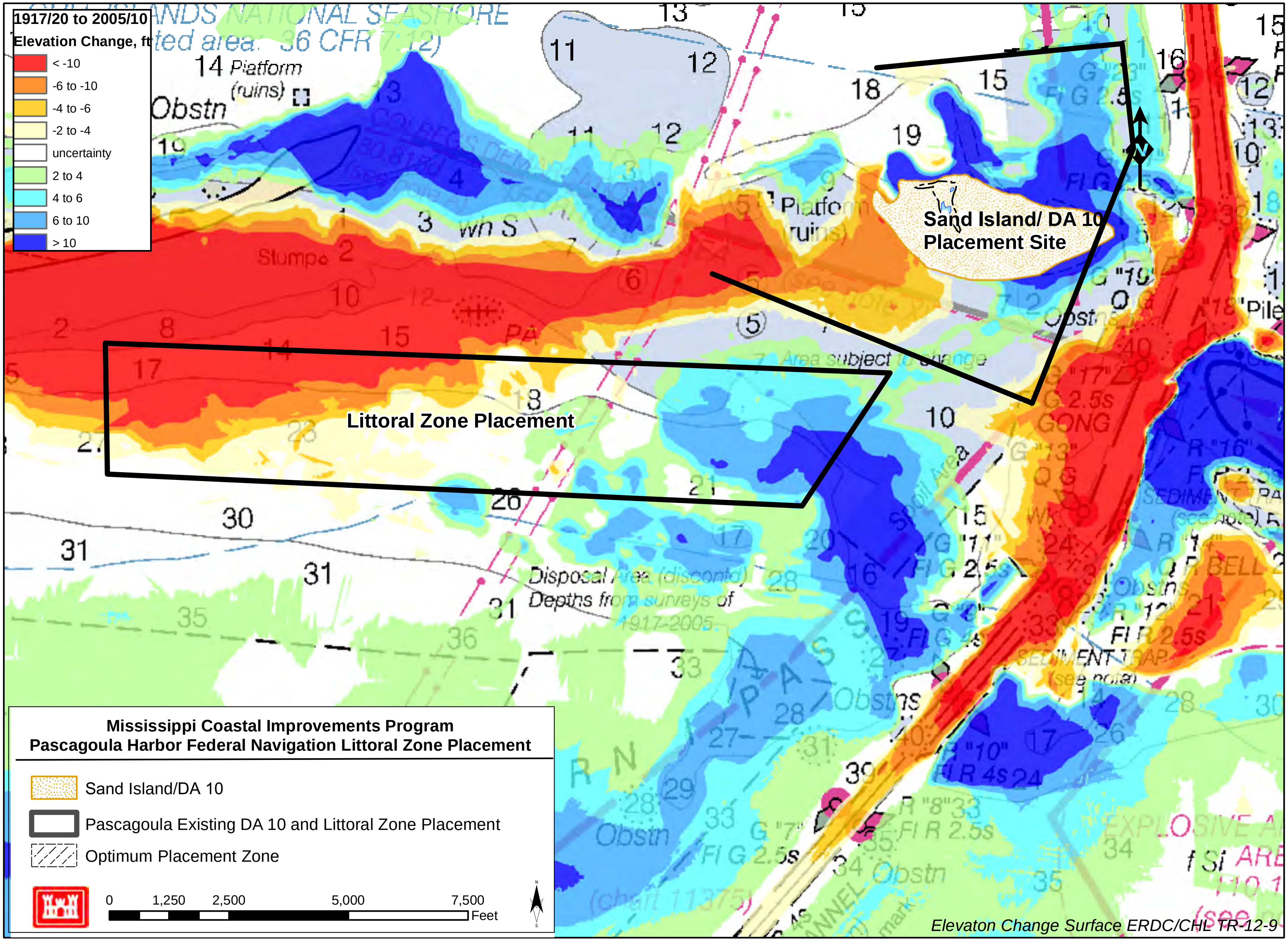
3.2.2.6 Analysis of Littoral Placement of Future Dredged Material from the Pascagoula Federal Navigation Channel

The USACE would modify the management of dredged material from the Pascagoula Federal Navigation project to enhance the littoral transport of sand from the site westward along the island chain and to improve the navigational characteristics of the adjacent channel. This modification would involve combination of existing DA-10 littoral zone and reorientation of placement within this combined site. These two sites (DA-10 and the littoral zone) have been combined to allow for optimal movement of placed sediment. Figure 3-15 shows the existing area of littoral placement at DA-10, and Figure 3-16 shows the proposed area of littoral placement.

This component of the project includes revisions to the dredged material placement practices within the littoral zone at Horn Island. The intent of the revisions is to ensure that placement of dredged material within the littoral zone best replicates natural sediment pathways in the system and minimizes potential adverse impacts to the surrounding area while not increasing costs for operation and maintenance of the Pascagoula Federal Navigation Channel. The need for these revisions was identified through the analysis of long-term sediment transport processes, historical dredging records, and modeling of sediment transport potential. Historical topographic surveys, bathymetric surveys, and dredging records over a period of record from 1848–2010 were compared to quantify past and present changes in the sand flux and the potential impact of dredging activities on transport quantities throughout the littoral system. Results of the sediment budget analysis showed that approximately 6.3 mcy (68,000 cy/yr) of dredged material had been removed from and placed offshore of the active littoral zone since 1917. In addition, another 6.9 mcy (75,000 cy/yr) had been placed within DA-10/Sand Island (Appendix B) during this same period. Although the intent of placing dredged material from Horn Island Pass at DA-10 was to put the material within the downdrift littoral system to continue to supply sediment to the barrier islands, the analysis indicated that the average transport rates are extremely low in this area because Sand Island is located too far north on the shoal.

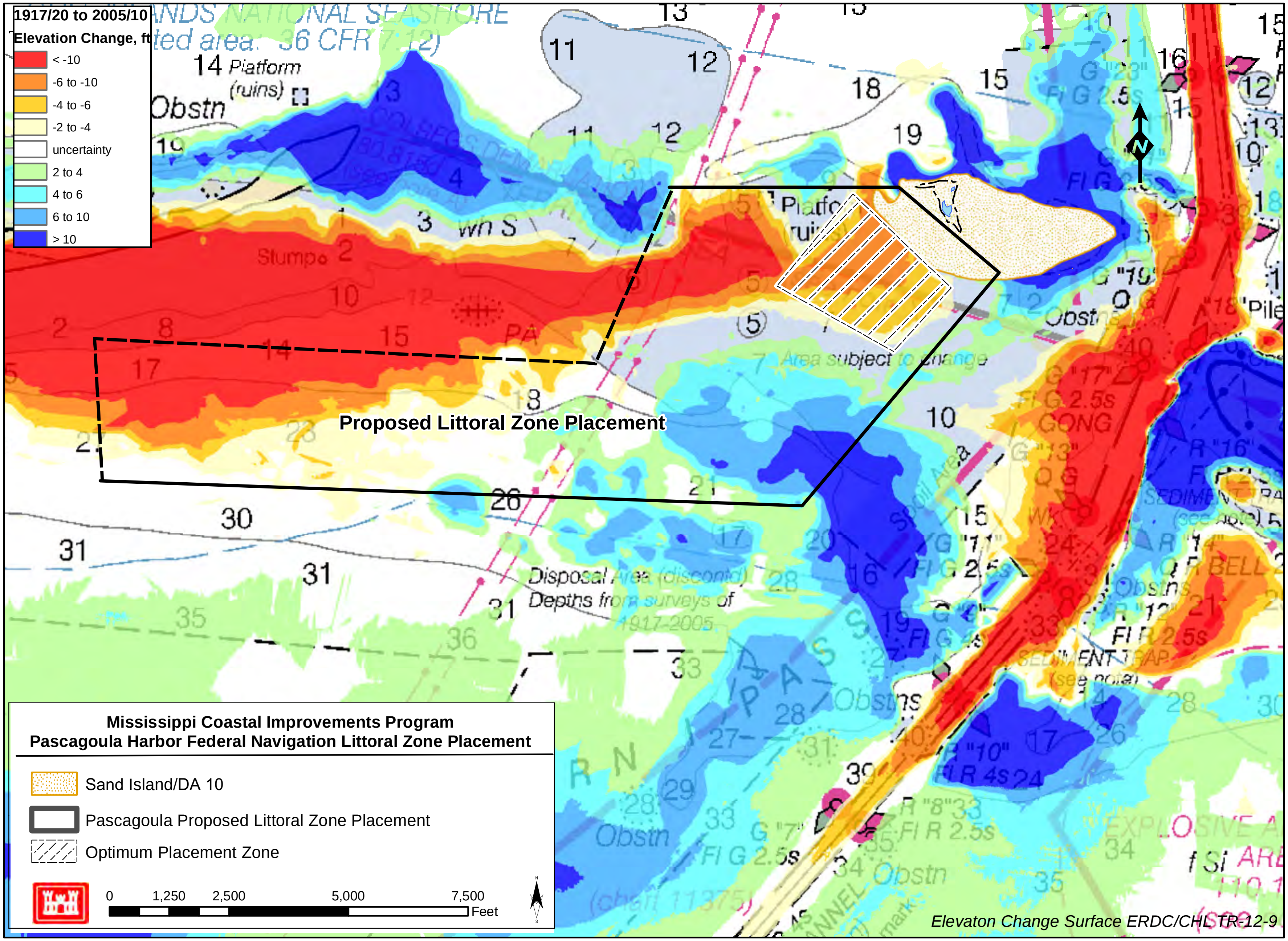
In addition, disposal of material within DA-10/Sand Island has resulted in a reduction in conveyance area through the pass, causing increased velocities and scour. This has contributed to scour at depths as great as 20 feet deeper than authorized (Appendix B).

It is recommended that suitable sandy material dredged from the Horn Island Pass part of the Pascagoula Federal Navigation Channel be placed in the combined DA-10/littoral zone site along the shallow shoals exposed to the open Gulf waves with the greatest sand transport potential (Appendix F). This area is preferred from both a sediment transport potential and an operational standpoint to minimize unnecessary pumping distances.



NOAA Chart 11373
Source Data: NOS surveys 1970 to 2009

FIGURE 3-15
EXISTING DA-10 LITTORAL ZONE PLACEMENT
MsCIP COMPREHENSIVE BARRIER ISLAND RESTORATION SEIS



NOAA Chart 11373
Source Data: NOS surveys 1970 to 2009

FIGURE 3-16
PROPOSED DA-10 LITTORAL ZONE PLACEMENT
MsCIP COMPREHENSIVE BARRIER ISLAND RESTORATION SEIS

ES041513031852KNV F3-17_ProposedDA-10_LittoralZonePlace 2/20/14 lk

3.2.3 Construction Methodology Evaluation

3.2.3.1 Dredging and Construction Equipment

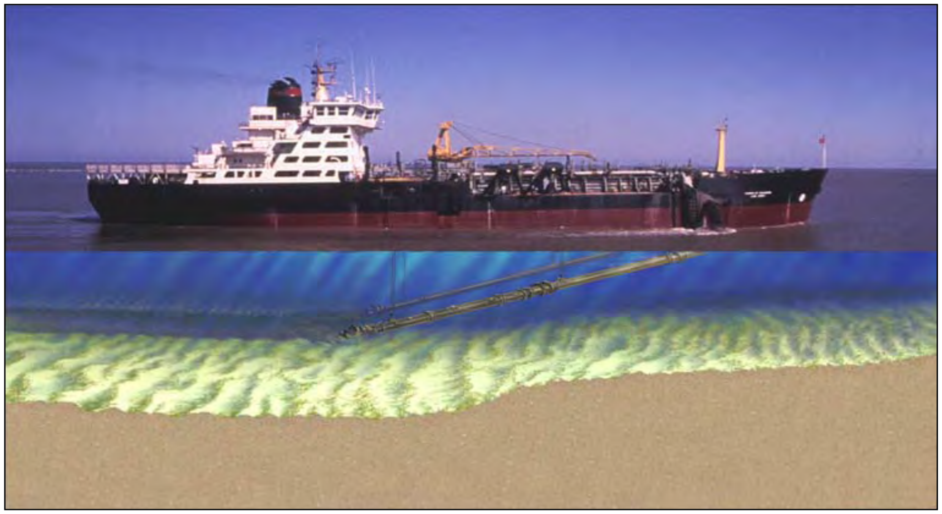
The dredging equipment that would be used for removal and placement depends primarily on the volume of material to be collected, the depth of the borrow material, and the depth of the water over the site. Most dredging would be performed using hydraulic dredges (Figure 3-17). Hydraulic dredges work by excavating a mixture of dredged material and water from the bottom. During operation, the amount of water pulled in with the material would be controlled to make a workable mixture. Water pumped would be discharged with the sand at the point of placement. A pipeline dredge would be used to excavate sand through an intake pipe, and then push it out of a discharge pipeline directly into the placement site. Because pipeline dredges pump directly to the placement site, they operate continuously and are cost-efficient. Most pipeline dredges have a cutterhead on the suction end. A cutterhead is a mechanical device equipped with rotating blades or teeth to break up or loosen the bottom material so that it can be sucked through the dredge. Pipeline dredges are mounted on barges and are not usually self-powered, but are towed to the dredging site and secured in place by spuds (anchor pilings). Cutterhead pipeline dredges work best in large protected areas with deep shoals, where the cutterhead is buried in the bottom.

Hopper dredges are ships with large hoppers, or containment areas, inside (Figure 3-17). These dredges are fitted with powerful pumps. During operation, the dredge suctions material from the channel bottom through long intake pipes, called drag arms, and stores it in the hoppers. The water portion of the slurry is drained from the material and is discharged from the vessel during operations. When the hopper is full, dredging stops and the ship travels to the placement site for discharge. Hopper dredges are well-suited to dredging heavy sands. They can maintain operations in relatively rough seas and because they are mobile, can be used in high traffic areas. However, because of their size, they cannot be used in confined or shallow areas. Hopper dredges can move quickly to disposal sites under their own power, but since the dredging stops during transit to and from the disposal area, the operation loses efficiency if the haul distance is great (USACE, 2011a).

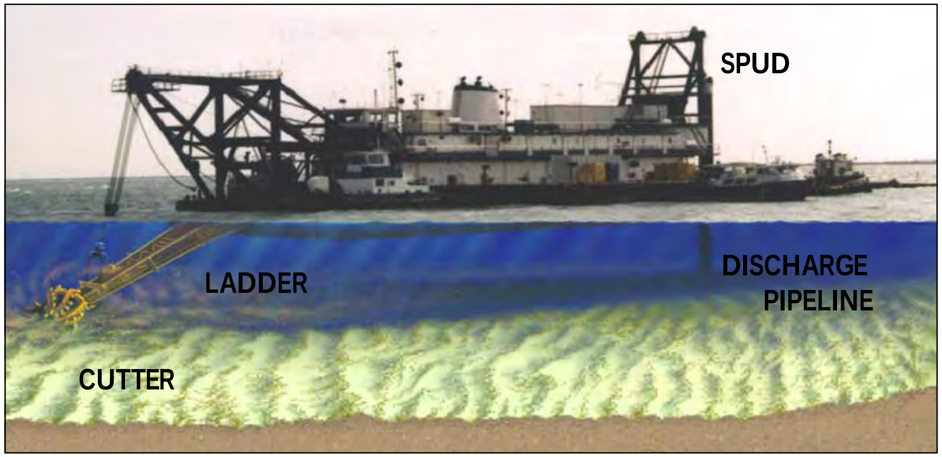
Additional dredging and placement could be conducted using bucket/mechanical dredges. The dredges remove material by scooping it from the bottom and then placing it onto a waiting barge or into a designated area. Mechanical dredges can work in tightly confined areas and are best at moving consolidated, or hard-packed, materials. The dredges typically are mounted on a large barge, towed to the dredged site, and secured in place by anchors or spuds.

Usually disposal barges, called dump scows, are used in conjunction with a mechanical dredge to move dredged materials. If numerous barges are used, work can proceed continuously, only interrupted by changing dump scows or moving the dredge (USACE, 2011a).

Hopper Dredge



Hydraulic Cutterhead Pipeline Dredge



Pipeline Dredge Discharge

Bucket/mechanical Dredge

FIGURE 3-17
DREDGING DEVICES FOR THE MOVEMENT AND PLACEMENT OF SAND
MsCIP COMPREHENSIVE BARRIER ISLAND RESTORATION SEIS

Other construction equipment used would vary based on site conditions and specific project needs, but would include sediment transport equipment, retaining structures, heavy machinery, and a variety of support equipment. Sediment transport equipment could include several types of conveyances, such as scows, crane barges, and jack-up barges, pipelines (submerged, floating, and land), and booster pumps. Heavy machinery would be used to move sand and facilitate construction. The equipment could include bull-dozers, front-end loaders, track-hoes, marshbuggy trackhoes, and backhoes. Various support equipment also would be used, such as crew and work boats, trucks, trailers, construction trailers, all-terrain vehicles, and floating docks or channels with pilings to facilitate loading and unloading of personnel and equipment. Locations of temporary floatation docks or channels are to be determined, but would likely be along the northward sides of the Camille Cut, and or island tips near the placement areas. Channels would be placed outside of environmentally sensitive areas to the maximum extent possible.

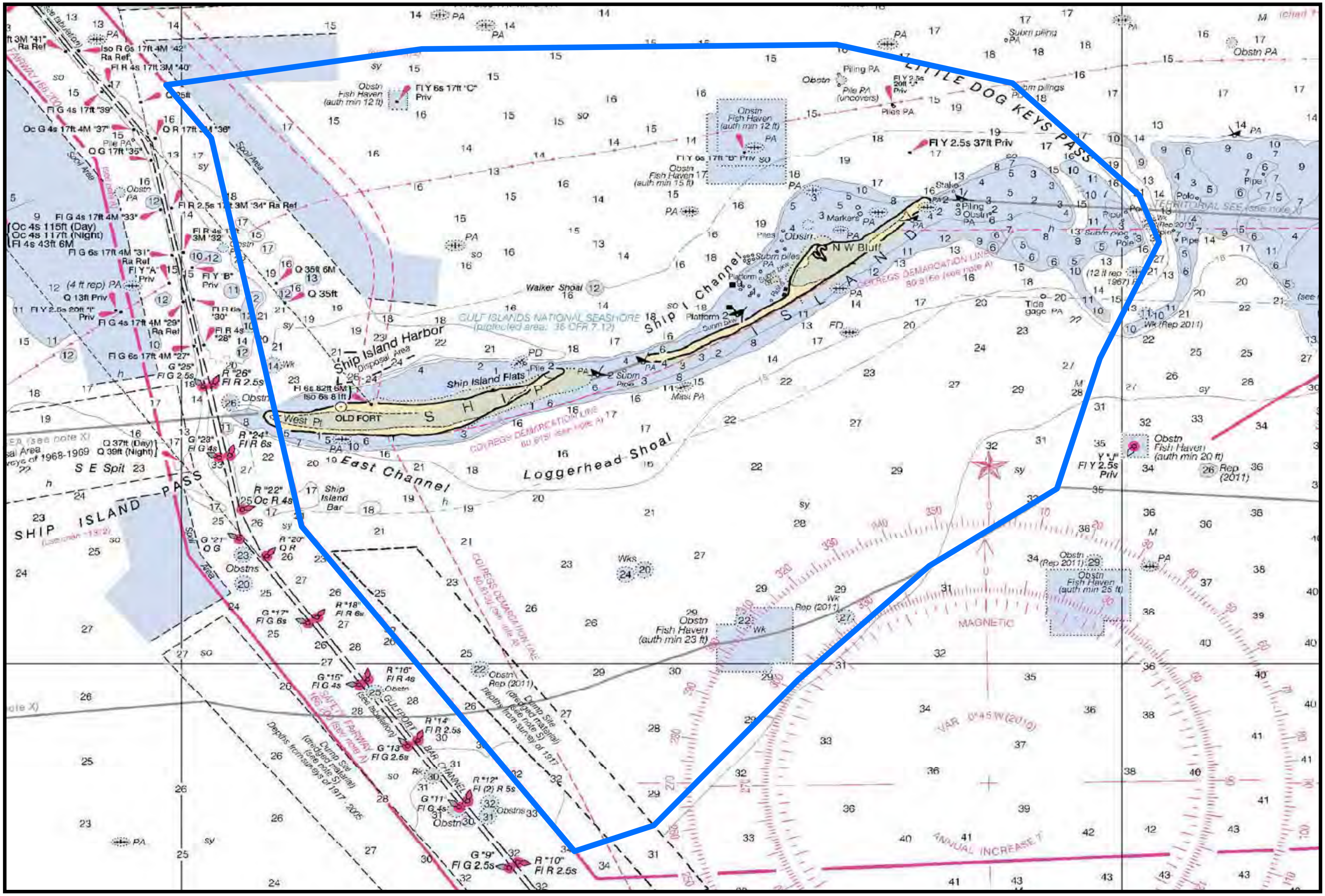
Along with the dredges, this equipment could be staged offshore and outside the restoration area during use. At Ship Island, the area between the -30-foot contour, the GIWW, Gulfport Navigation Channel, and Dog Keys Pass (Figure 3-18) could be used to stage or anchor equipment before or during use. Equipment also would be staged onshore. Heavy machinery, vehicles, sediment retaining structures, and other construction equipment could be parked or staged before and during use.

3.2.3.2 Construction Mixing Options

Four options for mixing sand dredged from separate borrow areas were considered for filling Camille Cut. The options take into account the need for compatible sand on Ship Island to resist erosion while maximizing the use of finer-grained sources. No mixing options were considered for Cat Island. For each option described below, material would be dredged, hauled to Ship Island, and pumped off directly to the southern shoreline of East Ship Island. The following construction options were evaluated for placing sand in Camille Cut.

Offshore Mixing

Offshore mixing would consist of dredging sand from the Petit Bois Pass borrow area and placing it on the sand in the Ship Island borrow area. Material from the Petit Bois Pass site would likely have to be pumped off onto the Ship Island borrow area because the water surrounding the borrow site is too shallow for most hopper dredges to access and bottom dump. Once the material from the Petit Bois Pass site is placed atop the Ship Island borrow area, a cutterhead dredge would be used to dredge the layered material (coarse-grained material from Petit Bois Pass on the fine-grained material from the Ship Island borrow area) and place it in Camille Cut. Mixing would be achieved during this phase of the dredging/ placement process. Approximately 8 mcy of sand from each borrow site (16 mcy total) would be used.



Potential Temporary Construction Disturbance Area

NOAA Chart 11375
Source Data: NOS surveys 1970 to 2012

FIGURE 3-18
POTENTIAL CONSTRUCTION STAGING AREA FOR RESTORATION AT CAMILLE CUT AND EAST SHIP ISLAND
MsCIP COMPREHENSIVE BARRIER ISLAND RESTORATION SEIS

ES041513031852KNV F3-19_Staging_1 2/20/14 lk

Onsite Mixing

The difference in the onsite mixing approach is that the material from the Petit Bois Pass site would be placed in an area south of the Ship Island borrow area (rather than on top of it) where the water depths would allow all hopper dredges to bottom dump the material (instead of pumping off). Two cutterhead dredges would then be used to achieve mixing. One dredge would work in the Ship Island borrow area and one in the area where the Petit Bois Pass material was deposited. The dredge discharge lines would be combined to achieve a mixed slurry of dredged material at the placement site. About 8 mcy of sand from each of the borrow sites (16 mcy total) would be used.

3.2.3.3 Construction Phasing

The Ship Island restoration component would be constructed in five phases. Four of the phases would consist of dredging and placement activities and the fifth phase would consist of dune planting activities on the newly restored Ship Island. Phases 3, 4, and 5 may be constructed concurrently. Work being performed under Phases 3 and 4 would be completed at different locations (i.e., Camille Cut and East Ship Island). Work completed under Phases 4 and 5 would occur in the same location (i.e., Camille Cut), but Phase 5 would begin approximately 2 months after Phase 4 begins, to allow for the Phase 5 effort to occur on the portion of the Phase 4 work that would have already been completed. It is estimated that the five phases would be completed over a period of 2.5 years. Each phase is detailed below.

- **Phase 1:** Approximately 6.0 mcy of in-placed sand volumes would be used to construct the initial berm across Camille Cut and approximately 0.8 mcy would be used to construct a portion of the berm on East Ship Island. The term "in-placed" refers to the actual volume of sand material on the beach, assuming that some fraction above this net volume might be lost in the process. Material for Phase 1 would likely be dredged from a combination of the PBP- OCS East and West, Horn Island Pass and PBP-MS borrow sites. The initial berm at Camille Cut would have a crest width of approximately 500 feet, a top elevation of +5 feet NAVD88, and a length of approximately 22,500 feet. The berm along East Ship Island would have a crest width of approximately 500 feet, a top elevation of +5 feet NAVD88, and a length of approximately 3,000 feet including the appropriate taper to transition into the existing island. The East Ship Island berm would be constructed adjacent to the Camille Cut berm along the west end of the southern shoreline of East Ship Island. It would serve as a feeder source for Camille Cut until the remaining portion of the East Ship Island berm is constructed under Phase 3. Work is anticipated to occur generally from east to west, but depending on the contractor and equipment, could also occur west to east. It is estimated that Phase 1 would be completed over a period of 15 months.

- **Phase 2:** Approximately 6.3 mcy of in-placed sand volumes would likely be dredged from a combination of the PBP - OCS West and PBP-AL borrow sites to raise and widen the initial Camille Cut berm constructed in Phase 1 to elevation +7 feet NAVD88 and approximately 1,100 feet, respectively. The berm would be approximately 24,500 feet long, including the taper to tie into the East Ship Island berm. The upper interior portion of the berm would be left void during this phase and would be filled using finer-grained sand from the Ship Island borrow site during Phase 4. It is estimated that Phase 2 would be completed over a period of 10 months.

- **Phase 3:** Approximately 4.7 mcy of in-placed sand would be used to extend and expand the initial East Ship Island berm constructed in Phase 1 and complete the restoration of the southern shoreline of the East Ship Island. Material for Phase 3 would likely be dredged from a combination of PBP - OCS West and PBP-AL borrow sites. The final berm along the southern shoreline of East Ship Island would have a crest width of approximately 1,200 feet, a top elevation of +6 feet NAVD88, and a length of approximately 8,000 feet. It is estimated that Phase 3 would be completed over a period of 7 months.
- **Phase 4:** Approximately 1.1 mcy of in-placed sand would be used to fill the void left from Phase 2 in the upper interior portion of the Camille Cut fill. Material for Phase 4 would be dredged from the Ship Island borrow site. The sand in the Ship Island borrow site is finer grained than the material in the other borrow sites and would serve as a more suitable substrate for vegetation growth. The final Camille Cut berm would have a crest width of approximately 1,100 feet with a top elevation of +7 feet NAVD88 after the Phase 4 cap is constructed. It is estimated that Phase 4 would be completed over a period of 5 months.
- **Phase 5:** Work under Phase 5 would consist of planting the Camille Cut restoration berm with native dune vegetation. The newly created island segment would be planted with native dune vegetation, including sea oats, gulf bluestem, and or other grasses and forbs, to restore stable dune habitat. Planting would include vegetation similar to that found in the existing coastal habitats (Section 4.5.1). It is estimated that Phase 5 would be completed over a period of 7 months.
- **Cat Island:** Restoration work at Cat Island would be conducted in one phase. The proximity of the borrow area to the island's eastern shoreline in relatively shallow water would allow the rapid placement of sand on the beach, likely using a pipeline dredge. The material would be pumped onto the beach and shaped using land-based equipment. Following placement, the area would be vegetated with native grasses. Restoration would occur over approximately 6 months.

3.3 Summary of Alternatives Eliminated

The MsCIP PEIS of June 2009 evaluated a full range of barrier island ecosystem restoration alternatives, from very limited restoration of East Ship Island and West Ship Island to massive restoration of the islands' historical dimensions (USACE, 2009a). The ROD for the MsCIP PEIS recommended a comprehensive restoration plan that combined two of the alternatives. P.L. 111-32, enacted June 24, 2009, authorized and funded the recommended restoration plan for construction to restore historical levels of storm damage risk reduction to the Mississippi Gulf Coast. Thus, alternatives that were evaluated and rejected under the MsCIP PEIS are not carried forward for analysis.

Alternatives considered in this SEIS are tiered from the MsCIP PEIS (40 C.F.R. 1508.28). They include site-specific borrow areas, sand placement areas, and construction options for implementing the authorized project.

3.3.1 Borrow Material Sites Not Carried Forward

As detailed in Section 3.2.1.2, the St. Bernard Shoals, Gulfport Channel, Mississippi Sound, Ship Island Pass, Dog Keys Pass, and Lower Tombigbee River Upland disposal sites were identified as not feasible based on additional available information or detailed geophysical survey and associated vibracore samples. The following is the rationale for eliminating them:

- **St. Bernard Shoals**—Sand at this site is too dark gray and fine-grained (0.12 to 0.16 mm). Use of this site would not be cost-effective because of the distance from placement areas. The site is crossed by numerous pipelines that would complicate the dredging operation.
- **Gulfport Channel**—Since identification of this site, it has already been used as a borrow source for the West Ship Island north shore restoration (USACE, 2010b). Remaining sediments are unsuitable because of high silt and clay content and limited volumes of available sand.
- **Mississippi Sound**—Sand deposits at this site are mixed with areas of silt and clay overburden. The sand is finer than desired, with grain sizes ranging from 0.16 to 0.21 mm. The site is in designated GSCH.
- **Ship Island Pass**—Upon investigation, sand deposits at this site were not as large as expected and contained 8–20 feet of muddy overburden. Most of the sand is finer than desired, with grain sizes ranging from 0.13 to 0.19 mm. The site is located in GSCH.
- **Dog Keys Pass**—Most of the site is within GUIS boundaries, adjacent to and within the active tidal inlets that provide sediment to the barrier island system. Sand deposits encountered outside of these boundaries were generally too fine-grained for use with this project.
- **Lower Tombigbee River Upland Sites**—Particles at this site are coated with iron oxide and therefore have a reddish pink hue. Use of upland river sites would involve high costs associated with required haul distances (approximately 78 miles for the Sunflower dredged material placement area and 92 miles for the Lower Princess dredged material placement area, from the mouth of the Mobile River) and logistical difficulties in transporting the material to the placement locations.

3.3.2 Sand Placement Options Not Carried Forward

Three sand placement locations, as identified in the PEIS, were evaluated but not carried forward: East Ship Island littoral zone, Petit Bois Island littoral zone, and Cat Island littoral zone. As discussed in Section 3.2.2, the results of additional sediment transport assessments determined that better replenishment of Ship and Cat Islands would occur from placement of sand on and immediately adjacent to East Ship Island and Cat Island rather than within the littoral zone. In addition, the sediment budget analysis determined that there was sufficient material in the littoral zone of Petit Bois Island to support the island maintenance process (Appendix B). Because placement was not deemed necessary to maintain the island, this placement location was eliminated from further evaluation.

Three construction mixing options were considered but not carried forward. The offshore mixing and onsite mixing construction options were eliminated from consideration. They were less cost-effective than the capping option because of the need to handle the material multiple times. The finer-grained core construction option was eliminated even though its cost was comparable to that of the capping option, because it increased the risk of reducing the longer-term stability of the restored Camille Cut and posed significant construction challenges to contain the finer-grained material.

3.4 Alternatives Considered

3.4.1 No-Action

The No-Action Alternative represents without-project conditions that would occur in the project area without comprehensive restoration of the Mississippi barrier islands. The MsCIP PEIS (USACE, 2009a), from which this SEIS is tiered, describes future without-project conditions and evaluates the environmental effects of the No-Action Alternative. The No-Action Alternative serves as the baseline against which potential environmental impacts and benefits associated with site-specific implementation of barrier island restoration are compared.

Under the No-Action Alternative, erosion of the barrier islands would continue, increasing salinity of the Mississippi Sound, and continuing degradation and loss of estuarine habitats and productive fisheries (USACE, 2009a). Net land loss and morphological changes would continue along the barrier islands into the future, primarily as a result of storms. Historical analysis of barrier island change by Morton (2008) and recent analysis by Byrnes et al. (2013) indicate that East Ship Island would continue to narrow and lose land area under the No-Action alternative. Sand transport from East Ship Island would be depleted in a matter of decades, as storm and other normal transport processes reduce the island to a shoal. Dog Keys Pass would become wider as East Ship Island evolves to a shoal, and natural sediment bypassing to West Ship Island would be greatly diminished. Cat Island would continue to lose land area from persistent erosion due to increased exposure to southeast waves from the Gulf.

Loss of coastal ecotone habitat would continue. Barrier islands and beaches along eroding margins of the islands would transition to open-water habitat. These changes would alter and reduce the integrity of existing beach and nearshore habitats for use by communities of terrestrial and benthic invertebrates, fish, wetland plants, submerged aquatic vegetation (SAV), marine mammals, and migratory and coastal birds (USACE, 2009a). Beach and littoral habitats for threatened and endangered species, such as Gulf sturgeon, sea turtles, and piping plover, would also diminish. Continuing loss of the barrier islands would alter water quality in the Mississippi Sound as a result of increasing salinity and would threaten commercial and recreational fishing as well as essential fish and shellfish habitats for estuarine species. In addition, unprotected cultural resource sites along eroding shorelines of the barrier islands could be lost.

The structural integrity and efficacy of the barrier islands as a first line of defense of mainland habitats would continue to diminish, reducing the resilience of the coast against damage from future storms. These changes would threaten the estuarine ecosystem of the Mississippi Sound and expose the mainland coast and its associated wetlands and coastal habitats to increasing saltwater intrusion and damage from future storms.

As documented in the MsCIP PEIS (USACE, 2009a), the No-Action Alternative would fail to address the need for comprehensive improvements in the coastal area of Mississippi in the interest of hurricane and storm damage reduction, prevention of saltwater intrusion, preservation of fish and wildlife, prevention of erosion, and other related water resource purposes. Although the No-Action Alternative was determined not to meet the purpose of and need for barrier island restoration, it is considered herein to meet the requirements of NEPA and for use in Section 5 as the baseline for evaluating the effects of the TSP.

3.4.2 Tentatively Selected Plan

The only component of the action alternatives that varies from the TSP is the potential combination of borrow sites. All action alternatives carried forward include the following components:

- Restoration of Ship Island, including Sand Placement in Camille Cut and Replenishment of East Ship Island;
- Beach-front and Dune Placement of Sand Along Cat Island; and
- Management of Maintenance Dredged Material from Pascagoula Ship Channel.

The text below provides details on the three common components of the action alternatives. These alternatives would be carried out in accordance with the MAM Plan to determine progress toward restoration success and to increase the likelihood of achieving desired project outcomes in the face of uncertainty. The MAM Plan is a living document and will be regularly updated to reflect monitoring-acquired and other new information as well as resolution of and progress on resolving key uncertainties and/or discovering lessons learned to help with management of coastal resources.

3.4.2.1 Ship Island Restoration

The restoration of Ship Island includes closing Camille Cut, restoring the shoreline of the current East Ship Island, and using sand from five borrow areas (Borrow Site Option 4). Section 3.2.2.4 summarizes the detailed design. Restoration would be accomplished in five phases over a 2.5-year period, as described in Section 3.2.3.3.

Direct Sand Placement in Camille Cut

To restore East Ship Island and West Ship Island to a single elongated barrier island, the 3.5-mile-long Camille Cut would be filled with approximately 13.5 mcy of sand. Sand used to fill Camille Cut would come from a combination of borrow sites described below. Sand from potential borrow sites would likely be dredged with a hopper dredge and/or cutterhead dredge, loaded into scows, and hauled/pumped to the placement site.

The newly formed island segment would be constructed as a low-level dune system connecting West Ship Island and East Ship Island (Figure 3-19). The constructed Camille Cut template would be approximately 1,100 feet wide. The fill would tie into the island shoreline just below the frontal dune line at an elevation of +7 feet NAVD88 with a 1V:12H slope to the MHWL and a 1V:20H slope below the MHWL. The fill at its western and eastern ends would tie into the existing berm along the eastern end of West Ship Island and transition into the East Ship Island placement. Sand from potential borrow sites would likely be dredged with a hopper dredge and/or cutterhead dredge, hauled, and then pumped directly onto the site. The direct placement of sand to fill Camille Cut would be a one-time event.

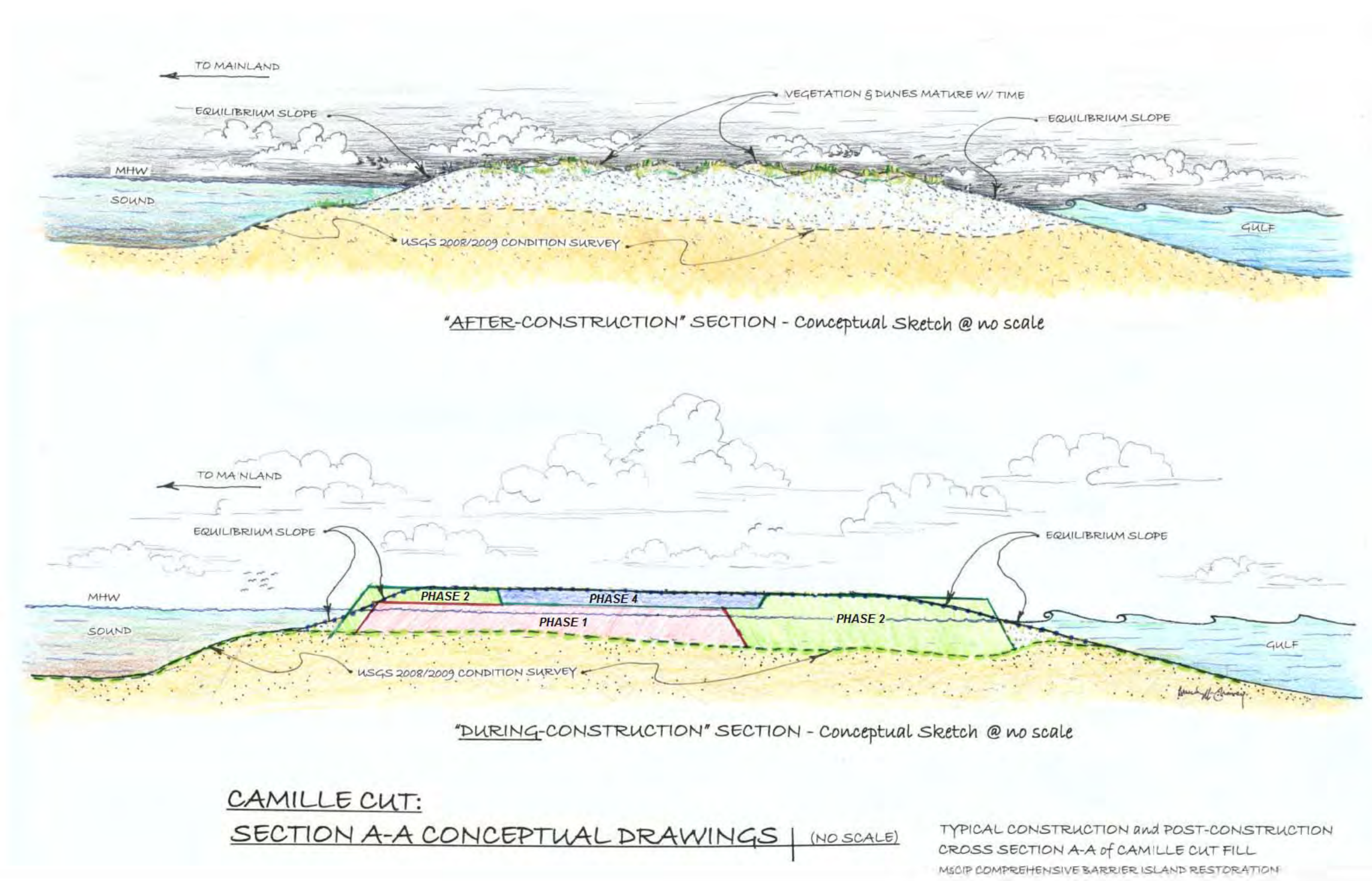


FIGURE 3-19
CAMILLE CUT TYPICAL CROSS SECTION (A-A)
MsCIP COMPREHENSIVE BARRIER ISLAND RESTORATION SEIS

As sand placement in Camille Cut progresses, the newly created island segment would be planted with native dune vegetation, including sea oats and/or other grasses and forbs, to restore stable dune habitat. The planting would include dune grasses in groupings within the newly created beach.

Replenishment of East Ship Island

Restoration of East Ship Island would consist of placing approximately 5.5 mcy of sand along the southern shoreline. Placement of sand in this area would add material to the littoral system of Ship Island, which would support the overall replenishment of the system as identified in the sediment budget and sediment transport analysis. The construction template for the restored southern shoreline would consist of an average berm crest width of approximately 1,200 feet at an elevation of +6 feet NAVD88 with a 1V:12H to 1V:20H slope from the seaward edge of the berm to the toe of the fill (intersection with the existing bottom) (Figures 3-20 and 3-21).

Sand used to restore East Ship Island would come from a combination of borrow sites. Sand from potential borrow sites would likely be dredged with a hopper dredge and/or cutterhead dredge, loaded into scows, and hauled/pumped to the placement site. Placement of the material would be concurrent with the fill of Camille Cut.

The combined Camille Cut and East Ship Island equilibrated fill would encompass 1,500 acres, of which 800 acres would be above the MHWL. The placement of sand would be a one-time event.

Borrow Site Option 4

Borrow Site Option 4 would use approximately 19.0 mcy of in-placed sand volumes, which would be dredged from five borrow areas for Camille Cut closure and restoration of East Ship Island. The borrow sites are Ship Island, PBP-AL, PBP-MS, PBP-OCS, and Horn Island Pass. The estimated rough order of magnitude cost of this option is $385.5 million.

3.4.2.2 Cat Island Restoration

Dune and beach restoration on Cat Island, including revegetation, would be implemented through the direct placement of 2 mcy of sand on the eastern beach fronting Cat Island (Figure 3-14). The recommended design was largely based on restoring the eastern shoreface of Cat Island to 1998 conditions. The construction template would include an average dune width of 40 feet at an elevation of approximately +7.5 feet NAVD88. The construction berm would have an average constructed width of 250 feet at an elevation of approximately +5 feet NAVD88 with a 1V:12H to 1V:20H slope from the seaward side of the berm to the toe of the fill. Direct placement of sand on the eastern beach would restore the island habitats, thereby enhancing the island’s ability to absorb energy from westward-propagating waves. The construction profile is expected to adjust rapidly through the erosion of the upper profile and mimic the natural nearshore profile once it reaches equilibrium. The equilibrium design berm width averages 175 to 200 feet. The total equilibrated fill area encompasses approximately 305 acres.

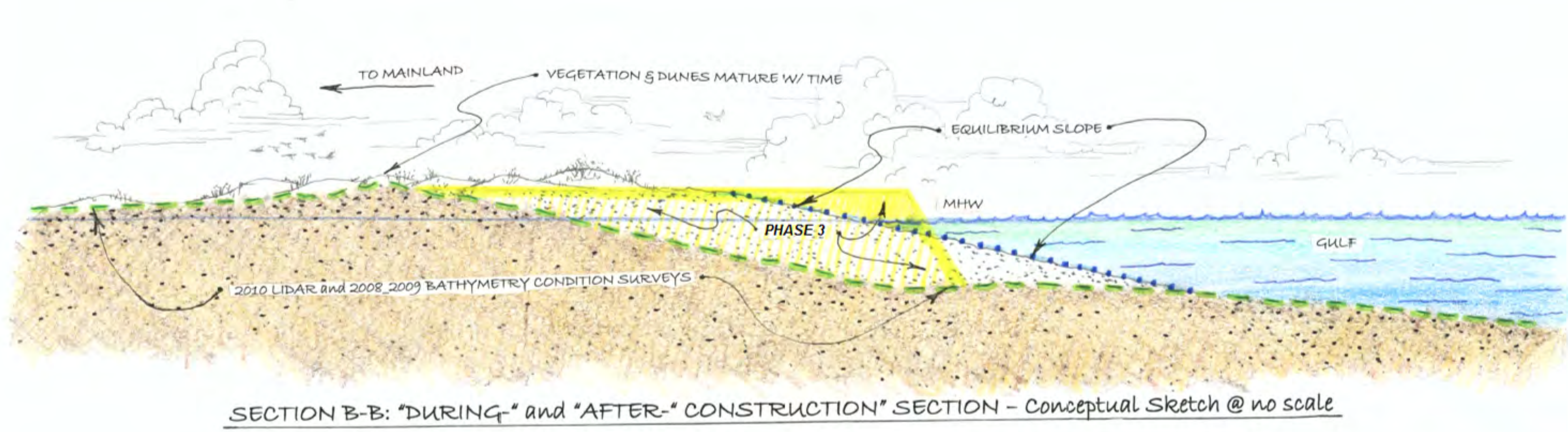


FIGURE 3-20
EAST SHIP ISLAND TYPICAL CROSS SECTION (B-B)
MsCIP COMPREHENSIVE BARRIER ISLAND RESTORATION SEIS

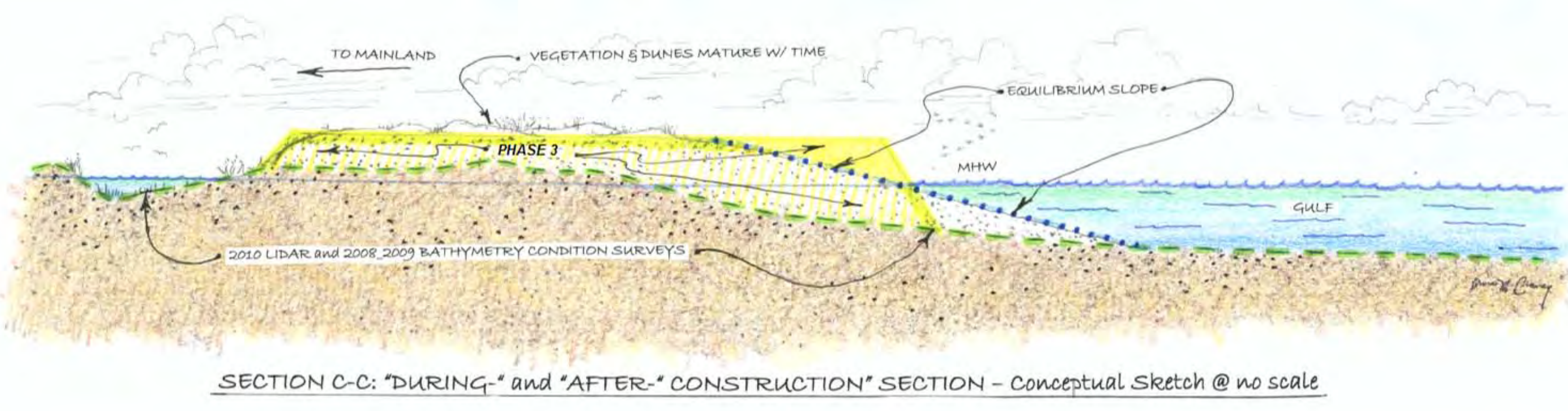


FIGURE 3-21
EAST SHIP ISLAND TYPICAL CROSS SECTION (CC)
MsCIP COMPREHENSIVE BARRIER ISLAND RESTORATION SEIS

Sand used in the restoration of Cat Island would come from a 429-acre sand deposit in an area about 2 miles long and 0.2-mile wide centered about 1.25 miles off the eastern shoreline of Cat Island (Figure 3-14). The borrow site would be east of the placement area and outside the GUIS boundaries. Geophysical survey data indicate that extensive sand deposits are available there (Appendix A). The borrow site would be dredged to a depth of 3 to 5 feet to minimize disruption of habitat and to minimize the effects of wave refraction over the site after excavation.

During the Cat Island Restoration Project, the MAM Plan will allow implementation of lessons learned (Section 7 of the MAM Plan). The MAM Plan will provide information and recommendations to other programs and/or future projects. Actual results from the Barrier Island Restoration Project will help refine modeling, design, and predictions of physical and ecological processes that will in turn inform design of the Cat Island Restoration Project. The barrier island prototype decision framework developed as part of the Special Data Management process (Section 6 of the MAM Plan) will also provide collaborative problem solving and stakeholder engagement tools that could be used to adjust future adaptive management decisions on the basis of lessons learned.

The MAM Oversight Committee will develop and compile lessons learned, best practices, and experiences relevant to implementation of barrier island restoration, technical and organizational challenges, and monitoring and adaptive management approaches. Lessons and experiences will be clearly documented with recommendations so that they can be easily applied to future barrier island and ecosystem restoration programs and projects, such as Cat Island Restoration. Documenting the lessons learned ultimately aims to reduce recurring technical or programmatic issues that negatively impact cost, schedule, restoration project performance, and success.

3.4.2.3 Management of Littoral Placement of Future Dredged Material from Pascagoula Federal Navigation Channel

The TSP recommends placement of suitable sandy material dredged from the Horn Island Pass part of the Pascagoula Federal Navigation Channel in the combined DA-10 littoral zone area along the shallow shoals exposed to the open Gulf waves with the greatest sand transport potential (Figure 3-16). The area of dredged material placement would encompass approximately 1,600 acres between DA-10 and the southern boundary of the Pascagoula Harbor littoral zone placement site at depths of 5 to 30 feet. The deeper waters are required for hopper dredges that cannot operate on the shallow shoals for material placement. The optimum dredged-material placement location for hydraulic pipeline dredges is just southwest of DA-10. This area is preferred from both a sediment transport potential and operational standpoint to minimize unnecessary pumping distances.

3.4.3 Other Borrow Alternatives Considered

Combined Borrow Site Options for Ship Island Restoration

The total volumes of suitable sand available from all borrow sites carried forward are shown in Table 3-4. Four borrow site options were developed for use in the closure of Camille Cut and restoration of East Ship Island. These options include identical placement locations, design and engineering methods, and construction methods and phasing, but different combinations and volumes from borrow area sites. Table 3-5 reflects the quantities of sand to be placed within the template from the specified borrow sites. The quantities shown in this table do not reflect the volumes that would be dredged from the specified borrow sites but rather the volumes placed in the template after considering dredging inefficiencies and placement losses. Use of sand from Petit Bois Alabama has been reduced as much as possible and depending on dredged efficiency may not be needed to complete the restoration. Additional sand for placement beyond the total volumes shown in Table 3-5 (up to 22 mcy) could be needed to account for background erosion and/or losses before and/or during construction from unforeseen events such as tropical and winter storms. This additional sand could be dredged from any of the identified borrow sites with suitable sand and adequate volume remaining.

TABLE 3-5
Potential Combined Borrow Areas for Camille Cut and East Ship Island Placement

	Placement Volumes from Borrow Source (mcy)							
Alternative ID	Ship Island	DA-10/Sand Island	Horn Island Pass	PBP-MS	PBP- AL	PBP-OCS	Total	Rough Order of Magnitude Cost ($ million)
Borrow Option 1	1.1	5.1	0	0	12.2	0	18.5	$402,000
Borrow Option 2	1.1	5.1	2.2	1.3	0	9.4	19.0	$314,000
Borrow Option 3	1.1	3.7	2.2	1.3	1.0	9.7	19.0	$307,000
Borrow Option 4	1.1	0	2.2	1.3	4.7	9.7	19.0	$385,500

PBP = Petit Bois Pass

All four borrow site options are viable sources of sandy material to be used to restore the barrier islands. The only differences among them are costs, access to the sandy material, and their specific locations—in Alabama, Mississippi, or the OCS. All four options are evaluated in Section 5. Borrow Site Option 4 was selected as the preferred borrow site option for the TSP. Borrow Site Option 1 is more expensive than other options and thus was not considered viable compared to the others. Borrow Site Option 4 is more costly than Options 2 or 3 because of the reduced/no use of borrow material from DA-10/Sand Island and higher use of sand from the PBP-AL site, which would require payment to the state of Alabama. Borrow Site Option 4 was selected to avoid using DA-10/Sand Island, because of concerns raised by NPS relative to impairment of GUIS resources and to be in compliance with NPS *Management Policies*.

3.4.3.1 Borrow Site Option 1

Borrow Site Option 1 would place 18.5 mcy of sand dredged from three borrow areas to close Camille Cut and restore East Ship Island: Ship Island, DA-10/Sand Island Area 1, and PBP-AL. The rough order-of-magnitude cost of this option is $402 million.

3.4.3.2 Borrow Site Option 2

Borrow Site Option 2 would place 19.0 mcy of sand dredged from six borrow areas to close Camille Cut and restore East Ship Island: Ship Island, DA-10/Sand Island Area 1, PBP-AL, PBP-MS, PBP-OCS, and Horn Island Pass. The rough order-of-magnitude cost of this option is $314 million.

3.4.3.3 Borrow Site Option 3

Borrow Site Option 3 would place 19.0 mcy of sand dredged from six borrow areas to close Camille Cut and restore East Ship Island: Ship Island, DA-10/Sand Island Area 2, PBP-AL, PBP-MS, PBP-OCS, and Horn Island Pass. The estimated rough order-of-magnitude cost of this option is $307 million.

Combined Borrow Site Options for Ship Island Restoration

Table 3-6 provides a general summary comparison of all borrow options.

TABLE 3-6
Summary Table of Potential Combined Borrow Areas for Camille Cut and East Ship Island Placement

Borrow Areas	Area (Acres)	Estimated Total Available Borrow Volume (mcy)	Estimated Placement Volume (mcy)	Existing Elevations (ft) NAVD88	Max Dredging Elevations (ft) NAVD88
Borrow Area Option 1					
Ship Island Borrow Area Option 3	183	2.7	1.1	-28	-38
DA-10/Sand Island Borrow Area Option 1	357	6.2	5.1	+18 to -10	-14
PBP-AL East Option 2 and West Option 2	1265	19.8	12.2	-31 to -37	-34 to -50
Borrow Area Option 2					
Ship Island Borrow Area Option 3	183	2.7	1.1	-28	-38
DA-10/Sand Island Borrow Area Option 1	357	6.2	5.1	+18 to -10	-14
Horn Island Pass	612	4.9	2.2	-27 to -40	-35 to -41
PBP-MS	175	2	1.3	-25 to -32	-33 to -48
PBP-AL Option 2	1265	19.8	0	-31 to -37	-34 to -50
PBP-OCS	1850	19.6	9.4	-45 to -60	-49 to -68
Borrow Area Option 3					
Ship Island Borrow Area Option 3	183	2.7	1.1	-28	-38
DA-10/Sand Island Borrow Area Option 2	304	4.7	3.7	+18 to -10	-14
Horn Island Pass	612	4.9	2.2	-27 to -40	-35 to -41
PBP-MS	175	2	1.3	-25 to -32	-33 to -48
PBP-AL East Option 2 and West Option 2	1265	19.8	0.7	-31 to -37	-34 to -50
PBP-OCS	1850	19.6	9.7	-40 to -60	-49 to -68
Borrow Area Option 4					
Ship Island Borrow Area Option 3	183	2.7	1.1	-28	-38
Horn Island Pass	612	4.9	2.2	-27 to -40	-35 to -41
PBP-MS	175	2	1.3	-25 to -32	-33 to -48
PBP-AL East Option 2 and West Option 2	1265	19.8	4.4	-31 to -37	-34 to -50
PBP-OCS	1850	19.6	9.7	-40 to -60	-49 to -68

4. Affected Environment

The MsCIP PEIS (USACE, 2009a) characterized the affected environment of the overall MsCIP project area, which includes Hancock, Harrison, and Jackson Counties, the Mississippi Sound, the Mississippi-Alabama barrier islands, and the nearshore Gulf of Mexico. The information in Section 4 of the PEIS is incorporated by reference into this section, which addresses the existing conditions of the sand borrow areas and the areas included in the TSP and the other restoration alternatives considered. Section 4.1 summarizes existing conditions within the project area, specifically the barrier islands. Subsequent sections describe the existing biological, physical, and chemical conditions, and socioeconomic conditions in the barrier island restoration project area (Figure 1-1) in greater detail.

4.1 Summary of Existing Conditions

The Mississippi barrier islands are dynamic coastal landforms that serve as the first line of defense between the Gulf of Mexico and the Mississippi mainland coast. The islands bear the full impact of atmospheric and oceanic energy from tropical storms and hurricanes passing through the region. They also contribute to the maintenance of the highly productive Mississippi Sound estuarine ecosystem. Hurricanes, variations in sediment supply, anthropogenic activities affecting littoral transport processes, and relative sea level changes have driven changes in island location and morphology and are reflected in the current conditions on the barrier islands (Appendix B).

The barrier islands have experienced substantial changes in shoreline position, configuration, and island landmass since the mid-1800s, and such changes continue to the present day (Byrnes et al., 2013; Morton, 2008). Lateral island migration (erosion along the eastern end of the islands and sand deposition to the west) and island narrowing and segmentation have occurred, driven by dominant east-to-west sediment transport and a net loss of sand to the littoral system from management activities at Horn Island Pass. Much of the littoral drift zone through which sand historically has migrated along the barrier islands is contained within the boundaries of the GUIS. Long-term land loss and morphological changes to the barrier islands affect their natural and historic resources. Moreover, loss of barrier island area threatens the ecosystem of the Mississippi Sound, and exposes the mainland coast and its associated wetlands and coastal habitats to increasing saltwater intrusion and damage from future storms and storm surges (USACE, 2009a; Appendix D).

4.2 Environmental Setting

The environmental setting for the project includes the Mississippi coastline (Hancock, Harrison, and Jackson Counties), the Mississippi Sound, and the Mississippi-Alabama barrier islands (Figure 1-1). From east to west, the islands are Dauphin Island in Alabama and Petit Bois Island, Horn Island, East Ship Island, West Ship Island, and Cat Island in Mississippi. The project area also includes the northern Gulf of Mexico to a distance about 8 miles seaward of the barrier islands to include offshore borrow material locations.

4.2.1 Mississippi Sound

The area is characterized by a humid subtropical climate and is partially isolated from the Gulf of Mexico. Average annual air temperatures are 66–68 degrees Fahrenheit (°F). The normal annual rainfall is 65–67 inches, distributed relatively evenly throughout the year. The area is subject to hurricanes from June through the end of November, with most occurring in August and September. In 1969, Hurricane Camille damaged the coastal area of Mississippi, and in 2005, Hurricanes Katrina and Rita damaged coastal areas from Galveston, Texas, through Mississippi and Alabama (USACE, 2010c).

The Mississippi Sound is a shallow, estuarine body of water averaging 6–12 miles wide and extending approximately 90 miles along the coast from Mobile Bay, Alabama, west to Lake Borgne, Louisiana (Figure 1-1). The average mean low water depth of the Sound is 10 feet, and over 99 percent of the area is less than 20 feet deep (Gulfbase.org, 2010).

Several navigation channels traverse the Mississippi Sound. The GIWW provides a shallow-draft navigation channel that parallels the mainland coast through the entire length of the Mississippi Sound. Four deepened navigation channels extend into the Mississippi Sound from Gulfport, Biloxi, Pascagoula/Bayou Casotte in Mississippi, and Bayou La Batre in Alabama. The USACE dredges the channels regularly. The deepest shipping channels are those connecting the ports of Gulfport and Pascagoula/Bayou Casotte to the Gulf of Mexico. The channels have authorized navigation depths of 36 and 44 feet, respectively, plus an additional 4 feet of advanced maintenance/overdepth dredging.

The barrier islands form the southern boundary of the Mississippi Sound and are located approximately 6–12 miles offshore. Generally, the islands feature broad, sandy beaches to the north with dunes on the southern Gulf side. With the exception of Cat Island, barrier islands within the project area, including Dauphin, Petit Bois, Horn, and East and West Ship Islands, have migrated westward over time. These islands will continue to migrate, as a result of the longshore littoral drift that moves sand from east to west across the barrier island chain (Morton, 2008; Appendix B). The barrier islands and surrounding waters contain important natural, cultural, and recreational resources. They include habitat for approximately 25 endangered and threatened animals in diverse ecosystems, serve as critical nursery habitat for marine flora and fauna, serve as a stopover for migratory birds, and provide recreational opportunities (NPS, 2010a).

The benthic habitat within the Mississippi Sound and the barrier islands provides a wide range of environmental conditions for macroinvertebrate assemblages. The composition and density of macroinvertebrates are influenced by a number of factors, including wave action, sediment properties (primarily percent sand), turbulence, salinity, dissolved oxygen (DO) (the occurrence of hypoxia), water depth, the occurrence and frequency of tropical storms/ hurricanes, and seasonal variability. For example, at the barrier islands, benthic habitat and corresponding benthic community varies from "protected" beaches on the north or Sound sides of the islands to "exposed" beaches on the south or Gulf of Mexico sides of the islands (Appendix I; Rakocinski et al., 1991).

Waters in the Mississippi Sound are influenced by saline gulf waters flowing into the Sound between the barrier islands, as well as freshwater drainage from 20,000 square miles of mainland watersheds. Larger rivers draining into the Mississippi Sound near the project include the Pearl, Pascagoula River, and Mobile Rivers. However, the Pascagoula River is the only river that discharges directly to the Sound and has the most influence on freshwater inflows. The mix of freshwater and saline conditions has created a dynamic estuarine environment (NOAA, 2004). Most of the Mississippi barrier islands are part of GUIS (Section 1.3; Figure 1-1) (NPS, 2010a). Within the project area, GUIS includes parts of Cat Island and all of West and East Ship, Horn, and Petit Bois islands. Part of Cat Island is privately owned and also within the project area. GUIS was established to preserve the barrier islands, salt marshes, wildlife, historic structures, and archaeological sites found along the islands. The barrier islands are dynamic land forms that act as the interface between the ocean and the Mississippi Sound. As such, the islands help to maintain the estuarine conditions in the Sound and provide a buffer to the mainland for hurricanes and major storms.

4.2.2 Outer Continental Shelf

The outer continental shelf (OCS) extends off the coast of Mississippi and Alabama approximately 70–80 miles. Within the project area, the continental shelf is generally flat, and water depths range from 24–60 feet. The major surface features include shoals and sand sheets. Beyond the project area, the shelf is bathymetrically diverse and includes slopes, escarpments, knolls, basins, and submarine canyons (NOAA, 2004). Water depths are up to 590 feet (180 meters) at the edge of the shelf (Gulfbase, 2013). Circulation patterns of the mid-shelf and deepwater regions of the northern Gulf of Mexico are influenced by the Loop Current. The Loop Current is associated with the upwelling and high nutrient levels that result from ocean water flow from the Yucatan Channel and input of freshwater from rivers originating in the U.S. and Mexico (NOAA, 2010a).

The Gulf of Mexico marine ecosystem has experienced stresses as a result of shoreline alteration, pollutant discharge, oil and gas development, and nutrient loading. Farther west of the Mississippi Sound into the Gulf of Mexico, there is a regional occurrence of hypoxic waters. Productivity in hypoxic waters is much lower than in other regions of the Gulf. Hypoxia is known to occur in shelf waters off the Louisiana coast during the summer and extends to Gulf waters east of the Mississippi River as well (Mississippi River/Gulf of Mexico Watershed Nutrient Task Force, 2008; USEPA, 2008).

The nearshore area, including the Mississippi Sound and the northern Gulf of Mexico, is used for commercial and recreational shipping, boating, and fisheries. A high number of oil and gas facilities, along with several fish havens, artificial reefs, and shipwrecks, are located in the area. These are considered important migration areas for marine mammals, such as the Atlantic bottlenose dolphin (*Tursiops truncates*), and coastal birds, such as the brown pelican (*Pelecanus occidentalis*), and are used as foraging habitat for Gulf sturgeon. Deeper water areas (> 98 feet) to the south of the barrier islands contain important commercial fish and shrimp fisheries, fish havens, shipwrecks, and offshore banks. Oil and gas activities occur south of the barrier islands. Pipelines running north/south between Horn and Petit Bois Islands and between Petit Bois and Dauphin Islands link these areas to the coast (BOEM, 2010).

4.3 Physical Environment

This section describes the physical environment in the barrier island restoration project area, including physiography, bathymetry, meteorology, hydrology and coastal processes, and sediment characteristics. These elements are described by the major physiographic units in the project area, including the mainland Coastal Plain, the Mississippi Sound, and the barrier islands and natural passes.

4.3.1 Physiography

4.3.1.1 Coastal Plain

Areas in Mississippi landward of the northern shore of the Mississippi Sound have been characterized as belonging to the "Outer Coastal Plain Mixed Forest Province Ecoregion" (USDA, 1995). Areas near the Sound have further been characterized as belonging to either the Gulf Coast Flatwoods, an irregular belt of lands consisting primarily of wet lowlands intermingled with some smaller zones of better drained uplands, or the Southern Lower Coastal Plain, a zone of undulating interior uplands. Land elevations range from sea level along the Sound up to 400 feet NAVD88 to the north (USACE, 2009a).

4.3.1.2 Mississippi Sound

USFWS and NOAA Fisheries (2009) described the Mississippi Sound as a 100-mile long lagoon system bounded on the west by Lake Borgne, Louisiana, and on the east by Mobile Bay, Alabama. The northern boundary is the Louisiana, Mississippi, and Alabama mainland coast. The southern boundary is the chain of barrier islands consisting of, from east to west, Dauphin Island, Petit Bois Island, Horn Island, East Ship Island, West Ship Island, and Cat Island. The Mississippi Sound, the barrier islands and their related passes, and the locations of relevant major navigational channels across the Sound are shown on Figure 1-1.

4.3.1.3 Barrier Islands and Natural Passes

The Mississippi barrier islands were formed during the mid- to late Holocene period by gradual nearshore sediment aggradation of sand and mud from coastal areas and Mobile Bay. A relict late Pleistocene barrier ridge on the western flank of the Mobile Bay entrance became the intermediate base that enabled continued westward sand transport by littoral drift and currents off (and parallel to) the mainland shore. As rising waters surrounded the elevated ridge, an apron of beach and dune sand encircled and partially covered it. The ridge turned into the core of eastern Dauphin Island. Dauphin Island then became the transmission site for large volumes of littoral sand. From this island, the rest of Dauphin Island aggraded and extended westward as a narrow, shore-parallel sandy shoal platform off Alabama and Mississippi. This elongated barrier platform belt extended well into southeastern Louisiana (Otvos and Giardino, 2004). The typical island profile includes:

- An average width of less than a half-mile;
- A Gulf-side broad beach backed by dunes;
- Intermittent beach and marsh zones in the interior of the island; and
- An additional dune bank on the mainland side.

Dune heights typically do not exceed 20 feet or so except on the eastern end of Dauphin Island, where dunes may reach 40 feet (USACE, 2007a). Gulfward of the barrier island shoreline, the bottom slopes fairly rapidly to depths greater than 20 feet within short distances from shore (USACE, 2007a). Substantive variations on these typical characteristics exist.

Byrnes et al. (2013) evaluated barrier island processes and determined that shoreline and beach evolution for the barrier islands fronting the Mississippi Sound is driven by longshore transport processes associated with storm and normal wave and current conditions. Although beach erosion and washover deposition are processes that have influenced island changes, the dominant mechanism by which sand is redistributed along the barrier islands and in the passes is the longshore currents generated by wave approach from the southeast.

Barrier islands fronting the Mississippi Sound have been losing surface area through time, proceeding rapidly to the west, except for Cat Island, which appears to be isolated from the east-to-west sediment transport system. The barrier islands are losing their capacity to reduce risk to mainland beaches, and infrastructure. Shoreline data were used to compare recent shoreline changes with historical trends relative to storms and sea level. The analysis indicated that historical change trends for the barrier islands will continue as a result of rising sea level, frequent intense storms, and reduced sand supply (Morton, 2008; Appendix B).

4.3.1.4 Outer Continental Shelf

The OCS extends 70–80 miles off the coast of Mississippi and Alabama and reaches depths of up to 590 feet (180 meters). The area between the Mississippi Delta near Biloxi and the eastern side of Apalachee Bay in Florida is characterized by soft bottom sediments (Gulfbase, 2013). The project's farthest seaward extent is approximately 6 to 7 miles south of Petit Bois Island and Petit Bois Pass, along the Mississippi-Alabama inner continental shelf area. The shallow stratigraphy in this area is the product of complex fluvial, coastal, and marine deposition and erosional processes associated with sea level fluctuations during the late Pleistocene and into the Holocene (Flocks et al., 2014). Distributary channels were incised in the shelf during times when sea level was falling or at a low stand position. During periods of sea level rise, the incised channels began to fill with fluvial sediment and estuarine deposits and higher elevation interfluves were reworked by coastal erosional/depositional processes. A subsequent cycle of sea-level drop and low stand produced a new phase of fluvial incision into the pre-existing fluvial, marine, and coastal deposits. This most recent low stand ended approximately 18,000 years before present when late Pleistocene to early Holocene sea-level rise resulted in coastal processes reworking antecedent deposits as the shoreline migrated landward, infilling incised channels with fluvial and estuarine sediments and producing transgressive sand sheets and ultimately shelf shoal complexes and the modern barrier island system (Flocks et al., 2014). Within this area, the seafloor slopes gently to the southeast at less than 1°, which is consistent with the shelf east of this area.

Shore-oblique sand ridges or shoals constitute the dominant seafloor topographic features found in the project area. The shoals are stable, aligning nearly perpendicular to the dominant southeast approaching wave direction in the region, and occur in approximately 13- to 66-feet water depths (Flocks et al., 2014). It has been proposed that they are vestiges of coastal deposits and shelf processes associated with the most recent sea-level rise, as well as modern shelf processes driven primarily by storms (McBride and Moslow, 1991; McBride et al., 1999). The shoals offshore the Mississippi coast are not considered active in contrast to their counterparts to the east offshore Alabama and Florida. This is due to the progradation of the St. Bernard Delta complex seaward and west of the area approximately 2,800 to 1,500 years before present resulting in an altered wave climate and increased mud deposition which blanketed some portions of these shoal sands to the west. The area can be subdivided based on the shoal locations. In the western side of the project area, there are four major shoal complexes. The eastern half contains smaller, but more numerous, shoals. Section 4.3.4.2 contains a discussion of the shoals' geometries and orientations. The intershoal area contains sand sheets with little relief. Shelf sand sheets are the other major seafloor feature in the project area and occur in differing sizes and orientations. Sand sheet thickness varies across the shelf, with the maximum thickness approximately 5 feet (Flocks et al., 2014). Intershoal areas may also grade into finer, muddier sediment deposits.

4.3.2 Meteorology

Coastal Mississippi is characterized by a mild and humid climate. Coastal areas of Mississippi typically experience mild temperatures. The coldest air temperatures occur in January, the warmest in July or August. Based on monitoring records of the Southeast Regional Climate Center (SRCC), the average maximum temperature in July varies from 89.6 to 90.9°F, and the average minimum temperature in January varies from 41.2 to 43.3°F. Localized variations in temperature occur because of the varied influences of proximity to the land/water interface.

Long-term rainfall records maintained by SRCC for Gulfport, Biloxi, and Pascagoula document that the region receives more than 65 inches of rainfall annually, with monthly averages generally ranging from 5–6 inches. The highest monthly rainfall totals typically occur during July and August.

The relatively even distribution of rainfall accumulations may be attributed to the occurrence and frequency of winter frontal storms balanced against thunderstorms during the wetter, summer months. Regional rainfall records are important sources of information on conditions within the project area because they reflect the availability of watershed accumulation of runoff and subsequent tributary water and sediment deliveries to the Mississippi Sound.

Prior characterizations of wind conditions in the project area indicate that prevailing nearshore surface winds are from the south from March to July, gradually shifting to more easterly in August and September. In winter, prevailing winds are from the north and associated with frontal systems (USEPA, 1986).

Frontal storm systems occur about weekly in the winter and have a substantial effect on the Mississippi Sound. Preceding the cold fronts, low barometric pressures typically generate onshore winds that drive water levels in the Sound higher. In combination with wind-driven waves, the elevated water levels contribute to flooding of beach zones and increased erosional impacts along the mainland and barrier island beaches. The wind and wave patterns reverse as storm fronts move through the area, leading to the waters of the Sound being forced into the backsides of the barrier islands and out of the Sound through the passes between the islands. USGS (2006) indicated that these storm-related wind and wave patterns contribute to erosional effects on both sides of the barrier islands and on the mainland shorelines. Modeling conducted for this SEIS (Appendix C) found that cold fronts resulted predominately in westward transport rates between 2,000 to 9,000 cy/yr on the Sound side of Ship Island. Computed model gradients of existing conditions suggest a tendency of accretion along the central section and a tendency of erosion along both ends of the Sound side of West Ship Island because of cold fronts (Appendix C).

The northern Gulf of Mexico experiences tropical storm and/or hurricane force storms on a routine basis. Tropical storms have historically made direct landfall in the Biloxi to Pascagoula area every 10 to 12 years or so (Appendix B). The major impacts associated with Hurricane Katrina in 2005 are well documented and prompted development of the MsCIP Comprehensive Plan.

During tropical storms and hurricanes, physical conditions within the Mississippi Sound and the adjacent barrier island system diverge radically from prevailing conditions. Combinations of extreme wind, wave, and current conditions create erosional and depositional forces that can cause changes in the physical environment of the barrier islands and the Mississippi Sound. These changes in turn can cause measurable impacts to the flora and fauna of the Sound as well as the wetland and upland habitats on the mainland.

4.3.3 Hydrology and Coastal Processes

4.3.3.1 Coastal Plain

Hydrologic characteristics of the Coastal Plain watersheds that drain to the Mississippi Sound are described by USGS (Wilson et al., 2009). The three basins are the Pascagoula River basin, the Coastal Streams basin, and the Pearl River basin. The Pascagoula and Pearl River basins are somewhat similar in terms of overall area, but the Coastal Streams basin is considerably smaller. The Coastal Streams basin includes the Wolf and Jourdan Rivers, which are tributaries to Bay St. Louis, and the Biloxi and Tchoutacabouffa Rivers, which are tributaries to Biloxi Bay. Of the three basins, the Pascagoula River basin is the largest contributor of fresh water directly to the Sound. The Pearl River basin is similar in overall area and discharge, but much of its freshwater influence is dispersed between Lake Bourne, the Mississippi Sound, and the open Gulf of Mexico to the south and east of the point of river discharge. The contribution of the Coastal Streams basin is substantially smaller than those of the other two basins with respect to freshwater inflow and cumulative influence on the estuarine water quality of the Mississippi Sound.

NOAA estimated that just over 882.4 cubic meters of fresh water flows into the Mississippi Sound per second (Moncreiff, 2006). Approximately half of that enters the Sound though the Pascagoula River basin, with the remainder representing the net contributions of the Coastal Streams and Pearl River basins to the west. Historical inflows are highly variable, depending on annual weather patterns. Hydrologic variability contributes to the wide range of salinity regimes and associated water quality within the Mississippi Sound, as characterized in Section 4.4.1.

4.3.3.2 Mississippi Sound

Hydrologic characteristics of the Mississippi Sound are strongly influenced by wind-driven currents in combination with tidal influences of the Gulf of Mexico. Tides within the Sound are diurnal, with an average range of up to 2 feet. The tides are strongly influenced by local bathymetry, local river discharges, and winds (Jarrell, 1981).

Tides across the northeastern parts of the Gulf of Mexico approach the coast from the south and enter the Sound through the natural passes between the barrier islands. Because of the relative depths of the coastal areas offshore of the barrier islands, tidal influence tends to penetrate the Sound near Petit Bois Island sooner than through the passes to the west. This results in tidal wave fronts to the west of Petit Bois Island propagating to the north and northwest, while those to the east of this system divide more to the east. Kjerfve and Sneed (1984) described tidally based circulation in the eastern portion of the Sound as having a strong clockwise rotation. The western parts of the Sound are characterized by a weaker, counter-clockwise rotation. These circulation patterns would contribute to how the potential effects of barrier island restoration might be distributed within the Sound, depending on proximity of the restoration activities to the passes where tidal inflow and outflow would transport any suspended materials. In addition, approximately 25 percent of the flows into Mobile Bay enter the far eastern Mississippi Sound through Pas aux Herons.

The influence of winds on coastal currents both within the Sound and on the Gulf side of the barrier islands is well documented (Morton et al., 2004; Appendix B). Wind-driven waves and associated currents were identified as the primary mechanisms driving sediment transport. Prevailing winds from the south and east drive currents toward the west (Cipriani and Stone, 2001). While much of the literature focuses on the east-to-west currents being major factors in influencing barrier island migration westward and to some degree landward, these same factors influence localized current speed and direction on the Sound side of the islands.

4.3.3.3 Barrier Islands and Natural Passes

Relevant hydrologic and coastal processes associated with the barrier islands relate primarily to the effects of waves and longshore currents on island stability over time. As noted, the prevailing winds and resultant longshore currents are the drivers behind the net east-to-west sand transport for any given island, as well as for the overall island system under evaluation. Wave energy is a key factor in sediment resuspension and promotion of lateral transport through longshore water movements.

Major sediment movements are considered to be storm-related where winds and associated waves and currents are forceful enough to cause both longshore transport and sand movements through the passes between the islands (Byrnes et al., 2010; Appendix B). Generally, the Gulf coast is considered a low energy coastal system, and typical wave heights on the barrier islands range from only 1 to 2 feet (Cipriani and Stone, 2001). During tropical storms, however, major episodes of sediment movement have been shown to be capable of making significant changes to island position or pass stability within very short periods of time. Further, winter frontal storms can at times create sufficient force to impact the mainland-facing margins of the barrier island system (USACE, 2009a and Appendix C) and the discharge rates from the Sound to the Gulf following major storms. Under storm-related flow modifications, tidal scour through the passes and along the barrier island margins can be substantial. Typical tidal currents range from 0.5–1.0 foot per second (USACE, 2009a). Seim et al. (1987) noted that tidal wave energy reflects "diffraction patterns radiating from the inlets . . ." Existing pass configurations thus influence tidal energy dissipation and associated potential for changes in the localized directions and magnitude of sediment transport.

A historical analysis of the sediment transport between 1917 to 1920 and 2005 to 2010 (single data set for study collected over a several-year period) documented an average sand flux of 300,000 to 400,000 cy/yr through the system extending from Dauphin Island in Alabama to West Ship Island (Byrnes et al., 2013; Appendix B). Consistent with prior studies, longshore transport was the dominant mechanism, and net transport was east to west along the islands. Transport rates decreased toward the western end of the system. The littoral system includes four historical channels or passes between the islands: Petit Bois Pass, Horn Island

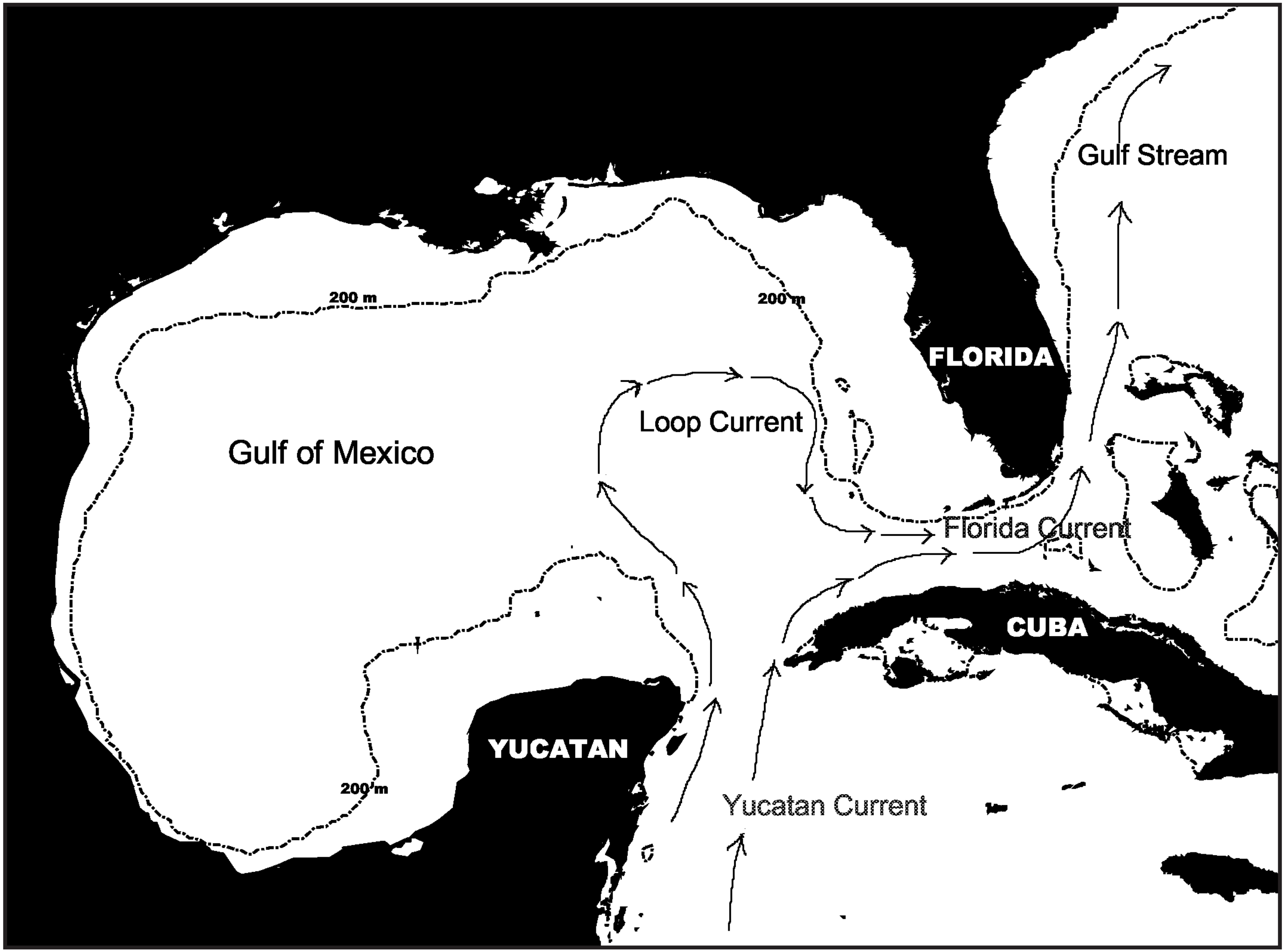
Pass, Dog Keys Pass, and Ship Island Pass. Two of these passes, Horn Island Pass and Ship Island Pass, are navigable and are maintained by dredging. Additional hydrodynamic and morphological modeling performed on the project area found similarities in the magnitude of the transport rates, though on the lower end of other studies with deviations in ranges within the uncertainty ranges identified in the analysis (Appendix C). By comparison, the modeled average annual net transport rate on the south side of Ship Island is estimated to be 10,000 to 120,000 cy/yr vs. 2,000 to 9,000 cy/yr on the north side of Ship Island (Appendix C). When factoring in the uncertainties these values can be up- or down-scaled with a factor of 0.5 to 3.5.

4.3.3.4 Outer Continental Shelf

The hydrology of the Mississippi-Alabama shelf reflects several external forces. These include wind, major storms and hurricanes, the Gulf Loop Current (and its northern plumes and gyres), and other deepwater currents of the Gulf (Minerals Management Service [MMS], 1991). The general circulation pattern in the area seaward of the Mississippi Barrier Islands to the edge of U.S. territorial waters at 12 nautical miles from the baseline suggests that a combination of wind-induced circulation, currents, discharge of water from the Mississippi River, and tidal motion around the Chandeleur-Breton Sound estuary and the Mississippi Sound interact to produce a clockwise gyre (USGS, 1982).

The Loop Current is a major oceanographic phenomenon affecting offshore circulation in the Gulf of Mexico (Figure 4-1). Water enters the Gulf through the Yucatan Strait between Cuba and the Yucatan Peninsula in Mexico, circulates clockwise as the Loop Current, and exits through the Florida Strait between the Florida Keys and Cuba, eventually joining the Gulf Stream. Closed rings of clockwise-rotating water often break away from the Loop Current, forming eddies or gyres which affect regional current patterns. Even though most of the Loop Current occurs in deep water, strong winds and currents affect the northeast Gulf of Mexico. The Loop Current can cause strong eastward upper level currents and warmer water temperatures between the Mississippi Delta and the De Soto Canyon (Thompson et al., 1999). Plumes associated with the Loop Current occasionally intrude across the shelf and can result in replacement of most of the shelf water within a few days (MMS, 1991).

Within the project area, wave data indicate that the prevailing wave direction is SE, similar to the wave climate during the late Holocene when wave action in shallower waters caused alignment of the major shoals to this direction (Flocks et al., 2014). The near parallel alignment of the shoals with the wave direction also helps to maintain the structure of the shoals as demonstrated by Hayes and Nairn (2004). Water depths in the project area range from 24 to 60 feet, with the major shoals located in approximately 13 to 66 feet of water (Flocks et al., 2014).



Source: http://www.wbrz.com

FIGURE 4-1
LOOP CURRENT
MsCIP COMPREHENSIVE BARRIER ISLAND RESTORATION SEIS

4.3.3.5 Sea Level Rise

Systematic long-term tide elevation observations suggest that the elevation of oceanic water bodies is gradually rising and this phenomenon is termed "sea level rise." The rate of rise is neither constant with time nor uniform over the globe. In addition to elevation of oceanic water bodies, however, is the gradual depression of land surface along the coast of Mississippi, referred to as "subsidence," which becomes an additional factor in the relationship between the land's elevation over time and changing sea levels. Because the coast of Mississippi is affected by both subsidence and global sea level rise (adjusted for local conditions), these factors combine in a single element of "relative" sea level rise. Relative sea level rise at a given location is the change in mean sea level at that location with respect to an observer standing on or near the shoreline. Analysis of historical data suggests a relative sea level rise of approximately 9 inches along the Mississippi coast during the 20th century.

Barrier islands are among the most vulnerable areas to the consequences of climate change. Serious threats to the islands come from the combination of elevated sea levels and intense hurricanes. The Mississippi barrier islands consist primarily of low-lying topography with beach-ridge interior cores near the hurricane-prone Gulf of Mexico. As a result, the barrier islands are more susceptible to the effects of storm surge than other areas. Rising sea levels result in pushing the high-water mark landward, potentially causing the islands to migrate slowly inland provided that sufficient sediment supply is available and the rate of sea level rise is such that the islands can keep pace. Losses could be accelerated by a combination of other environmental and oceanographic changes such as an increase in the frequency of storms and changes in prevailing currents, both of which could lead to increased beach loss through erosion (Antonelis et al., 2006; Baker et al., 2006). This could translate into continued loss of valuable habitat along the Mississippi barrier islands, including sea turtle nesting habitat, shorebird foraging and roosting areas, dune habitat supporting various flora and fauna, and general island ecosystem functions.

Under low to moderate rates of relative sea level rise, barrier islands typically do not lose their entire land mass, because eventually they become so low and narrow that surficial processes are dominated by storm overwash (Morton, 2008). Sand eroded from the open-ocean shore in this state would be transported across the barrier island and deposited in the Sound to the north. The western three-fourths of Dauphin Island is a transgressive landform. The Mississippi barrier islands of Petit Bois, Horn, and Ship Island, however, are dominated by alongshore sediment transport. The predominance of westward alongshore sand transport both at geological and historical time scales indicates that this motion will likely continue in the future, being driven by the prevailing winds, storm waves, and associated currents (Morton, 2008). Byrnes et al. (2012) found that under historical rates of sea level rise, potential shoreline recession on the island(s) due to sea level rise accounted for 4–5 percent of the total island change signal. The remaining signal was driven primarily by the prevailing winds, storm waves, associated currents, and sediment supply.

Recent climate research by the Intergovernmental Panel on Climate Change (IPCC) predicts continued or accelerated global warming for the 21st century and possibly beyond, which will cause a continued or accelerated rise in global mean sea level. Based on the historical rate of sea level rise taken from the NOAA tide station located at Dauphin Island, Alabama of approximately 0.01 ft/yr, sea level over the next 50 years is projected to rise approximately 0.4 foot from present day. Accounting for potential accelerated rise in global mean sea level in the future, it is projected that sea level over the next 50 years could increase as much as 0.8 foot to 2.0 feet based on the 1987 National Research Council's low and high curves modified with the IPCC current estimate of historical global mean sea level change rate. Island recession due to sea level rise projections based on the Brunn rule for erosion (Brunn, 1962) could range from 1.3 feet/year to upwards of 3 feet/year. In light of island background recession rates of up to 30 feet/year documented in Byrnes et al. (2012), the primary drivers of morphologic change during this period likely will continue to be sediment availability, prevailing winds, storm waves, and associated currents. The MsCIP barrier island restoration component seeks to minimize the island land losses by placement of sediment back into the most crucial areas of the system.

4.3.4 Bathymetry

4.3.4.1 Mississippi Sound

Depths within the Mississippi Sound are highly variable, but generally shallow. Blumberg et al. (2000) described two different regions within the Sound in terms of relative depths. The northern and western parts of the Sound were described as shallow, with depths ranging from 3 to 9 feet. Greater depths are found in the east, central, and southern portions of the Sound, with a mean depth of about 13 feet. In the vicinity of Pascagoula, natural depths in the Sound are generally less than 13 feet, whereas the Sound deepens toward the Gulf to approximately 20 feet (USACE, 2010c).

A combination of natural and constructed channels is found between the barrier islands. Petit Bois Pass, located between Dauphin Island and Petit Bois Island, and Dog Keys Pass, located between East Ship Island and Horn Island, are natural, relatively shallow passes. In contrast, Horn Island and Ship Island Passes have been modified by navigational channel construction and maintenance to support commercial uses. The Pascagoula Federal Navigation project, which extends through Horn Island Pass near the west end of Petit Bois Island, is to an authorized depth of 44 feet; the channel through the pass is dredged to a total depth of 48 feet, which includes the plus 2 feet of advanced maintenance and 2 feet of overdepth dredging. However, currents in the entrance channel have scoured the channel to as deep as 64 feet between DA-10 and Petit Bois Island. To the west, the Gulfport Federal Navigation project, which extends through Ship Island Pass near the west end of West Ship Island, is authorized to 38 feet; the channel through the pass is dredged to a total depth of 42 feet, which includes the plus 2 feet of advanced maintenance and 2 feet of overdepth dredging. Maintained channels penetrate the natural passes, which through natural tidal scour in some areas would normally exist to depths ranging from 10 to 35 feet, depending on position within these natural passes and proximity to natural tidally scoured zones (USACE, 2007a). In addition, a natural channel in Dog Keys Pass between East Ship Island and Horn Island leading toward Biloxi is approximately 15 feet deep; however, depths in this area are highly variable and the channel is not marked for navigation. To the north of the barrier islands, the GIWW extends from east to west through the Sound. The GIWW is a channel authorized to 12 feet deep and 150 feet wide; the channel is dredged to 18 feet, which includes plus 2 feet of advanced maintenance and plus 2 feet of overdepth dredging.

4.3.4.2 Outer Continental Shelf

The continental shelf is bathymetrically diverse and includes slopes, escarpments, knolls, basins, and submarine canyons (NOAA, 2004). Water depths are up to 590 feet (180 meters) at the edge of the shelf (Gulfbase, 2013). Within the project area, depths increase seaward of the Mississippi Sound and the barrier islands, ranging from 24 to 60 feet. The seafloor is generally flat, with a gentle slope of approximately 0.03 degrees to the southeast (Flocks et al., 2014). The dominant vertical features are the northwest-southeast-oriented linear sand ridges or shoals located primarily south of Dauphin and Petit Bois Islands in 13 to 66 feet of water. They are considered inactive and remain stationary based on comparison of historical bathymetric datasets dating from 1917 to 2013 (Twichell et al., 2011; Flocks et al., 2014). This area can be subdivided into a western and eastern half based on the location of the shoals, with a large low relief intershoal area dividing them. In the west, there are four major shoals that the USGS identified south of Petit Bois Island during their 2013 geophysical survey. The three largest shoals vary in width from 0.4 mile at their southeastern tips to over 0.9 mile at their northwestern ends, with lengths ranging from 4.3 to 5.6 miles. The shoal areas range from 1,754 to 1,878 acres. Thicknesses of the three shoals range from 4.6 to 13.1 feet (Flocks et al., 2014). The remainder of the area contains generally low relief sand sheets. On the eastern side of the divide, there are numerous, but smaller, shoals throughout the area. They are northwest-southeast-oriented, ranging from 0.6 to 2.2 miles long and 650 to 1,150 feet wide. Shoal thickness averages 6.6 feet, but can exceed 16.4 feet. Slope angles can be up to 1.4° along the seaward tips and flatten out with decreasing depth (Twichell et al., 2011).

4.3.5 Sediment Characteristics

4.3.5.1 Coastal Plain

The geological and soils features within the Coastal Plain consist of sedimentary rock and sediments deposited during the Cenozoic Era. Materials consist of limestone overlain by layers of gravel, sands, and finer-grained sediments (silt and clay). Otvos (1994) described these materials as alluvium and terrace deposits. There are three geologic formations recognized within the Coastal Plain of Mississippi: the Biloxi Formation (clay, sand, and sandy clay with abundant fossils); the Prairie Formation (sand and muddy sand mixed with organic matter); and the Gulfport Formation (sand deposited along the land/water interface during a period of sea level decline) (USACE, 2009a).

4.3.5.2 Mississippi Sound

A detailed description of the geological history of the Mississippi Sound and its surrounding areas is presented by Otvos and Giardino (2004) and Otvos and Carter (2008). The general coastal zone, including the Sound, is part of an interdeltaic province which has experienced extended periods of inundation during times of elevated sea level and subsequent periods dominated by erosion during times of lower sea level. During such erosional periods, river discharges cut trenches out to the Gulf through the deltas, and these trenches in turn were then filled with marine sediments during subsequent periods of higher sea levels (Velardo, 2005; USACE, 2010c).

More recently deposited sediments of the Mississippi Sound are attributed to a combination of sediment deliveries to the Sound through river discharges associated with the Mississippi and Mobile Rivers, and the smaller river systems located between these two major systems. Those include the Pascagoula, Biloxi, Tchoutacabouffa, Jourdan, Wolf, and Pearl Rivers. It is believed that most of the sediments deposited in the Sound originated in the Appalachian Mountains (Velardo, 2005). However, tidal flows result in sediment transport into as well as out of the Sound through the inter-island passes. The influence of major tropical storms on barrier island overwash and sediment movements into the Sound at the passes is well documented. Ludwick (1964) described the sediments of the Sound as predominantly sandy mud, but with regions of clean sands found near the passes between the barrier islands. Upshaw et al. (1966) indicated the following:

- Central portions of the Sound were primarily silt and clay (<62 microns [µm]);
- In the Pascagoula area, medium-grained sands (>250 µm) were more prevalent; and
- Coarse-grained sands occur in the vicinity of the barrier islands.

Fine-grained muds tend to accumulate in dredged channels within the Sound. According to Otvos (1973), mixed mud/sand areas are found west of Cat Island, between eastern Horn Island and Pascagoula, and between Biloxi Bay and Dog Keys Pass. This substrate mosaic typifies coastal lagoon systems, within which varied influences of mainland drainage and coastal processes contribute to sediment zonation in relation to material sources and routine or event-based sediment migration into and out of the system.

4.3.5.3 Barrier Islands and Natural Passes

Rosati and Stone (2009) provided a review of the literature on barrier island geomorphology in the northeastern Gulf of Mexico and differentiated the islands of the Alabama and Mississippi coastal zone from those to the east in Alabama and Florida, and to the west in Louisiana. Barrier islands off Louisiana are derived from former deltaic lobes of the Mississippi River, and a major factor in island stability is substrate subsidence and erosion. In contrast, subsidence in particular is viewed as much less of a factor for the islands of Mississippi, Alabama, and Florida. To the east, the Florida barrier islands are more stable in configuration, in part due to their proximity to more stable continuing sources of littoral sediments.

The primary source of sediment to barrier islands and passes fronting the Mississippi Sound is sand transported west from western Florida and coastal Alabama beaches. Local sources of sediment to the barrier islands are eastern Dauphin Island and the Mobile Pass ebb shoal complex (Otvos and Giardino, 2004). Analysis of historical data indicates that sand supplied to the Mobile Pass ebb shoal complex is derived primarily from beach and nearshore sediment east of Mobile Pass (Byrnes et al., 2010).

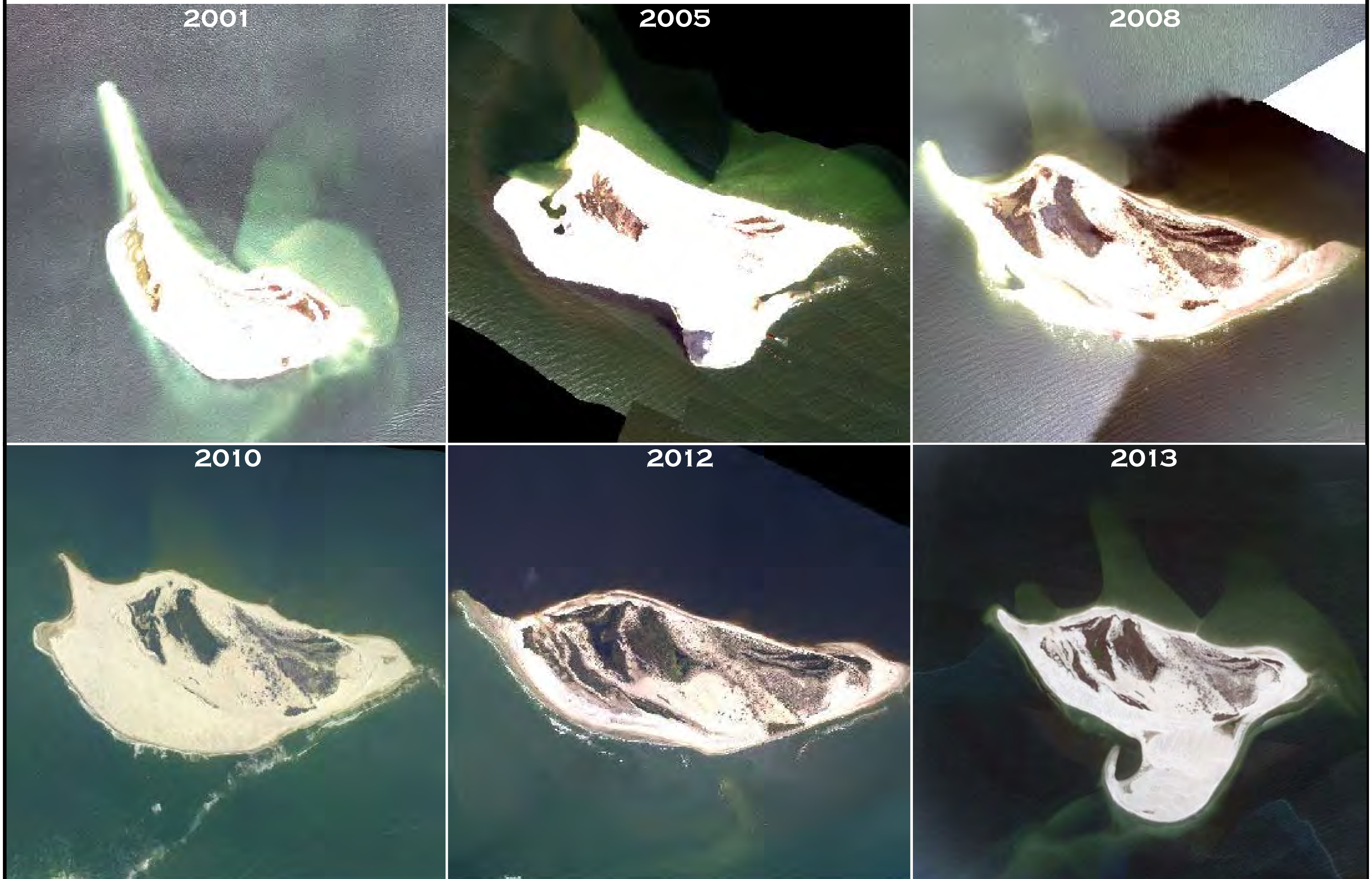
Dauphin, Petit Bois, Horn, East Ship, and West Ship Islands represent a linked system in which sand transport occurs within the littoral drift zone from east to west along each island and from the west end of the updrift island to the east end of the downdrift island (Byrnes et al., 2013). Island migration rates to the west for Dauphin, Petit Bois, Horn, and Ship Islands reported by Byrnes et al. (2012) were 45.8, 25.7, 28.7, and 8.5 meters per year, respectively, for the period 1847–1849 to 2010. Cat Island was described as the exception to the east-to-west sediment transport system. Cat Island is protected from offshore wave energy because of its position, which is somewhat sheltered by East Ship and West Ship Islands to the east and the Chandeleur Islands to the south (refer to Figure 1-1). Because of this sheltering, Cat Island is segregated from west-directed sand transport along the barrier islands. It is acknowledged that alternative judgments regarding the sand sources and transport quantities for these islands have been published. Cipriani and Stone (2001), using numerical modeling of normal wave processes, discussed evidence for each island having its own “cellular structure,” with a sediment budget being maintained under normal conditions. They supported the concept that some sediments of central Petit Bois Island routinely are derived from offshore sources. This concept had previously been suggested by Otvos (1979), who concluded that the primary source of sediment for these islands was the shelf.

Beach sand on the barrier islands (Cat, West and East Ship, Horn, DA-10/Sand Island, and Petit Bois) is predominantly light gray in color, with grain size ranging from 0.21 to 0.48 mm. The material on these islands ranges from fine-grained to medium-grained, poorly graded sand (Appendix A). The material from the borrow areas consists primarily of fine to coarse-grained sand with less than 10 percent fines. The range of mean grain sizes at the borrow sites is 0.20-0.33 mm, similar to the range of material at the placement sites: 0.21 to 0.48 mm. This sand size is consistent with that found on beaches of the Mississippi barrier islands. Tables 3-2 and 3-3 provide sediment characteristics for the potential borrow areas.

Overall, a majority of littoral sand supplied to downdrift beaches is derived from longshore transport during storm events (Appendix B). Therefore, restoration efforts updrift of Ship Island or near the south shore of East Ship Island would enhance the longevity of littoral sand transport in the area.

4.3.5.4 DA-10/Sand Island

DA-10, which includes an island locally known as Sand Island, is an existing dredged material placement site for the Pascagoula Federal Navigation project, which has a subaerial portion. The island within DA-10 was created as the result of placement of dredged material in the disposal area. This dredged material is composed primarily of poorly graded, fine to medium-grained, sand-sized quartz with less than 5 percent fine sediments. Between 1962 and 2009, changes in the configuration of the Pascagoula Bar Channel were implemented and placement of littoral sand dredged from the channel in DA-10 was performed frequently. Material dredged from the channel has been placed within DA-10 to maintain sandy sediment transport within the littoral drift. However, sand placement soon became subaerial as the amount of sand leaving the DA-10 via littoral transport could not keep pace with the amount of material being placed at the site (Appendix B). Consequently, a new island beach was established as a boundary along the western side of the navigation channel. The shape of this upland/island area has changed over time based on placements and sediment transport within DA-10 (Figure 4-2). Historically, material removed from the Pascagoula Federal Navigation project (i.e., Horn Island Pass section) was placed in the northern portion of DA-10 and eventually built the island to elevations as high as approximately +20 feet. Based on a better understanding of the littoral transport system in this area, the more recent method has been to place material at lower elevations (below +5 feet) off the southern end of the existing Sand Island.



0 650 1,300 2,600 3,900 Feet

X006_15OCT12_DA10_11X17.mxd

N W E S

FIGURE 4-2
HISTORICAL CONFIGURATION OF SAND ISLAND AT DA-10
MsCIP COMPREHENSIVE BARRIER ISLAND RESTORATION SEIS

ES041513031852KNV F4-2_HistoricalConfiguration 2/20/14 lk

4.3.5.5 Outer Continental Shelf

The bathymetry and subsurface sediment characteristics of the Alabama-Louisiana-Mississippi continental shelf south of the barrier islands reflect depositional sequences of delta outbuilding with intervening periods of erosion during low sea levels. Sediments in the area are associated with several different depositional periods. Surface sediments are generally sand enriched, averaging 56 percent sand with remaining sediments consisting of finer materials. Sediments in the area between Horn Island to approximately 5 miles seaward range from 50 to 75 percent sand and decrease in sand/increase in finer material further out. Sediments in the area between Petit Bois Island to approximately 10 miles seaward have high percentages of sand (>75 percent) and decrease to 50 to 75 percent beyond 10 miles (USGS, 1982). Within the project area, the major surface features south of Dauphin Island and the western half of Petit Bois Island include shoals and sand sheets grading laterally to muddier sediments in the intershoal areas. This area can be subdivided into a western and eastern area based on the location of the shoals. In the west, there are three major shoals which contain > 80 percent fine to medium-grained sand in thicker deposits (4.6 to 13.1 feet) than the sand sheets (0 to 4.9 feet) and are the predominant vertical features in the area (Flocks et al., 2014). Typically, they have little, if any, overburden on their distal ends in the southeast, but may be covered by thinner veneers of sand in the northwest before grading to finer sediments. They are oriented northwest-southeast, reflecting the dominant wave approach for the region and are associated with former coastal deposits that were produced and maintained during the Holocene transgression (McBride and Moslow, 1991; McBride et al., 1999; Flocks et al., 2014). McBride and Moslow state that a mixed energy, wave-dominated barrier island system experiencing transgression and containing laterally migrating tidal inlet systems produces shoreface-attached, and subsequently detached, oblique sand ridges. For the sand ridges in the project area, this model indicates that the origin and evolution of these shoals are genetically linked to the modern coastal system (both being sourced from scour of the same antecedent deposits during transgression and longshore transport from updrift sources to the east). Consequently, the sands that comprise the shoals and modern barrier islands exhibit similar textural and mineralogical properties.

Hayes and Nairn (2004) state that sand ridges aligned with the dominant wave direction are maintained through the action of waves converging over the crest of the sand ridge, leading to sand transport over the crest. They further state that this type of transport favors larger, heavier sand, possibly accounting for coarser sand on the crest and shoreward slope of the sand ridge. USACE vibracore samples from the shoals indicated that sand generally graded with depth from coarser to finer along the shoal crests. There are also subsurface deposits in the project area created by infilling of incised channels with transgressive sediments during eustatic transition from sea-level low stands to sea-level high stands. This sediment generally contains a high percentage of sand (83 to 97 percent) in approximately 3- to 22-foot-thick deposits (Flocks et al., 2014). Overburden thickness over these infilled channels varies throughout the project area. In the east, there are numerous, but smaller, shoals that contain the majority of the suitable sand in this half of the OCS project area. The genesis, shape, and orientation are similar to those of the shoals in the west described above, but they are smaller in size. See Section 4.3.4.2 for descriptions. The USGS calculated approximately 74×10^6 yd^3 of total sediment contained in the shoals, with the majority held in the southwestern shoal field of this area. Sediment quality for the shoals, based on vibracore data, is estimated to be 85 to 98 percent medium to fine sand with a D50 ranging from 0.23 to 0.28 mm (Twichell et al., 2011). Surface sediments in the proposed borrow areas are generally poorly graded sands with <5 percent silts and clays. However, lower elevation troughs or depressions in the borrow areas may contain higher silt or clay content near the surface. USACE vibracores indicate that sand grain size typically graded finer with depth in the shoals, and typically decreased seaward along the shoal body in the most southern shoals sampled.

4.3.6 Sediment Quality

Sediment quality was analyzed at 39 locations in the Mississippi Sound following Hurricane Katrina (2005 and 2006) and compared to pre-hurricane (2000 to 2004) sediment data collected from 172 stations as part of the USEPA's National Coastal Assessment (NCA) program. This analysis identified no exceedances of effects range median sediment quality guideline values for chemical contaminants in any of the sediment samples collected from the Mississippi Sound study following the hurricane. At several stations, lower threshold effects range low values were exceeded for three metals—arsenic, cadmium, and nickel, but at levels similar to those observed prior to the hurricane (Macauley et al., 2010).

In addition, the USACE Mobile District has routinely conducted sediment analyses on its federally authorized navigation projects, which include several within and near the MsCIP barrier island restoration effort. This material has been sampled using the protocols of the Inland and Ocean Testing manuals (USEPA and USACE, 1991) and found to meet ocean disposal criteria, based on physical, chemical, and biological parameters.

Following the Deepwater Horizon oil spill, USACE and USEPA jointly developed a testing protocol to analyze the spill's potential impact to USACE's Federal channels. In late 2010, sediment and water samples were collected and analyzed to characterize the physical and chemical quality of the proposed dredged material and disposal site(s). Physical sediment composition was described by grain size, Atterberg limits, specific gravity, total solids determinations, and unified soil classification. Chemical concentrations of polycyclic aromatic hydrocarbons, total organic carbon (TOC), and total petroleum hydrocarbons (TPH), including diesel-range organics, oil-range organics, and gasoline-range organics, were also identified in the sediment samples. Additionally, in June 2010, USACE conducted statistically random sediment testing in the borrow and placement areas that were under investigation at that time. Grab samples collected were analyzed for TPH.

Based on USACE-USEPA sediment and water sample results, no discernible changes in the sediment quality were attributable to the Deepwater Horizon oil spill. In more than 98 percent of the sediment samples collected during the USACE random testing from borrow and placement areas, concentrations of TPH were below method/laboratory detection limits. Random samples within the sampling grid were found to contain concentrations of TPH, but there was no pattern to the presence of TPH. These recent investigations, and past analyses, suggest a low likelihood of sediment contamination, and therefore low public health risk, around the Mississippi Sound and the OCS. Based on USACE conversations with U.S. Coast Guard (USCG) and the lead of the Operational Science Agency Team (OSAT3), oil is unlikely to be present in offshore borrow sites; however, it has been reported that tar balls have repeatedly occurred on Sand Island. During its geotechnical investigation, USACE conducted four vibracore sediment sampling events over 4 years following the 2010 BP oil spill. The first sampling event in 2010 consisted of 369 vibracores spread throughout each pass of the Mississippi barrier islands, from Ship Island Pass east to Petit Bois Pass, and in areas just south of the islands. The second sediment sampling event occurred in 2011 and consisted of 89 vibracores in Ship Island Pass, Horn Island Pass, and Petit Bois Pass. The third event occurred in 2012 and consisted of 230 vibracores in Horn Island Pass, Petit Bois Pass, and the shelf area 1 to 7 miles south of Petit Bois Island and Petit Bois Pass. The fourth event occurred in 2013 and consisted of 206 vibracores in Horn Island Pass and the shelf area 2 to 6 miles south of Petit Bois Island. No oil or tar products were observed during borrow site (in state or federal/OCS areas) sediment sampling from 2010 through 2014, and no oil or tar products were identified from core sediment sample analysis.

The presence of tar balls on Sand Island is not expected to result in significant impacts to any biological resources using that area or the placement area. Tar balls are composed primarily of sand mixed with degraded oil product. These features are formed when the degraded oils become entrained within the surf zone and adhere to the sand particles. The repetitive movement within the surf zone causes the oil-sand particles to coalesce into balls of various shapes and sizes. The toxicity of these materials has been tested and, due to the degraded nature of the oils, is very low. As of March 2013, Sand Island is no longer part of the active oil spill response (Simonson, personal comm., 2013).

4.4 Water Quality

Water quality within the Mississippi Sound is influenced by several factors, including the discharge of freshwater from rivers, seasonal climate changes, and variations in tide and currents. The primary drivers of water quality are the rivers that flow into the Sound, the largest contributors in the project area being the Pascagoula River, the Pearl River, and collectively the loading from the predominantly westward flow of the Mobile Bay system. Freshwater inputs from these major contributors and others such as the Wolf River, Escatawpa River, Biloxi River, and Jourdan River provide nutrients and sediments that serve to maintain productivity both in the Sound and in the extensive salt marsh habitats bordering the estuaries of the Sound. The salt marsh habitats act to regulate the discharge of nutrients from the mainland to coastal waters and serve as a sink for pollutants. Suspended sediments enter the Sound from freshwater sources but are hydraulically restricted due to the barrier islands. The barrier islands, combined with the Sound's shallow depth and mixing from wind, tides, and currents, promote resuspension of sediments. These suspended sediments give the Mississippi Sound a characteristic brownish color (MDEQ, 2006a).

The dynamic features of this area create variations in many water quality parameters throughout the project area, including temperature, salinity, DO, sediment oxygen demand, nutrients, TOC, and others that influence the biological and ecological processes naturally occurring in the estuary. Temperature and salinity strongly influence chemical, biological, and ecological patterns and processes.

The State of Mississippi classifies the Gulf of Mexico as an estuary within Mississippi waters to the state boundary located 3 nautical miles south of the barrier islands. MDEQ designates a use classification for this area primarily as Recreation with a small area near the mainland as Shellfish Harvesting and Recreation (MDEQ, 2007). All waters are classified to support aquatic life. MDEQ has established numeric criteria for various water quality parameters to evaluate whether the waters support those designated uses.

MDEQ evaluates the water quality of the Sound based on the monitoring it conducts through the Mississippi Coastal Assessment Program (MCA). This program builds on the NCA program established by USEPA. The MCA monitors the same parameters as those monitored through the NCA program, and 25 sites are randomly selected each year for sampling during July, August, and September (MDEQ, 2010a).

4.4.1 Salinity

The salinity regime of the Mississippi Sound is highly variable and characterized by multiple sharp fronts as a result of freshwater inflow from larger rivers, an irregular coastline with bayous, tidal flow through natural passes and navigation channels, and meteorological forces, such as wind (Kjerfve, 1986; Vinogradova et al., 2005). Salinity commonly varies from 20–35 parts per thousand (ppt) (Kjerfve, 1986). Average salinity is about 24 ppt (USEPA, 1999). Salinity levels are typically lowest along the mainland coast, where levels fluctuate more widely (Mississippi Department of Wildlife, Fisheries, and Parks [MDWFP], 2005) due largely to variations in freshwater inflow. During normal rainfall periods, the western Sound is fed by higher freshwater inflows from Lake Borgne, whereas the central Sound receives less freshwater inflow, circulates poorly, and experiences extensive tidal flushing through the barrier island passes. The eastern Sound receives freshwater river inflows primarily from the Pascagoula River and Mobile River further to the east (MDWFP, 2005).

Surface salinity is influenced by the discharge of freshwater from large rivers and is reduced during periods of higher flow in late spring and early summer (Thompson et al., 1999). To assess the potential for water quality effects post-restoration of Ship Island and the closure of Camille Cut, the Engineer Research and Development Center (ERDC) developed a hydrodynamic (CH3D) and water quality model (CEQUAL-ICM) of the study area to evaluate potential changes in circulation and water quality in the Mississippi Sound (Appendix D). The impacts are discussed in Section 5.3. Related to existing conditions, the water quality modeling (Appendix D) confirms the trends of lower salinity values in the spring months due to the increased rainfall upstream causing higher flow conditions in the rivers discharging to the Sound. These higher flow rates contribute to lower salinity levels along the coastline during this timeframe. The salinity gradient between bottom and surface waters results from the combination of denser water from outside the Sound moving along the channel toward shore and less dense freshwater remaining at the surface.

During the three benthic macroinfauna community assessments conducted for MsCIP, in June 2010, September 2010, and April/May 2011, water quality samples were collected from 20 offshore locations (borrow site stations), 19 beach/subtidal locations (beach transect stations), and 25 sand placement locations (placement site stations) (Appendix I). In June 2010, salinity stratification (greater than 3-ppt difference between surface and bottom salinities) was measured at every borrow site station, with average surface salinities ranging from 10 to 13 ppt and bottom salinities ranging from 17 to 20 ppt. Salinity stratification was measured at eight placement site locations. During the April/May 2011 event, a less-pronounced salinity stratification was measured at 9 of the 20 borrow site locations.

However, at placement site locations, salinity stratification was measured at 13 stations, with several having a significant variation (at least a 10-ppt difference) between surface and bottom salinities (Vittor and Associates, 2013).

At the beach transect locations, salinity measurements were collected at only one depth. Among these locations, salinities measured on the Mississippi Sound side of the barrier islands were lower than those on the Gulf side. In June 2010, salinities varied from 15.8 ppt on the Sound side of Horn Island to 28.5 ppt on the Gulf side. In September 2010, salinities were greater than 20 ppt at all beach transect locations, ranging from 23 ppt at the Cat Island stations (not divided into Sound and Gulf sides) to 32 ppt on the Sound side of Horn Island. During the April/May 2011 event, salinities ranged from 16 ppt at Cat Island and on the Sound side of Horn Island to 25 ppt on the Gulf side of Petit Bois Island (Vittor and Associates, 2013).

Tides across the northeastern portions of the Gulf of Mexico approach the coast from the south and enter the Sound through the passes between the barrier islands, which act as natural barriers to more saline waters. The shipping channels and Camille Cut have allowed higher-salinity water to accumulate in the vicinity of those channels and in the Sound over time.

Seaward of the barrier islands along the continental shelf, salinity patterns are variable due to river and tidal inlet plumes and Loop Current intrusions. The salinity regimes reflect freshwater outflows from the north and west and high-salinity inflows from the open Gulf. Masses of water with different salinities may remain relatively distinct or may mix depending on conditions. Both surface and bottom salinities tend to be lower closer to shore (MMS, 1991). Borrow stations sampled by Vittor and Associates (2013) at locations furthest seaward of the barrier islands (i.e., BSR2, BSR3, BSR4) had higher salinity than other sampling locations, with differences in surface salinities greater than differences in bottom salinities.

4.4.2 Temperature

Data collected from a USGS gauge in the Mississippi Sound at East Ship Island between 2007 and 2012 show daily mean temperatures as low as approximately 50ºF in the winter and up to 86ºF in the summer (10ºC to 30ºC) (USGS, 2013). Previous studies have identified the annual range in temperature for the Mississippi-Alabama shelf as 62.6 to 71.6ºF (17º to 22ºC). Temperatures in both deep and shallow water correspond to seasonal variations in air temperature: higher temperatures in the summer months and lower temperatures in the winter months (Thompson et al., 1999). Recent modeling efforts (Appendix D) confirm that temperature patterns increase from the spring through the summer months and eventually begin to decrease in the fall. The State of Mississippi Water Quality Criteria indicate that the maximum water temperature in coastal and estuarine waters shall not exceed 90ºF (32.2ºC) (MDEQ, 2007). MDEQ’s 2010 use support report indicates that 97.3 percent of its estuary waters meet the temperature standard (MDEQ, 2010a).

As the distance seaward from the barrier island increases, and depth increases, water temperature becomes less dependent on air temperature. Temperature stratification of the water column may be well developed along the continental shelf by late summer (MMS, 1991). Surface water temperatures offshore average 71.1°F during the winter and 84.4°F during the summer. Bottom temperatures offshore average 57.4°F in the winter and 53.6°F in the summer (MMS, 1991).

4.4.3 Dissolved Oxygen and Hypoxia

Nearshore and open Gulf waters are normally at or near oxygen saturation. However, high organic loading, high bacterial activity related to the decomposition of organic material, and restricted circulation due to stratification of the water column during the summer can cause near-bottom waters to be depleted of oxygen. Oxygen depletion results from the combination of these and other physical and biological processes. In the Gulf of Mexico waters, hypoxia (DO < 2 milligrams per liter [mg/L]) is a common occurrence during the late spring and summer months (Appendix I). USEPA estimates that 4 percent of the bottom waters in the Gulf estuaries have hypoxic conditions or low DO on a continuing basis (USEPA, 2001). Hypoxia affects living resources, biological diversity, and the capacity of aquatic systems to support biological populations. When oxygen levels fall below critical values, those organisms capable of swimming (e.g., fish, crabs, and shrimp) evacuate the area and many bottom-dwelling organisms perish under those conditions. Hypoxic conditions are considered to be hazardous for less or non-mobile macrobenthos (e.g., polychaete worms and burrowing amphipods), with prolonged exposure having the potential to result in deterioration of the benthic community (Appendix I).

During the three benthic macroinfauna community assessments conducted for MsCIP in June 2010, September 2010, and April/May 2011, water quality measurements were collected from 20 offshore locations (borrow site stations), 19 beach/subtidal locations (beach transect stations), and 25 sand placement locations (placement site stations; on Cat Island, Ship Island, Horn Island, and Petit Bois Island). During the assessment, hypoxic conditions were measured at borrow site stations and placement site stations, with a greater occurrence at the borrow site stations. The beach transect stations generally had the highest DO concentrations. The relatively low occurrence of hypoxic conditions at barrier island placement site locations is likely due to shallow water depths and highly dynamic habitats. The high DO concentrations at beach transect stations, relative to borrow site and placement site locations, is likely due to the high-energy nature of subtidal beach habitats (Appendix I).

From May through June 2010, prolonged hypoxia occurred at the bottom of all borrow site sampling stations. During the June 2010 sampling event, DO concentrations were < 2.0 mg/L at 19 of the 20 stations, and levels were < 0.5 mg/L at 5 stations in the Ship Island Pass and 1 station south of Petit Bois Island. During the same event, hypoxia was measured at 3 of the 25 placement site stations—1 barrier island location and 2 Mississippi Sound locations. It was not determined whether the June 2010 hypoxic conditions were exacerbated by the Deepwater Horizon oil spill or whether DO concentrations were the result of normal seasonal variations. In September 2010, DO levels were > 2.0 mg/L at all MsCIP benthic study locations. During the April/May 2011 sampling event, hypoxic conditions were observed at six borrow site stations: one south of Horn Island and five near or within Petit Bois Pass.

DO in continental shelf waters is normally high. No hypoxic conditions have been recorded in the Mississippi-Alabama continental shelf area (MMS, 1991). During an investigation of the continental shelf conducted from 1987 through 1989, DO levels in bottom water ranged from 2.93 to 8.99 mg/L, with the lowest summer level being 4.63 mg/L (MMS, 1991). The

State of Mississippi Water Quality Criteria require that the DO concentrations be maintained at a daily average of 5.0 mg/L with an instantaneous minimum of not less than 4.0 mg/L (MDEQ, 2007). MDEQ estimates that 99.3 percent of its waters meet the DO standard; all estuarine waters that do not meet the standard are small estuarine embayments rather than waters in the Sound (MDEQ, 2010a).

4.4.4 Turbidity

Turbidity is usually considered a good measure of water quality and is determined by measuring the degree to which the water loses its transparency due to the presence of suspended particulates. The more total suspended solids that occur in the water, the less light penetration and the higher the turbidity.

Various parameters influence the turbidity of the water, including increased sediment levels from erosion or construction activities, suspended sediments from the bottom, waste discharge, algae growth, and urban and agricultural runoff. Suspended sediments enter the Sound from freshwater sources, but are hydraulically restricted due to the barrier islands. The barrier islands, combined with the Sound's shallow depth and mixing from wind, tides, and currents, promote re-suspension of sediments (MDEQ, 2006a). Data available for the USGS station at Ship Island light (USGS Gage 301527088521500) from July to November 2012 showed that turbidity levels were generally less that 20–30 formazin nephelometric units (FNU) with occasional turbidity spikes to as high as 380 FNU (USGS, 2012). Typical turbidity levels in the Sound are relatively high and have been identified as a limiting factor for SAV growth in portions of the Sound (USACE, 2010b, Moncreiff, 2006).

In the continental shelf, schools of demersal animals (those that live or feed near the bottom) may create turbid conditions in bottom waters. Additionally, turbid lenses of brackish water have been observed in surface waters. Offshore of the Mississippi barrier islands, turbidity decreases when clear oceanic waters from the Loop Current intrude into the area. However, these waters are generally more turbid than water off the coast of west Florida. Clear-water layers sometimes occur between turbid surface and bottom turbid layers (MMS, 1991).

MDEQ has a standard for turbidity that is based on the background condition plus 50 nephelometric turbidity units (NTUs) outside a 750-foot mixing zone. MDEQ also grants exemptions to the turbidity standard for environmental restoration projects.

4.4.5 Nutrients

Nutrients are a primary concern in both freshwater and marine ecosystems, providing the building blocks of biological production. The Mississippi Sound is a productive estuarine system. MDEQ data (Segrest, personal comm., 2010) show that nitrate concentrations in the project area ranged from 0.005-0.065 mg/L, total phosphorus concentrations ranged from 0.02-0.21 mg/L, and orthophosphate concentrations ranged from 0.002-0.096 mg/L. Nitrogen is generally the limiting nutrient for phytoplankton and algal production in estuarine systems and elevated levels can lead to eutrophication. Data from USEPA for various stations across the Sound (bordered by East Ship Island to the southeast, Deer Island to the northeast, and Henderson Point to the northwest) showed that total nitrogen ranged from 0.33-0.96 mg/L (USEPA, 2012).

Nitrate levels in the OCS tend to be low during the summer months and higher during the winter. Phosphate levels are typically uniformly low year-round (MMS, 1991). Nutrient levels are higher to the west of the project area along the Louisiana-Texas coast where elevated levels of nutrients cause a seasonal hypoxic (low oxygen) zone to develop. High levels of algal and plankton growth associated with elevated nutrient levels followed by bacterial decomposition of organic matter result in DO levels below 2 parts per million (ppm) (USGS, 2013).

4.5 Biological Resources

4.5.1 Coastal Habitats

The Mississippi coast contains a wide diversity of flora and fauna associated with habitats found in coastal Mississippi counties (Hancock, Harrison, and Jackson Counties), as well as the Mississippi Sound and the barrier islands. These habitats provide essential services for the plants and animals that live within them, such as physical habitat for many of the species and storm buffering capacity. The Mississippi Sound estuary includes shallow open waters, oyster reefs, tidal pools, mud and sand flats, and river deltas. The barrier islands that lie approximately 6-12 miles offshore include a dynamic and diverse integrated system of beaches, dunes, marshes, bays, maritime forests, tidal flats, and inlets. Natural habitats along the Mississippi coast include many of these same habitat types. Barrier island and Mississippi coastal habitats are described below. In addition, wetland habitats are further discussed in Section 4.5.1.3.

Coastal Mississippi habitats support an array of reptiles, amphibians, birds, and mammals. Reptiles and amphibians found in the area include 23 species of turtles, 10 species of lizards, 39 species of snakes, and the alligator. Eighteen species of salamanders and 22 species of frogs and toads are indigenous to the coastal region. Fifty-seven species of mammals are known to the area and include marsupials, moles and shrews, bats, armadillos, rabbits, rodents, carnivores, even-toed hoofed mammals, and dolphins. Mammals occur within all habitats of the system, using underground burrows, the soil surface, vegetative strata, the air, and the water for feeding, resting, breeding, and bearing and rearing young. Common species of mammals include the raccoon, river otter, gray fox, striped skunk, mink, white-tailed deer, bottlenose dolphin, beaver, opossum, and nine-banded armadillo. Over 300 species of birds have been reported as migratory or permanent residents within the area. Common shorebirds include osprey, great blue heron, great egret, piping plover, red knot (*Calidris canutus*), sandpiper, gulls, brown (and white during migration periods) pelicans, American oystercatcher (*Haematopus palliates*), and terns. Birds of the area eat a great variety of foods, function as food for many predators, and exhibit a diversity of nesting behaviors (USACE, 2009a).

4.5.1.1 Barrier Island Beaches

Barrier island beaches consist of two parts, the foreshore, or swash zone, and the backshore. The swash zone includes the area where waves break in moderate weather, and the backshore where waves break during frontal passages, storm surges, and high tides. The beaches consist of well-sorted, fine to coarse sand containing large quantities of quartz and minor amounts of shell and heavy minerals. These shorelines experience erosion and accretion on an ongoing basis, with erosion strongly influenced by tropical storms. Barrier island beaches on northern shores are somewhat protected from waves generated by storms striking from the Gulf of Mexico and are often narrow and more steeply sloped.

Surveys of the mean lower low water (MLLW) and higher high water (MHHW) contours within the potential project footprint identified approximately 34.77 acres of this swash zone/unconsolidated shoreline habitat on the affected barrier islands (Cat Island, Sand Island, and East and West Ship Islands) (see Appendix M).

The backshore is the landward end of the beach where strand lines form and serve as a transition zone to the vegetated landscape. Strand lines are places where sand forms berms and seaborne debris accumulates. Beach vegetation is usually very sparse and confined to the upper edges of the backshore. Sea oats (*Uniola paniculata)*, beach morning glory (*Ipomoea imperati*), and gulf bluestem (*Schizachyrium maritimum*) are the most capable of tolerating the harsh conditions of the backshore. A few animals, such as the ghost crab, amphipods, and various insects, are permanent residents. These beaches provide structural habitat and nutrient and carbon sources that are used by invertebrates, fishes, and wading birds (MDWFP, 2005).

4.5.1.2 Barrier Island Dry Beach and Dune Systems

Dry beach and dune systems on barrier islands consist of zones of well-drained, mostly deep soils composed of windblown sand adjacent to beaches. Some areas are periodically overwashed by storm surges. These habitats contain sparse vegetation, reflecting their exposure to heat, wind, and salt spray. Inland from the dry beach zone and parallel to the shore, swales and dune ridges are present. The dunes, often referred to as “relict dunes,” have a crust of microscopic organisms and can be either stable and firm, with little movement, or semi-stable with some active sand movement. Backbeaches and semi-stable dunes commonly support a sparse cover of a variety of grasses, including gulf bluestem, sea oats, rosette grass (*Dichanthelium* sp.), and dropseed (*Sporobolus* sp.). Common herbs are squareflower (*Paronychia erecta*), pineland scalypink (*Stipulicida setacea)*, Dixie sandmat (*Chamaesyce bombensis)*, and camphorweed (*Pluchea* sp.). The dry meadows are dominated by torpedo grass (*Panicum repens)*, broomsedge bluestem (*Andropogon virginicus*), needlepod rush (*Juncus scirpoides)*, and panic grass (*Panicum* sp.) and contain lesser amounts of saltmeadow cordgrass (*Spartina patens)*. Relict dunes are dominated by shrubby species, including woody goldenrod (*Chrysoma pauciflosculosa)*, prickly pear (*Opuntia* sp.), and saw palmetto (*Serenoa repens)* and occasionally sand live oak (*Quercus geminata)* (Mississippi Museum of Natural Science, 2005). Many shorebirds and waterbirds use these areas for resting and feeding.

Common birds known to frequent these areas include the black skimmer (*Rynchops niger*), black necked stilt (*Hiamantopus mexicanus*), American avocet (*Recurvirostra americana*), laughing gull (*Larus atricilla*), and gull billed tern (*Sterna nilotica*) (Turcotte and Watts, 2009). Bryzoans, a type of floating aquatic colonial animal, are seasonally important and provide both structural habitat and nutrient sources for marine invertebrates, fishes, and wading birds. Common reptiles in these areas include loggerhead sea turtle (*Caretta caretta*) and Mississippi diamondback terrapin (*Malaclemys terrapin pileata*) (Mississippi Museum of Natural Science, 2005).

4.5.1.3 Coastal Wetlands

Coastal wetlands are defined by the Mississippi Coastal Wetlands Protection Act as "all publicly owned lands subject to the ebb and flow of the tide; which are below the watermark of ordinary high tide; all publicly owned accretions above the watermark of ordinary high tide and all publicly owned submerged water-bottoms below the watermark of ordinary high tide"(MS Code 49-27-1-49-27-71 [revised 2003]).These wetlands include tidal marshes, swamps, estuaries, and SAV, which are important as habitat for larval, juvenile, and adult stages and for shoreline protection. On barrier islands, these include interior freshwater wetlands.

The USACE wetland definition is based on the CWA. Under that definition, wetlands are areas that are inundated or saturated by surface- or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions.

NPS Director's Order #77-1, Wetland Protection, requires the NPS to assign, classify, and inventory wetlands in accordance with the USFWS definition in *Classification of Wetlands and Deepwater Habitats of the United States* (Cowardin et al., 1979). The USFWS defines wetlands as lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water and must have one or more of the following three attributes:

1. At least periodically, the land supports predominantly hydrophytes (wetland vegetation);
2. The substrate is predominantly undrained hydric soil; and
3. The substrate is non-soil and is saturated with water or covered by shallow water at some time during the growing season of each year.

The USFWS's definition includes marine and estuarine intertidal habitats and aquatic habitat areas that, though lacking vegetation and/or soils due to natural, physical, or chemical factors such as wave action or high salinity, are still saturated or shallow inundated environments that support aquatic life. This broader definition encompasses the intertidal wetland resources affected by the project. These marine habitats are exposed to the waves and currents of the open ocean, and the water regimes are determined primarily by the ebb and flow of oceanic tides (Cowardin et al., 1979).

Since this project is being executed by the USACE, wetlands are determined as defined by the CWA and applicable regulations and policies.

Barrier Island Wet Habitats

Wet habitats on barrier islands include low flats, linear depressions, swales, ponds, and intertidal zones. These habitats occur along the seashore and at slightly higher elevations, often associated with depressions along linear-ridged sand dunes. Wetland communities that form in some wet habitats include freshwater marshes, salt marshes, salt meadows, estuarine shrublands, and slash pine woodlands. They receive freshwater primarily from rainfall and/or saltwater from ocean processes.

Common plants in brackish marsh areas include smooth cordgrass (*Spartina alterniflora*) and black needlerush (*Juncus roemarianus)*. Salt meadow habitats occur at slightly higher elevations above brackish marshes. These are typically dominated by salt meadow cordgrass and torpedo grass. Salt marsh morning glory (*Ipomoea sagittata*), dotted smartweed (*Polygonum punctatum*), umbrellasedge (*Fuirena scirpoidea*), bushy goldentop (*Euthamia leptocephala*), and poorjoe (*Diodia sp.*) are common forbs.

Estuarine shrublands typically contain eastern baccharis (*Baccharis halimifolia*), southern bayberry (*Morella caroliniensis*), and yaupon (*Ilex vomitoria*) with salt marsh cordgrass and torpedo grass forming ground cover within these shrublands. Island pinelands are found on low flats, along pond shores, and within swales of the linear dune systems. These pinelands consist of dense to open stands of slash pine (*Pinus elliottii*) as well as shrubs such as yaupon, saw palmetto, southern bayberry and occasionally, sand live oak (MDWFP, 2005; USACE, 2009a).

The total wetlands area on Sand Island encompasses 45.48 acres, 6.69 of which are internal wetlands and 18.79 of which are marine intertidal, including the marine intertidal beach. These wetlands were delineated under the NPS classification system and according to Procedural Manual #77-1 (NPS, 2012). These wetlands were formed on the west-central part of the island between 2001 and 2013 as the result of disposal activities associated with maintenance of the Pascagoula Federal navigation project within this area of DA-10 (Figure 4-2). Additionally, approximately 25.57 acres of existing wetlands were identified within the proposed project footprint on Cat Island (2.52 acres of intertidal wetlands) and East and West Ship Islands (21.75 acres of marine intertidal wetlands and 1.3 acres of estuarine pond).

Tidal Marshes, Swamps, and Bayous

Coastal wetlands, such as freshwater and tidal or salt marshes, swamps, and bayous, are found in the project area along the Mississippi coast, estuaries, and tidal inlets. Freshwater marshes are often tidally influenced, with varying elevations and functioning buffers, and are dominated by grasses. Freshwater flows through the marshes are necessary to limit saltwater intrusion. These freshwater flows also maintain suitable habitat for many species of marine flora and fauna that begin their lives in the marsh, as well as foraging, breeding, and nesting areas. Salt marshes in the area are tidally influenced and are characterized by their low position within the tidal zone, increased exposure to higher water salinities, and increasing salinity in the soils. They often have functioning buffers and marsh zonation. Black needlerush is often the dominant plant species in the salt marshes of the area. Salt pannes or flats are salt marsh areas with highly saline soils and salt marsh vegetation, typically short halophytic plants including saltwort (*Batis maritima*), glasswort (*Salicornia* spp.), seepweed (*Suaeda* spp.), and saltgrass (*Distichlis spicata*). Where salinity is extremely high, the pannes become barren (MDWFP, 2005). Coastal Mississippi swamps and bayous are regularly flooded, forested habitats dominated by bald cypress (*Taxodium distichum*) and pond cypress (*Taxodium ascendens*). Swamps and bayous are important habitat for many species of reptiles, insects, mammals, birds, amphibians, finfish, and shellfish.

The project area is bordered by two large marsh systems along the Mississippi mainland coast. The Grand Bay Marshes to the east lies within the 18,000-acre Grand Bay National Estuarine Research Reserve (NERR) in Jackson County (USACE, 2009a). The Grand Bay NERR was established in 1999 and is managed through a unique local, state, and federal partnership designed to promote estuarine research and education within Mississippi's Coastal Zone and its adjacent ecosystems. In addition, the Grand Bay National Wildlife Refuge is located in Jackson County. It was established in 1992 under the Emergency Wetlands Resources Act of 1986 and is managed by the USFWS to protect one of the largest expanses of undisturbed pine savanna habitats in the Gulf Coastal Plain region. The Hancock County Marshes to the west, at 13,570 acres, is the second largest continuous marsh area in Mississippi, extending from the Pearl River to Point Clear.

4.5.1.4 Submerged Aquatic Vegetation

SAV in the project area includes various types of seagrass. Historical studies have identified varying areas of SAV in the Mississippi Sound ranging from a high of approximately 13,000 acres in 1969 to around 2,000 acres in 1999 (Moncreiff, 2006). Approximately 2,000 acres of seagrass beds were identified along coastal Mississippi in 2005 (MDWFP, 2005). Within the project area, SAV is found primarily along the northern shores of the barrier islands and in small patches throughout the immediate shorelines. These areas are characterized by shoal grass (*Halodule wrightii*), manatee grass (*Cymodocea manatorum*), turtle grass (*Thalassia testudinum*), and widgeon grass (*Ruppia maritime*) (USACE, 2009a).

Suitable habitat for seagrass is determined by the depth and clarity of the water, sediment characteristics, salinity, and wave energy. It is estimated that 50 to 90 percent of all marine species utilize SAV at some point in their life cycle (Moncreiff et al., 1998). SAV provides spawning, nursery, refuge, and feeding areas for many species in the project area, including shrimp, crabs, scallops, redfish, speckled trout, and mullet.

The health, continued survival, and future growth of many SAV areas have been threatened by natural processes, such as disease, fluctuations in salinity, declining water quality, and storm events, as well as anthropogenic activities. There are also significant seasonal and annual variations in SAV abundance and species composition (Cho and May, 2006). As more stable, climax seagrasses such as turtle grass and manatee grass have declined, the relative abundance of opportunistic, pioneer species such as widgeon grass and shoal grass in estuaries and along barrier islands of the northern Gulf of Mexico has increased. These changes accentuate the temporal and spatial fluctuations of SAV because areal coverage and distribution of both widgeon grass and shoal grass change substantially from season to season and year to year (Cho and May, 2006).

Decreases in seagrass in the project area have been documented between 1969 and 1992. Horn Island has seen a decrease of approximately 5,000 acres during this period, with Cat Island, East Ship Island and West Ship Island, and Petit Bois Island losing approximately 430 acres, 1,280 acres, and 1,300 acres, respectively (USACE, 2009a). Table 4-1 shows SAV acreage by Barrier island. A 1999 survey estimated remaining SAV and seagrasses at approximately 1,594 acres around Cat Island, 242 acres around East Ship Island and West Ship Island, 578 acres around Horn Island, and 425 acres around Petit Bois Island (Handley et al., 2007).

TABLE 4-1
SAV Acreage—July 2010

Location	Density	Acreage
Cat Island	Continuous	178
	Patchy	1,534
West Ship Island	Patchy	261
East Ship Island	Patchy	125
Horn Island	Patchy	974
Petit Bois Island	Patchy	541

Source: Vittor and Associates, 2013

Because the Mississippi Sound's seagrasses and other SAV provide critical habitat for recreational and commercial marine species, The Nature Conservancy has named the area a priority conservation area on the Gulf Coast. Threats to this area include increased inshore fishing pressure, recreational boating, increased turbidity from incompatible development, and nutrient runoff (Beck et al., 2000).

As part of this SEIS, SAV within the project area was surveyed in July 2010 (Vittor and Associates, 2011). Overall, 3,614 acres of SAV were mapped around the barrier islands. Surveyed areas of SAV consisted of shoal grass at all locations. Vegetated bed densities were mostly patchy (<50 percent coverage) (Appendix H) with the largest SAV areas mapped near Cat Island. Figures 4-3 and 4-4 show SAV locations on Cat and East and West Ship Islands, respectively.

4.5.1.5 Shrublands

Estuarine shrublands follow the shoreline of marshes and adjoin upland areas along intertidal marsh fringes and on small islands. Common vegetation in these areas includes eastern baccharis and southern bayberry (Mississippi Museum of Natural Science, 2005). Many of the same birds that are found in the beach and dune habitat are found in shrublands.

4.5.1.6 Coastal Flatwood and Maritime Forests

The coastal forests of Mississippi include upland and wetland slash pine flatwood/savanna communities that occupy ancient low shoreline beach ridges and low flats situated immediately inland from tidal marshes. They are also found along terrace levees of tidal creeks. Slash pine and the understory species found in the forests can tolerate seasonally wet or saturated soils, including saturation due to periodic storm surges of brackish water. Adjacent to the coast, saltmeadow cordgrass dominates the understory. Saltmeadow cordgrass is no longer dominant a short distance inland, but occasionally the species persists several miles inland along creeks and bayous. Common shrubs in the community include southern bayberry, eastern baccharis, and yaupon. Coastal flatwood forests are fire-dependent and can become brushy during long intervals between burns (MDWFP, 2005).

Coastal live oak woodlands are another maritime forest community found along both the Mississippi coast and on barrier islands. Live oak woodlands are found on coastal cheniers and ancient beach ridges that straddle the coast line. These woodlands are dominated by live oaks and upland laurel oaks (*Quercus hemisphaerica*) and typically contain an understory of saw palmetto. These forests and coastal flatwood forests provide important stop-over locations for neotropical migrants during spring and fall migrations (MDWFP, 2005).

4.5.1.7 Mississippi Mainland Beaches

The majority of the shoreline in coastal Mississippi consists of man-made beaches waterward of concrete seawalls. These beaches are often located in areas that were historically marshes. These beaches were frequently built to reduce risk of storm damage to the roadways and seawalls and also to provide recreation and aesthetic benefits. The marsh habitat was destroyed or eliminated along with its associated storm surge protection (USACE, 2009a).

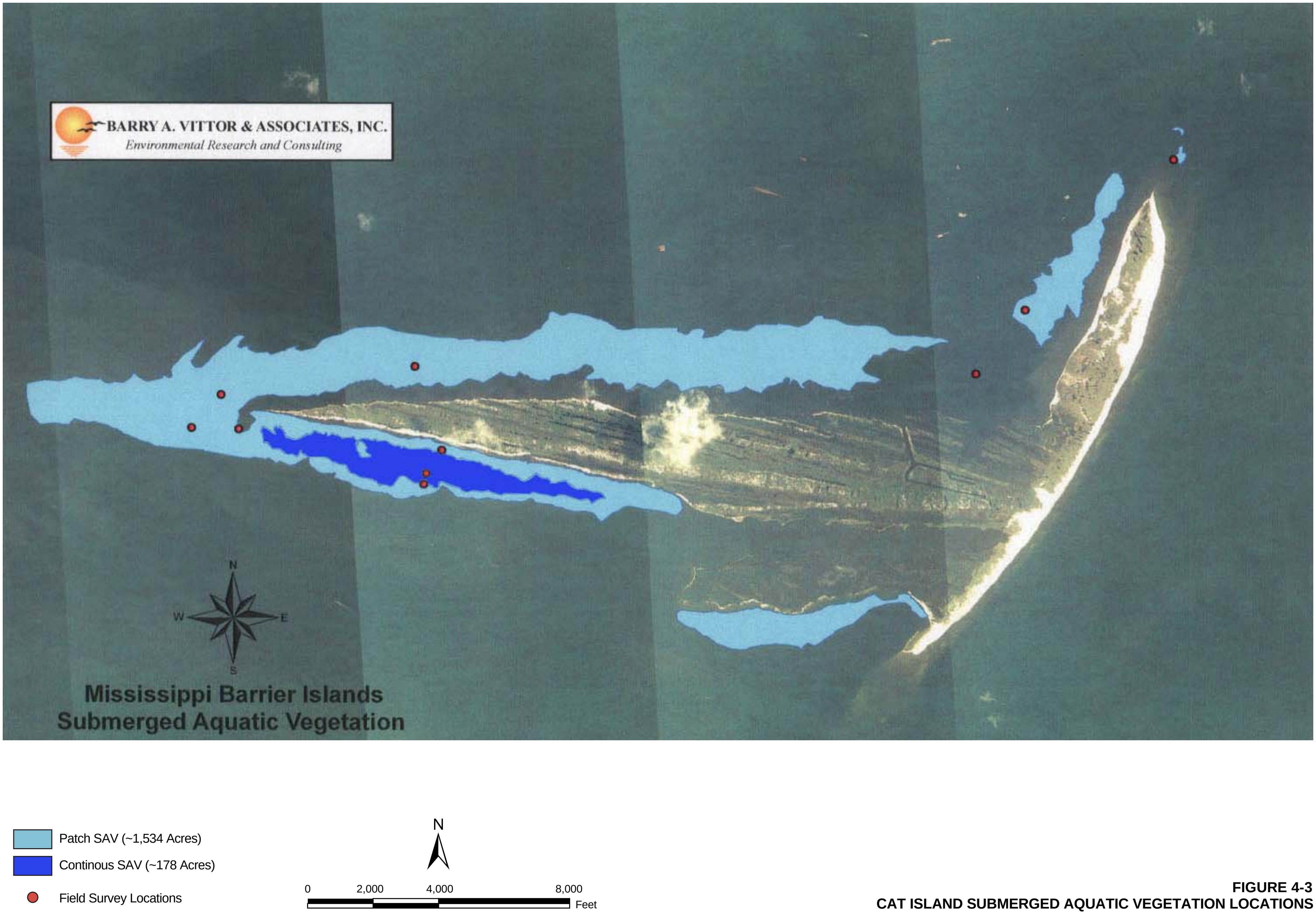
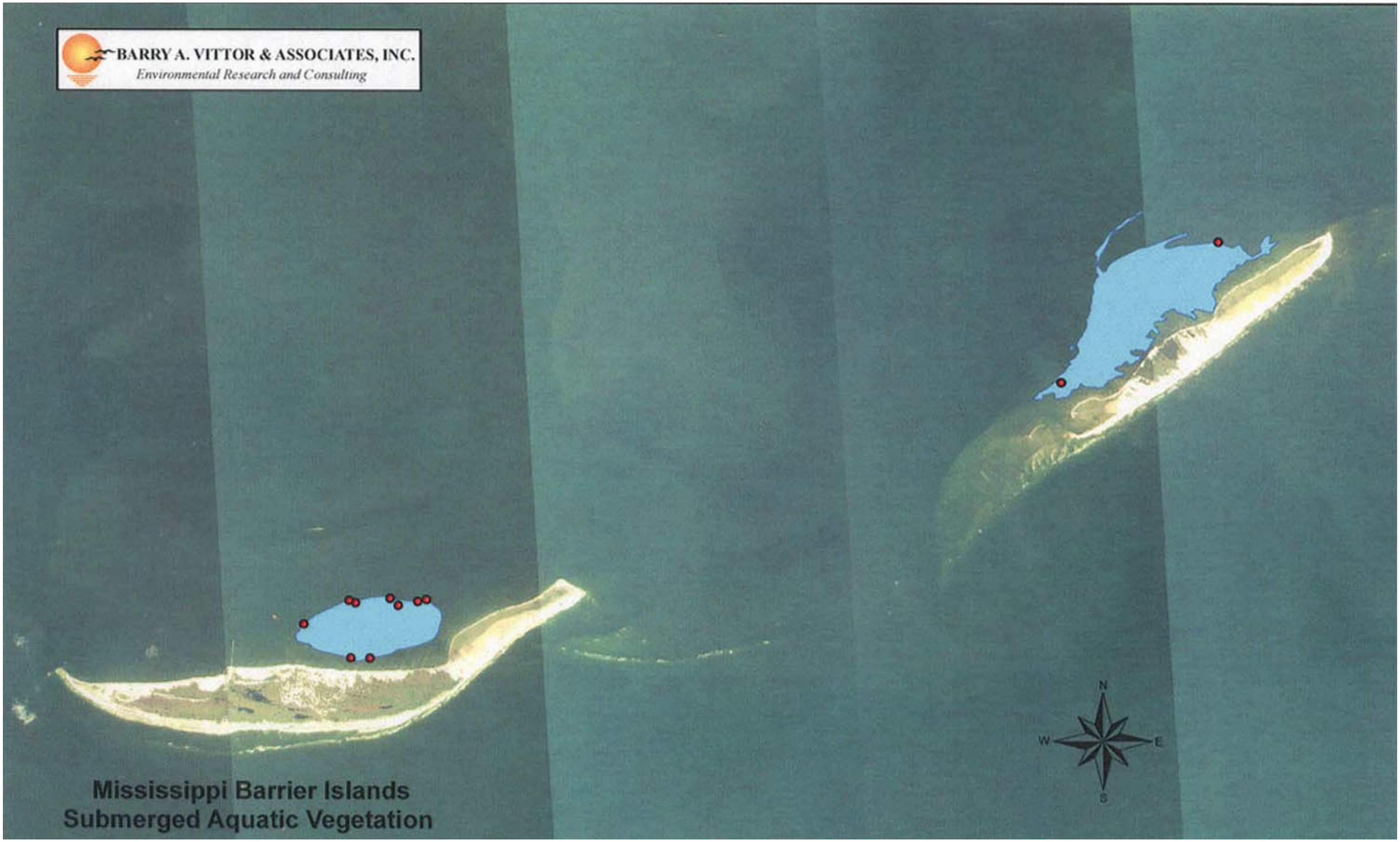


FIGURE 4-3
CAT ISLAND SUBMERGED AQUATIC VEGETATION LOCATIONS
MsCIP COMPREHENSIVE BARRIER ISLAND RESTORATION SEIS



Patch SAV (~387 Acres)
Field Survey Locations

0 2,000 4,000 8,000 Feet

FIGURE 4-4
WEST AND EAST SHIP ISLAND SUBMERGED AQUATIC VEGETATION LOCATIONS
MsCIP COMPREHENSIVE BARRIER ISLAND RESTORATION SEIS

Some natural beaches occur along the mainland coast. These are predominantly found at the mouths of rivers, such as the Pearl and Pascagoula Rivers. These beaches often have substrates that are muddy in texture because they originate from the eroding intertidal marshes. However, a few significant segments of sand or shell beach exist along the mainland, such as along the Rigolets Islands on the borders of Mississippi and Louisiana, Pointe-aux-Chenes, southwest of the mouth of Graveline Bayou, southeast of the mouth of Davis Bayou in Jackson County, on Big Island in Back Bay of Biloxi in Harrison County, and between the mouth of Bayou Caddy and Landmark Bayou in Hancock County. These beaches serve as important nesting habitat for the Mississippi diamondback terrapin.

In addition to natural beaches and sandy shores, mud and sandy mud shores occur along tidal streams and mud flats occur within the coastal estuaries. Mud shores and mud flats harbor numerous microorganisms, such as phytoplankton, fungi, bacteria, and protozoans that serve as an important food source for benthic invertebrates (polychaetes, mollusks, and crustaceans), which in turn support mid- and upper level consumers such as crabs, shorebirds, shrimp, and fish. Wading and shorebirds are especially dependent on mud shores. Herons, egrets, sandpipers, plovers, godwits, willets, terns, gulls, ducks, and osprey frequent this habitat (MDWFP, 2005).

4.5.2 Plankton

4.5.2.1 Plankton and Algae

Phytoplankton and Filamentous Algae

Diatoms and dinoflagellates are the dominant components of the phytoplankton community in the Gulf of Mexico, and the relative composition of these organisms depends on nutrient and silica availability in the water. Over 900 diatom species and 400 dinoflagellate species have been reported from the Gulf of Mexico.

Within the Mississippi Sound, phytoplankton communities are generally quite diverse, with occasional monotypic blooms. Salinity, nutrient concentrations, temperature, and wind conditions influence the distribution of phytoplankton. Population composition, abundance, and diversity also vary by season. Seventy-seven species of marine algae have been identified as part of the summer flora of the Mississippi Sound, though more species are likely present (Eleuterius, 1981). The greatest diversity of phytoplankton has been reported in areas affected by river discharges where both riverine and marine species occur (USEPA, 1991).

Blue-green algae and diatoms are the dominant microflora in marshes and seagrass beds in the Mississippi Sound (Stout and de la Cruz, 1981; Daehnick et al., 1992). Red algae are the dominant filamentous algae in those systems and support coverings of epibenthic diatoms. Phytoplankton production in seagrass beds is highest in summer (August) and lowest in winter (January) (Moncreiff et al., 1992). Chlorophyll *a* concentrations in seagrass beds have been measured in a range of 14 to 125 milligrams per square meter (mg/m^2), but average 26 to 86 mg/m^2 depending on season and water conditions (Daehnick et al., 1992).

Seaward of the barrier islands along the shelf, both estuarine and Gulf species of plankton are present. Populations are greatest during the winter and spring and lowest during the late summer and fall. Surface chlorophyll *a* concentrations range from 0.04 to 1.73 mg/m^2

and average 0.69 mg/m^2. This value is about three times those of the open Gulf (MMS, 1991).

Zooplankton

Median zooplankton biomass has been measured on the continental shelf at 10.1 cubic centimeters per liter (USEPA 1991). Copepods are typically the dominant zooplankton form in this environment. In the mid-shelf region south of Mississippi, the copepod genus *Paracalanus* has been reported in concentrations of 3,036 individuals per cubic meter. Relatively high zooplankton abundance has been reported within the passes of the barrier islands (USEPA, 1991).

The zooplankton community seaward of the barrier islands is composed of estuarine and open Gulf species and, thus, exhibits high diversity. Zooplankton volumes are greatest nearshore and tend to decrease with distance from shore. Seasonal changes in species composition and abundance are also evident, with zooplankton most abundant in the winter and high during the summer, and less abundant in the fall. Surface zooplankton volumes average 80 to 108 individuals per milliliter in waters shallower than 40 meters (MMS, 1991). Ichthyoplankton are an important component of the zooplankton community and are addressed in Section 4.5.4.

Harmful Algal Blooms

"Harmful algal bloom" (HAB) refers to a phytoplankton bloom producing toxins that cause harmful conditions. A small number of phytoplankton species produce neurotoxins. These toxins can be transferred through the food web where they affect higher forms of life such as zooplankton, shellfish, fish, birds, marine mammals, and humans that feed either directly or indirectly on them.

The source of HABs is not clear. Such blooms have occurred in waters where pollution is not an obvious factor, although an increase in nutrients stimulates algal blooms. The presence of toxic species is a natural occurrence that can be exacerbated by natural currents and environmental forces (e.g., hurricanes). The recent identification of a higher number of bloom events may reflect better detection methods and an increase in the number of observers (Anderson, 2010). Two species of algae (*Alexandrium monilata* and *Karenia breivs*) have caused HABs near the Mississippi coast. The species *K. breivs* causes neurotoxic shellfish poisoning; previous blooms have affected scallops, surfclams, oysters, southern quahogs, coquinas, tunicates, commercial and recreational species of fish, sea birds, sea turtles, manatees, and dolphins. Blooms of *A. monilata* have impacted oysters, coquinas, mussels, gastropods, and fish (Anderson, 2010).

4.5.3 Benthic Environment

4.5.3.1 Benthic Invertebrates

The bottom sediments in the Mississippi Sound provide habitat for multiple species of infaunal and epifaunal invertebrates. Due to the frequent disturbances in the area (e.g., sediment disposal, storm action, and maritime activity), species present tend to be either tolerant of disruption or capable of rapidly re-colonizing disturbed areas.

The two most comprehensive historical studies of benthic habitats in the project area include the "Benthic Macroinfauna Community Characterizations in the Mississippi Sound and Adjacent Areas" study (MSAAS) (Shaw et al., 1982) and studies conducted by Rakocinski and colleagues in the 1990s (Rakocinski et al., 1991, Rakocinski et al., 1993, Rakocinski et al., 1998). The MSAAS involved sampling habitats in the Mississippi Sound and in shallow water (10 to 50 feet) in the Gulf of Mexico, while the Rakocinski studies focused on Mississippi barrier island beaches. Together, these studies provide a historical account of "typical" macroinvertebrate assemblages in the following habitat types: shallow Sound, tidal pass, offshore barrier island, offshore shallow water, and barrier island beach.

In the 1982 study, over 532 taxa from offshore Mississippi and Alabama and 437 taxa from the Mississippi Sound were identified. Densities of individuals varied from 910 to 19,536 individuals per square meter for the offshore and 1,200 and 38,863 individuals per square meter for the Sound area (USACE, 2009a).

In a 1980 comprehensive benthic invertebrate study, Vittor identified 330 infauna taxa, with a single polychaete (*Myriochele oculata*) comprising over 40 percent of all organisms encountered during the survey (over 198,000 specimens). Three other polychaetes, *Mediomastus* ssp., *Paraprionospio pinnata,* and *Owenia fusiformis,* represented over 13 percent of the community (Vittor, 1981). Other common benthic invertebrates in the Mississippi Sound include bivalves, gastropods, malacostracans, and nemertean worms (MDEQ, 2006b).

A 3-year (1987 to 1989) evaluation of the benthic community seaward of the barrier islands determined that the benthic macroinfauna were dominated by polychaete species, which represented about 60 percent of the community. Mollusks and crustaceans each constituted approximately 15 percent, with the remaining 10 percent of the community consisting of more than 12 different phyla. Macroinfaunal density was closely related to the sediment type. Highest densities occurred in areas with coarse sediments of sand and shell and lowest densities appeared in the sediments consisting of silt and clay (MMS, 1991).

During the three benthic macroinfauna community assessments conducted for MsCIP in June 2010, September 2010, and April/May 2011, benthic macroinfauna samples were collected from 20 offshore locations (borrow site stations), 19 beach/subtidal locations (beach transect stations), and 25 sand placement locations (placement site stations) (Figure 4-5). The offshore locations were selected within each potential borrow area to be representative of conditions in each of the potential borrow areas and included littoral shoal/disposal habitats (e.g., DA-10/Sand Island and Petit Bois Pass) and fluvial/ebb-tide delta habitats (Ship Island and Cat Island Pass borrow areas). The beach/subtidal locations on the Mississippi Sound and Gulf of Mexico sides of the barrier islands were representative of potential island restoration placement areas (e.g., Cat Island). The sand placement locations were close to the islands and were representative of MsCIP sand placement alternatives, including shallower, shoreline habitat along the barrier islands and within Camille Cut. The results of the study (Vittor and Associates, 2013) are included as Appendix I and summarized below. When applicable, comparisons to historical studies are also provided.

4.5.3.1.1 Borrow Site Stations

Table 4-2 summarizes the dominant taxa at borrow site stations in the Mississippi Sound, near the barrier islands, and at offshore locations south of the barrier islands during the MsCIP benthic macroinfauna study and those at comparable historical sampling stations.

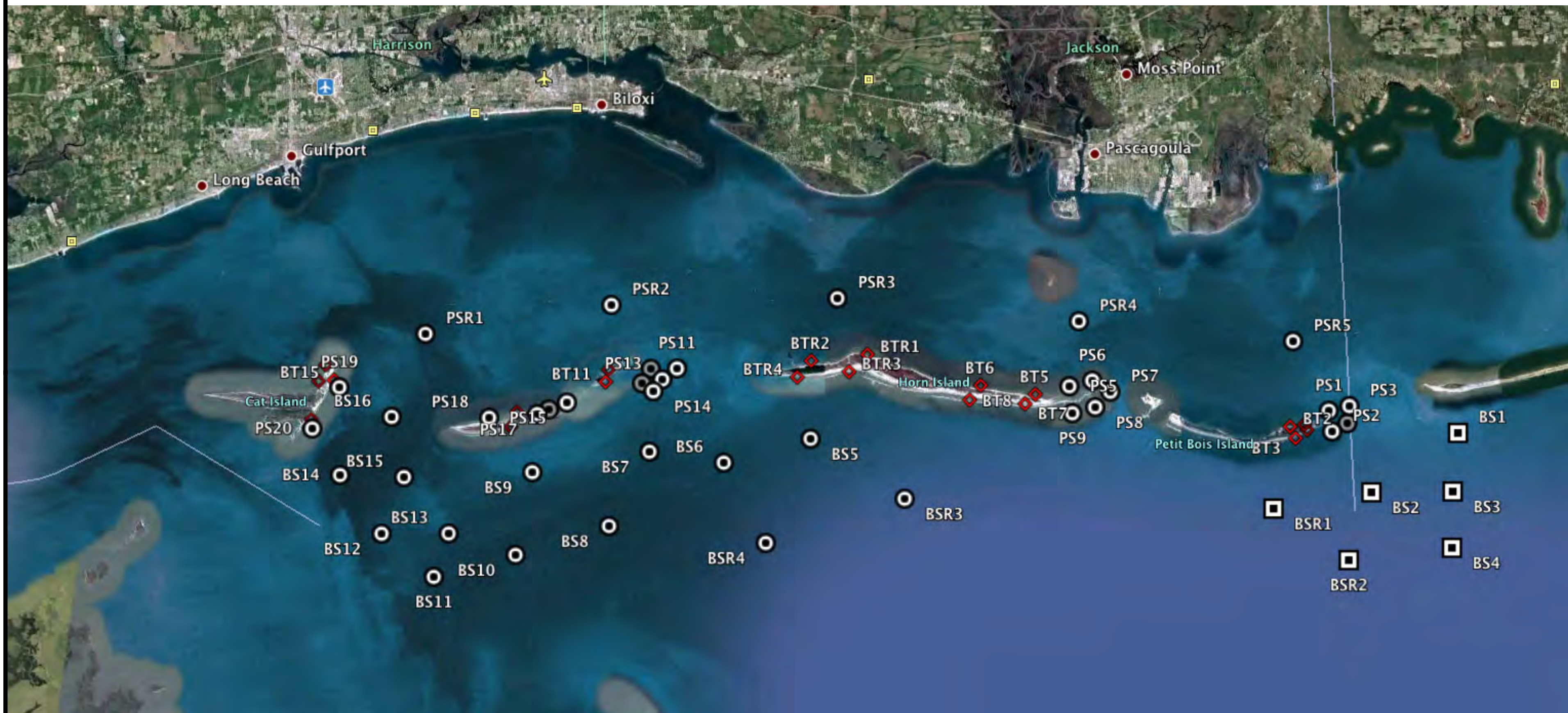


FIGURE 4-5
STATION LOCATIONS FOR THE BENTHIC MACROINFAUNAL COMMUNITY ASSESSMENT, 2010-2011
MsCIP COMPREHENSIVE BARRIER ISLAND RESTORATION SEIS

ES121410141439ATL

TABLE 4-2
Summary of Dominant Taxa, Taxa Richness, and Densities at MsCIP Benthic Macroinfauna Study Borrow Sites and Dominant Taxa at Comparable Historical Sampling Sites

Location	Sampling Season	Dominant Taxa	Average Taxa Richness[a]	Average Density[b] (number/square meter)
East Borrow Sites (Vittor and Associates, 2013)	June 2010	Polychaete assemblage (*Paraprionospio pinnata, Mediomastus* spp., *Meredithia uebelackerae)*	23	2,000
	September 2010	Polychaete assemblage (*P. pinnata, M. uebelackerae)* and chordate *Branchiostoma* spp.	13	600
	April/May 2011	Mixed polychaete/crustacean assemblage Polychaetes (*Meredithia uebelackerae, Mediomastus* spp., and *Sigambra tentaculata)*	25	1,600
West Borrow Sites (Vittor and Associates, 2013)	June 2010	Polychaete assemblage (*Paraprionospio pinnata, Mediomastus* spp., *Meredithia uebelackerae)*	15	1,700
	September 2010	Polychaete assemblage *(P. pinnata, M. uebelackerae*) and chordate *Branchiostoma* spp.	7.5	500
	April/May 2011	Mixed polychaete/bivalve assemblage Polychaetes (*Meredithia uebelackerae, Mediomastus* spp., and *Sigambra tentaculata)*	10.5	1,400
MSAAS Offshore Locations (Shaw et al., 1982)	Fall 1980	Surface and subsurface deposit feeding polychaetes (*Magelona* cf. *phyllisae*, *Mediomastus* spp. and *Galathowenia oculata)*	N/A	N/A
	Spring 1981	Surface and subsurface deposit feeding polychaetes (*M. phyllisae* and *Mediomastus* spp.)	N/A	N/A
Inner Subtidal Zone (depths < 2 meters) (Rakocinski et al., 1991; Rakocinski et al., 1993)	1993	Polychaetes (*Paraonis, Leitoscoloplos*), crustaceans (haustorid amphipods), and bivalves (*Donax*)	N/A	N/A
Mississippi-Alabama Continental Shelf (MMS, 1991)	1987–1989	Polychaetes (approximately 60%), mollusks (15%), and crustaceans (15%) over 12 different phyla (10%)	N/A	N/A

N/A = not available
[a] Taxa richness is a measure of the number of different taxa present in the ecological community.
[b] Taxa density is a measure of how abundant the taxa are within the sample.

During the MsCIP study, a polychaete assemblage dominated the benthos at borrow site stations in June 2010 and September 2010. In April and May 2011, a mixed polychaete/ crustacean assemblage dominated the six most eastern borrow site stations off the eastern tip of Petit Bois and the western tip of Dauphin Island, and a polychaete/bivalve assemblage dominated the 14 borrow site stations to the west, off of Horn, East Ship, West Ship, and Cat Islands (Table 4-2). The polychaetes, *Paraprionospio pinnata, Mediomastus* spp., *Meredithia uebelackera*, and the chordate, *Branchiostoma* spp., dominated both the east and west borrow sites in June and September 2010. The polychaetes, *M. uebelackerae, Mediomastus* spp., and *Sigambra tentaculata,* dominated the borrow sites during the April/May 2011 event. The macroinvertebrate assemblages found at borrow site stations were generally similar to those collected at offshore locations in 1980to 1981 for the MSAAS (Shaw et al., 1982), as well as those collected by Rakocinski et al. (1993) in the inner subtidal zone, ranging between the island shore and 100 meters from the shore. Additional detail on the studies conducted for MsCIP is in Appendix I.

Macroinvertebrate taxa richness and densities at the borrow site stations during the MsCIP study exhibited significant variation between events and locations (Table 4-2). Taxa densities and richness were higher at the east borrow site stations than at the west borrow site stations during each of the three sampling events. Seasonal variations, including a decrease in taxa richness and macroinvertebrate densities during September 2010 may be partially attributable to one or both of two events: (1) the Deepwater Horizon oil spill, in April 2010, in which the Mississippi barrier islands and adjacent waters received surface and subsurface petrochemicals and dispersant chemicals; and (2) a prolonged hypoxic event at all borrow site stations in May-June 2011. Taxa richness at the east borrow site stations decreased significantly from June 2010 to September 2010, but taxa richness recovered to June 2010 levels by the April/May 2011 sampling event. Taxa richness at the west borrow site stations similarly decreased from June 2010 to September 2010. Macroinvertebrate densities at both the east and west borrow site stations decreased significantly from June 2010 to September 2010, and densities only partially recovered by April/May 2011.

Benthic invertebrate communities in the Petit Bois South OCS borrow areas have been evaluated in three separate and independent studies including a benthic community characterization of the Mississippi Sound and adjacent waters (Shaw et al., 1982); a survey of Alabama sand resource areas (Byrnes et al., 1999); and a Mississippi Sound and Gulf of Mexico benthic macroinfauna community assessment (Vittor and Associates, 2013, Appendix I). The station depth ranges and sediments are consistent with the conditions in the OCS borrow areas (Table 4-3).

TABLE 4-3
Summary of Benthic Studies in Proximity to the Petit Bois South OCS Borrow Areas.

Study and Survey Year	Number of Stations/Seasons	Water Depth	Predominant Sediment Textures
MSCIP 2010-11	6/3	9 to 18 m (30 to 59 ft)	Sand, muddy sand, sandy mud
MMS AL 1997	14/2	13 to 20 m (43 to 66 ft)	Slightly gravelly sand, muddy sand
USACE 1980-81	9/2	11 to 18 m (36 to 59 ft)	Sand, muddy sand, sandy mud
Petit Bois South OCS Resource Areas	--	12 to 18 m (40 to 58 ft)	Sand, gravelly sand, sand-gravel-silt mixes

Mean densities were comparable among the three studies (Table 4-4). The mean number of taxa was generally lower during the MsCIP surveys (Vittor, 2013) compared to the two previous studies, in part due to study design differences and sampling techniques. In general, station means for number of taxa, density (individuals/m^2), and diversity (H') were higher in the spring and summer compared to fall and winter surveys. Mean densities of individuals varied greatly ranging from 981 to 4,632 individuals/m^2.

TABLE 4-4
Community Statistics for Stations Sampled In the Petit Bois South OCS Borrow Areas

Study and Survey Year	Month or Season (N)	Mean Number of Taxa	Mean Density (individuals/m^2)	Diversity (H')
MsCIP 2010-11	June (6)	23.6 (±8.3)	3,347.0 (±1,622.9)	2.60 (±0.31)
	September (6)	13.4 (±5.6)	981.0 (±746.3)	2.53 (±0.80)
	April-May (6)	25.2 (±10.3)	2,028.2 (±1,358.3)	3.11 (±0.43)
MMS 1997	May (14)	65.1 (±23.0)	2,985.7 (±1777.2)	3.27 (±0.63)
	December (14)	33.2 (±16.3)	1,098.57 (±615.7)	2.81 (±0.62)
USACE 1980-81	Fall (9)	29.0 (±10.1)	1,854.4 (±1,092.0)	3.36 (±0.70)
	Spring (9)	48.2 (±19.4)	4,632.2 (±2,824.5)	3.46 (±0.48)

The numerically dominant taxa collected during the MsCIP survey were primarily polychaetes, including *Mediomastus ambiseta*, *Meredithia uebelackerae*, and *Paraprionospio pinnata* (Table 4-5). These taxa were also among the numerical dominants in the MMS AL and Shaw et al. studies. In addition, lancelets (*B. caribaeum*) were abundant in the MsCIP and Shaw et al. studies, and the archiannelid *Polygordius* was abundant in the MMS AL and Shaw et al. studies.

TABLE 4-5
Numerically Dominant Taxa Collected in Proximity to the Petit Bois South OCS Borrow Areas

MsCIP	MMS AL	Shaw et al.
June 2010 *Mediomastus ambiseta* (P) *Paraprionospio pinnata* (P) *Spiophanes bombyx* (P)	May 1997 *Aricidea taylori* (P) *Mediomastus ambiseta* (P) *Paraprionospio pinnata* (P) *Polygordius* (A)	Fall 1980 *Mediomastus ambiseta* (P) *Paraprionospio pinnata* (P) *Meredithia uebelackerae* (P)
September 2010 *Branchiostoma caribaeum* (C) *Paraprionospio pinnata* (P) *Meredithia uebelackerae* (P) April-May 2011 *Mediomastus ambiseta* (P) *Meredithia uebelackerae* (P) Bivalvia spp.	December 1997 *Armandia maculata* (P) *Mediomastus ambiseta* (P) *Meredithia uebelackerae* (P) *Phascolion strombi* (S)	Spring 1981 *Branchiostoma caribaeum* (C) *Mediomastus ambiseta* (P) *Polygordius* (A)

Key – A = Archiannelida; C = Cephalochordata; P = Polychaeta; S = Sipuncula

4.5.3.1.2 Placement Site Stations

Table 4-6 summarizes the dominant taxa at placement site stations during the MsCIP benthic macroinfauna study and those at comparable historical sampling stations. The placement site stations were primarily dominated by polychaetes (e.g., *Spiophanes, Polygordius, Magelona, Meredithia, Mediomastus, Paraonis, Paraprionospio),* bivalves *(Gemma gemma),* arthropods (*Pinnixa),* chordates (*Branchiostoma),* and amphipods (*Acanthohaustorius)*. Camille Cut was the only location that was dominated almost entirely by bivalves, though the polychaete *Paraonis* was also dominant during the April/May 2011 event. The Mississippi Sound stations were the only sites dominated by gastropods (*Nuculana, Nassarius*) in addition to polychaetes.

Among the placement site stations, taxa richness and macroinfaunal densities varied by location. Taxa richness at the five Mississippi Sound stations was significantly lower than that at the barrier island locations. Habitat at the Mississippi Sound stations differed from other placement site stations due to deeper water and silty, clay sediment. The sediment at other placement site stations was comprised of clean sand. Macroinfaunal densities at the three Camille Cut stations were significantly higher than those at the other barrier island locations and the Mississippi Sound locations.

TABLE 4-6
Summary of Dominant Taxa, Taxa Richness, and Densities at MsCIP Benthic Macroinfauna Study Placement Sites and Dominant Taxa at Comparable Historical Sampling Sites

Location	Sampling Season	Dominant Taxa	Approximate Average Taxa Richness	Approximate Average Density (number/ square meter)
Petit Bois Island	June 2010	Polychaete, *Spiophanes;* arthropod, *Pinnixa;* bivalve, *Gemma*	27.5	3,500
	September 2010	Bivalve, *G. gemma;* chordate, *Branchiostoma*	12.5	5,100
	April/May 2011	Polychaete, *Polygordius;* bivalve, *G. Gemma*	22.5	5,000
Horn Island	June 2010	Polychaetes, *Polygordius* and *Magelona*; bivalve, *G. gemma;* chordate, *Branchiostoma*	17.5	4,000
	September 2010	Bivalve, *G. gemma;* chordate, *Branchiostoma*	11.0	900
	April/May 2011	Polychaetes, *Polygordius*; bivalve, *G. gemma*	25.0	11,000
Ship Island	June 2010	Polychaetes, *Magelona* and *Meredithia;* amphipod, *Acanthohaustorius*; bivalve, *G. gemma*	16.5	4,700
	September 2010	Polychaetes (*Mediomastus, Paraonis, Magelona*); chordate, *Branchiostoma*	16.0	1,800
	April/May 2011	Polychaetes (*Mediomastus, Spiophanes*); haustorid amphipod assemblage	21.0	2,700

TABLE 4-6
Summary of Dominant Taxa, Taxa Richness, and Densities at MsCIP Benthic Macroinfauna Study Placement Sites and Dominant Taxa at Comparable Historical Sampling Sites

Location	Sampling Season	Dominant Taxa	Approximate Average Taxa Richness	Approximate Average Density (number/ square meter)
Camille Cut	June 2010	Bivalve, *G. gemma* (> 70% of the assemblage)	12.5	9,000
	September 2010	Bivalve, *G. gemma* (> 85% of the assemblage)	13.0	30,000
	April/May 2011	Bivalve, *G. gemma;* polychaete, *Paraonis*	15.0	13,000
Cat Island	June 2010	Polychaete, *Mediomastus;* amphipod, *Acanthohaustorius*	25.5	3,500
	September 2010	Cirratulid polychaete, *Mediomastus; Branchiostoma*	10.0	750
	April/May 2011	Polychaetes, *Mediomastus* and *Meredithia*	28.0	4,000
Mississippi Sound	June 2010	Polychaete complex (*Mediomastus, Paraprionospio*) and gastropods (*Nuculana, Nassarius*)	16.0	1,100
	September 2010	Polychaete complex (*Mediomastus, Paraprionospio*) and gastropods (*Nuculana, Nassarius*)	7.5	500
	April/May 2011	Polychaete, *Mediomastus*	20.0	1,600
MSAAS Shallow Sound Sand (Shaw et al., 1982)	Fall 1980/ Spring 1981	Bivalve, *G. gemma*; polychaete, *Paraonis;* amphipod, *Lepidactylus* (these same taxa were dominant components of the barrier island macroinvertebrate assemblages seen in Vittor and Associates, 2013)	N/A	N/A
MSAAS Inshore Sound (Shaw et al., 1982)	Fall 1980/ Spring 1981	Polychaetes, *Galathowenia* and *Owenia;* haustorid amphipods	N/A	N/A
MSAAS Tidal Pass (Shaw et al., 1982)	Fall 1980/ Spring 1981	Surface and subsurface deposit feeders (e.g. polychaetes, *Polygordius and Spiophanes*; chordate, *Branchiostoma*; haustorid amphipods; suspension feeding bivalves)	N/A	N/A
Inner Subtidal (Rakocinski et al., 1993)	1993	Polychaetes (*Paraonis)*; haustorid amphipods; bivalves (similar to assemblages associated with the barrier islands in Vittor and Associates, 2013)	N/A	N/A
Shallow Subtidal (Rakocinski et al., 1991)	1991	Polychaetes (*Paraonis, syllids*); chordate, *Branchiostoma*; amphipod (*Lepidactylus*)	N/A	N/A

N/A—Not Available

The macroinvertebrate assemblages at placement site stations varied significantly between locations and among seasonal events (Table 4-6). Significant declines in taxa richness between June 2010 and September 2010, as well as recovery by April/May 2011, were observed at Petit Bois Island, Horn Island, and the Mississippi Sound stations. Macroinvertebrate densities significantly declined between June 2010 and September 2010 at stations on Horn Island, Ship Island, Cat Island, and Mississippi Sound locations, with recovery occurring by April/May 2011 on Horn Island, Cat Island, and the Mississippi Sound. Densities at Ship Island stations only partially recovered to June 2010 levels by the April/ May 2011 event. Unlike at the borrow site stations, hypoxic conditions were infrequent at the placement site locations (only measured at three locations in June 2010), likely due to shallow water depths and highly dynamic habitats.

Historical sampling locations representative of the MsCIP placement site stations include the MSAAS shallow Sound, inshore Sound, and tidal pass locations and Rakocinski's inner subtidal and shallow subtidal locations. Macroinvertebrate assemblages in the MSAAS shallow Sound sand habitat were similar to those observed at the barrier island placement site stations. The MSAAS Tidal Pass and the MsCIP Camille Cut assemblages were comparable, dominated by surface and subsurface deposit feeders. Macroinvertebrate assemblages in Rakocinski et al. (1993) inner subtidal and shallow subtidal habitats were similar to those at the barrier island placement site stations. At the Mississippi Sound locations, the macroinvertebrate assemblages were dominated by polychaetes (*Mediomastus, Paraprionospio*) and gastropods (*Nuculana, Nassarius*) in June and September 2010 and by *Mediomastus* in April/May 2010. These assemblages were similar to those observed in the MSAAS's Inshore Sound stations in 1980 and 1981 (Shaw et al., 1982).

4.5.3.1.3 Beach Transect Stations

Taxa richness and density data collected from beach transect stations at depths of 10, 20 and 50 feet had low taxa richness (relative to the borrow site and placement site stations) and variable densities (Tables 4-7 and 4-8). Beach transect station samples contained patchy distributions of several habitat-specific macroinvertebrate taxa, and there were no apparent seasonal trends. Dominant taxa varied by depth as follows:

- Shallow (10-foot) stations were dominated by oligochaetes, bivalves, amphipods, cumaceans, isopods, and polychaetes;
- Mid-depth (20-foot) stations were dominated by oligochaetes, amphipods, mysids, cumaceans, a pinnotherid crab, bivalves, and polychaetes; and
- Deep stations (50-foot) stations were dominated by polychaetes, bivalves, amphipods, isopod, and a cumacean.

TABLE 4-7
Summary of Dominant Taxa, Taxa Richness, and Density at Shallow, Mid-depth, and Deep Beach Transect Stations

Location	Dominant Taxa	Average Taxa Richness [a,b]	Average Density (number/square meter) [a,b]
Gulf Shallow (10-feet) Stations (n = 8)	All Shallow Stations: Oligochaetes; bivalves, *Gemma* and *Donax variabilis;* amphipod, *Lepidactylus triarticulatus;* cumacean, *Spilocuma;* isopod, *Exosphaeroma;* polychaete, *Paraonis fulgens*	1.5–3.5	500–4,000
Miss. Sound Shallow Stations (n = 8)		5–11.5	5,200–34,000
Gulf Mid-depth (20-feet) Stations (n = 8)	All Mid-depth Stations; Oligochaetes; amphipods, *Lepidactylus* and *Haustorius*; mysid, *Metamysidopsis;* cumacean, *Spilocuma;* pinnotherid crab, *Pinnixa;* bivalves, *G*. *gemma* and *D*. *variabilis;* polychaetes, *Paraonis*, *Leitoscoloplos*, *Sphaerosyllis* and *Nereis*	2–5	900–3,000
Miss. Sound Mid-depth Stations (n = 8)		5.5–15	8,500–45,000
Gulf Deep (50-feet) Stations (n = 8)	All Deep stations: Polychaetes, *Paraprionosyllus*, *Sphaerosyllis*, *Leitoscoloplos*, *Capitella* and *Paraonis;* bivalves, *G*. *gemma* and *D*. *variabilis;* amphipods, *Lepidactylus* and *Acanthohaustorius;* isopod, *Ancinus*, and the cumacean, *Spilocuma*	2.5–6	1,000–3,600
Miss. Sound Deep Stations (n = 8)		6–14.5	7,200–48,000

[a] Does not include Cat Island stations, which were not separated into Sound side/Gulf side groupings
[b] Range among locations (5) and events (3)

TABLE 4-8
Summary of Taxa Richness and Density at Beach Transect Barrier Island Locations

Location	Dominant Taxa	Average Taxa Richness[a]	Average Density (number/square meter) [a]
Petit Bois Island Gulf side (n = 2)	Oligochaetes, Enchytraidae and Tubificidae Malacostracea, *Lepidactylus sp.*; bivalves, *G*. *gemma* and *D*. *variabilis*	1.5–5	800–4,000
Petit Bois Island Miss. Sound side (n = 2)	Malacostracea, Haustoriidae and Mysidae; Polychaete, *Paraonis sp.;* Nemertea; bivalves, *G*. *gemma* and *D*. *variabilis*	7.5–14.5	12,000–48,000
Horn Island Gulf side (n = 2)	Malacostracea, *Metamysidopis sp*., *Ancinus sp., Lepidactylus sp*.; Nemertea; bivalves, *G*. *gemma* and *D*. *variabilis*	1.5–4	500–4,000
Horn Island Miss. Sound side (n = 2)	Oligochaetes, Enchytraidae and Tubificidae; Polychaete, *Paraonis sp.*; Malacostracea, *Lepidactylus sp*.; Nemertea	7–2.5	8,400–24,000
Ship Island Gulf side (n = 2)	Malacostracea, *Lepidactylus sp*. and *Exosphaeroma sp*.; bivalves, *G*. *gemma* and *D*. *variabilis*	1.5–3.5	800–2,900

TABLE 4-8
Summary of Taxa Richness and Density at Beach Transect Barrier Island Locations

Ship Island Miss. Sound side (n = 2)	Oligochaetes, Enchytraidae; Polychaete, *Paraonis sp.*, *Leitoscoloplus sp. and* Terebellidae.; Malacostracea, *Spilocuma sp and Houstorius sp.*; bivalves, *G. gemma* and *D. variabilis*	5–9	12,000–45,000
West Horn Island Gulf side (n = 2)	Polychaete, *Paraonis sp, Scolelepis sp.;* Malacostracea, *Acanthohaustorius sp.*, *Spilocuma sp., Pinnixa sp. and Lepidactylus sp.*; bivalves, *G. gemma* and *D. variabilis*	1.5–6	600–3,500
West Horn Island Miss. Sound side (n = 2)	Oligochaetes, Enchytraidae, and Tubificidae; Polychaetes, *Paraonis sp. and Capitella sp.; Malacostracea,* Malacostracea, *Lepidactylus sp.*, *Haustorius sp.*, and *Exosphoeroma sp.* Nemertea	8–15	5,200–25,000
Cat Island (n = 3)[b]	Polychaete, *Paraonis sp, Leitoscoloplus s.* and *Nereididae sp.;* Malacostracea, *Lepidactylus sp.*, *Haustorius sp.*, *Spilocuma sp.* and *Exosphoeroma sp.;* bivalves, *D. variabilis* and *Petricola sp.*	2–5	3,500–12,000

[a] Range among depths (3) and events (3)
[b] Cat Island stations were not separated into Sound /Gulf groupings

One distinguishing factor of the beach transect samples was the significantly higher taxa richness and densities observed at stations on the Mississippi Sound side of the barrier islands, relative to those at the Gulf side. Stations located on the Sound side of the islands typically had 2 to 4 times more taxa, and often an order of magnitude higher densities, than stations located on the Gulf side.

Beach transect assemblages were similar to those found by Rakocinski et al. (1991) at barrier islands with exposed Gulf beaches and protected Sound beaches. In this study, Lepidactylus and Paraonis were found to dominate protected beach habitat, while an isopod, mysid, haustorid amphipods, a cumacean, and a bivalve dominated exposed beaches. In the MSAAS (Shaw et al., 1982), the Shallow Sound sand habitats exhibited macroinvertebrate assemblages similar to those of the beach transect stations and also had lower taxa richness, higher densities, and lower diversity than offshore and tidal pass locations.

4.5.3.2 Mollusks

Important bivalves in the northern Gulf of Mexico include bay scallop (*Argopecten irradians*), Eastern oyster *(Crassostrea virginica)*, and hard clam (*Mercenaria* sp.). These species typically inhabit nearshore coastal areas where they feed on phytoplankton and detritus (Pattillo et al., 1997). Bay scallop, Eastern oyster, and northern and Texas quahog clams (*Mercenaria* and *M. mercenaria texana*) are among the bivalves that have also been identified in estuaries around Mississippi's barrier islands (Cake, 1983).

All lifestages of the bay scallop are estuarine and marine in nearshore, subtidal waters. They have been collected in waters ranging in depth from 0 to 33 feet down to a maximum of 59 feet, but are most abundant in waters 1 to 2 feet deep at low tide (Pattillo et al., 1997).

The Eastern oyster is one of the more valuable shellfish resources of the Mississippi Gulf coast. The oysters inhabit shallow estuarine waters during all lifestages. MDMR manages 17 natural oyster reefs (MDMR, 2010a). The areal extent of oyster reefs in Mississippi is estimated at 10,000 to 12,000 acres (4,000 to 4,900 hectares), of which 7,400 acres (3,000 hectares) are located in the western Mississippi Sound (MDWFP, 2005). Approximately 97 percent of the commercially harvested oysters in Mississippi come from the reefs in the western Mississippi Sound, primarily from Pass Marianne, Telegraph, and Pass Christian reefs. No actively managed oyster reefs are present in close proximity to the barrier islands (MDMR, 2010a). The hard clam is an estuarine and marine species most often found in coastal bays from intertidal zones to water depths of 50 feet. These clams may be found in open ocean, but prefer shallow waters (<33 feet). Juvenile and adult clams occur primarily in soft bottom habitats of sand and mud. Spawning coincides with high concentrations of plankton during spring, fall, and winter (Pattillo et al., 1997).

The Atlantic oyster drill (*Thais haemastoma*) is a significant predator of the economically important Eastern oyster. The species prefers the small juvenile stage of the oyster over larger adults. Predation rates for drills 50 mm in size have been documented at 85 2-week-old spat per day. The drill tolerates a range of salinities, but prefers the more saline parts of estuaries. Its destructiveness to oyster beds increases as salinity increases. Reproduction occurs in waters with salinity above 20 ppt (Butler, 1985). Localized population increases in this species have occurred in Gulf coast areas that have experienced increases in salinity (Alabama Current Connection, 2011).Other abundant mollusks found in the Mississippi Sound include various gastropods (snails, limpets, nudibranchs, and sea slugs) and cephalopods (octopods and squids).

During a 3-year (1987 to 1989) evaluation of the continental shelf, over 23,000 epifaunal invertebrates, including 310 recognizable species, were observed. Of these, mollusks comprised 7.7 percent of the sample. Sample results suggested that mollusks were more widespread and abundant during the summer months than during the winter. The abundance patterns of the macroinfauna were not shown to be dependent on sediment type (MMS, 1991).

4.5.3.3 Crustaceans

Crustaceans of abundance in the Mississippi Sound include a variety of amphipods, isopods, shrimps, and crabs. Three commercially important species of shrimp and one commercially important species of crab are found in Mississippi coastal waters: the brown shrimp *(Penaeus aztecus)*, the pink shrimp (*Penaeus duorarum),* the white shrimp *(Penaeus setiferus),* and the blue crab (*Callinectes sapidus).*

The life histories of the shrimp species are generally similar, although the time of spawning varies among the species. Mating takes place in shallow offshore waters, while actual spawning takes place in deeper offshore waters. The eggs are released and fertilized externally in the water. Within 24 hours, fertilized eggs hatch into a microscopic larva. The larvae are capable of only limited horizontal, directional movement in response to light conditions and are unable to swim independently of the water currents. Shrimp migrate via currents from offshore waters to coastal bays during the last planktonic stage and enter estuarine nursery grounds as post-larvae. Development to the post-larval stage takes several weeks. Post-larvae have well developed swimming capabilities. Once they move into brackish waters, the post-larvae abandon their planktonic way of life and become part of the benthic community. Young shrimp remain in the estuary until they approach maturity. Adult shrimp migrate offshore to spawn, and the cycle is repeated.

As noted above, there are seasonal variations in the spawning times of pink, brown, and white shrimp. Brown post-larvae enter the Mississippi Sound in large numbers during the spring, with a smaller wave of migration in the fall. White and pink shrimp post-larvae arrive during the summer and fall, with white post-larvae being more abundant. Of the three species, white shrimp spawn closest to the shore and brown shrimp spawn the farthest from shore (Perry, 2010*)*. Brown shrimp inhabit offshore waters ranging from 45–360 feet in depth and adults are most abundant from June to October (Pattillo et al., 1997; MDMR, 2010b). Mature pink shrimp inhabit deep offshore waters, and the highest concentrations occur in depths of 33 to 145 feet (Pattillo et al., 1997). Pink shrimp are most abundant in winter and early spring. They are usually found in higher-salinity waters and are generally caught at night (MDMR, 2010b). White shrimp adults are typically found in nearshore waters rarely exceeding 90 feet in depth and generally become most abundant at about 45 feet in depth (Pattillo et al., 1997). White shrimp are caught mostly during daylight hours in the fall months and can be found in shallower waters with mud bottoms (MDMR, 2010b).

Brown shrimp comprise approximately 85 percent of Mississippi's harvest. Brown shrimp are most abundant from June to October and can be found in inshore and offshore waters. White shrimp, found in shallower waters over mud bottoms, are caught mostly during daylight hours during the fall months. Pink shrimp are usually found in higher-salinity waters and are generally caught at night. These shrimp are most abundant in winter and early spring. Water temperatures, salinity, available food, and habitat area affect the size of the shrimp harvest. The most productive seasons are those when water conditions are warm and brackish, i.e., in the spring (MDMR, 2010b).

The blue crab is another commercially important crustacean. The blue crab spends most of its life in bays, brackish estuaries, and nearshore areas in the Gulf of Mexico. Spawning occurs near the mouths of estuaries or in open water (Pattillo et al., 1997). Crabs have a long spawning period in Mississippi and egg-bearing crabs may be found in all but the coldest months. Females with eggs are found around barrier islands (e.g., Horn Island and Petit Bois) in large numbers during the summer (MDMR, 2010c). Eggs hatch near those areas and planktonic zoeal larvae are carried offshore for up to 1 month to spend their larval stage in the offshore plankton (Pattillo et al., 1997; MDMR, 2010c). Once metamorphosis to the megalopa stage is complete, they re-enter estuarine waters to develop before molting into the crab stage. Spawning activity is greatest in late spring and late summer. Most adult crabs move to deeper waters during winter (Pattillo et al., 1997).

During a 3-year (1987 to 1989) evaluation of the continental shelf, decapods comprised approximately 77.8 percent of the epifaunal invertebrates observed. The dominance of decapods was due to the large numbers of shrimp sampled. Sample results suggested that decapods prefer coastal marshes during the summer and migrate to deeper waters during the winter (MMS, 1991).

4.5.4 Fish

Christmas and Waller (1973) reported 138 species of finfish taken in trawl surveys from the Mississippi Sound. The most abundant species was the bay anchovy, comprising over 70 percent of the reported catch. Six species have been identified as being dominant in the

Pascagoula Harbor area year-round: bay anchovy, Gulf menhaden, Atlantic croaker, spot, harvestfish (*Peprilus alepidotus*), and sand seatrout or white trout (*Cynoscion arenarius*) (USEPA, 1991; Hoese and Moore, 1998). In general, movement of fish into the Pascagoula estuaries occurs mainly from January to June, while migration back into the Gulf typically occurs from August to December (USEPA, 1991). As part of an NCA program, the MDEQ conducted fishery trawl surveys in the Mississippi Sound from 2000 to 2004. These surveys identified 56 species of finfish in the Mississippi Sound.

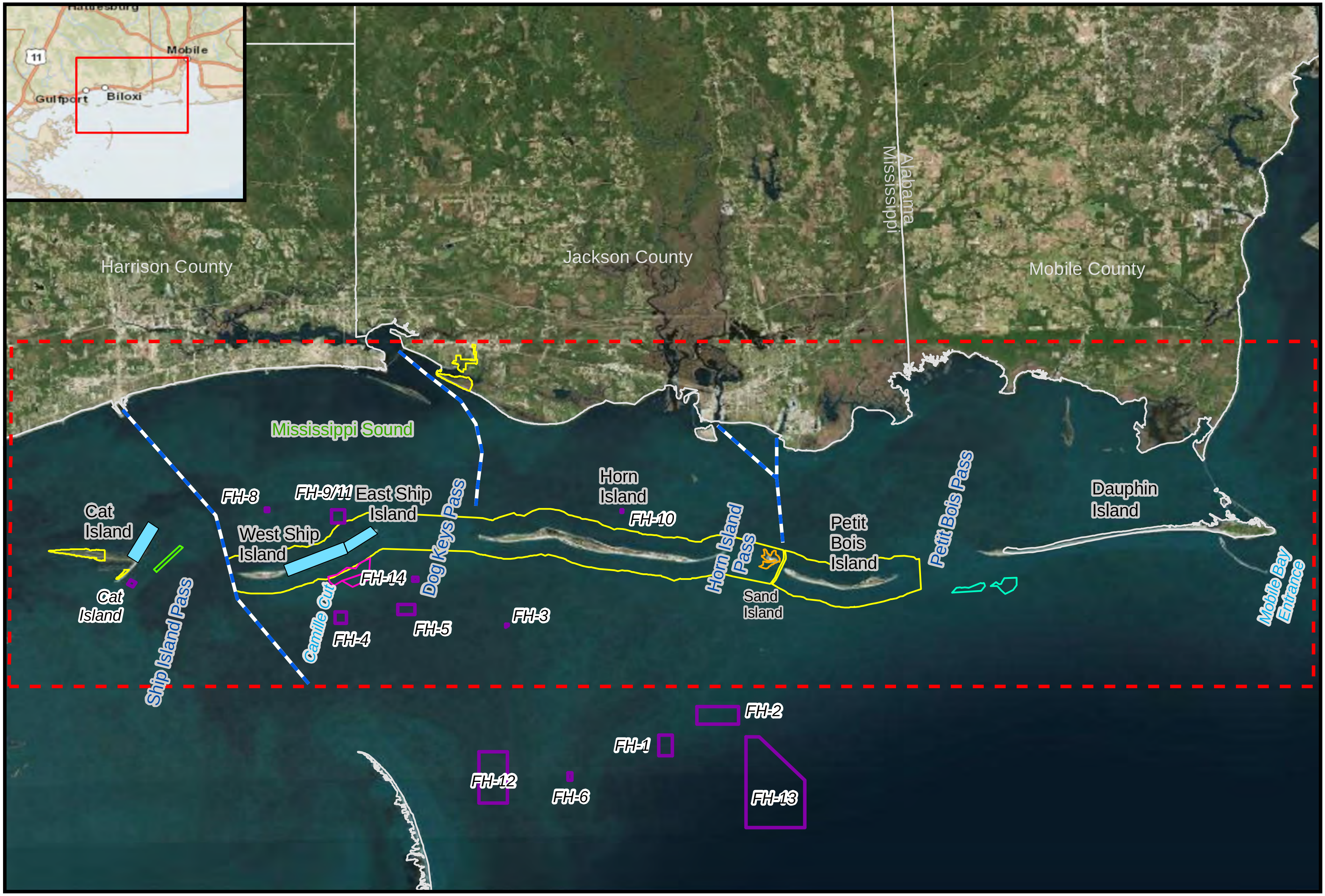
The fish community in the vicinity of the Mississippi barrier islands represents a wide array of species from both nearshore and offshore taxa. Christmas and Waller (1973) report that 98 percent of the fishes collected in the Mississippi Sound were also present in offshore trawl samples. The majority of the fish species present are estuarine-dependent for part of their life cycle. Although three anadromous fish species (Alabama shad [*Alosa alabamae*], striped bass [*Morone saxatilis*], and Gulf sturgeon) occur, typically, fish species found in the Mississippi Sound spawn in the Gulf of Mexico and the larvae (ichthyoplankton) are carried inshore to estuaries to mature (USEPA, 1991). These small, immature forms are susceptible to flow regime changes around the barrier islands (Horn and Petit Bois Islands) where the surrounding grassbeds provide nursery grounds. The greatest abundance of larvae occurs in the spring and summer. There were 69 species of ichthyoplankton recorded from the Horn Island surf zone, which were dominated in numerous studies by six species: striped anchovy (*Anchoa hepsetus*), dusky anchovy (*Anchoa lyolepis*), bay anchovy (*Anchoa mitchilli*), scaled sardine (*Harengula jaguana*), Gulf kingfish (*Menticirrhus littoralis*), and Florida pompano (*Trachinotus carolinus*) (Ross, 1983). Other dominant larval forms included Gulf menhaden (*Brevoortia patronus*), spot (*Leiostomus xanthurus*), silversides (*Menidia* sp.), and southern kingfish (*Menticirrhus americanus*) (Ross, 1983), and Florida pompano. These species are most abundant in late spring and summer and again in late winter. Fish abundance at given locations within the surf zone are affected by tide level, time of day, and water temperature (Modde and Ross, 1981).

Because of the importance of the Mississippi Sound to the fish community, MDMR has created 15 offshore reef sites to help maintain and enhance fisheries (Figure 4-6). These reefs cover a total of approximately 16,000 acres and range in size from 3 to 10,000 acres.

The sites located north of the barrier islands consist of concrete rubble. Those located south of the barrier islands consist of concrete culverts, steel hull vessels, and artificial reef pyramids. All of the reefs are located outside the boundaries of GUIS.

The artificial reef nearest to a proposed sediment borrow or placement area is Cat Island reef. It is located approximately 0.5 mile east of Cat Island and 0.5 mile south of the proposed Cat Island borrow area. Reefs FH-4, FH-5, and FH-14 are located approximately 2 miles south or east of the proposed Ship Island borrow areas. FH-9/11 is located approximately 2 miles north of Ship Island. There are no other reefs within approximately 2 miles of the project area (MDMR, 2010a).

The major fishery of the Mississippi Sound area is Gulf menhaden. Gulf menhaden is a commercially important species typically harvested from April to October as they move inshore from offshore wintering grounds on the continental shelf (Pattillo et al., 1997).



Deep Draft Shipping Channel
Project Area
Gulf Islands National Seashore
Artificial Reef Location
Ship Island Borrow Area
Petit Bois Island Borrow Area
DA-10 Borrow
Cat Island Borrow Area
Proposed Sand Placement Areas

N

0 4 8 16 Miles

FIGURE 4-6
ARTIFICIAL REEF LOCATIONS
MsCIP COMPREHENSIVE BARRIER ISLAND RESTORATION SEIS

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Larvae can begin migration into estuaries in October and continue through late May, while adults and maturing juveniles migrate from estuaries to open Gulf waters to overwinter and reproduce, with peak movement occurring from October to January (Pattillo et al., 1997). Other commercially important fisheries of the Mississippi coastal area include the striped mullet (*Mugil cephalus*) and Atlantic croaker (*Micropogonias undulates*) (USEPA, 1991). Striped mullet juveniles enter estuarine areas from November through February. Adults move offshore in Gulf waters to overwinter and spawn from October to March. Peak spawning occurs in November and December (Pattillo et al., 1997). The Atlantic croaker is the most important commercial species of bottomfish, and major harvesting areas are located between Mobile Bay, Alabama and Calcasieu Lake, Louisiana (Pattillo et al., 1997). Larvae are carried by longshore currents into nearshore areas from October to May, peaking between November and February (Pattillo et al., 1997). Offshore movement by mature juveniles and adults begins in late March and continues until November. Spawning occurs from September to May, peaking in October (Pattillo et al., 1997).

The fish community on the continental shelf south of the barrier islands is composed of a variety of offshore taxa. Commercial fishing on the Mississippi-Alabama continental shelf includes purse seining for menhaden, trawling for demersal fish species, and using hook and line (trolling, bottom lining, and longlining) for reef-related as well as coastal and offshore pelagic species (e.g., bluefin tuna, swordfish) (MMS, 1991). A study of the fish community in the OCS found that fish densities were higher during summer months compared to winter months. During summer months, densities were highest at relatively shallow stations. During winter months, a reduction of fish species diversity was observed at the shallowest stations and an increase in diversity at deeper stations. This suggests that fish migrate offshore to greater depths during the colder months. Size class analysis indicates that most of the demersal fish species of the Mississippi-Alabama continental shelf have life histories between 1 and 2 years long, with a range of spawning season lengths (MMS, 1991).

4.5.4.1 Fish Tissue Contaminants

Fish consumption advisories for mercury have been issued for several species of fish in the Gulf of Mexico. Three species (king mackerel larger than 39 inches, bluefish, and blacktip shark) have a Gulf-wide mean mercury concentration between 0.86 and 1.0 ppm. Fish consumption advisories are issued at different levels in each state, but generally a mercury level of 1.0 ppm triggers an advisory for the general public to limit consumption. Special populations, such as children and pregnant women, may be advised to limit consumption when mercury levels reach 0.5 ppm. Other species with mercury levels greater than 0.5 ppm include Spanish mackerel, jack crevalle, bonnethead shark, and sand seatrout (Ache et al., 2000).

The MDEQ published a consumption advisory concerning mercury for the Gulf of Mexico in 1998. Specifically, the advisory was for king mackerel and suggested that people limit the amount of 33- to 39-inch king mackerel (no more than one meal every 2 months) and avoid eating all king mackerel longer than 39 inches (MDEQ, 2010b).

4.5.5 Marine Mammal Communities

There are 28 species of marine mammals known to occur in the Gulf of Mexico. All marine mammals are covered under the Marine Mammal Protection Act (MMPA), regardless of their status under the ESA. This section includes a discussion of impacts to all marine mammals; it should be noted that the only two whale species that may occur in the project area are also covered under the ESA.

As discussed in Section 4.5.8, there are six threatened or endangered whale species (i.e., whale species protected under both the ESA and MMPA). Of these, only North Atlantic right whales and humpback whales may be found in nearshore waters of the Gulf of Mexico (i.e., waters less than 200 meters deep), though their occurrence there is not common.

All marine mammals are protected by the MMPA of 1972, as amended, but the West Indian manatee and five whale species, which include the blue, finback, humpback, sei, and sperm whales, are also listed as endangered and, therefore, are also protected under the ESA. The MMPA prohibits, with certain exceptions, the *take* of marine mammals in U.S. waters and by U.S. citizens on the high seas, and the importation of marine mammals and marine mammal products into the U.S.

Twenty-nine marine mammal species (Table 4-9), including the West Indian manatee, have been or are known to occur in the Gulf of Mexico. Based on NOAA Fisheries aerial surveys, the most often sighted groups along the upper continental slope of the north-central Gulf of Mexico were Risso's dolphin, Atlantic bottlenose dolphin, Atlantic spotted dolphin, pantropical spotted dolphin, striped, spinner, and clymene dolphin, sperm whale (*Physeter macrocephalus*), dwarf and pygmy sperm whales, and short-finned pilot whale (Evans, 1999; Waring et al., 2013). However, sperm whales tend to inhabit areas with a water depth of 1,968 feet (600 meters) or more, and are uncommon in waters less than 984 feet (300 meters) deep. Of the species sited along the upper continental shelf, three marine mammal species are commonly found along nearshore areas of the continental shelf, near the Mississippi Sound barrier islands, and within the Mississippi Sound. They include Atlantic bottlenose dolphin, Atlantic spotted dolphin (*Stenella frontalis*), and spinner dolphin (*Stenella longirostris*) (MMS, 2000; Waring et al., 2013). In recent years, the West Indian manatee has become a more common transient, frequently migrating from Florida along the coast as far as Louisiana in warmer weather. However, this species typically remains close to the coast and would not be expected near the barrier islands.

Other marine mammal species, such as whales, are inhabitants of the deeper waters (greater than 200 feet) off the continental shelf. They would be unlikely to be encountered in the Mississippi Sound but these animals could appear as transients through the area. No sightings of these species have been recorded near the project area (Waring et al., 2013).

The western north Atlantic bottlenose dolphin populations found along the mid-Atlantic coast have been designated as depleted under the MMPA and, therefore, are more stringently managed to replenish them (NOAA Fisheries, 2010a). The Gulf of Mexico population, however, is not considered to be at risk and is managed less stringently. The Mississippi Sound is home to the largest stable population of Atlantic bottlenose dolphins in the world, generally because of the warm and protected waters (Institute for Marine Mammal Studies [IMMS], 2007). Atlantic bottlenose dolphins inhabiting different areas of the bays and sounds form distinct communities. Seasonal migration of bottlenose dolphins is indicated by changes in abundance within a population in the Mississippi Sound. It is likely that interbreeding can occur between the Mississippi Sound dolphins and those that typically remain in the northern Gulf of Mexico (IMMS, 2007).

TABLE 4-9
Marine Mammals Occurring in the Gulf of Mexico

Scientific Name	Common Name
Balaenoptera acutorostrata	Minke whale
Balaenoprera borealis	Sei whale[a]
Balaenoptera edeni	Bryde's whale
Balaenoptera musculus	Blue whale[a]
Balaenoptera physalus	Finback whale[a]
Eubalaena glacialis	Northern right whale
Feresa attenuate	Pygmy killer whale
Globicephala macrorhynchus	Short-finned pilot whale
Grampus griseus	Risso's dolphin
Kogia breviceps	Pygmy sperm whale
Kogia simus	Dwarf sperm whale
Lagenodelphis hosei	Fraser's dolphin
Megaptera novaeangliae	Humpback whale[a]
Mesoplodon bidens	Sowerby's beaked whale
Mesoplodon densirostris	Blainville's beaked whale
Mesoplodon europaeus	Gervais' beaked whale
Orcinus orca	Killer whale
Peponocephala electra	Melonheaded whale
Physeter macrocephalus	Sperm whale[a]
Pseudorca crassidens	False killer whale
Stenella attenuate	Pantropical spotted dolphin
Stenella clymene	Clymene dolphin
Stenella coeruleoalba	Striped dolphin
Stenella frontalis	Atlantic spotted dolphin
Stenella longirostris	Spinner dolphin
Steno bredanensis	Rough toothed dolphin
Trichechus manatus	West Indian manatee[a]
Tursiops truncates	Atlantic bottlenose dolphin
Ziphius cavirostris	Cuvier's beaked whale

Sources: MMS, 2000; NOAA Fisheries, 2010a.
[a] Protected under the ESA of 1973 as endangered.

4.5.6 Marine and Coastal Birds

The Gulf coast, including the Alabama coast, the Mississippi coast, the Mississippi Sound, and the barrier islands, provides feeding, nesting, resting, and wintering habitat for numerous resident and migratory bird species (MDMR, 2010d). Over 300 species of birds have been reported as migratory or permanent residents within the area, including several species that breed there. Shorebirds found in the area include osprey, great blue heron, great egret, piping plover, sandpiper, gulls, brown and white pelicans, American oystercatcher, and terns (USACE, 2009a).

The project area serves as part of an important migration corridor (i.e., the Mississippi Flyway) for birds migrating to and from tropical wintering areas in the Caribbean, Mexico, and Central and South America. The majority of the birds migrating through the Mississippi Flyway in spring and fall cross the Gulf of Mexico. The coastal woodlands and narrow barrier islands that lie scattered along the northern coast of the Gulf of Mexico provide important stopover habitat for these neotropical landbird migrants. They represent the last possible stopover before fall migrants make a non-stop flight (18 to 24 hours) of greater than 1,000 kilometers (km), and the first possible landfall for birds returning north in spring (USACE, 2009a).

4.5.6.1 Barrier Islands

The Mississippi Sound barrier islands represent the primary marine and coastal bird habitat in the project area. These islands feature a variety of habitat types, including subtidal estuarine habitat, open beaches, pond and lagoon complex, freshwater and saltwater marshes, wooded inland, and seagrass beds and mollusk reefs offshore (MDMR, 2010d).

More than 280 species of birds have been identified within the island boundaries (NPS, 2010a). Between 1992 and 1994, bird research was conducted on Horn Island and East and West Ship Islands and found that approximately 74 species of land-based migratory birds use the area as a stopover (University of Southern Mississippi, 2010). Twenty-three common (5 to 25 individuals per day) permanent resident birds have been identified on and around the Mississippi barrier islands (USGS, 2007). The greatest number of migrating birds is typically observed in April and May and early September through mid-October (Moore et al., 1990).

Bird surveys conducted in support of the MsCIP barrier island restoration project included weekly observations at five locations (eastern and western East Ship Island, eastern and western West Ship Island, and DA-10/Sand Island) from December 2012 through December 2013. Two additional surveys were completed on August 22, 2014 and September 2, 2014. Bird survey data are provided in Appendix J; figures in Appendix J show the number of species and total number of birds collected monthly at each of these locations. Species observed on West Ship Island included American oystercatcher, piping plover, red knot, reddish egret (*Egretta rufescens*), short-billed dowitcher (*Limnodromus griseus*), snowy plover (*Charadrius nivosus*), western sandpiper (*Calidris mauri*), marbled godwit (*Limosa fedoa*), and Wilson's plover (*Charadrius wilsonia*). On East Ship Island, these same species were observed, in addition to the stilt sandpiper (*Calidris himantopus*). More birds were observed on Ship Islands during the months April through August than during the months December through March, with the exception of the west end of East Ship Island, which had a relatively large number of birds during the months October through December as well. Among Ship Islands, the total number of birds observed was largest (30,730 birds) on the west end of East Ship Island and smallest (9,287) on the east end of East Ship Island.

The barrier islands serve as important breeding habitat and contain rookeries for several species (MDMR, 2010d). Some of the solitary nesting bird species known to regularly breed on the barrier islands include the American egret (*Ardea alba*), snowy egret (*Egretta thula*), black nighthawk (*Chordeiles minor)*, yellow nighthawk, great blue heron (*Ardea herodias*), willet (*Tringa semipalmata*), American oystercatcher, snowy plover, and Wilson's plover (GUIS, 2012). In addition, the white ibis (*Eudocimus albus*) is known to breed on Cat Island

and the Louisiana heron (*Egretta tricolor*) on Petit Bois Island (GUIS, 2012). Nighthawks nest on unsheltered ground, such as sand dunes and gravel beaches. Most plover nests are found on the bare sand, high on the beach with scattered vegetation. It should be noted, however, that piping plovers do not nest in the project area. Adult plovers and young move down to the tidal flats and shoreline to feed and retreat to the vegetation for cover. Willets feed openly along the shoreline. The American oystercatcher nests on the open beach, usually next to a clump of vegetation or other cover. The adults are quite vocal and are easily seen feeding at the water's edge (NPS, 2011). The great blue heron occurs in areas that include brackish marshes and ocean beaches. It commonly nests high in trees in swamps and forested areas. The Louisiana heron can be found in several types of habitats ranging from marshes to salt- and freshwater islands. It mainly nests near saltwater marshes or bare coastal islands (NatureServe, 2010).

Colonial nesting species known to regularly breed on the barrier islands include the gull-billed tern (*Gelochelidon nilotica*), least tern (*Sterna antillarum*), sandwich tern (*Thalasseus sandvicensis*), royal tern (*Thalasseus maximus*), and black skimmer (GUIS, 2012). These species nest in mixed colonies on the high sparsely or unvegetated beach (Hopkins, 2011). Once the chicks have matured and have developed plumage, the adults move them down to the water's edge until they are able to forage and fledge. The least tern requires open sandy coastal beaches and river sandbars for nesting. It nests in scrapes in sand above ordinary high tides and breeds during the summer months. The sandwich tern prefers seacoasts, bays, estuaries, mudflats, and lagoons. It nests with the royal tern on unvegetated bare sand or sand-shell substrates. The royal tern nests typically on open sandy beaches, sandbars, and sand/shell substrates. The black skimmer nests primarily near coasts on sandy beaches, coastal and estuary islands, on wrack and drift of salt marshes, and on dredged material sites. These birds usually nest in association with or near terns (NatureServe, 2010).

Two species of raptor, the osprey (*Pandion haliaetus*) and bald eagle (*Haliaeetus leucocephalus*), are known to breed on the barrier islands. The bald eagle breeding habitat is generally close to coastal areas and large bodies of freshwater; the bald eagle usually nests in tall trees or on cliffs near water. Ospreys nest along streams and in coastal areas in living and dead trees, but also on several different types of man-made structures (NatureServe, 2010). Breeding seasons for most of these species typically occur between April and June, with young birds remaining through August or September. Eagles, however, breed over winter, typically from September 1 to April 30.

The barrier islands also serve as wintering habitat for the federally protected piping plover. Cat, Ship, Horn, Petit Bois, and Round Islands have been designated critical habitat for the wintering piping plover (USFWS, 50 C.F.R. § 17). Plovers begin arriving on wintering grounds in early July and continue arriving into September. Although some individuals can be found on the wintering grounds throughout the year, most plovers depart in spring and sightings are rare in June and early July (USFWS, 2010a). The piping plover is further discussed in Section 4.5.8.

The red knot, a bird species proposed for listing under the ESA, has also been observed on the wintering grounds of East Ship Island, Cat Island, and Petit Bois Island (Necaise, personal comm., 2012). The red knot is further discussed in Section 4.5.8. The reddish egret has been observed on East Ship Island, West Ship Island, Horn Island, and Petit Bois Island during fall migration (Zdravkovic, 2010).

4.5.6.2 DA-10/Sand Island

DA-10 contains a 165-acre island created by placement of dredged material from dredging activities associated with the Pascagoula Federal navigation project. The island is vegetated in areas, but serves as habitat for shorebirds. Historically, the island has been a consistent colonial shorebird nesting site, with the largest number and diversity of species in the Mississippi District of the GUIS. Pre-Katrina, nesting colonies were documented to consist of several thousand birds. The island supports a variety of bird habitats, including tidal flats, open beach, vegetated beach dune, tidal marsh, marsh meadow, and interior relic dune (NPS, 2011).

During bird surveys conducted in support of the MsCIP barrier island restoration project, species observed on Sand Island included the American oystercatcher, piping plover, red knot, snowy plover, and western sandpiper. More birds were observed in May (1,150 birds) and June (2,134 birds) than in other months. No birds were observed in July through December and less than 300 birds were observed monthly, during the months January through April.

Colonial nesting species observed on the island include least terns, black skimmers, royal terns, sandwich terns, black terns (*Chlidonias niger*), common terns (*Sterna hirundo*), and gull-billed terns (Hopkins, 2011; GUIS, 2012). Since 2005, colonies have ranged from 350 to over 500 birds. In 2010 the nesting colony consisted of 409 pairs of least terns, 103 black skimmers, and 11 gull-billed terns (NPS, 2011). Solitary nesting shorebirds observed include the American egret, snowy egret, black nighthawk, yellow nighthawk, willet, American oystercatcher, snowy plover, Wilson's plover, and great blue heron (GUIS, 2012). In 2010, two pairs of snowy plovers, one pair of willets, one pair of American oystercatchers, and one pair of Wilson's plovers were observed nesting (NPS, 2011). The reddish egret has also been observed on Sand Island during the fall migration (Zdravkovic, 2010).

4.5.7 Hard Bottom Habitats

Natural hard bottom habitats serve as important spawning areas for fish species and support unique communities of marine organisms. "Hard" or "live" bottom habitat refers to "those areas which contain biological assemblages consisting of such sessile invertebrates as sea fans, sea whips, hydroids, anemones, ascidians, sponges, bryozoans, or corals living upon or attached to naturally occurring hard or rocky formations with rough, broken, or smooth topography; or areas whose lithotope favors the accumulation of turtles, fishes, and other fauna" (Thompson et al., 1999).

No natural hard bottom habitats are located within the Mississippi Sound. A small area of rock outcrop and consolidated features is found approximately 3 miles south of Mississippi's barrier islands. Most hard bottom habitats lie east of the Mississippi coast, although some calcareous outcrops occur south of Biloxi in 60 feet of water and along most of the continental shelf within the 150- to 300-foot depth. Small, isolated patches of lag deposits composed of shell and rock gravel are found off the south sides of the barrier islands (MDWFP, 2005). Some artificial reefs consisting of concrete rubble, concrete culverts, steel hull vessels, and artificial reef pyramids have been placed near the project area, as discussed in Section 4.5.4 above.

4.5.8 Rare, Threatened, and Endangered Species

Table 4-10 presents the species listed by USFWS as either threatened or endangered, or as a candidate for federal protection that may occur in the project area. This includes Hancock, Harrison and Jackson Counties, Mississippi, as well as waters offshore of Mississippi and Alabama. Table 4-10 also includes 12 species that NOAA Fisheries, Protected Resource Division, St. Petersburg Field Office lists that may occur within the area under their purview as threatened and/or endangered. Five of these species are also listed by USFWS (Table 4-10).

TABLE 4-10
Federally Listed Threatened and Endangered Species in Hancock, Harrison and Jackson Counties, Mississippi, and Offshore Waters of Mississippi and Alabama

Common Name	Scientific Name	Status[a]	Area of Potential Occurrence	Habitat
Inflated Heelsplitter	*Potamilis inflatus*	LT (USFWS)	Hancock County	Historically in the Pearl River drainage. Prefers soft, stable substrata in slow to moderate currents on the protected side of bars and may occur in depths exceeding 20 feet (USFWS, 1993a).
Red Knot [b]	*Calidris canutus ssp. rufa*	LT (USFWS)	County-level range has not been defined in Mississippi or Alabama	Sandy beaches, tidal mudflats, salt marshes, and peat banks (USFWS, 2010i).
Pearl Darter	*Percina aurora*	C (USFWS)	Jackson County (Pascagoula River system)	Deeper runs and pools with larger substrate particle size. In rivers and large creeks with moderate current (USFWS, 2010b).
Mississippi Gopher Frog	*Rana sevosa*	LE (USFWS)	Harrison County	Upland sandy habitats, historically forest dominated by longleaf pine (*Pinus palustris*), and isolated temporary wetland breeding sites embedded within the forested landscape (USFWS, 2010c).
Alabama Red-bellied Turtle	*Pseudemys alabamensis*	LE (USFWS)	Harrison and Jackson Counties	Sluggish bays and bayous in brackish marshes adjacent to the main channels of large coastal rivers (USACE, 2009a; USFWS, 1990a).
Black Pine Snake	*Pituophis melanoleucus lodingi*	C (USFWS)	Hancock, Harrison, and Jackson Counties	Well-drained, upland longleaf pine forests with a fire-suppressed mid-story and dense herbaceous ground cover (USACE, 2009a).
Eastern Indigo Snake	*Drymarchon corais couperi*	LT (USFWS)	Hancock, Harrison, and Jackson Counties	Dry, mature pinelands dominated by longleaf pine, with a fire-maintained subclimax understory community (USFWS, 1982).
Gopher Tortoise	*Gopherus polyphemus*	LT (USFWS)	Hancock, Harrison, and Jackson Counties	Longleaf pine hills with well-drained, sandy soils, an abundance of herbaceous ground cover, and a generally open canopy with sparse shrub cover (USACE, 2009a; USFWS, 1990b).
Ringed Map Turtle	*Graptemys oculifera*	LT (USFWS)	Hancock	

TABLE 4-10
Federally Listed Threatened and Endangered Species in Hancock, Harrison and Jackson Counties, Mississippi, and Offshore Waters of Mississippi and Alabama

Common Name	Scientific Name	Status[a]	Area of Potential Occurrence	Habitat
Yellow-blotched Map Turtle	*Graptemys flavimaculata*	LT (USFWS)	Jackson County	Main channels of rivers and large creeks, oxbow lakes (USFWS, 1993b).
Mississippi Sandhill Crane	*Grus canadensis pulla*	LE (USFWS)	Jackson County	Nests in open area of grasses/sedges with perennial shallow water, often near grasslands, pasture, or open pine forests. Forages in savannas, swamps, and open forest lands, corn and chufa fields, pastures, and pecan orchards. Roosts in fresh and brackish marshes, freshwater ponds, open forests, pastures, and moist clearings (USFWS, 1991).
Piping Plover [b]	*Charadrius melodus*	LT and Critical Habitat (USFWS)	Hancock, Harrison, and Jackson Counties	Barrier islands, along sandy peninsulas, and near coastal inlets. Also on sand, mud, and algal flats, washover passes, salt marshes, and coastal lagoons (USFWS, 1996).
Red-Cockaded Woodpecker	*Picoides borealis*	LE (USFWS)	Harrison and Jackson Counties	Open pine woodlands with large old pine trees (USFWS, 2003).
Louisiana Black Bear	*Ursus americanus luteolus*	LT(USFWS)	Hancock, Harrison, and Jackson Counties	Bottomland hardwood forests (USACE, 2009a).
West Indian Manatee	*Trichechus manatus*	LE (USFWS)	Mississippi Sound	In marine, estuarine, and freshwater environments (USACE, 2009a).
Louisiana Quillwort	*Isoetes Louisianensis*	LE (USFWS)	Hancock, Harrison, and Jackson Counties	Sandy soils and gravel bars in or near shallow blackwater streams and overflow channels in riparian woodland/ bayhead forests of pine flatwoods and upland longleaf pine (USACE, 2009a; USFWS, 2010d).
Green Sea Turtle [b]	*Chelonia mydas*	LT (USFWS and NOAA)	Mississippi Sound and oceanward waters near the barrier islands	Throughout the Atlantic, Pacific, and Indian Oceans, primarily in tropical regions and shallow waters (USACE, 2009a).
Kemp's Ridley Sea Turtle [b]	*Lepidochelys kempii*	LE (USFWS and NOAA)	Mississippi Sound and oceanward waters near the barrier islands	Nearshore and inshore waters of the northern Gulf of Mexico, especially Louisiana waters (NOAA Fisheries et al., 2010).
Loggerhead Sea Turtle [b]	*Caretta*	LE (USFWS) LT (NOAA)	Mississippi Sound and oceanward waters near the barrier islands	Ocean beaches and estuarine shorelines with suitable sand and relatively narrow, steeply sloped, coarse-grained beaches (USACE, 2009a).
Leatherback Sea Turtle[b]	*Dermochelys coriacea*	LE (USFWS)	Mississippi Sound and oceanward waters near the barrier islands	High energy beaches with deep, unobstructed access along continental shorelines. Oceans worldwide.

TABLE 4-10
Federally Listed Threatened and Endangered Species in Hancock, Harrison and Jackson Counties, Mississippi, and Offshore Waters of Mississippi and Alabama

Common Name	Scientific Name	Status[a]	Area of Potential Occurrence	Habitat
Hawksbill Sea Turtle [b]	*Eretmochelys imbricate*	LE (USFWS)	Mississippi Sound	Coral reefs, shoals, lagoons, lagoon channels, and bays with marine vegetation; also can tolerate muddy bottoms with sparse vegetation.
Gulf Sturgeon [b]	*Acipenser oxyrhynchus desotoi*	LT (USFWS and NOAA)	Hancock, Harrison, and Jackson Counties, and offshore waters	Rivers, estuaries, and Gulf of Mexico waters (USFWS and NOAA Fisheries, 2009).
Smalltooth Sawfish	*Pristis pectinata*	LE (USFWS and NOAA)	Mississippi Sound (no County-level range identified)	Very shallow coastal waters, particularly shallow mud banks and mangrove habitats and offshore at depths up to at least 400 feet (NOAA Fisheries, 2009a).
Blue Whale	*Balaenoptera musculus*	LE (USFWS and NOAA)	Offshore waters	Offshore waters.
Finback Whale	*Balaenoptera physalus*	LE (USFWS and NOAA)	Offshore waters	Offshore waters.
Humpback Whale	*Megaptera novaeangliae*	LE (USFWS and NOAA)	Offshore waters	Offshore waters.
Right Whale	*Eubalaena glacialis*	LE (USFWS and NOAA)	Offshore waters	Offshore waters.
Sei Whale	*Balaenoptera borealis*	LE (USFWS and NOAA)	Offshore waters	Offshore waters.
Sperm Whale	*Physeter macrocephalus*	LE (USFWS and NOAA)	Offshore waters	Offshore waters.

[a] LE = Listed Endangered; LT = Listed Threatened, C = Candidate for listing
[b] Species with the potential to occur in the project area.

There are seven federally listed species, two critical habitat designations for piping plovers and Gulf sturgeon, and one candidate species for federal protection that may occur in the vicinity of the proposed project and could be affected by construction activities. A summary of species that are removed from further discussion is included in Section 4.5.8.1. Species that could be affected by construction activities are listed in Sections 4.5.8.2 through 4.5.8.9.

In addition, a biological assessment (BA) addressing potential impacts on protected species has been prepared for the proposed project (Appendix N).

4.5.8.1 Species Not Discussed Further

Due to a lack of suitable habitat and their location in coastal upland coastal freshwater, or nearshore coastal estuarine environments, the following 13 species would not occur in or around the barrier islands or sediment borrow areas and are not further discussed:

- Inflated heelsplitter;
- Pearl darter;
- Mississippi gopher frog;
- Black pine snake;
- Eastern indigo snake;
- Gopher tortoise;
- West Indian manatee;
- Yellow-blotched map turtle;
- Louisiana black bear;
- Mississippi sandhill crane;
- Red-cockaded woodpecker;
- Louisiana quillwort; and
- Ringed map turtle.

The Alabama red-bellied turtle is listed as endangered under the ESA (USFWS, 2010e) and is known to occur in the lower reaches of the Old Fort Bayou, Escatawpa, and Pascagoula Rivers in Jackson County, and the Tchoutacabouffa and Biloxi Rivers in Harrison County (USACE, 2009a). The Alabama red-bellied turtle is a freshwater, herbivorous turtle that (USFWS, 1990a) is most common in sluggish bays and bayous in brackish marshes adjacent to the main channels of large coastal rivers (USACE, 2009a, USFWS, 1990a). Several Alabama red-bellied turtle hatchlings have been found on Horn Island (Necaise, personal comm., 2012). These turtles were perhaps introduced to the island by humans. However, the estuarine habitats on the Mississippi barrier islands and DA-10/Sand Island are not suitable to sustain a viable, healthy population of these species. Therefore, these species are not discussed further.

The smalltooth sawfish is listed as endangered under the ESA (NOAA Fisheries, 2009a and NOAA Fisheries, 2009b) and was once encountered commonly from Texas to North Carolina. The species is now known to occur regularly only in south Florida. The fish prefers very shallow coastal waters of bays, banks, estuaries, and river mouths, particularly shallow mud banks and mangrove habitats, although larger smalltooth sawfish may occur offshore at depths up to at least 400 feet. There is no designated critical habitat for the smalltooth sawfish in the project area (NOAA Fisheries, 2009b). Because of the distance from known populations and the lack of preferred habitat, this species is unlikely to occur in the project area and is not discussed further.

Whale species protected under NOAA Fisheries (Table 4-10) are unlikely to occur in the nearshore project area due to its shallow waters. These species occur in the OCS, but typically at depths greater than 200 feet, and therefore not within the proposed OCS borrow site areas. The following species are therefore not further discussed:

- Blue whale;
- Finback whale;
- Humpback whale;
- Sei whale; and
- Sperm whale.

4.5.8.2 Gulf Sturgeon and Gulf Sturgeon Critical Habitat

NMFS and USFWS (2003) jointly designated GSCH on April 18, 2003 (68 *Federal Register* [Fed. Reg.] 13370, March 19, 2003). GSCH is shown on Figure 4-7. Within the project vicinity, the GSCH is identified as Unit 8 (approximately 881,280 acres), Lake Pontchartrain, (east of causeway), Lake St. Catherine, Little Lake, the Rigolets, Lake Borgne, Pascagoula Bay, and Mississippi Sound systems in Louisiana and Mississippi, and sections of the state waters within the Gulf of Mexico. The primary constituent elements essential for the conservation of the Gulf sturgeon are those habitat components that support foraging, water quality, sediment quality, and safe unobstructed migratory pathways. This unit provides juvenile, subadult and adult feeding, resting, and passage habitat for Gulf sturgeon from the Pascagoula and the Pearl River subpopulations (68 Fed. Reg. 13395). One or both of these subpopulations have been documented by tagging data, historical sightings, and incidental captures as using Pascagoula Bay, the Rigolets, the eastern half of Lake Pontchartrain, Little Lake, Lake St. Catherine, Lake Borgne, and the Mississippi Sound, within 1 nautical mile of the nearshore Gulf of Mexico adjacent to the barrier islands and within the passes (Appendix N). Substrate in these areas ranged from sand to silt, all of which contain known Gulf sturgeon prey items (Appendix N).

Incidental captures and recent studies confirm that both Pearl River and Pascagoula River adult Gulf sturgeon winter in the Mississippi Sound, particularly around barrier islands and passes (Appendix N). Gulf sturgeon exiting the Pascagoula River move both east and west, with telemetry locations as far east as Dauphin Island and as far west as Cat Island and the entrance to Lake Pontchartrain (Ross et al., 2009). Tagged Gulf sturgeon from the Pearl River subpopulation have been located between Cat Island, Ship Island, Horn Island, and east of Petit Bois Island to the Alabama state line (Appendix N). Habitat used by Gulf sturgeon in the vicinity of the barrier islands is 6.2 to 19.4 feet deep (average 13.8 feet), with clean sand substrata (Appendix N).

An ongoing Mobile District Gulf sturgeon monitoring effort at Ship Island is being conducted by the USACE ERDC. The objective is to characterize the seasonal occurrences and movements of the sturgeon around Ship Island and within Camille Cut. In late spring 2011, a total of 21 receivers were placed around 3 areas (western tip of West Ship Island, Camille Cut, and eastern tip of East Ship Island) and monitored for Gulf sturgeon detections. No detections were documented during this period. The receivers were placed in the same locations in September 2011 and remained in place through June 2012. A total of 13,720 detections from approximately 14 Gulf sturgeon that originated from 5 rivers (Pearl, Pascagoula, Escambia, Blackwater, and Yellow) were found at all three sites. However, the largest number of detections was found along the eastern side of East Ship Island (ERDC, 2012). During the 2011–2012 monitoring period, the greatest number of sturgeon was detected in November, and numbers decreased each month (Appendix K).

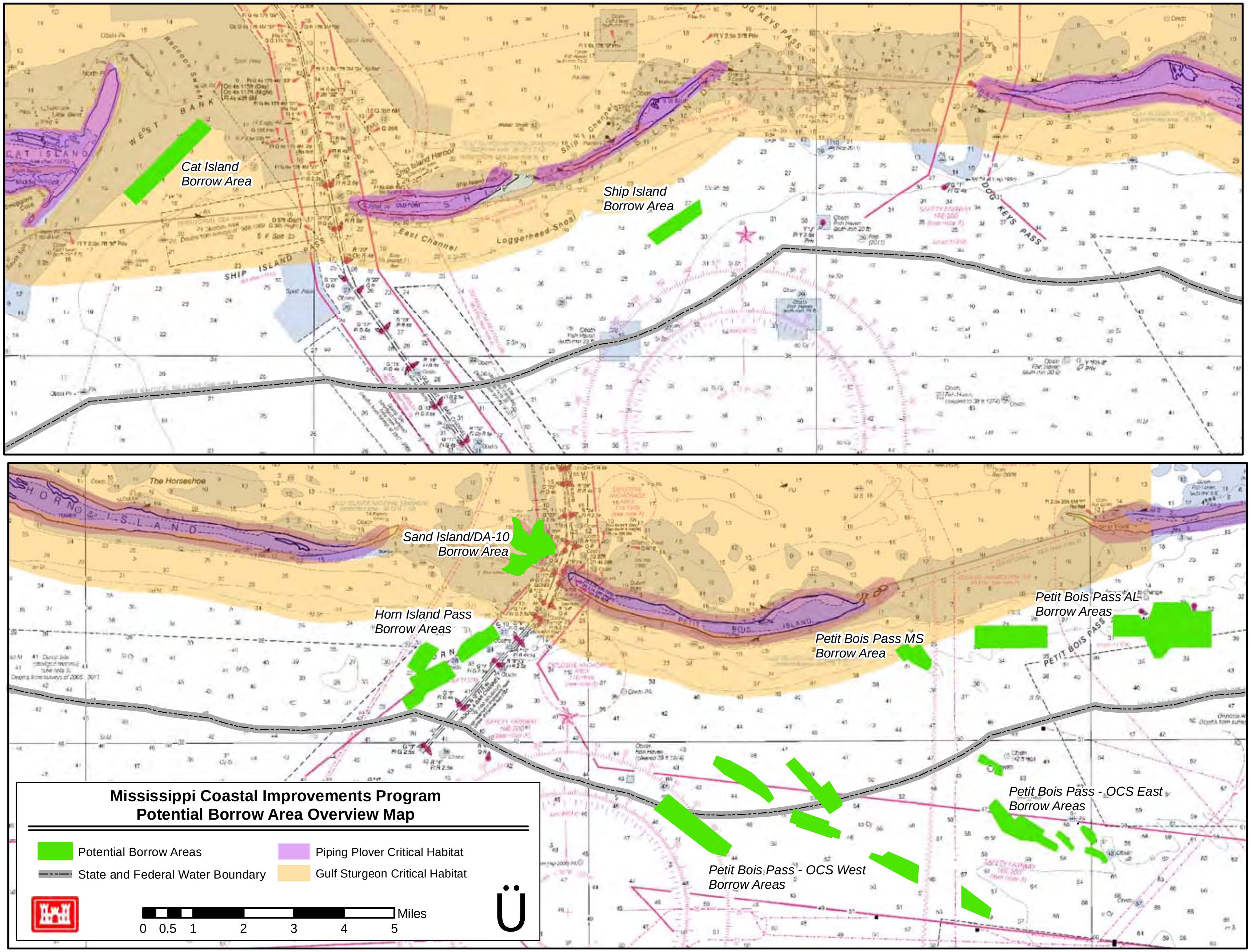

FIGURE 4-7
CRITICAL HABITAT BOUNDARIES
MsCIP COMPREHENSIVE BARRIER ISLAND RESTORATION SEIS

During the third year of monitoring, eight additional receivers were placed in Dogs Keys Pass. From September 2012 through June 2013, 21 Gulf sturgeon (19 adult, 2 sub-adult) were detected. These sturgeon originated from the Pearl (6), Pascagoula (4), Escambia (1), Yellow (2), Brothers (4), Blackwater (3) and Choctawhatchee (1) Rivers. Overall, 94,244 detections were recorded during time period. This larger number than during the previous monitoring year may be attributed to the greater number of arrays (29 arrays) in 2012 to 2013 than in 2011–2012 (21 arrays). During the 2012 to 2013 monitoring period, the largest number of sturgeon was detected in December and decreased monthly (Appendix K).

A summary of the 2012–2013 detections includes:

- West Ship Island—4 receivers; 2 percent of total detections; 11 Gulf sturgeon;
- Camille Cut, Mississippi Sound side—9 receivers; 18 percent of total detections; 8 Gulf sturgeon;
- Camille Cut, Gulf side—4 receivers; 6 percent of total detections; 11 Gulf sturgeon;
- East Ship Island—4 receivers; 9 percent of total detections; 10 Gulf sturgeon; and
- Dog Keys Pass—8 receivers; 65 percent of total detections; 15 Gulf sturgeon.

A study to identify benthic communities of the Mississippi Sound and the Gulf of Mexico, with a focus at Mississippi barrier islands, was conducted during three sampling periods: June and September 2010 and May 2011. A total of 636 samples were collected, with taxa densities ranging from 257 to 10,206 individuals per square meter. Results show that the benthic community within the project area provides suitable forage habitat for adult and subadult fish. A wide variety of benthic invertebrates were found in the placement and borrow sites, including polychaetes, chordates, nemerteans, gastropods, amphipods, and bivalves, with polychaete worms dominating the majority of the sampling areas. However, taxa densities and richness were extremely variable between the sampling stations (Vittor and Associates, 2013). Additional benthic invertebrate sampling was conducted in October 2011 to support the evaluation of Gulf sturgeon habitat conditions in the project area (Appendix K).

ERDC (2012) correlated the Gulf sturgeon locations with the abundance of eight principal prey benthic species and identified a direct relationship between the number and detections of Gulf sturgeon and the availability of primary prey. The sturgeon were found more frequently in the areas with the higher abundance of principal prey species. Further, Camille Cut and the eastern side of Ship Island have relatively high overall abundances of these prey taxa compared to the west side of Ship Island (ERDC, 2012).

Gulf sturgeon occupy the coastal waters of Mississippi beginning in October or November to March. They move offshore, primarily to the barrier island passes, to feed (Appendix N; Ross et al., 2009). As discussed in the BA prepared for this SEIS (Appendix N), Gulf sturgeon move along the nearshore area at depths of 10 meters or less. A total of 71 tagged Gulf sturgeon were located in the Mississippi Sound and the adjoining barrier islands over a 5-year study period (Ross et al., 2009). Winter telemetry locations of Gulf sturgeon from the Pascagoula and Pearl Rivers were primarily along the barrier islands, and only four fish were found north of the barrier islands and south of the West Pascagoula River mouth

(Ross et al. 2009). The spatial distribution of Gulf sturgeon within the marine environment was strongly nonrandom, but was highly structured, and likely caused by the distribution of preferred prey taxa (Ross et al., 2009). Of the fish located in the barrier island region, 93 percent were found in the passes between the islands, including the two small passes between Ship Islands (Ross et al. 2009). The occurrence of Gulf sturgeon in the barrier island passes was consistent over the 5-year period of study (Ross et al., 2009).

Similarly, preliminary data by ERDC (2012) indicate that tagged sturgeon from five rivers, including the Pearl and Pascagoula Rivers, migrate from the rivers to the mainland shoreline, barrier islands, and passes in search of food. There are five passes within the Mississippi and Alabama barrier island chain, which include Ship Island Pass, Dog Keys Pass, Little Dog Keys Pass, Horn Island Pass, and Petit Bois Pass. These passes provide adequate shallow, sandy areas where Gulf sturgeon have been documented to congregate and feed (Appendix N; Ross et al., 2009). As noted previously, the area east of East Ship Island (Little Dog Keys Pass) and the Camille Cut had the overall higher abundances of Gulf sturgeon compared to the area west of Ship Island (Ship Island Pass) (ERDC, 2012). Multiple detections of these fish within the barrier island passes suggest that these are feeding areas (Appendix N; Ross et al., 2009; ERDC, 2012). Gulf sturgeon tagged in the Pascagoula and Pearl Rivers occupy the same marine feeding habitats (Ross et al., 2009).

4.5.8.3 Green Sea Turtle

The breeding populations of the green sea turtle off Florida and off the Pacific coast of Mexico are listed as endangered. All other breeding populations are listed as threatened (USFWS, 2010f). Although green sea turtles are found worldwide, this species is concentrated primarily between the 3º North and 35º South latitudes. Green sea turtles tend to occur in waters that remain warmer than 68ºF; however, there is evidence that they may be buried under mud in a torpid state in waters to 50ºF (Ehrhart, 1977; Carr et al., 1979). In the southeastern U.S., nesting season is approximately June through September. Nesting occurs nocturnally at 2-, 3-, or 4-year intervals. The turtles are not known to nest on the Mississippi coast or barrier islands, but have been found feeding in the seagrass beds in nearshore waters. Nesting has occurred in Alabama, and therefore it could occur in Mississippi.

Only occasionally do females produce clutches in successive years. Estimates of age at sexual maturity range from 20 to 50 years (Balazs, 1982; Frazer and Ehrhart, 1985), and they may live over 100 years. Immediately after hatching, green turtles swim past the surf and other shoreline obstructions, primarily at depths of about 8 inches or less below the water surface, and are dispersed both by vigorous swimming and surface currents (Balazs, 1982). The whereabouts of hatchlings to juvenile size is uncertain. Green turtles tracked in Texas waters spent more time on the surface, with less submergence at night than during the day, and a very small percentage of the time was spent in the federally maintained navigation channels. The tracked turtles tended to utilize jetties, particularly outside of them, for foraging habitat (Renaud and Carpenter, 1994).

4.5.8.4 Kemp's Ridley Sea Turtle

The Kemp's ridley sea turtle is listed as endangered under the ESA (USFWS, 2010g). The Kemp's ridley occurs mainly in coastal areas of the Gulf of Mexico and the northwestern Atlantic Ocean, with occasional individuals reaching European waters. Immature turtles have been found along the eastern seaboard of the U.S. and in the Gulf of Mexico, including the Mississippi Sound. In the Gulf, studies suggest that immature turtles stay in shallow, warm, nearshore waters in the northern Gulf until cooling waters force them offshore or south along the Florida coast (Renaud, 1995). Little is known of the movements of the post-hatching stage (pelagic stage) within the Gulf. Studies have indicated that this stage varies from 1 to 4 or more years and the immature stage lasts about 7 to 9 years (Schmid and Witzell, 1997). The maturity age of this species is estimated to be 7 to 15 years.

Kemp's ridley sea turtles are regularly seen in the Mississippi Sound, and although no nesting has been documented, they could potentially nest on the Mississippi barrier islands. Immature Kemp's ridley turtles have been incidentally captured by recreational fishermen at Mississippi fishing piers. In 2012, almost 200 Kemp's ridley turtles were captured and rehabilitated (Coleman, personal comm., 2012). Nests have been documented on Santa Rosa Island in the Florida District of the GUIS along the Gulf coast. In addition, nesting is being reestablished in Texas through conservation programs; however, its primary nesting area is near Rancho Nuevo in Tamaulipas, Mexico (Rothschild, 2004).

4.5.8.5 Loggerhead Sea Turtle

The loggerhead sea turtle is currently listed as endangered by USFWS and threatened by NOAA Fisheries. Loggerhead sea turtles occur throughout the temperate and tropical regions of the Atlantic, Gulf of Mexico, Pacific, and Indian Oceans. This species may be found hundreds of miles out to sea, as well as in inshore areas such as bays, lagoons, salt marshes, creeks, and the mouths of large rivers.

Nesting in the northern Gulf outside of Florida occurs primarily on the Chandeleur Islands in Louisiana and to a lesser extent on adjacent Ship, Horn, and Petit Bois Islands in Mississippi (Ogren, 1977). Ogren (1977) reported a historical reproductive assemblage of sea turtles, which nested seasonally on remote barrier beaches of eastern Louisiana, Mississippi, and Alabama. These sea turtles have historically nested on Mississippi's barrier islands (e.g., Ship, Horn, and Petit Bois) about 19 km south of the mainland (Appendix N). More recent occurrences of sea turtles nesting on the Mississippi barrier islands have been documented by the NPS. From 1990- 2011, loggerhead sea turtle nesting and/or false crawls have been documented at several barrier islands (Cat, West and East Ship, Horn, and Petit Bois). Among the barrier islands, most of the nesting occurred on Petit Bois and Horn Islands, with few nests documented on the other islands. There was one nest documented on East Ship Island (1992), two nests on Cat Island (1998), 16 nests on Horn Island (1998), and 12 nests on Petit Bois Island (1998). For the 2012 nesting season, there were several documented nests on East, and West Ship Island and Cat Island. A total of four nests were documented on West Ship Island, including three on the southern shoreline and one on the northern shoreline (Hopkins, personal comm., 2012). A total of three nests were observed by Hopkins on the southern shoreline of East Ship Island. There were three confirmed nests and one potential nest on Cat Island (Necaise, personal comm., 2012). In addition, four confirmed nests were reported on the Mississippi mainland, including one on Deer Island (Coleman, personal comm., 2012) and several on Petit Bois and Horn Islands. As of July 2013, there have been two confirmed loggerhead nests during the 2013 nesting season. One nest was observed on the north shore of West Ship Island (Williams, personal comm., 2013), and one nest was observed on the Mississippi mainland (Coleman, personal comm., 2013).

There is currently no designated critical habitat for the loggerhead sea turtle in the affected project area.

4.5.8.6 Hawksbill Sea Turtle

The hawksbill sea turtle is the second smallest sea turtle and is somewhat larger than the Kemp's ridley. The hawksbill sea turtle is small to medium size, with a very elaborately colored shell of thick overlapping scales. The overlapping carapace scales are often streaked and marbled with amber, yellow, or brown. Hawksbill turtles have a distinct, hawks-like beak. The name of the turtle is derived from the tapered beak and narrow head.

Hawksbill sea turtles are a highly migratory species. These turtles generally live most of their life in tropical waters, such as the warmer parts of the Atlantic Ocean, Gulf of Mexico, and the Caribbean Sea (Appendix N). Florida and Texas are the only states where hawksbills are sighted with any regularity (NMFS and USFWS, 1993). Juvenile hawksbills are normally found in waters less than 45 feet in depth. They are primarily found in areas around coral reefs, shoals, lagoons, lagoon channels, and bays with marine vegetation that provides both protection and plant and animal food. Unlike the green turtles, hawksbills can tolerate muddy bottoms with sparse vegetation. They are rarely seen in Louisiana, Alabama, and Mississippi waters.

Hawksbills nest throughout their range, but most of the nesting occurs on restricted beaches, to which they return each time they nest. These turtles are some of the most solitary nesters of all the sea turtles. Depending on location, nesting may occur from April through November (Appendix N). Hawksbills prefer to nest on clean beaches with greater oceanic exposure than those preferred by green sea turtles, although they are often found together on the same beach. The nesting sites are usually on beaches with a fine gravel texture. Hawksbills have been found in a variety of beach habitats ranging from pocket beaches only several yards wide formed between rock crevices to a low-energy sand beach with woody vegetation near the waterline. These turtles tend to use nesting sites where vegetation is close to the water’s edge.

4.5.8.7 Leatherback Sea Turtle

The leatherback sea turtles are the largest of all sea turtles. These turtles may reach a length of about 7 feet and weigh as much as 1,600 pounds. The carapace is smooth and gray, green, brown, and black. The plastron is yellowish white. Juveniles are black on top and white on the bottom. This species is highly migratory and is the most pelagic of all sea turtles (NMFS and USFWS, 1992). They are commonly found along continental shelf waters (Appendix N). Leatherback sea turtles’ range extends from Cape Sable, Nova Scotia, south to Puerto Rico and the U.S. Virgin Islands. Leatherbacks are found in temperate waters while migrating to tropical waters to nest (Ross, 1981). The distribution of this species has been linked to thermal preference and seasonal fluctuations in the Gulf Stream and other warm water features (Fritts et al., 1983). The general decline of this species is attributed to exploitation of eggs (Ross, 1981).

Leatherback sea turtles are omnivorous. They feed mainly on pelagic soft-bodied invertebrates, such as jellyfish and tunicates. Their diet may also include squid, fish, crustaceans, algae, and floating seaweed. Highest concentrations of these prey animals are often found in upwelling areas or where ocean currents converge.

Nesting of leatherback sea turtles is nocturnal, with only a small number of nests occurring in the Florida portion of the Gulf of Mexico from April to late July (Appendix N). There is very little nesting in the U. S except in the western Atlantic, where leatherback and hawksbill primarily nest at sites in the Caribbean, with isolated nesting on Florida beaches (Gunter, 1981; Rothschild, 2004). However, leatherback sea turtles have been occasionally seen feeding in the drift lines of jellyfish in the Mississippi Sound and the Gulf waters surrounding the Mississippi barrier islands (Hopkins, personal comm., 2012).

Leatherback sea turtles prefer open access beaches, possibly to avoid damage to their soft plastron and flippers. Unfortunately, such open beaches with little shoreline protection are vulnerable to beach erosion triggered by seasonal changes in wind and wave direction. Thus, eggs may be lost when open beaches undergo severe and dramatic erosion. The Pacific coast of Mexico supports the world's largest known concentration of nesting leatherbacks.

4.5.8.8 Piping Plover and Piping Plover Critical Habitat

Different distinct population segments of the piping plover are listed as endangered or threatened under the ESA (USFWS, 2010h). Piping plover critical habitat in and near the project area is shown on Figure 4-7. The project area is located within piping plover critical habitat, Mississippi Unit 14. The final rule designating critical habitat for the wintering population of the piping plover was published in the Fed. Reg. on July 10, 2001. The primary constituent elements for the piping plover wintering habitat are those habitat components that are essential for the primary biological needs of foraging, sheltering, and roosting, and only those areas containing these primary constituent elements within the designated boundaries are considered critical habitat. The primary constituent elements are found in geologically dynamic coastal areas that support or have the potential to support the species, such as intertidal beaches and flats and the sparsely vegetated back beach areas. Important components of intertidal flats include sand and/or mud flats with no or sparse emergent vegetation. Critical habitat for Mississippi Unit 14 extends to the MLLW.

Surveys for piping plovers on Mississippi barrier islands and mainland beaches indicate a midwinter period when most of the birds are winter residents and a spring-fall migration when many more birds move through the islands, staying for only a short time. During the migration, these areas serve as refueling spots on the long migratory journey. Within the project area, piping plovers are known to congregate primarily along the tidal flats and tips of West and East Ship Islands and at Petit Bois, Horn, Cat Islands. In a survey for the 2009 migratory period, approximately 24 to 34 piping plovers on Petit Bois, Horn, and West and East Ship Islands (Zdravkovic, 2009) were counted. However, higher numbers of plovers were observed for Cat, West, and East Ship Islands during the 2010 to 2011 migratory period (Necaise, person comm., 2012).

During the 2008–09 wintering period, piping plovers were surveyed from Boca Chica, Texas to Marco Island, Florida (Maddock, 2010). Over a 9-day period, the Mississippi mainland and barrier islands were observed. A maximum of 41 birds were observed on Cat Island, 24 on East Ship, 25 on West Ship, 29 on Horn, and 14 on Petit Bois. Moderate numbers of piping plovers were counted on the mainland beaches. Maddock observed higher frequencies of plover use on areas that had large exposed flats, overwash areas, or newly created inlets.

In a 2011 wintering survey, the majority of birds were recorded at East Ship, Cat, and Horn Islands; and of the three, Cat Island had the most, with 45 birds (Winstead, personal comm., 2012). In addition, a 2012 survey noted at least 38 piping plovers on Cat Island, 55 on East Ship Island, 15 on Petit Bois, 3 on West Ship Island, and 532 on Horn Island (Winstead, personal comm., 2012). There were approximately 57 bird surveys conducted in support of the MsCIP barrier island restoration project between December 28, 2012 and December 18, 2013 (Appendix J). A total of 1,154 piping plovers were observed in the project area. Piping plover were observed on DA-10/Sand Island (17), East Ship Island (779), and West Ship Island (358). Figures in Appendix J show the number of piping plover observed monthly at each of the survey locations. On East Ship Island, the largest number of piping plover was observed during the month of October (416 birds). Relatively large numbers of piping plovers were observed on East Ship Island during the months August through December, while relatively large numbers were observed on West Ship Island during the months January through April. On Sand Island, the month of February had the largest number (12) of piping plovers, and all other months had much lower numbers of this species.

4.5.8.9 Red Knot

The red knot (*Calidris cantus*) is a sandpiper shorebird species of concern that has been observed wintering on the majority of the barrier islands, especially Cat and Petit Bois Islands, in few numbers. The USFWS recently listed the subspecies, the rufa red knot (*Calidris canutus rufa*), as a threatened species under the ESA (USFWS, 2013). *C. canutus rufa* breed in the central Canadian Arctic and most winter in Tierra del Fuego, Maranhão, or Florida (New Jersey Dept. of Env. Protection, 2007). The USFWS lists Mississippi and Alabama as states where *C. canutus rufa* are known or believed to occur. However, a county-level range has not been defined for Mississippi or Alabama. The USFWS Species Action Plan for *C. canutus rufa* does not include the Mississippi or Alabama coastline in wintering or stopover paths of C. c*anutus rufa* (USFWS, 2010i).

The approximately 57 bird surveys, conducted in support of the MsCIP barrier island restoration project during the period December 28, 2012 and December 18, 2013, identified a total of 292 red knots in the project area. Figures in Appendix J show the number of red knot observed monthly at each of the survey locations. Red knots were observed on DA-10/Sand Island (11), East Ship Island (265), and West Ship Island (16) (Appendix J). Most red knots were observed in January 2013 (75) and May 2013 (61).

4.6 Essential Fish Habitat

The Magnuson Fisheries Conservation and Management Act of 1976 (the Act) was passed to promote sustainable fish conservation and management. Under the Act, NOAA Fisheries was granted legislative authority for fisheries regulation in the U.S. within a jurisdictional area located between 3 miles and 200 miles offshore, in the Exclusive Economic Zone depending on geographic location. NOAA Fisheries was also granted legislative authority to establish eight regional fishery management councils responsible for the proper management and harvest of fish and shellfish resources within these waters. Measures to ensure the proper management and harvest of fish and shellfish resources within these waters are outlined in Fisheries Management Plans prepared by the eight councils for their respective geographic regions. The Mississippi Sound system and nearshore Gulf of Mexico are within the management jurisdiction of the Gulf of Mexico Fishery Management Council (GMFMC).

NOAA Fisheries recognized that many marine fisheries are dependent on nearshore and estuarine environments for at least part of their life cycles. The Act was reauthorized and changed extensively via amendments in 1996 (P.L. 104-297), stressing the importance of habitat protection to healthy fisheries. The authority of NOAA Fisheries and its councils was strengthened by the reauthorization to promote more effective habitat management and protection of marine fisheries. Specific marine environments important to marine fisheries are referred to as EFH in the Act and are defined as those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity (16 U.S. Code [U.S.C.] § 1802 (10)). The EFH regulations (at 50 C.F.R. § 600 Subpart J) provide additional interpretation of the definition of EFH: waters include aquatic areas and their associated physical, chemical, and biological properties that are used by fishes and may include areas historically used by fishes. Substrate includes sediment, hardbottom, structures underlying the waters, and any associated biological communities. "Necessary" means the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem. Spawning, breeding, feeding, or growth to maturity covers all habitat types used by a species throughout its life cycle. Figures showing EFH in the project area are presented in Appendix O.

4.6.1 Species Accounts

Three key sources (GMFMC, 1998, 2004, 2005) were used to describe the life history and preferred habitat of managed species with EFH designated within the area encompassed by all the restoration alternatives considered. Relative abundance information was obtained from Estuarine Living Marine Resources database (NOAA; http://ccma.nos.noaa.gov/ecosystems/estuaries/elmr.aspx).

4.6.1.1 Red Drum Fishery

The red drum occurs throughout the Gulf of Mexico in a variety of habitats, ranging from depths of about 40 meters (130 feet) offshore to very shallow estuarine waters. Red drum commonly occur in most Gulf estuaries where they are found over a variety of substrates, including seagrass, sand, mud, and oyster reefs. Spawning occurs in deeper water near the mouths of bays and inlets, and on the Gulf side of the barrier islands (Pearson, 1929; Simmons and Breuer, 1962; Perret et al., 1980) from about September through November. Red drum are known to spawn in depths ranging from a minimum of 40 meters to a maximum of 70 meters (130 to 230 feet) (NOAA Fisheries, 2004a). The eggs hatch mainly in the Gulf, and larvae are transported into the estuary where the fish mature before moving back to the Gulf (Perret et al., 1980; Pattillo et al., 1997). Known nursery areas in the western Gulf of Mexico are Lake Pontchartrain and Mobile Bay (NOAA, 2010b). Estuarine wetlands are especially important to larval, juvenile, and subadult red drum. An abundance of juvenile red drum has been reported around the perimeter of marshes in estuaries (Perret et al., 1980). Young fish were found in quiet, shallow, protected waters with grassy or slightly muddy bottoms (Simmons and Breuer, 1962). Shallow bay bottoms or oyster reef substrates were especially preferred by subadult and adult red drum (Miles, 1950). Adult red drum use estuaries but tend to spend more time offshore as they age.

Larval red drum feed almost exclusively on mysids, amphipods, and shrimp, whereas larger juveniles feed more on crabs and fish (Peters and McMichael, 1987). Overall, crustaceans and fishes are most important in the diet of red drum; primary food items are blue crabs, striped mullet, spot, pinfish, and pigfish.

In the Mississippi Sound, juvenile red drum are relatively common year-round, and adults are relatively common from February to October.

4.6.1.2 Shrimp Fishery

Brown, white, and pink shrimp occur throughout the Mississippi Sound. A description of the life histories of the three shrimp species and their seasonal movements is presented in Section 4.5.3.

4.6.1.3 Stone Crab Fishery

Florida stone crab (*Menippe mercenaria)* and Gulf stone crab (*M. adina*) comprise the stone crab fishery in the Gulf of Mexico. The Gulf stone crab is typically smaller than the Florida stone crab and replaces it in the northern and western Gulf of Mexico (northwest Florida to Tamaulipas, Mexico). Adult stone crabs are benthic organisms and can be found from the shoreline out to depths of 61 meters (200 feet). They occupy a variety of habitats, including burrows under rock ledges, coral heads, dead shell, and seagrass patches. Adults also inhabit oyster bars and rock jetties and are commonly found on artificial reefs where adequate refugia are present. Stone crabs spawn principally from April through September.

Juveniles are also benthic but do not burrow; they use readily available refugia in proximity to food items. Juveniles can be found on shell bottom, sponges, and *Sargassum* mats as well as in channels and deep grass flats. After reaching a width of about 0.5 inch, the crabs live within oyster beds and rocks in shallow parts of estuaries. There are numerous reports of large juveniles to small adults being abundant on oyster reefs (Florida Marine Research Institute, 2001). Adults and juveniles appear to be hardy, can tolerate most environmental extremes within their distribution range, and are capable of surviving salinities considerably higher or lower than 33 ppt. Stone crab larvae are planktonic and require warm water 30°C (86°F) and high salinity (30 to 35 ppt) for most rapid growth (Lindberg and Marshall, 1984).

The stone crab is a high trophic level predator and is primarily carnivorous at all lifestages. Juveniles feed on small mollusks, polychaetes, and crustaceans. Adults consume several species of mollusks, including oysters and mussels, and also consume carrion and vegetable matter such as seagrass (Lindberg and Marshall, 1984).

Adult and juvenile stone crabs are relatively common in most of the Mississippi Sound year-round.

4.6.1.4 Reef Fishery

Gray snapper occur in estuaries and shelf waters of the Gulf and are particularly abundant off south and southwest Florida. Considered to be one of the more abundant snappers inshore, the gray snapper inhabits waters to depths of about 180 meters (590 feet). Adults are demersal and mid-water dwellers, occurring in marine, estuarine, and riverine habitats. They occur up to 32 kilometers (20 miles) offshore and inshore as far as Coastal Plain freshwater creeks and rivers. They are found among mangroves, sandy grassbeds, and coral reefs and over sandy, muddy, and rocky bottoms. Spawning occurs offshore around reefs and shoals from June to August. Eggs are pelagic, and are present from June through September after the summer spawn, occurring in offshore shelf waters and near coral reefs. Larvae are planktonic, occurring in peak abundance from June through August in offshore shelf waters and near coral reefs from Florida through Texas. Post-larvae move into estuarine habitat and are found especially over dense grass beds of *Halodule* and *Syringodium*. Juveniles are marine, estuarine, and riverine dwellers, often found in estuaries, channels, bayous, ponds, grassbeds, marshes, mangrove swamps, and freshwater creeks. They appear to prefer *Thalassia* grass flats, marl bottoms, seagrass meadows, and mangrove roots. Juveniles utilize the estuarine bays as nursery grounds from May through September.

Gray triggerfish are found throughout the Gulf of Mexico. Eggs are deposited in late spring and summer in nests prepared in sand near natural and artificial reefs. Larvae and post-larvae are pelagic, occurring in the upper water column, usually associated with *Sargassum* and other flotsam. Early and late juveniles also are associated with *Sargassum* and other flotsam, and may be found in mangrove estuaries. Triggerfish leave the surface *Sargassum* habitat in the fall, when juvenile fish (5 to 7 inches) move to reef habitat on the bottom. Adults are found offshore in waters deeper than 10 meters (33 feet) where they are associated with natural and artificial reefs. Triggerfish may move away from the reef structure in order to feed. Spawning adults occur in late spring and summer, also around natural and artificial reefs in water depths greater than 10 meters (33 feet).

Lane snapper occur throughout the shelf area of the Gulf in depths ranging from 0 to 130 meters (0 to 427 feet). The species is demersal, occurring over all bottom types, but is most common in coral reef areas and sandy bottoms. Spawning occurs in offshore waters from March through September. Nursery areas include mangrove and grassy estuarine areas in southern Texas and Florida and shallow areas with sandy and muddy bottoms off of all the Gulf States. Early and late juveniles appear to favor grass flats, reefs, and soft bottom areas to offshore depths of 20 meters (66 feet) (NOAA, 1985). Adults occur offshore at depths of 4 to 132 meters (13 to 433 feet) on sand bottom, natural channels, banks, and man-made reefs and structures.

Red snapper occur throughout the Gulf of Mexico shelf. They are particularly abundant on the Campeche Banks and in the northern Gulf. The species is demersal and is found over sandy and rocky bottoms, around reefs, and around underwater objects from shallow water to 200 meters (656 feet). Adults favor deeper water in the northern Gulf. Spawning occurs in offshore waters from May to October at depths of 18 to 37 meters (59 to 121 feet) over fine sand bottom away from reefs. Eggs are found offshore in summer and fall. Larvae, post-larvae, and early juveniles are found from July through November in shelf waters ranging in depth of 17 to 183 meters (55 to 600 feet). Early and late juveniles are often associated with structures, objects, or small burrows, but also are abundant over barren sand and mud bottoms. Late juveniles are caught year-round at depths of 20 to 46 meters (65 to 130 feet).

4.6.1.5 Coastal Pelagic Fishery

In the Gulf of Mexico, cobia are found in coastal and offshore waters (from bays and inlets to the continental shelf) from depths of 1 to 70 meters (3 to 230 feet). Adults feed on fishes and crustaceans, including crabs. Spawning occurs in coastal waters from April through September at temperatures ranging from 23 to 28°C (73.4 to 82.4°F). These fish migrate seasonally, and are commonly seen among other species in the family. Eggs are found in the top meter of the water column, drifting with the currents. Larvae are typically found in offshore waters of the northern Gulf of Mexico, where they likely feed on zooplankton. Juveniles occur in coastal and offshore waters, feeding on small fishes, squid, and shrimp.

King mackerel occur in the Gulf of Mexico, with centers of distribution in south Florida and Louisiana. Adults are found over reefs and in coastal waters, although they rarely enter estuaries. Migrations to the northern Gulf in the spring are believed to be temperature-dependent, and the species is found in waters with temperatures greater than 20°C (68°F). Although adults can be found at the shelf edge in depths to 200 meters (656 feet), they generally occur at depths less than 80 meters (262.5 feet) and at oceanic salinities from 32 to 36 ppt. Adults feed mostly on fishes, and less often on crustaceans and mollusks, with a diet that includes jacks, snappers, grunts, halfbeaks, penaeid shrimp, and squid. Adults spawn over the OCS from May to October, with the northwestern and northeastern Gulf of Mexico considered important spawning areas. The pelagic eggs are found offshore over depths of 35 to 180 meters (115 to 591 feet) in spring and summer. Larvae occur over the middle and OCS, principally in the north-central and northwestern Gulf, where they consume larval fishes such as carangids, clupeids, and engraulids. Juveniles are found from inshore to the middle shelf, where they feed on engraulid and clupeid fishes and some squid.

Spanish mackerel occur in the Gulf of Mexico, with their center of distribution off the Florida coast. Adults are found in inshore coastal waters, and may enter estuaries in pursuit of baitfish. Migrations to the northern Gulf in the spring are believed to be temperature-dependent, and the species is found in waters with temperatures greater than 20°C (68°F) and out to depths of 75 meters (246 feet) at oceanic salinities. Adults feed mostly on fishes, and less often on crustaceans and mollusks, with a diet that includes clupeids, engraulids, carangids, and squid. Adults spawn over the inner continental shelf from May to September, with the north-central and northeastern Gulf of Mexico considered important spawning areas. The pelagic eggs are found over the inner continental shelf at depths less than 50 meters (164 feet) in spring and summer. Larvae occur over the inner continental shelf, principally in the northern Gulf, where they consume larval fishes such as carangids, clupeids, and engraulids. Juveniles occur in estuarine and coastal waters, where they feed on engraulid and clupeid fishes, gastropods, and some squid. Juveniles are relatively common in the Mississippi Sound from spring through fall.

4.6.1.6 Highly Migratory Species

The Mississippi Sound and adjacent waters have been identified as important nursery areas for nine shark species, primarily Atlantic sharpnose (*Rhizoprionodon terraenovae*), blacktip (*Carcharhinus limbatus*), finetooth (*Carcharhinus isodon*), and bull sharks (*Carcharhinus leucas*). Other less common species are the spinner (*Carcharhinus brevipinna*), blacknose (*Carcharhinus acronotus*), sandbar (*Carcharhinus plumbeus*), bonnethead (*Sphyrna tiburo*), and scalloped hammerhead (*Sphyrna lewini*). EFH has been identified in this area for the blacknose, Atlantic sharpnose, bonnethead, tiger (*Galeocerdo cuvier*), spinner, bull, blacktip, and scalloped hammerhead sharks.

Typically sharks migrate inshore in the early spring around March and April, remain inshore during the summer months, and then migrate offshore around October. Most shark species in the Mississippi coastal waters give birth during late spring and early summer, with young sharks spending just a few months of their lives in shallow coastal waters.

Most shark species are abundant around barrier islands, with adult sharks commonly present south of the barrier islands. Younger sharks, which can tolerate lower salinities, have been found as far inshore as Round and Deer Islands.

The four most common inshore shark species feed primarily on fish, including menhaden, spot, croaker, speckled trout, and hardhead catfish. In addition, researchers have found crabs in the stomachs of bonnethead shark and stingrays and smaller sharks in the stomachs of blacktip and bull sharks.

4.7 Special Aquatic Sites

Special aquatic sites include marine sanctuaries and protected coastal marsh areas.

The National Marine Sanctuary System consists of 14 marine protected areas (MPAs) that range from less than 1 square mile to 137,792 square miles of ocean and Great Lakes waters (NOAA, 2010b). Two national marine sanctuaries are located in the Gulf; however, both are far from the project area. The Flower Garden Banks National Marine Sanctuary is located in the western part of the Gulf, 75 to 120 miles off the coasts of Texas and Louisiana. The Florida Keys National Marine Sanctuary is located off the southern tip of Florida (NOAA, 2010b).

The project area is bordered by two large marsh systems along the Mississippi mainland coast. The Grand Bay Marshes to the east lie within the 18,000-acre Grand Bay NERR in Jackson County (USACE, 2009a). Other important marsh areas are the Grand Bay National Wildlife Refuge in Jackson County and the Hancock County Marshes.

4.8 Cultural Resources

This section presents information on cultural resources located in the project area. The discussion includes a description of regulatory requirements, methods used to identify existing archaeological and architectural resources, and the number and types of archaeological and architectural resources known or expected to occur within the project area and the number of archaeological and architectural resources that are listed in or eligible for listing in the NRHP.

For NPS management purposes, cultural resources are identified as archaeological resources, cultural landscapes, structures, museum objects, and ethnographic resources. Cultural resources are discussed in terms of archaeological sites, which include both prehistoric and historical occupations either submerged or on land, and architectural resources. Archaeological sites can become submerged when they are inundated following impoundment of rivers as well as by natural sea level rise from Holocene glacial melting, and shifting landforms due to erosion and weather events. Shipwrecks are a specific type of submerged archaeological site (NPS, 2010b).

Federal projects are subject to a number of federal laws and regulations regarding cultural resources: NEPA, Antiquities Act of 1906, Archaeological and Historic Preservation Act of 1974, Archaeological Resources Protection Act of 1979, Abandoned Shipwreck Act of 1987, Sunken Military Craft Act of 2005, Native American Graves Protection and Repatriation Act (NAGPRA), Section 106 of the NHPA (36 C.F.R. § 800), and Protection of Archaeological Resources (43 C.F.R. § 7), as well as executive orders. Guidance issued by the NPS in Bulletin

Number 20 (Delgado, 1997) highlights consultation with the State Historic Preservation Office (SHPO) regarding shipwrecks. Furthermore, 43 U.S.C. § 2105 supports transfer of title for qualifying Abandoned Shipwrecks to State Governments, "The title of the United States to any abandoned shipwreck asserted under subsection (a) of this section is transferred to the State in or on whose submerged lands the shipwreck is located."

Section 106 of the NHPA, as amended (16 U.S.C. § 470), governs Federal actions that could affect cultural resources. Section 106 requires Federal agencies to take into account the effects of their undertakings on cultural resources and to afford the Advisory Council on Historic Preservation (ACHP) and other interested parties a reasonable opportunity to comment. USACE acted as the lead federal agency for Section 106 compliance in accordance with 36 C.F.R. Part 800.2(2), while BOEM acted as a cooperating agency for Section 106 compliance, established in the Cooperating Agency letter. As such, BOEM archaeologists worked with USACE to satisfy BOEM's OCS Section 106 compliance, offering input and consultation as needed.

Section 101(b)(4) of NEPA requires Federal agencies to coordinate and plan their actions so as to preserve important historic, cultural, and natural aspects of the country's national heritage.

As defined broadly by the regulations implementing Section 106 (36 C.F.R. § 800), historic property is defined as any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion in, the NRHP. The criteria for NRHP eligibility are set forth in Title 36 of C.F.R. § 60.4 as follows:

> *The quality of significance in American history, architecture, archaeology, engineering, and culture is present in districts, sites, building, structures, landscapes, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association." and:*
>
> *A. That are associated with events that have made a significant contribution to the broad patterns of our history; or*
>
> *B. That are associated with the lives of persons significant in our past; or*
>
> *C. That embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or*
>
> *D. That has yielded, or may be likely to yield, information important in prehistory or history.*

In addition, to qualify for listing in the NRHP, a resource usually must be at least 50 years old, with stipulated exceptions under Criteria Consideration G for properties that have not reached that threshold. Properties that qualify for listing in the NRHP also must possess aspects or qualities of integrity, defined by the following categories: location, design setting, materials, workmanship, feeling, and association (NPS, 2000).

Shipwrecks could include those from the earliest period of exploration of the Americas and the southern United States to modern times, including those from Hurricane Katrina in 2005. Shipwrecks are defined as a submerged or buried vessel that has been foundered, stranded, scuttled, or wrecked and includes vessels that are intact or scattered components on or in the sea bed, lake bed, mud flats, beaches, or other shorelines, excepting hulks (NPS, 1992). To be eligible for listing in the NRHP, a vessel must have significance as one of five basic types of historic vessels: floating, dry-berthed, small craft, hulk, or shipwreck. As with other cultural resources, to be NRHP-eligible, the vessel must also retain the seven aspects of integrity.

In accordance with the recommendations in Chapter 4 of the MsCIP PEIS (USACE, 2009a) and the NHPA, USACE has engaged in Section 106 consultation on the barrier island restoration project with the SHPOs, interested tribes, and other consulting parties regarding the following: project Area of Potential Effects (APE), cultural resources inventory strategies, NRHP eligibility, and project effects. All coordination letters received to date are located in Appendix T.

4.8.1 Cultural Context

Information regarding the past cultural chronology in the region is used in the assessment of archaeological potential, and provides an interpretive context for any potential archaeological or other cultural resources in the project area. Knowledge of local prehistory and history helps to place cultural resources within their historical context and is necessary for evaluating the importance of cultural resources within the APE.

The project area encompasses several barrier islands in Mississippi. The MsCIP PEIS (USACE, 2009a) provides a brief overview of the context for prehistoric and historic periods.

The prehistoric occupation of the coastal Mississippi region is delineated by archaeologists into five major periods: the Paleo-Indian, Archaic, Gulf Formational, Woodland, and Mississippian periods. The majority of the prehistoric resources identified in the region have been found along rivers (particularly the mouths of rivers) and on the barrier islands. Most surveys during which these sites were identified were conducted at limited locations, so they cannot predict the probability or certainty of other sites in the area (USACE, 2009a).

Explorers, particularly of French origin, began to arrive in the area in the mid- to late 17th century. The French established the first settlement in the region in 1699 at Old Biloxi, which is now Ocean Springs. The territory changed hands between the French, English, and Spanish between 1763 and the Louisiana Purchase in 1812, when it became part of the United States. The early French settlements began along the local bays, rivers, and other waterways and grew into prosperous ports. The economy of the region was centered around agriculture, timber, charcoal, commercial fishing, and oyster and shrimp processing. Later in the 19th century, the economy also included resort destinations and tourism (USACE, 2009a).

Ship Island served as a major port for explorers and colonists and received its name from the deep harbor on the north side of the island where large ships could anchor. In 1847, the island was named a military reservation. Construction of what is now called Fort Massachusetts began in 1859 and was mostly completed by 1866. Before the fort was complete, a lighthouse was built on the island, but was destroyed early in the Civil War. The lighthouse was replaced in 1862 and underwent various upgrades and additions throughout the early 20th century. In 1969, Hurricane Camille damaged the lighthouse. The lighthouse was rebuilt on its historic foundation in 1999, but was destroyed by Hurricane Katrina in 2005 (USACE, 2010b; NPS, 2010b). Remnants of the lighthouse and foundation remain in the swash zone.

The entire Gulf coast area in Mississippi was designated a national heritage area in 2004. The Mississippi Gulf Coast National Heritage Area includes the six coastal counties in Mississippi and the islands in this project area. Three NRHP-listed properties are shown in the heritage area off the coast of Mississippi: Fort Massachusetts on West Ship Island, the French Warehouse site on East Ship Island, and the Round Island Lighthouse on Round Island (MDMR, 2005).

4.8.2 Cultural Resources within the Project Area

Types of cultural resources that could be found in the project area include sunken shipwrecks, inundated sites, terrestrial sites, and standing structures, particularly forts or other military and marine associated structures. Submerged archaeological sites in the area could include inundated prehistoric middens, remnants of historic structures, as well as ballast, cannons and cannon balls, and pottery sherds. Traditional cultural properties can also be significant due to their traditional religious or cultural importance to a tribe or other established community. According to the PEIS, the potential for identifying additional buried archaeological sites and submerged historic shipwrecks in the project area is considered high, based on the number of known resources (USACE, 2009a). Thus, additional surveys have been completed. While fieldwork is complete and some effects determinations have been coordinated with the appropriate resource agencies, several reports of investigation findings need to be reviewed and coordinated to ensure potentially eligible resources are identified and management and avoidance plans can be developed and implemented. A discussion of these efforts will be included in the Record of Decision.

4.8.2.1 Previously Identified Cultural Resources

Three sites have been identified previously on West Ship Island, including Fort Massachusetts and the Ship Island Lighthouse. Fort Massachusetts on the northern shore of West Ship Island was built alternately by Confederate (renamed Fort Twiggs under Confederate control) and U.S. Government forces between 1859 and 1866 as a part of a program to bolster national defense. It was listed in the NRHP in 1971. According to the 1971 NRHP nomination form, the fort has national, state, and local significance. In keeping with the style and materials of the time, it is built of brick with segmental arches. The fort is constructed in the shape of a D, with the rounded side facing the water. It is significant for its architectural integrity as well as for the events that took place around it, including the Civil War. It is an integral component of the collection of seacoast defensive structures that represent Gulf coast development from early exploration and colonization through the mid-20th century (Maddox 1971; NPS, 2010b; USACE, 2010a).

The Ship Island Lighthouse is also located on West Ship Island. The first lighthouse tower was constructed in 1853. This tower was built of brick and was equipped initially with a multiple lamp and reflector system. Three years later, it was upgraded to a Fresnel lens. In January of 1861, at the beginning of the Civil War, Confederate forces seized the island, including the lighthouse. When they abandoned the fort in September, they removed the lighthouse lens and set the interior of the structure on fire. Union forces occupied the island shortly thereafter and restored the light to operation in November of 1862, using a captured lens and lantern. The light was obscured to the north to prevent aiding blockade runners approaching from the mainland. By this time, the tower had begun to noticeably lean, and in 1886 it was condemned, and a new tower was erected about 300 feet away. This replacement tower was constructed entirely of wood and was originally open framework, though it was quickly enclosed with siding. The light was changed from fixed white to red in 1880. The old tower finally collapsed in 1901.

The new light was automated in 1950. The lighthouse was sold to a private citizen in 1964. The tower was damaged beyond repair by Hurricane Camille in 1969, but remained standing until 1972, when it was accidentally burned down by sparks from a camper's campfire.

A replica of the lighthouse was built in 2000, but, as happened to its earlier predecessor, the light was completely destroyed by Hurricane Katrina in 2005 (USCG 2014).

An archaeological site, 22HR640, dating from the Paleo-Indian period, is located in the vicinity of the remains of the historic lighthouse. The condition and NRHP status of this site are unknown.

Three archeological sites have been previously identified on East Ship Island including site 22HR638, containing both historic and prehistoric materials, which is referred to as the French Warehouse site. It was listed in the NRHP in 1991 for its significance under Criterion D for the data it could provide on the history of Mississippi and the region, particularly 18th century commerce and reconstruction of past lifeways, including French exploration and Gulf coast settlement. The site is approximately 8 acres and is made up of the remains of a complex of warehouse buildings established before 1720 to serve as the primary port for the capital of New Biloxi because the harbor at Biloxi was too shallow for larger ships. The site sustained damage during Hurricane Katrina, but is still accessible (Hammersten, 1991; USACE, 2009a; Hester 2012).

A second site, 22HR639, identified as the Quarantine Station was found in 1973 was submerged during Hurricane Katrina. Its status is currently unknown and will be discussed in Section 5.7.

The third archaeological site, 22HR1106, contains prehistoric materials and is referred to as the Sherds on the Beach site. Following the 2010 oil spill, it was determined to be a NAGPRA Site and a report and associated action plan are on file with the NPS. This site is considered to be eligible for nomination.

Previous research conducted on Cat Island, most of which was conducted as part of the Oil Spill Response, located a number of cultural resources on Cat Island (Table 4-11).

The Cat Island Lighthouse was built in 1831; it was initially lit by whale oil. Several storms undermined the poorly built lighthouse at Cat Island. An 1851 hurricane cut a channel, through the spit, separating the lighthouse from the rest of the island. Another hurricane in 1855 demolished the keeper's house and further weakened the poorly designed structure.

In 1856, $12,000 was allocated for moving the tower, but the tower remained in place and a new Fresnel lens was installed the following year. Another hurricane in 1860 severely damaged the tower and keeper's home. Confederate forces took over the damaged lighthouse in 1861, confiscated the light apparatus, and reinstalled it at the historic River Light Station in Louisiana.

Considered essential to navigation, it was recommended in 1868 that the damaged lighthouse be repaired. Instead, a prefabricated lighthouse was located on Cat Island in 1871. The 1871 Cat Island lighthouse remained in use for 66 years, until its deactivation in 1937. In 1950 Nathan Boddie, the island's owner, purchased the lighthouse reservation from the federal government. The lighthouse burned down in 1961 (Wharton et al., 2013).

TABLE 4-11
Known Cultural Resource Sites on Cat Island

Site No.	Recorder	Year	Site Name	Site Type/Components	NRHP Status
22HR531 (GUIS149)	Dale Greenwell	1971	Boiler Point	Oyster and rangia shell midden with Early Middle Woodland-Late Woodland components	Unknown
22HR532 (GUIS149)	Dale Greenwell	1971	Little Bay I	Oyster shell midden with Late Woodland–Early Mississippi components	Unknown
22HR533 (GUIS150)	Dale Greenwell	1971	Little Bay II	Late Woodland through Mississippi shell midden	Unknown
22HR1166 (GUIS163)	NPS/HDR	2012	Cuevas	Early Archaic, Middle Woodland, Historic Indian through Early 20th c. habitation site	Unknown
22HR1162	HDR	2012	South Shore III	Late Woodland, Mississippi, Protohistoric, Early Historic artifact scatter	Unknown
22HR1161 (GUIS169)	HDR	2012	West Point	Unknown Aboriginal, 19th c.–Modern artifact scatter	Unknown
22HR1169	HDR	2012	Middle Spit Mound	Middle–Late Woodland artifact scatter/possible mound	Unknown
22HR1163	HDR	2012	South Shore II	Middle–Late Woodland, Late 18th–Early 20th c. Historic artifact scatter	Unknown
Formerly 22HR1171	HDR	2011	-	Unknown Aboriginal artifact scatter	Unknown
22HR1174 (GUIS170)	HDR	2012	South Spit	Unknown Aboriginalartifact scatter	Unknown
22HR1164 (GUIS162)	HDR	2012	South Shore I	Middle Woodland, Late 19th–Early 20th c. artifact scatter	Unknown
22HR1177	HDR	2012	East Shore	Middle Woodland, Early18th–Early 20th c. artifact scatter	Ineligible
22HR1175	HDR	2012	Little Bay III	Protohistoric–Early 20th c. artifact scatter/shell midden	Unknown
22HR1176	HDR	2012	Little Bay IV	Unknown Aboriginal artifact scatter/shell midden	Unknown

TABLE 4-11
Known Cultural Resource Sites on Cat Island

Site No.	Recorder	Year	Site Name	Site Type/Components	NRHP Status
22HR1195	HDR	2012	Little Bay V	Unknown Aboriginal artifact scatter/shell midden	Unknown
22HR1196	HDR	2012	Cat Island Cheniere	Middle–Late Mississippi artifact scatter	Unknown
16SB14	Gagliano	1978	Cat Island	Unknown shell midden	Unknown
GUIS141	NPS	2006	Cat Island War Dog Reception and Training Center	WWII dog training facility	Unknown
GUIS141.001	NPS	2006	" " (sub-site)	Shell access road and pier	Unknown

Previous cultural resources investigations in the three southern counties for the MsCIP PEIS (USACE, 2009a) identified eight shipwrecks in that project area. No shipwrecks were identified in Hancock County, seven in Harrison County, and one in Jackson County. One of these in Harrison County is listed in the NRHP (the *Josephine*) and the others have no NRHP eligibility recommendations. From available materials, the exact locations of these sunken vessels are not known, but the geographic information would be available from the SHPO (USACE, 2009a).

The wreck of the *Josephine* (22HR843) is a sunken iron-hull sidewheeler listed in the NRHP in 2000. The *Josephine* is significant for the data she could possess about the shipping industry and the development of 19th century iron-hulled steamship construction and technology. This shipwreck is outside the project APE (MMS, 2006; USACE, 2009a).

Table 4-12 summarizes additional cultural resources identified during previous investigations in the area.

TABLE 4-12
Summary of Additional Previously Identified Cultural Resources

Resource Name	Resource Type	Location	NRHP Status
Wreck of the *Josephine* (22HR843)	Shipwreck	Off the Coast of Biloxi, Mississippi	Listed 2000
Gulf Island National Seashore	National Park	Mississippi and Florida Coasts	NA
Fort Massachusetts (22HR641)	Standing Structure	West Ship Island	Listed 1971
Ship Island Lighthouse	Archaeological Site	West Ship Island	Unknown
22HR640	Archaeological Site	West Ship Island	Unknown
French Warehouse (22HR0638)	Archaeological Site	East Ship Island	Listed 1991

TABLE 4-12
Summary of Additional Previously Identified Cultural Resources

Resource Name	Resource Type	Location	NRHP Status
Quarantine Station (22HR639)	Archaeological Site	East Ship Island	Unknown,
Sherds on the Beach (22HR1106)	Archaeological Site	East Ship Island	Unknown, Potentially Eligible

4.8.2.2 Recently Conducted Cultural Resource Investigations

To ensure full Section 106 and NEPA compliance, and to protect cultural sites in the APE, several additional surveys, both terrestrial and maritime, have been initiated and the fieldwork is complete for all surveys. This information is summarized in the paragraphs below. It is customary not to publish the locations of archaeological sites due to their cultural sensitivity and risk of looting or disruption, so the exact locations of the sites listed are not being released.

In 2012, NPS archaeologists conducted a remote sensing (magnometer, sidescan sonar, and sub–bottom sonar) survey of Camille Cut by boat. Nineteen anomalies which were identified in the 2012 survey were cleared by NPS archaeologists during dive operations as part of the 2015 fieldwork. In addition, under an interagency agreement with USACE, the NPS Submerged Resources Center (SRC) conducted an additional survey north of Camille Cut to investigate the best placement of contractor access channels, and a survey of the southern placement area and proposed pipeline corridors. An additional magnetic anomaly was identified during the 2015 NPS SRC survey that corresponds with a wreck charted on NOAA charts. This anomaly was investigated using hydroprobing and a hard return suggesting cultural material was located.

Additional maritime survey work was conducted by contractors of the offshore borrow areas to identify potential cultural resource sites. In addition, the beach and inland placement areas on East and West Ship Island were surveyed for possible resources. All of the survey work for the borrow areas and beach placement areas has been completed and coordinated with the SHPOs.

In the summer of 2015, USACE contracted a professional cultural resources firm to complete the fieldwork for the final Phase I maritime archaeological survey for the Cat Island access channel placement, aquatic placement of dredge material, and borrow site. This survey was conducted in accordance with Federal and State Phase I maritime archaeological standards and included the use of magnometer, sidescan sonar, and sub–bottom sonar instrumentation. Although the fieldwork for this survey is complete, the final report for this fieldwork has not been delivered. The management summary indicates no potential cultural resources in the borrow areas or access channel areas; thus no effect determinations were made in these areas. However, the management summary indicated that there were four anomalies in the Cat Island placement areas. Upon delivery of the final report, USACE archaeologists will make effects and eligibilities determinations and coordinate these determinations and any future investigation with the appropriate reviewing agencies.

Table 4-13 summarizes the results of the maritime investigations conducted to date.

TABLE 4-13
Number of Maritime Cultural Avoidance Anomalies

Survey Area	Acoustic Avoidance Anomalies	Magnetic Avoidance Anomalies	Total Avoidance Anomalies
Cat Island Borrow Area	0	0	0
Ship Island Borrow Area	0	0	0
HIP (3 Borrow Areas)	0	8	8
PBP, AL (2 Borrow Areas)	0	2	2
PBP, MS	0	0	0
PBP, OCS West (6 Borrow Areas)	0	0	0
PBP, OCS East (5 Borrow Areas)	5	5	10
North of Camille Cut (Access Channels)	0	139	139
South of Camille Cut (Pipeline Corridors)	0	1 (Quarantine Station)	1
Cat Island Access Channels	0	0	0
Total	5	155	160

4.9 Visual and Aesthetic Resources

Visual and aesthetic resources in the project area consist of the Mississippi barrier islands, the Mississippi Sound, and the natural areas along the coastline of Mississippi and offshore in the Gulf of Mexico. These areas are used for a variety of recreational activities, including viewing nature and wildlife.

The barrier islands include the Mississippi barrier islands within the GUIS. These include East Ship and West Ship Islands, Horn Island, Petit Bois Island, and their adjacent waters, and parts of Cat Island. The islands are listed as a national watchable wildlife area and include designated wilderness areas (Horn Island and Petit Bois Island) (NPS, 2010a).

The following description is summarized from Marsh (2010). Aesthetic resources on Petit Bois Island include sandy beaches and pond/lagoon complexes. Its Gulf beach is composed of white quartz sand up to 500 feet wide. The island provides excellent feeding, resting, and wintering habitat for numerous types of migrant and wintering waterfowl species. Horn Island contains white sand beaches and dunes, pines and live oak trees, numerous marshes, and ponds and lagoons in the interior. It supports abundant wildlife and is used by both campers and hikers. East Ship Island and West Ship Island contain beautiful beaches as well as historic resources that draw over 60,000 visitors each year. Cat Island contains a greater diversity of vegetation and wildlife than any of the islands currently within the project area. Habitats include saltwater marsh, ephemeral saltwater marsh, freshwater marsh, palmetto-slash pine forest, and live oak stands.

Several governmental entities manage natural resources along the Mississippi coastline. The MDMR manages sensitive coastal wetland habitats along the Mississippi Gulf coast as part of its Coastal Preserves Program. The State owns approximately 30,000 acres of coastal habitat. The managed sites include Davis Bayou, Grand Bay, and the Pascagoula River marshes, as well as Round Island in the Mississippi Sound (MDMR, 2010e). Three wildlife refuges, Mississippi Sandhill Crane, Grand Bay, and Bon Secour, are part of the Gulf Coast Refuge Complex, which is managed by the USFWS (USFWS, 2010j). The NPS manages the resources within the Mississippi coastal portion of the GUIS (i.e., Davis Bayou Unit). Additionally, offshore oil rigs are visible in the Gulf of Mexico.

4.10 Noise

Noise sources in the project area include: (1) air noise (which can impact humans and marine and coastal birds) and (2) underwater noise (which can impact fish, marine mammals, and sea turtles). Air noise is measured in sound pressure units called decibels (dB). Underwater noise is measured in dB and then compared to a fixed reference level. The standard reference for underwater sound is 1 dB with reference to 1 micro-Pascal (1dB re 1μPa), and 1dB re 1μPa root-mean-square (rms) units are used to assess impacts under the MMPA. It is important to note that the underwater sound dB scale is different than the in-air dB scale. A 100-dB in-air sound does not represent the same intensity level as a 100-dB in-water sound. The in-water intensity level is lower than the equivalent in-air dB value (Kipple and Gabriele, 2007).

Noises in the project area consist of natural background sounds (e.g., the ocean, coastal winds, and fauna) and anthropogenic noise sources (e.g., fishing/shrimp boats, pleasure craft, dredges, shipping traffic, oil/natural gas rigs, and aircraft from Keesler Air Force Base and Gulfport-Biloxi International Airport). Shipping traffic throughout the GIWW exceeds 232,000 vessel trips per year (USACE, 2008). Marine shipping activities produce underwater noise, typically low-frequency sounds in the range of 20-500 hertz (Hz), resulting from operation of engines and propellers. Low-frequency sound travels farther underwater than higher-frequency sound (University of Rhode Island, 2003). Vessel propulsion type and horsepower are important factors in the intensity of underwater sound emitted by powered vessels. Source levels for hopper dredges generally range from 161.3 dB to 176.7 dB re 1 μPa at 1 meter (Reine et al., 2014). Source levels for cutterhead dredges range from 151.48 dB to 157.43 dB re 1 μPa at 1 meter (Reine et al., 2014). Underwater noise levels of marine vessels range from 157 to 182 dB re 1 μPa at a distance of 1 meter (3.1 feet) (Kipple and Gabriele, 2007).

4.11 Air Quality

The Clean Air Act (CAA) requires USEPA to set National Ambient Air Quality Standards (NAAQS) for pollutants considered harmful to public health and the environment. NAAQS include two types of air quality standards. Primary standards protect public health, including the health of sensitive populations, such as asthmatics, children, and the elderly. Secondary standards protect public welfare, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings (USEPA, 2010). USEPA has established NAAQS for six principal pollutants, which are called “criteria pollutants.” Criteria pollutants include carbon monoxide (CO), lead, nitrogen dioxide, particulate matter

(PM), ozone, and sulfur dioxide (USEPA, 2010). Areas that meet the air quality standard for the criteria pollutants are designated as being "in attainment." Areas that do not meet the air quality standard for one of the criteria pollutants may be subject to the formal rule-making process and designated as being "in non-attainment" for that standard. Coastal counties in Mississippi are in attainment for all NAAQS (MDEQ, 2010c).

4.11.1 Emission Sources

Shipping traffic and vehicular land traffic contribute to mobile emission sources along coastal Mississippi. Major traffic areas are located along U.S. 90 and I-10. Ground vehicle use and shipping are mostly pass-through traffic and contribute only minimally to air pollution.

Dredging activities, commercial shipping, and operation of smaller watercraft contribute air emissions periodically in and around parts of the project area. Total emissions vary based on the duration of activities and the type of equipment used.

USEPA estimates that commercial watercraft entering, leaving, and operating in the Port of Gulfport generate 5 tons/year of total hydrocarbons (THC), 49 tons/year of CO, 322 tons/year of nitrogen oxides (NOx), 13 tons/year of PM and 81 tons/year of sulfur oxides (SOx). Waterborne activities associated with the Port of Pascagoula are estimated to generate 19 tons/year of THC, 111 tons/year of CO, 937 tons/year of NOx, 66 tons/year of PM, and 465 tons/year of SOx (USEPA, 2002).

There are no permitted sources of air emissions on the barrier islands.

Emission factors for diesel-powered dredging vessels, which would be the large vessels most frequently operating as part of the action alternatives, are shown in Table 4-14.

TABLE 4-14
Emission Factors for Diesel-Powered Dredging Vessels

Operating Mode	PM (lb/Mgal)	TOG (lb/Mgal)	NOx (lb/Mgal)	SOx (lb/Mgal)	CO (lb/Mgal)
<500 horsepower					
Full (80% Power)	17	21	275.1	125.6	58.5
Cruise (50% Power)	17	51.1	389.3	125.6	47.3
Slow (20% Power)	17	56.7	337.5	125.6	59
500–1,000 horsepower					
Full (80% Power)	17	24	300	125.6	61
Cruise (50% Power)	17	17.1	300	125.6	80.9
Slow (20% Power)	17	16.8	167.2	125.6	62.2

Note: PM = particulate matter; lb/Mgal = pounds per million gallons; TOG = total organic gases; NOx = nitrogen oxides; SOx = sulfur oxides; CO = carbon monoxide
Source: California Air Resources Board, 1999

Typical dredges are estimated to operate 14 hours a day for 190 days per year, consuming 19.14 gallons of diesel fuel per hour (California Air Resources Board, 1999). Under that alternative, approximately 50,912 gallons of fuel would be consumed and annual emissions for a 1,000-horsepower dredge would be:

- 0.86 tons PM;
- 0.85–1.22 tons TOG;
- 8.5–15.3 tons NOx;
- 6.4 tons SOx; and
- 3.1–4.1 tons CO.

4.12 Recreation

Coastal-based tourism and recreation account for approximately one-third of Mississippi's tourism industry. Opportunities for recreation include arts and entertainment, boating, golfing, sightseeing, picnicking, swimming, bird watching, and fishing. Dockside gaming and casinos are also a major attraction for tourists (USACE, 2009a). Table 4-15 shows the number of people who participated in coastal-based recreation activities based on the most recent national survey on recreation and the environment in 2001. Visiting the area beaches and photographing scenery attracted the highest number of participants in 2001.

TABLE 4-15
Participation in Coastal Recreation in Mississippi

Activities	Participants (Millions)
Visit Beaches	1,042,000
Swimming	563,000
Snorkeling	25,000
SCUBA Diving	4,000
Wind Surfing	8,000
Fishing	312,000
Motorboating	228,000
Sailing	47,000
Personal Watercraft	70,000
Canoeing	10,000
Kayaking	5,000
Water-Skiing	39,000
Bird watching	317,000
Viewing Other Wildlife	235,000
Photographing Scenery	1,324,000
Hunting Waterfowl	6,000
Total	**4,235,000**

Source: Leeworthy and Wiley, 2001

4.12.1 Gulf Islands National Seashore

The barrier islands are part of GUIS and are owned and managed by the NPS. Recreational uses on the islands include general recreation, such as boating, sightseeing, picnicking, swimming, and fishing from banks and boats. Additionally, the western portion of Ship Island, known as West Ship Island, is home to a nationally registered historic site, Fort Massachusetts, and East Ship Island is home to a second one, the French Warehouse. Fort Massachusetts is open for free public tours.

Horn, Petit Bois, Sand, and East Ship Islands are open year-round to private boaters. West Ship Island is open to private boaters from sunrise to sunset. The 2 miles of the western tip and the southern tip of Cat Island are within the GUIS boundaries and are open to private boaters. The islands are not accessible by automobile. West Ship Island is also accessible by a privately owned ferry company under contract with NPS, Ship Island Excursions. Passengers are ferried from Gulfport 12 miles (19 km) out to the island for a fee (Ship Island Excursions, 2010). Prior to 2005 (2000–2005), public visitation to East Ship and West Ship Islands ranged from 62,000–66,000 visitors per year. The 2005 Atlantic hurricane season did considerable damage to the public infrastructure of the islands and several of the historic forts, and caused a severe decline in public visitation. For 2006 and 2007, visitation was approximately 20,000 and 37,000, respectively. By 2009, visitation had not returned to pre-Katrina levels, approximately 43,000 (NPS, 2010c).

4.12.2 Gaming

Casino gaming is a major tourist attraction in the project area, and many casinos were destroyed or damaged as a result of Hurricane Katrina. Gross gaming revenues went from over $100 million per month before Hurricane Katrina to $0 after the storm. The industry rebuilt during 2006 and in 2007, and gaming revenues have rebounded to near pre-Katrina levels. Revenues for 2012, the most recent year for which data are available, were $1,094,789,448, which is approximately $91 million per month (Mississippi State Tax Commission, 2013).

4.13 Socioeconomic Resources

The socioeconomic Region of Influence (ROI) for the restoration alternatives is defined as the geographic area within which the restoration alternatives are likely to have a direct or indirect effect on socioeconomic resources. The ROI for socioeconomic resources that could be affected by the barrier island restoration was determined by the physical location of the restoration alternatives as well as the areas that are likely to experience social and economic impacts from future coastal storm events. The barrier islands, the Mississippi Sound, and the coastal regions of Mississippi shown in Figure 1-1 comprise the geographic area of the ROI. This includes areas within Hancock, Harrison, and Jackson Counties, Mississippi. The major cities include (from west to east) Waveland, Bay St. Louis, Pass Christian, Long Beach, Gulfport, Biloxi, Ocean Springs, Gautier, Moss Point, and Pascagoula. The socioeconomic resources within the ROI are summarized below. Additional details are available in the economics appendix (Appendix B) of the MsCIP PEIS (USACE, 2009a).

The State of Mississippi was profoundly impacted by Hurricane Katrina. In 2005, insured losses from hurricanes and other catastrophes were greater than in any other year in U.S. history. NOAA’s National Hurricane Center estimates that $85 billion of total damage to all affected areas resulted from Hurricanes Katrina and Rita alone. More than 7 years later, the region continues to struggle to recover as both a place to live and as a workable economy.

This section includes existing conditions information on demographics, Environmental Justice (EJ), economics, land, water, transportation, utilities, public safety, and navigation and ports within the ROI.

4.13.1 Demographics

This section summarizes the demographic trends within the ROI. According to the U.S. Census, the ROI experienced small population changes from 2000–2010. Hancock, Harrison, and Jackson Counties experienced population changes of +1.0 percent, -2.5 percent, and +5.4 percent, respectively. The State of Mississippi experienced a population increase of 3.9 percent and the United States an increase of 8.3 percent over the same time period (U.S. Census Bureau, 2000; U.S. Census Bureau, 2010).

Hurricane Katrina had a significant impact on the population along the Gulf coast. Because significant portions of some cities were destroyed, other cities which remained unscathed from the hurricane such as Baton Rouge became home to new populations of people seeking to start over as their homes and businesses were destroyed. Others who were temporarily displaced by the hurricane returned and began rebuilding homes. In some areas, populations increased or decreased as these populations shifted. For example, Hancock

County experienced a 24.0 percent loss of population after Katrina. Population estimates before and the year after Hurricane Katrina for the counties within the ROI and the State of Mississippi are included in Table 4-16.

TABLE 4-16
Population Estimates Before and After Hurricane Katrina

	Percent Population Change between 1990 and 2000	2000[a] Population	Estimated June/July 2005 Population		Estimated 2006, Population		Percent Change
			(Pre-Hurricane Katrina)[b]	Population Change 2000–2005	(Post-Hurricane Katrina)[c]	Post-Katrina Population Change	
Hancock County	35.3%	42,967	46,240	3,273	35,129	-11,111	-24.0%
Harrison County	14.7%	189,601	186,530	-3,071	155,817	-30,713	-16.5%
Jackson County	14.0%	131,420	134,249	2,829	126,311	-7,938	-5.9%
Mississippi	10.5%	2,844,658	2,921,088	76,430	2,910,540	-10,548	-0.36%
United States	13.1%	281,421,906	296,410,404	14,988,498	299,398,484	2,988,080	1.01%

Sources:
[a] U.S. Census Bureau. 2000.
[b] City-data.com. 2010.
[c] U.S. Census Bureau. 2006.

4.13.2 Economics

Important socioeconomic assets within the Gulf of Mexico and along the Mississippi coast include commercial fishing and seafood processing, tourism, energy production, shipping and associated maritime services, and NASA's Stennis Space Center. The Gulf ecosystem and its natural resources produced 30 percent of the nation's gross domestic product in 2009. The region provides more than 33 percent of the nation's seafood and, of the top 20 ports by tonnage in the United States in 2009, 13 were in the region (Gulf Coast Ecosystem Restoration Task Force, 2011).

The Gulf region contains one-fourth of the nation's seafood processing and wholesale establishments and provides jobs and recreational activities such as marine sport-fishing (Adams et al., 2004; Mississippi State University [MSU], 2004). NOAA Fisheries reported that the Gulf States produce approximately 1.7 billion pounds (approximately 772 million kg) of fish and shellfish valued at more than $705 million annually (NOAA Fisheries, 2004b). Hundreds of commercial and sport-fishing boats operate out of Mississippi (Gulf Coast Ecosystem Restoration Task Force, 2011).

The Gulf of Mexico accounts for 90 percent of the U.S. offshore oil and natural gas production and about 23 percent of the resulting U.S. gasoline production. The infrastructure for oil and gas production in the Gulf area is concentrated in coastal Louisiana and east Texas. About 55,000 workers are employed in the Gulf petroleum-related offshore industry (USACE, 2009c). Shipping and maritime services are an important part of the Gulf economy. For example, within Mississippi, the Mississippi State Port at Gulfport generates more than 2,000 jobs for Mississippi residents, with that number expected to increase. The largest military shipbuilder in the United States is located in Pascagoula. As the largest private employer in the state, it provides 11,000 jobs for residents of the northern

Gulf region (Gulf Coast Ecosystem Restoration Task Force, 2011). Coastal tourism and recreation in the three Mississippi counties that border the Gulf Coast account for about $1.6 billion in visitor expenditures, 32 percent of state travel and tourism tax revenues, and 24,000 direct jobs (Gulf Coast Ecosystem Restoration Task Force, 2011). Dockside gaming development and casinos have displaced other waterfront-dependent industries in some locations. Demand for coastal housing also increased, with new residents employed in the gaming industry. Rezoning and dockside casino accommodations have also resulted in a shortage of mooring facilities for small commercial and recreational craft, and waiting lists have developed for dock spaces (MSU, 2004).

NASA's Stennis Space Center on the Mississippi coast supports more than 30 federal, state, academic, and private organizations and numerous technology-based companies and employs approximately 2,000 people (Gulf Coast Ecosystem Restoration Task Force, 2011).

In addition, economic conditions and trends in the Gulf coast region are closely associated with land and water transportation (Mississippi Department of Transportation [MDOT], 2004). The area has transitioned in recent years from an industrial/manufacturing economy to a service-based economy. The service sector growth has resulted in new transportation demands and expectations (MDOT, 2004).

4.13.2.1 Employment

The total employment in Harrison (88,500), Hancock (14,380), and Jackson (53,060) Counties in 2009 made up approximately 13 percent of the total state employment (1,205,500). The number of residents employed in the major sectors of the labor market in 2009 varied by county. Government, leisure and hospitality, and retail trade industries employed the highest number of workers in Harrison and Hancock Counties, whereas manufacturing, government, and retail industries were the dominant employers in Jackson County.

Immediately following Hurricane Katrina, unemployment rates were close to 20 percent in the three coastal Mississippi counties. However, as these counties rebuilt and populations shifted, unemployment rates decreased. The unemployment rate for Jackson County decreased from 14.4 percent in January 2006 to 6.9 percent in November of the same year. Significant unemployment rate decreases occurred over that period: 18.5 to 8.3 percent in Harrison County and 16.8 to 5.3 percent in and Hancock County (Mississippi Governor's Office of Recovery and Renewal, 2007; Mississippi Gulf Coast, 2006).

Unemployment increased again in 2009 following a national trend, with rates for Hancock, Harrison, and Jackson Counties at 8.0 percent, 7.6 percent, and 8.3 percent, respectively. These rates were lower than the rates for the U.S. (9.3 percent) and State of Mississippi (9.6 percent) (U.S. Bureau of Labor Statistics, 2009; Mississippi Department of Employment Security, 2010).

4.13.2.2 Housing

Hurricane Katrina had a devastating impact on the housing stocks of south Mississippi. The total number of housing units destroyed or damaged by Hurricane Katrina in the Mississippi Gulf coast area was 234,284 (USACE, 2010b). At the highest point, there were over approximately 40,000 Federal Emergency Management Agency (FEMA) trailers and mobile homes in the three coastal counties of Mississippi. As of August 2010, only 79 of the more than 40,000 FEMA trailers that were once located in the three coastal counties remained in service (Gulf Coast Business Council Research Foundation, 2010). More than 90 percent of homes in Harrison and Jackson Counties did not have flood insurance prior to Hurricane Katrina. Most of the housing (62 percent) in the three coastal Mississippi counties was built before 1980 (Bernstein et al., 2006). As a result, the cost to repair storm damage exceeded the insured value of the property. Programs have been implemented in Mississippi to help provide affordable housing to those who were affected, while other states also have helped accommodate displaced Mississippi residents.

New housing starts in the three coastal counties increased after Hurricane Katrina (2006) but slowed again in 2008 following the financial crisis and decline in the nationwide housing market. Harrison County had the highest number of building permits for single-family new construction since Hurricane Katrina compared to nearby Hancock and Jackson Counties.

4.13.3 Commercial and Recreational Fishing

The Gulf of Mexico fisheries are some of the most productive in the world. The Gulf produces approximately 40 percent of the total U.S. fisheries landings (Lynch et al., 2003) and about 28–30 percent of the total fishery products of the United States. Within the Gulf of Mexico, the region known as the Fertile Fisheries Crescent has been called the core of the Gulf fishing industry. The Fertile Fisheries Crescent extends across three areas: the West Florida Shelf, the Mississippi-Alabama Shelf, and the Louisiana-Texas Shelf. The Mississippi Sound is located within the very center of the Fertile Fisheries Crescent (USACE, 2009a).

In 2009, the commercial fish and shellfish harvest from the five U.S. Gulf States was estimated to be nearly 1.43 billion pounds. In the same year, commercial catches in the Gulf were valued at over $629 million. The State of Mississippi accounted for over 230 million pounds of commercial fisheries landings in 2009, exceeded only by Louisiana among the Gulf States (NOAA Fisheries, 2010b). Of the Mississippi commercial fisheries landings in 2009, approximately 217.4 million pounds were attributed to the Pascagoula-Moss Point area and 12.9 million pounds were attributed to the Gulfport-Biloxi area (NOAA Fisheries, 2010c). The majority of these commercial fisheries landings in Mississippi for 2009 occurred from May to September (NOAA Fisheries, 2010d). Table 4-17 summarizes the quantity and value of the commercial catch for Pascagoula-Moss Point, Gulfport-Biloxi, the State of Mississippi, and the four other Gulf States during 2009.

TABLE 4-17
2009 Value of Finfish and Shellfish in the Gulf States, Mississippi, Pascagoula-Moss Point, and Gulfport-Biloxi

	Catch (pounds)	Value ($)
Finfish		
Mississippi	217,461,279	18,667,208
Alabama	4,456,317	3,656,016
Florida (west coast)	37,921,822	49,163,740
Louisiana	806,493,773	62,444,748
Texas	4,134,484	7,487,760
Shellfish		
Mississippi	12,823,138	19,331,265
Alabama	25,236,769	36,873,742

TABLE 4-17
2009 Value of Finfish and Shellfish in the Gulf States, Mississippi, Pascagoula-Moss Point, and Gulfport-Biloxi

	Catch (pounds)	Value ($)
Florida (west coast)	27,391,980	66,926,894
Louisiana	198,650,911	221,980,686
Texas	95,362,580	142,744,171
Total Commercial Fisheries		
Gulf of Mexico	1,429,933,053	629,276,230
State of Mississippi	230,284,417	37,998,473
Port of Pascagoula-Moss Point	217,400,000	18,600,000
Port of Gulfport-Biloxi	12,900,000	19,300,000

Sources: NOAA Fisheries, 2010b; NOAA Fisheries, 2010c.

4.13.3.1 Fish

The Gulf of Mexico leads the U.S. in the level of recreational fishing. Lynch et al. (2003) reported 264,718 marine recreational anglers comprising over 1 million angling trips in 2002 in Mississippi. Gulf States Marine Fisheries Commission (GSMFC) reported 4,045 marine licenses sold in 2009 generating revenues of $373,896 for the state (GSMFC, 2010). This number is a significant decrease from the 69,458 licenses (worth $961,070) issued in 2008.

NOAA Fisheries tracks the economic impact of commercial and recreational fishing in the Gulf of Mexico. The major fisheries species that are regulated by NOAA Fisheries and GMFMC for the Mississippi Gulf coast are listed in Table 4-18 along with the 2009 landing statistics.

Pascagoula-Moss Point is the center of Mississippi's Gulf menhaden fisheries industry, which accounts for the largest total landings of seafood in the state (NOAA Fisheries, 2010c). The menhaden are used in reduction fisheries to produce fish meal, fish oil, and condensed fish soluble, which are components in animal feeds, paints, plastics, and resins.

TABLE 4-18
2009 Commercial Fish Landing Statistics for Mississippi

Common Name	Species Name	Landing (pounds)	Value ($)
Finfish			
Croaker, Atlantic	*Micropogonias undulatus*	105	53
Drum, Black	*Pogonias cromis*	9,608	2,926
Drum, Red	*Sciaenops ocellatus*	32,027	50,432
Finfishes (general)	*UNCLASSIFIED*	485,555	237,661
Flatfish (Flounders)	*Bothidae* sp.	24,695	57,815
King Whiting	*Menticirrhus* sp.	5,636	4,755
Menhaden	*Brevoortia patronus*	216,709,145	17,986,861
Mullet, Striped	*Mugil cephalus*	62,330	29,993
Seatrout, Sand	*Cynoscion arenarius*	8,249	6,604
Seatrout, Spotted	*Cynoscion nebulosus*	52,615	120,614
Sheepshead	*Archosargus probatocephalus*	11,675	6,714
Snapper, Gray	*Lutjanus griseus*	1,440	3,553

TABLE 4-18
2009 Commercial Fish Landing Statistics for Mississippi

Common Name	Species Name	Landing (pounds)	Value ($)
Snapper, Red	*Lutjanus campechanus*	57,264	157,560
Tripletail	*Lobotes surinamensis*	935	1,667

Source: NOAA Fisheries, 2010a

4.13.3.2 Shellfish

The common commercial and recreational shellfish of the Mississippi coastal region are listed in Table 4-19. MDMR regulates shellfish in the generic categories of crab, oyster, and shrimp fisheries through recreational and commercial licenses and establishment of seasons for those species (MDMR, 2010f; MDMR, 2010g).

TABLE 4-19
2009 Commercial Shellfish Landing Statistics for Mississippi

Common Name	Species Name	Landing (lb)	Value ($)
Crab, Blue	*Callinectes sapidus*	545,328	572,852
Oyster, Eastern	*Crassostrea virginica*	2,191,724	6,100,264
Shellfish (general)	*UNCLASSIFIED*	2,445	4,003
Shrimp, Brown	*Penaeus aztecus*	6,347,459	6,847,481
Shrimp, Pink	*Penaeus duorarum*	480	192
Shrimp, White	*Penaeus setiferus*	3,735,702	5,806,473

Source: NOAA Fisheries, 2010a

Shrimp

Brown, white, and pink shrimp are the three major types of shrimp harvested on the Mississippi coast. Approximately 63 percent of the harvest was brown shrimp in 2009 (NOAA Fisheries, 2010b). Mississippi's annual commercial shrimp landings for 2009 were 10.1 million pounds. The dockside value of this harvest, according to NOAA Fisheries statistics for 2009, was $12.7 million. In recent years, a rise in the amount of foreign shrimp being imported into the U.S. has caused the dockside price to decrease (MDMR, 2010g).

The Commission on Marine Resources establishes season opening and closing dates for shrimp fisheries and regulates the size and number of trawls pulled by boats. The MDMR collects shrimp samples to aid in determining the time to open shrimp season.

Crabs

The blue crab is the most important commercial crab species in the Gulf of Mexico. In Mississippi, 545,328 pounds of blue crab landings valued at $572,852 were reported in 2009 (NOAA Fisheries, 2010b).

Oysters

The Eastern oyster is one of the more valuable resources of the Mississippi Gulf coast. More than 2 million pounds of oysters worth over $6 million were collected in 2009 (NOAA Fisheries, 2010b).

Oyster reefs are typically located in shallow waters that rapidly change in temperature and salinity. The MDMR manages 17 natural oyster reefs. Approximately 97 percent of the commercially harvested oysters in Mississippi come from the reefs in the western Mississippi Sound, primarily from Pass Marianne, Telegraph, and Pass Christian reefs (MDMR, 2010h).

4.13.3.3 Other

Other commercial species of importance in the Gulf include sponges, squids, conchs, sand dollars, and sea biscuits. Commercial sponge harvesting is generally limited to the eastern Gulf along the Florida coast. The squid industry in the Gulf is associated with the seafood industry and typically squid collected for consumption are by-catch from fishing trawls. The conchs, sand dollars, and sea biscuits taken along the Gulf are generally used for souvenirs in the tourism industry.

4.13.4 Land and Water Use

Hurricane Katrina damaged tens of thousands of acres in coastal Mississippi as well as the barrier islands. Intense winds and salt spray affected thousands of acres of standing trees, wetlands, and other vegetation, and how much will survive remains unknown.

The Mississippi Forestry Commission estimated that 60 percent of the coastal forests have been lost.

Wind, rain, and storm surge destroyed tens of thousands of homes, thousands of small businesses, and dozens of schools and public buildings. The highways, arterial roadways, ports, railroads, and water and sewer systems suffered varying degrees of damage, in some cases complete destruction.

Destroyed and damaged infrastructure, businesses, and homes have been and are being reconstructed through federally funded disaster relief efforts, loan programs, and small business loan programs. State and federal environmental restoration and hurricane protection programs are in the planning stages, and potential protection and redevelopment projects are being evaluated and implemented.

4.13.4.1 Territorial Water Boundaries

The project area includes both State and Federal territorial waters in the Mississippi Sound and along the OCS. State territorial waters and therefore state jurisdiction extends for 3 nautical miles from the baseline along either the coast or the barrier islands. Federal territorial waters extend to 12 nautical miles from the baseline (NOAA, 2013a).

4.13.4.2 Gulf Islands National Seashore

The project area includes borrow and placement locations within GUIS, Mississippi unit. GUIS's purpose is to preserve, protect, and interpret its Gulf Coast barrier island and bayou ecosystem and its system of historic coastal defense fortifications, while providing for public use and enjoyment. NPS resources are managed primarily through the NPS's *Management Policies* (2006). Chapter 3 of the *Management Policies* establishes governing principals for land protection and management, and Chapter 9 includes specific restrictions for borrow pits and spoil areas. In accordance with the NPS Management Policies, dredging from borrow pits on NPS lands (such as DA-10/Sand Island) can be undertaken only if dredging will not impair park resources or values, is economically, environmentally, and ecologically reasonable, and provides the only reasonable source of borrow material. These policies must be considered during evaluation of the environmental effects (Section 5) and selection of the TSP.

NPS's vision for management of the Mississippi barrier islands includes the preservation of natural biological and geological marine and terrestrial conditions and processes, and the preservation of cultural resources, consistent with peer-reviewed and documented scientific study (USACE, 2009a). Horn and Petit Bois Islands are designated as a wilderness area, the Gulf Islands Wilderness, and receive an even higher level of protection. In wilderness areas, the NPS vision and management focus on providing park visitors with an undisturbed environment, a pristine and unencumbered viewshed, an atmosphere of solitude, an opportunity for primitive, unconfined recreation, and negligible evidence of resource impairment. NPS implements this vision by controlling nonconforming uses, preventing unnecessary or undue reduction of wilderness values, and applying the "minimum requirement" concept of the 1964 Wilderness Act to all proposed projects involving these islands. In addition, only recreational fishing is allowed within the GUIS boundaries.

Based on federal statutes such as the NPS Organic Act and the GUIS' enabling legislation, NPS management policies, and management plans, NPS is mandated to preserve and protect the natural conditions and processes affecting the barrier islands, and to preserve the significant cultural resources existing on the islands. In addition, GUIS's enabling statute directs that beach erosion control measures and spoil deposition activities in the park undertaken by USACE must be carried out in a manner that is acceptable to NPS and consistent with the park's purposes (16 U.S.C. § 459h-5). NPS must also fully and properly utilize and integrate the results of scientific study for park management decisions (16 U.S.C. § 5936) (USACE, 2009a).

4.13.4.3 Air and Rail Transportation

Although there are some smaller airports throughout coastal Mississippi, the Gulfport-Biloxi International Airport is the only passenger airport accepting major commercial airlines. Stennis International Airport, located 8 miles north of Bay St. Louis, is owned and operated by the Hancock County Development Commission. The Mississippi Gulf Coast is served by three railroads: the CSX Transportation Railroad, Kansas City Southern (KCS) Railroad, and Port Bienville Shortline Railroad. CSX is a Class I railroad serving the developed portion of the Mississippi coastal area. Its main lines traverse most of the region's municipalities. The CSX track has an east-west orientation and serves as a major linkage between the deepwater ports in New Orleans and Mobile through connection lines from each port. This line is also a major connector across the country between Jacksonville, Florida and Los Angeles, California The main line of the KCS Railroad, also a Class I railroad, has a north-south orientation extending approximately 69 miles northward from the Port of Gulfport through Harrison, Stone, and Forrest Counties to Hattiesburg, Mississippi. The Port Bienville Shortline Railroad is a Class III railroad with 9 miles of track owned and operated by the Hancock County Port and Harbor Commission. It serves the Port Bienville Industrial Park and connects with the CSX line southwest of Waveland (USACE, 2010b).

4.13.5 Utilities

Utilities include water supply, wastewater, stormwater, solid waste, hazardous waste, telecommunications, and energy systems. The geographical region evaluated for utilities encompasses the coastal regions of Hancock, Harrison, and Jackson Counties. Utility services are summarized in Table 4-20 (USACE, 2009a). In addition, the NPS provides limited electrical, water, and wastewater utilities at Horn and West Ship Islands.

TABLE 4-20
Utility Services for Hancock, Harrison, and Jackson Counties, Mississippi

County Name	Electricity	Natural Gas	Water and/or Sewer	Telephone
Hancock	Coast Electric Power Association and Mississippi Power Company	Bay St. Louis Utilities Department and Waveland Gas and Water Department	Bay St. Louis Utilities Department, Diamondhead Water and Sewer, Kiln Water District, and Waveland Gas and Water Department	AT&T South
Harrison	Coast Electric Power Association and Mississippi Power Company	Center Point Energy	Eco Resources, Westwick Utilities, City of D'Iberville Water and Sewer Department, Long Beach Water Department, and Pass Christian Utilities Department	AT&T South
Jackson	Mississippi Power Company and the Singing River Electric Power Association	Center Point Energy and Pascagoula Utilities Department	Ocean Springs Water and Sewage Department, Coast Water Works, Magnolia Utilities, Gulf Park Water, Gautier Utility District, Pascagoula Utilities Department	AT&T South

Source: USACE, 2009a

4.13.5.1 Water Supply

Approximately 88 community water systems provide potable water to the Mississippi Gulf coast. The water they provide is available for residential, commercial, industrial, and agricultural use, including landscape irrigation, and is delivered by a system of wells, water distribution piping, and water storage tanks. All of these systems rely on groundwater as their sole source of supply for drinking water, although in Jackson County surface water is used for industrial end use (USACE, 2009a).

4.13.5.2 Wastewater

In coastal Mississippi, 49.5 percent of Hancock County, 18.9 percent of Harrison County, and 27.0 percent of Jackson County do not have access to a public wastewater system. Those who are not connected to a public wastewater system use onsite treatment, which consists of either package plants or septic tanks/drain fields. Package plants are small, self-contained wastewater treatment facilities built to serve a developed area, such as a subdivision (USACE, 2009a).

The wastewater treatment facilities in the ROI treat more than 45 million gallons of wastewater each day. Hancock County facilities treat approximately 3 million gallons per day (mgd), Harrison County facilities treat 29.3 mgd, and Jackson County facilities treat 12.0 mgd (USACE, 2009a).

4.13.5.3 Stormwater

MDEQ has been delegated responsibility for the NPDES stormwater program for local governments. Hancock, Harrison, and Jackson Counties are all Phase II municipal separate storm sewer system (MS4) governments, as are Bay St. Louis, Biloxi, D'Iberville, Gautier, Gulfport, Long Beach, Moss Point, Ocean Springs, Pascagoula, Pass Christian, and Waveland. The NPDES Phase II stormwater program requires local governments to develop stormwater programs that include six minimum control measures:

- Public education and outreach;
- Public involvement and participation;
- Illicit discharge detection and elimination;
- Construction site runoff control;
- Post-construction runoff control for new development and redevelopment; and
- Pollution prevention and good housekeeping.

The City of Gulfport has developed a storm drainage master plan that addresses the need to eliminate stormwater-related flooding in the Gulfport and Orange Grove areas. Jackson County and each municipality within the county have adopted a stormwater plan that addresses the capabilities and requirements of the various stormwater systems.

4.13.5.4 Solid Waste Disposal and Collection System

There is one permitted municipal solid waste landfill in the ROI, and there are seven Class I rubbish sites for construction-related waste. The Pecan Grove Landfill and Recycling Center, located in Pass Christian, receives approximately 90 percent of the total solid waste stream produced in the three coastal Mississippi counties (USACE, 2009a).

4.13.6 Oil and Gas Utilities

Oil and gas leases and active extraction operations are located off the Mississippi and Alabama coastlines, seaward of the barrier islands. Active lease areas and oil and gas infrastructure are located seaward of Petit Bois Island near the Petit Bois borrow areas. Pipelines connecting this infrastructure to the coast extend through portions of the project area. Pipelines pass between Horn and Petit Bois Islands to Pascagoula, between Petit Bois and Dauphin Islands to Pascagoula, and between Petit Bois and Dauphin Islands to Mobile. Pipelines also connect directly to Dauphin Island (BOEM, 2010, 2013). A high-pressure gas pipeline, the Gulfstream, passes through the proposed Petit Bois Alabama borrow area. Two pipelines pass between the Petit Bois Mississippi and Petit Bois Alabama borrow area and to the West of the Petit Bois OCS borrow area (see Figure 3-9).

4.13.6.1 Deepwater Horizon

The 2010 Deepwater Horizon oil spill could potentially adversely impact USACE water resources projects and studies within the Mississippi coastal area. The USACE continues to monitor and closely coordinate with other federal and state resource agencies and local sponsors in determining how best to address any potential problems associated with the oil spill that may adversely impact USACE water resources development projects/studies. This could include revisions to proposed actions as well as the generation of supplemental environmental analysis and documentation for specific projects/studies as warranted by changing conditions. For the proposed Ship and Cat Island restoration program, USACE will coordinate with the USCG to ensure resources are available should any residual oil (tar bars) be deposited during the placement process.

4.13.7 Public Safety

Public safety resources are provided by federal, state, and local entities. Federal entities include NPS and the USCG. The NPS has ranger stations on Horn and West Ship Islands that are operated as required. The USCG has a station in Gulfport. The Gulfport station is equipped with two 41-foot utility boats, one 25-foot boat, and two 24-foot boats. Station Gulfport is host to three other commands, including two 87-foot patrol boats, USCG Cutters RAZORBILL and POMPANO, and Aids to Navigation Team Gulfport. There are 41 active duty members attached to the station, at times augmented by more than 60 Coast Guard Auxiliary members and 9 reservists (USCG, 2010).

The Mississippi Emergency Management Agency (MSEMA) coordinates emergency preparation, response, recovery, and mitigation activities for the State of Mississippi. MSEMA has a representative assigned to each coastal county to coordinate emergency management programs, including hurricane planning and response activities (MSEMA, 2012). Hurricane evacuation routes are designated and maintained by the MDOT and published in the Mississippi Hurricane Evacuation Guide.

Fire protection, emergency, and law enforcement services are coordinated locally by county and municipality in Hancock, Harrison, and Jackson Counties.

4.13.8 Coastal Infrastructure/Ports

The Mississippi Gulf Coast has two deep draft harbors: Gulfport and Pascagoula. These ports are served by USACE-maintained navigation channels (Gulfport and Pascagoula) connecting them to the Gulf of Mexico, as well as many other shallow draft channels, such as those in Pass Christian and Biloxi. The GIWW also crosses the Mississippi Sound from east to west. The GIWW is a channel authorized to 12 feet deep and 150 feet wide.

The Port of Pascagoula is a major port in Mississippi, supporting national and international shipping commerce. The Port of Pascagoula is operated by the Jackson County Port Authority and includes public and private cargo facilities in two harbors (the Pascagoula River Harbor and Bayou Casotte Harbor), nine deepwater berths, and one barge berth. The Port's two harbors are a combination of public and private terminals moving in excess of 35 million tons of cargo through the channels annually (Port of Pascagoula, 2010). The Pascagoula River Harbor has five of the deepwater berths, covered storage, a cold storage/freezer area, and land available for open storage. Bayou Casotte Harbor has four of the deepwater berths, covered storage, paved open storage, and unpaved open storage. The Port is public, though most facilities are operated through leases, operating agreements, or space assignment agreements with private operators or users (USACE, 2010b).

Access to the Port of Pascagoula is provided by the Pascagoula Harbor Federal Navigation project (the USACE-maintained Pascagoula Navigation Channel). The project is comprised of a number of segments: the entrance channel from the Gulf into the Mississippi Sound, the Lower Sound segment which runs northward to mid-Sound where the project 'Y's, the Upper Sound segment to the west, which leads into the Pascagoula River segment, and the Bayou Casotte segment to the east. The Pascagoula Entrance Channel and lower Sound segments are authorized to 44 feet deep and 450 feet wide. The Upper Sound segment, which leads to the Port, is currently 350 feet wide and is authorized to a depth of 38 feet. The Bayou Casotte segment is authorized to 42 feet deep and varies in width from 225–350 feet (USACE, 2010b). To maintain the Pascagoula Navigation Channel, the USACE conducts maintenance dredging on a regular basis. Material dredged from the entrance channel is currently placed within DA-10, including areas adjacent to Sand Island. Without this dredging, sand that moves from east to west in the littoral sand transport system, and would naturally be deposited on the islands further west (Horn Island and East and West Ship Islands), accumulates in the Pascagoula Navigation Channel.

The Port of Gulfport, located directly on the Mississippi Sound, encompasses approximately 204 acres, has nearly 6,000 feet of berthing space, and averages over 2 million tons of cargo a year. Water depths at the Port's 10 berths range from 32–36 feet, and berth lengths range from 525–750 feet. All are designed as multi-use, multi-purpose berths (Mississippi State Port Authority at Gulfport, 2010). Port facilities include multi-purpose Pier 7, a rail-served heavy lift pier that was completed in January 2003 (USACE, 2009c).

Access to the Port of Gulfport is provided by the Gulfport Harbor Federal Navigation project (the USACE-maintained Gulfport Navigation Channel), which extends northward from vessel anchorage just south of East Ship Island and West Ship Island. The Entrance Channel is authorized to a depth of 38 feet, while the Sound Channel (which leads to the Port) is currently 350 feet wide and is authorized to a depth of 36 feet. The Port's north harbor is maintained to a depth of 32 feet, while the south harbor and turning basin, which are approximately 1,320 feet wide, are maintained to a depth of 36 feet (USACE, 2010b). The USACE conducts maintenance dredging on the entrance channel. Dredged material is deposited in a thin layer immediately adjacent to the channel.

4.14 Environmental Justice and Protection of Children

4.14.1 Environmental Justice

Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, provides that "each Federal agency shall make achieving environmental justice part of its mission by identifying, and addressing as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority and low-income populations." Consideration of EJ through the NEPA process is accomplished through analyzing environmental effects on the natural or physical environment and interrelated effects, including human health, economic, and social effects; recommending mitigation measures whenever feasible; and providing opportunities for effective community participation in the process (CEQ, 2007).

4.14.1.1 Race and Ethnicity

The ROI for EJ includes the population centers within each county of the project area. Table 4-21 summarizes the 2010 population and racial make-up of these cities, the State of Mississippi, and the U.S. for comparison.

TABLE 4-21
Race and Ethnicity Data for the ROI

	White	Black	Hispanic[a]	Asian	American Indian	Other	Multiple Races
U.S.	72.4%	12.6%	16.3%	4.8%	0.9%	6.2%	2.9%
Mississippi	59.1%	37.0%	2.7%	0.9%	0.5%	1.3%	1.1%
Hancock County	88.4%	7.1%	3.3%	1.0%	0.5%	0.3%	2.1%
Harrison County	69.7%	22.1%	5.3%	2.8%	0.5%	0.9%	2.7%
Jackson County	72.1%	21.5%	4.6%	2.2%	0.4%	0.7%	1.9%

Source: U.S. Census Bureau, 2010
[a] Hispanic: The 2000 Census included a category for Hispanic or Latino. This category is for individuals who classify themselves in one of the specific Hispanic or Latino categories such as “Mexican,” Puerto Rican,” or “Cuban,” as well as those who indicate that they are “other Spanish, Hispanic, or Latino.” Origin can be viewed as the heritage, nationality group, lineage, or country of birth of the person or the person’s parents or ancestors before arrival in the United States. People who identify their origin as Spanish, Hispanic, or Latino may be of any race.

4.14.1.2 Income and Poverty

Median household income and poverty levels for the U.S., Mississippi, and each county in the ROI, for 2010 are shown in Table 4-22. The state had a lower median income than that of the U.S. Each of the three counties in Mississippi had a higher median household income and a lower poverty rate than those of the state of Mississippi in 2010.

TABLE 4-22
2010 Median Household Income and Poverty Rate for the ROI

	Median Income	Poverty Rate
U.S.	$51,914	13.8%
Mississippi	$37,881	21.2%
Hancock County	$45,956	15.9 %
Harrison County	$44,846	16.7%
Jackson County	$50,203	14.6%

Source: U.S. Census Bureau, 2010

Mississippi has the highest percentage of low-income workers in the U.S., with more than 42 percent of all working families considered low income. More than a third of all jobs pay below-poverty wages.

The U.S. Census Bureau bases the poverty status of families and individuals on 48 threshold variables, including income, family size, number of family members under the age of 18 and over the age of 65, and amount spent on food. Table 4-23 lists the percentage of individuals under 18 and over 65 who were below the poverty level in each city and county in 2010.

TABLE 4-23
2010 Poverty Levels by Age Group for Cities and Counties Within the ROI

	Number of Individuals Below Poverty Level	Percentage Under 18 years	Percentage 65 years and over
U.S.	40,917,513	34.2%	8.7%
Mississippi	604,272	37.3%	8.7%
Hancock County	6,785	39.6%	6.1%
Harrison County	30,095	37.6%	6.5%
Jackson County	20,097	36.6%	9.4%

Source: U.S. Census Bureau, 2010

4.14.2 Protection of Children

On April 23, 1997, President Clinton issued Executive Order 13045, *Protection of Children from Environmental Health Risks and Safety Risks.* This Executive Order directs each Federal agency to ensure that its policies, programs, activities, and standards address disproportionate risks to children that result from environmental health risks or safety risks that are attributable to products or substances that the child is likely to come in contact with or ingest, such as air, food, water (drinking or recreation), soil, and manufactured products.

To the extent permitted by law, and appropriate and consistent with each agency's mission, each Federal agency shall make it a high priority to identify and assess environmental health risks and safety risks that might disproportionately affect children and shall ensure that the agency's policies, programs, activities, and standards address disproportionate health risks to children that result from environmental health risks or safety risks.

The number of children 17 years and younger for the major cities and counties of the ROI are shown in Table 4-24. The percentage of children in Hancock, Harrison, and Jackson Counties is lower than in the state of Mississippi.

TABLE 4-24
Children 17 Years and Younger in Project Area

	Male	Female	Subtotal	Total Population	Percent Children
U.S.	37,945,136	36,236,331	74,181,467	303,965,272	24.4%
Mississippi	385,763	369,792	755,555	2,941,991	25.7%
Hancock County	5,389	5,109	10,498	43,929	23.9%
Harrison County	23,373	22,480	45,853	187,105	24.5%
Jackson County	18,127	17,473	35,600	139,668	25.5%

Source: U.S. Census Bureau, 2010

5. Environmental Effects

5.1 Introduction

This section describes the environmental effects of alternative actions for restoration of the barrier islands. Performing an evaluation of environmental consequences for proposed Federal actions is a requirement of federal law (40 C.F.R. §§ 1500-1508). An impact analysis must be compared to a significance threshold to determine whether a potential consequence of an alternative is considered a significant impact. If the impact is significant, it may be mitigable (i.e., measures are available to reduce the level of impact, so it is no longer significant) or unmitigable. The discussion includes potential impacts to biological, physical, and chemical conditions, fishing and recreation, and socioeconomic conditions in the project area.

The following evaluation of environmental effects addresses the No-Action Alternative (Section 3.4.1), the TSP (Section 3.4.2), and Other Alternatives Considered (Section 3.4.3). The four main components of the TSP include: (1) Ship Island Restoration (the closure of Camille Cut and placement of sand on East Ship Island), (2) Borrow Site Option 4 (the removal of sand from selected borrow sites for Ship Island restoration), (3) Cat Island Restoration (use of the Cat Island borrow site and placement of borrow material at Cat Island), and (4) Littoral Placement of Dredged Material (the revised management of dredged material from the Federal Pascagoula Ship Channel at DA-10). Three additional borrow site combinations to support the proposed restoration at Ship Island (Borrow Site Options 1, 2, and 3) are evaluated as Other Alternatives Considered. These combinations are summarized in Table 5-1 and described in more detail in Section 3.4.2.

TABLE 5-1
Summary of Borrow Site Options for Ship Island Restoration

	Placement Volumes from Borrow Source (mcy)							
Alternative ID	Ship Island	DA-10/Sand Island	Horn Island Pass	PBP-MS	PBP- AL	PBP-OCS	Total	Rough Order of Magnitude Cost ($ million)
Borrow Option 1	1.1	5.1	0	0	12.2	0	18.5	$402,000
Borrow Option 2	1.1	5.1	2.2	1.3	0	9.4	19.0	$314,000
Borrow Option 3	1.1	3.7	2.2	1.3	1.0	9.7	19.0	$307,000
Borrow Option 4	1.1	0	2.2	1.3	4.8	9.7	19.0	$385,500

PBP = Petit Bois Pass

This SEIS does not analyze impacts from the ongoing use of DA-10 for disposal of dredged material. The evaluation is restricted to potential impacts from changing the location of primary disposal within DA-10 to a location that better feeds the littoral transport process. An SEIS for the Pascagoula Harbor Navigation Channel, which addresses constructing the navigation project to its federally authorized dimensions, was completed in 2010 and included the use of DA-10.

5.2 Physical Environment

5.2.1 Physiography

Physiography includes physical geography and geology. Potential impacts on physical geography are addressed in Section 5.4.1, and therefore only impacts to geology are addressed in this section. The significance criterion for geology would be a permanent change in underlying bedrock that interferes with the natural movement and deposition of sediments in the Mississippi Sound or the OCS.

5.2.1.1 Tentatively Selected Plan

The TSP would cause no temporary or long-term change to geology, including bedrock, in the project area. Therefore, the TSP would have no impacts on the physiography of the project area.

5.2.1.2 Other Alternatives Considered

Use of Borrow Site Options 1, 2, or 3 would not impact geology and would therefore have no impacts on the physiography of the project area.

5.2.1.3 No-Action Alternative

Under the No-Action Alternative, the proposed restoration would not be implemented, and there would be no change in the physiography of the project area. The No-Action Alternative would therefore have no impacts on the physiography of the project area.

5.2.2 Meteorology

The significance criterion for meteorology would be a permanent disruption in the climate or weather patterns in the proposed project area.

5.2.2.1 Tentatively Selected Plan

The scale and type of activities associated with the TSP (e.g., construction and related movement of materials) would not change the climate or weather patterns in the project area. As a result, there would be no impacts on meteorology in the project area.

5.2.2.2 Other Alternatives Considered

As with the TSP, use of a different borrow site (Borrow Site Options 1, 2, or 3) would result in no change in the climate or weather patterns in the project area. As a result, there would be no impacts on meteorology in the project area.

5.2.2.3 No-Action Alternative

Under the No-Action Alternative, the proposed restoration would not be implemented. There would be no change in the climate or weather patterns in the project area. As a result, there would be no impacts on meteorology in the project area.

5.2.3 Hydrology and Coastal Processes

The significance criteria for hydrology and coastal processes would be a permanent disruption in current or tide patterns in the Mississippi Sound, the sediment transport system or channel shoaling and frequency of dredging within the Gulfport Navigation Channel.

5.2.3.1 Tentatively Selected Plan

Ship Island Restoration

Under the TSP, the closure of Camille Cut would enhance the littoral sediment budget along the restored Ship Island by adding sediment to a system that has been negatively affected by natural coastal processes and possibly anthropogenic removal of sand from the littoral transport zone at Horn Island Pass. Combined with the deposition of sand along the south shore of the East Ship Island updrift zone, the sand would be transported along the southern shoreline toward the central part of the restored Ship Island and then toward West Ship Island. Analysis indicates that some sedimentation could occur within a 10- to 15-year time period under average wave climate conditions. However, given the frequency of hurricanes it is likely that sediment accumulation along the island will diffuse throughout the system with only a negligible effect on Ship Island Pass, given the large morphological changes induced by hurricanes (Appendix C). There could be an increase in sedimentation in the pass and outer bar segments of the navigation channel during hurricane events. The larger hurricanes considered in the assessment (Katrina and Georges) resulted in a potential 10 to 30 percent increase in sedimentation in the entrance channel and the smaller hurricanes resulted in a potential 5 to 10 percent increase (Appendix C). Based on historical dredging records, hurricanes have accounted for approximately 23 percent of the channel dredging within the Gulfport entrance channel. The overall increase based on historical records within this segment of the Gulfport channel is anticipated to be less than 4 percent of the overall historical dredging quantity.

Filling Camille Cut would close a hydraulic pathway between East Ship Island and West Ship Island. This would result in a larger flow around the east and west ends of the contiguous island.

The filling of Camille Cut and the restoration of Ship Island would restore a protective barrier and may reduce storm waves at the mainland. Modeling of wave changes (Appendix D) indicated that the maximum reduction in wave height at the mainland Mississippi coast ranged from 0.2 to 1.25 meters compared to existing conditions. This reduction in wave height would be a beneficial effect on the coastal mainland.

In summary, the restoration of Ship Island would cause significant changes in hydrology. Because of the resulting changes to littoral transport and storm surge protection, implementation of the Ship Island restoration and closure of Camille Cut would have a significant beneficial effect on hydrologic conditions in the Mississippi Sound through the reduction of wave heights on the mainland coast during storm events. The effects of sediment transport from placement of material at East Ship Island and Camille Cut are expected to be localized to Ship Island, and impacts to the Gulfport Navigation Channel in Ship Island Pass based on the analysis are anticipated to be minor.

Borrow Site Option 4

Removals of sand from the Ship Island, PBP-AL, and Horn Island Pass borrow sites were modeled as part of the modeling assessment of the project area (Appendix C; Appendix D). Under this analysis, removal at the borrow sites produced a localized reduction in wave energy leeward of the borrow area when compared to existing conditions. However, removal of sand also caused localized increases in wave energy at the fringes of the borrow sites that would result in larger wave heights in the immediate area, but would not have an adverse effect the barrier islands, pipeline infrastructure or the coast (Appendix C; Appendix D; Appendix G). Based on that analysis, the removal of sand from those proposed borrow sites would have long-term minor, and therefore not significant, impacts on the overall hydrodynamics of the area. These effects would be localized and would be reduced over time as the bottom contours gradually reach equilibrium.

Due to the small size (183 acres) and limited average excavation depth (7 feet) of the Ship Island borrow site, use of this site would not have, long-term impacts on the overall morphological development of Ship Island. Any changes in waves would lessen and dissipate at the inshore borrow sites, as slopes flatten and the borrow area naturally fills in over time (Appendix C). These impacts are therefore considered not significant.

The removal of sand from the PBP-AL and Horn Island Pass borrow sites would result in long-term minor, and therefore not significant, impacts on the overall morphology of these areas. These borrow areas are located outside of the island sediment transport system and would not impact nourishment of Dauphin Island or the Mississippi barrier islands (Appendix B and Appendix D). An analysis of 20 years of shoreline change shows negligible difference between the dredged and existing cases for the Horn Island borrow (Appendix D). Analysis of Petit Bois Alabama borrow indicates West Dauphin Island would experience small dredging-induced decreases in erosion and accretion in areas where they occur (Appendix D). Additional analysis of sediment transport and morphological change demonstrated that maintaining a minimum 1,000-foot buffer around the pipeline infrastructure and eliminating two of the eastern most subcuts of the western PBP-AL borrow reduced the potential for significant bathymetric changes along the pipeline (Appendix G). As with the Ship Island borrow site, long-term impacts would lessen and dissipate at inshore borrow sites, as slopes flatten and the borrow area naturally fills in over time (Appendix D).

Removal of material from the PBP-MS and PBP-OCS borrow sites was not modeled. PBP-OCS sites are located more than 2 miles offshore in water depths of 40 to 60 feet. Given the offshore distance and ambient water depths, it is unlikely that use of the potential borrow areas in the OCS would cause impacts from wave refraction or focusing. Furthermore, Byrnes et al. (2004) found minor wave modifications and minor impact of sediment and fluid dynamics from offshore sand extraction at sand mining offshore locations in Alabama. Based on their locations and similarities with sites that have been modeled in Alabama (Byrnes et al., 2004) and as part of the proposed project (Appendix C and Appendix D), only long-term minor, and therefore not significant, impacts on the overall morphology and hydrodynamics of the area would be expected. As with those locations, the PBP-MS and PBP-OCS borrow areas are located outside of the island sediment transport system and would not impact nourishment of the barrier islands. Impacts to inshore borrow areas would lessen and dissipate as the borrow site slopes flatten and the borrow areas naturally fill in over time.

In summary, removal of material from the borrow areas under Borrow Site Option 4 would cause long-term localized minor impacts to wave energy, with wave reductions over most of the borrow area and wave increases only at the edges of the borrow area (Appendix C). These impacts would lessen and dissipate at inshore borrow site as the slopes flatten and the borrow areas naturally fill in over time. Sediment transport for barrier island nourishment and coastal areas would not be adversely impacted (Appendix B). No significant impacts to hydrology or coastal processes would occur from implementation of Borrow Site Option 4.

Cat Island Restoration

The removal of sand from the proposed Cat Island borrow area would have long-term minor, and therefore not significant, impacts on the overall morphology and hydrodynamics of the area. Removal of material from the borrow area would cause long-term localized minor impacts to wave energy, with wave reductions over most of the borrow area and wave increases only at the edges of the borrow area. Due to the relatively small size and limited excavation depth of the borrow site, use of the site would not be expected to negatively impact the overall morphological development of Cat Island (Appendix D and Appendix E). Long-term impacts would lessen and dissipate at inshore borrow sites as the slopes flatten and the borrow areas naturally fill in over time. Placement of sand at Cat Island would occur primarily on existing upland and beach areas. Therefore, no significant impacts to hydrology or coastal processes would occur from the proposed restoration of Cat Island.

Littoral Placement of Dredged Material

Modification of the continuing placement of dredged material in the combined DA-10 and littoral zone disposal site would provide up to 1 million cubic yards of material into the littoral transport system every 18 months. Future placement of dredged material, in the south and west parts of the disposal area (Figure 3-17) would provide a source of material for sediment transport to the downdrift barrier islands (e.g., Horn Island) (Appendix B). This activity would have a long-term beneficial impact on the availability of sand in the littoral system and island morphology.

5.2.3.2 Other Alternatives Considered

Borrow Site Option 1

Removal of sand from the proposed Ship Island borrow area would result in impacts identical to those described under Borrow Site Option 4 above.

The removal of sand from the PBP-AL borrow area would result in impacts similar to those described under Borrow Site Option 4. Impacts on the overall morphology and hydrodynamics would be greater due to the greater amount of sand that would be removed (12.2 mcy under Borrow Site Option 1 compared to 4.7 mcy under Borrow Site Option 4). These effects would be localized and would be reduced over time as the bottom contours gradually reach equilibrium (Appendix D).

The removal of sand from the DA-10/Sand Island borrow area would have long-term minor, and therefore not significant, impacts on the overall morphology and hydrodynamics of the area. Past placement of dredged material within the northern portion of DA-10 created a subaerial feature, known as Sand Island. The rate of transport out of this area to feed the downdrift barrier islands (Horn and Ship Islands) is very low. Therefore, the natural rate of sand transport in the system would not be adversely affected by removing sand from this location (Appendix B). Hydrodynamic and sediment transport analysis indicates that tidal flows through Horn Island pass are more channelized and sediment transport potential between DA-10/Sand Island and Petit Bois Island is higher with the current location of Sand Island (Appendix D and Appendix F). This increase in channel velocities has likely contributed to the scour in and near the channel up to 20 feet deeper than the authorized channel depths (Appendix B). With the removal of over 50 percent of the subaerial portion of DA-10/Sand Island more area for tidal flow to pass through the inlet would be provided, which could result in less flows and souring within the inlet channel.

Analysis of wave propagation through Horn Island pass indicates that wave energy is physically obstructed by DA-10/Sand Island. Leaving the southern shoreline of Sand Island intact would continue to provide a buffer to higher gulf wave energy propagating into the Mississippi Sound (Appendix D and Appendix F; Chapman et al., 2012).

Overall, removal of material from the borrow areas under Borrow Site Option 1 would cause long-term localized minor impacts to wave energy, with wave reductions over most of the borrow area and wave increases only at the edges of the borrow area. No significant impacts to hydrology or coastal processes would occur.

Borrow Site Option 2

Under Borrow Site Option 2, the removal of sand from the proposed borrow areas at Ship Island, Horn Island Pass, PBP-MS, and PBP-OCS would have impacts identical to those described under Borrow Site Option 4.

Impacts at the DA-10/Sand Island borrow area would be identical to those at Borrow Site Option 1.

Borrow site Option 2 would utilize the least amount of sand from the PBP-AL borrow area (0 mcy) compared to the other borrow site options. Should a contingency volume be needed this would allow for use the eastern PBP-AL borrow site, which is located the furthest away from the pipeline infrastructure. With the smaller area that would be dredged, this option would result in the least amount of impact to coastal processes at this location compared to the other restoration alternatives. Impacts from removal at this location would be minor and long-term, and therefore not significant. These effects would be localized and would be reduced over time as the bottom contours gradually reach equilibrium (Appendix D).

Overall, removal of material from the borrow areas under borrow site Option 2 would cause long-term localized minor impacts to wave energy, with wave reductions over most of the borrow area and wave increases only at the edges of the borrow area. No significant impacts to hydrology or coastal processes would occur.

Borrow Site Option 3

Under Borrow Site Option 3, impacts at the Ship Island, Cat Island, Horn Island Pass, PBP-MS, and PBP-OCS borrow areas would be identical to those under Borrow Site Option 2.

Impacts at DA-10/Sand Island would be less than those under Borrow Site Options 1 and 2. Under Borrow Site Option 3, 3.7 mcy of sand would be removed compared to 5.1 mcy under Borrow Site Option 2. While a portion of DA-10/Sand Island is within the active littoral zone, the sediment contained within this area was artificially placed by dredging practices. The rate of transport out of this area to feed the downdrift barrier islands (Horn and Ship Islands) is very low compared to the rate in areas where the material would have naturally been transported. Therefore, the natural rate of sand transport in the system would not be adversely affected by removing sand from this location (Appendix B). Hydrodynamic and sediment transport analysis indicates that tidal flows through Horn Island pass are more channelized and sediment transport potential between DA-10/Sand Island and Petit Bois Island is higher with the current location of Sand Island (Appendix D and Appendix F). This increase in channel velocities has likely contributed to the scour in and near the channel up to 20 feet deeper than the authorized channel depths (Appendix B). With the removal of over 30 percent of the subarial portion of DA-10/Sand Island more area for tidal flow to pass through the inlet would be provided, which could result in less flows and souring within the inlet channel.

Analysis of wave propagation through Horn Island pass indicates that wave energy is physically obstructed by DA-10/Sand Island. Leaving the majority of southern shoreline of Sand Island intact would continue to provide some buffer to higher gulf wave energy propagating into the Mississippi Sound. Impacts at PBP-AL, in Borrow Site Option 3 (which would utilize 1 mcy of sand from this location), would be greater than impacts of Borrow Site Option 2, but would be less than impacts of Borrow Site Option 1 or 4. As with Borrow Site Option 2, the smaller quantity to be utilized from this site would allow for use the eastern PBP-AL borrow site, which is located the furthest away from the pipeline infrastructure. Impacts from removal at this location would be minor and long-term, and therefore not significant. These effects would be localized and would be reduced over time as the bottom contours gradually reach equilibrium (Appendix D and Appendix F).

Overall, removal of material from the borrow areas under Borrow Site Option 1 would cause long-term localized minor impacts to wave energy, with wave reductions over most of the borrow area and wave increases only at the edges of the borrow area. No significant impacts to hydrology or coastal processes would occur.

5.2.3.3 No-Action Alternative

Under the No-Action Alternative, East and West Ship Islands would continue to narrow and lose land area as a result of updrift erosion (Byrnes et al., 2012). Given historical rates of shoreline recession (15 to 20 ft/yr) and associated littoral transport rates (300,000 to 400,000 cy/yr) along East Ship Island, the island could become a subaqueous shoal within the next decade (Appendix B; Morton et al., 2004).

Cat Island would continue to experience beach erosion and the gradual conversion of upland areas to shallow sub-aqueous areas.

DA-10, including Sand Island, would continue to be used for disposal of dredged material. However, the material would not be placed primarily in the portion of that site within the littoral transport zone. Therefore, the majority of the placed sand would not be transported to downdrift barrier islands.

Without restoration of the barrier islands, wave conditions on the mainland coast would increase from 0.2 to 0.4 meter during storm events (Appendix C). Therefore, under the No-Action Alternative, there would be long-term significant impacts to hydrology and coastal processes.

5.2.4 Bathymetry

The significance criterion for bathymetry would be a permanent change in depth that adversely affects currents, tides and/or natural water movement in the Mississippi Sound or OCS.

5.2.4.1 Tentatively Selected Plan

Ship Island Restoration

The TSP would cause a permanent change in bathymetry at East and West Ship Islands. Following restoration, the combined Camille Cut and East Ship Island equilibrated fill areas would encompass approximately 1,500 acres, of which approximately 700 acres would be below the MHWL. Within Camille Cut, subaqueous bottom currently at an elevation averaging -5 feet NAVD88 between West and East Ship Islands would be converted to barrier island habitat.

Analysis indicates that the restoration of the littoral sediment transport system and changes to local currents resulting from the closing of Camille Cut could potentially result in increased sedimentation in the Ship Island Pass over a 10- to 15-year period under average wave climate conditions. However, given the frequency of hurricanes it is likely that sediment accumulation along the island will diffuse throughout the system with only a negligible effect on Ship Island Pass, given the large morphological changes induced by hurricanes (Appendix C). There could be an increase in sedimentation in the pass and outer bar segments of the navigation channel during hurricane events. Larger hurricane events could result in potential 10 to 30 percent increase in sedimentation in the entrance channel, and smaller hurricanes could result in a potential 5 to 10 percent increase (Appendix C). This would require some additional maintenance of the Ship Island Pass after these events, although the overall frequency of dredging would not be expected to increase (Appendix C). Therefore, impacts to required maintenance dredging would not be significant.

Overall, there would be long-term, beneficial, significant changes to bathymetry from the restoration of Camille Cut and East Ship Island. The closure of Camille Cut and the restoration of Ship Island would restore a protective barrier and reduce storm waves at the mainland as described in Appendix C. The effects of sediment transport from placement of material in the East Ship Island and Camille Cut are expected to be localized to Ship Island, and impacts to the Gulfport Navigation Channel in Ship Island Pass are anticipated to be minimal (Appendix C).

Borrow Site Option 4

Borrow Site Option 4 would cause long-term minor changes in bathymetry at the Ship Island, Horn Island Pass, PBP-MS, PBP-AL, and PBP-OCS borrow sites (Figures 3-5, 3-6, 3-10, 3-11, and 3-12, respectively). The maximum sizes of the areas that could be affected and the maximum new depths that could occur post-dredging are shown in Table 3-6. It should be noted that the maximum dredging depths presented here include 2 feet of allowable overdepth to compensate for dredging inaccuracies. Also included beyond the elevations and depths indicated in Table 3-6 is an additional disturbance layer of up to 5 feet. The disturbance layer, also known as the non-paid overdepth, involves dredging outside the paid allowable overdepth that may occur due to such factors as unanticipated variation in substrate and/or wind or wave conditions that reduce the operators' ability to control the excavation head. Due to the potential of this layer possibly being disturbed by equipment, the disturbance layer has been included in the maximum total depth considered but is not considered a layer that would be fully removed. As described in Section 5.2.3.1, removal of material from each of the borrow areas in Borrow Site Option 4 would not significantly affect island morphology, the movement of sand, or hydrological processes. As with Borrow Site Option 4, the removal of sand would result in long-term minimal, and therefore not significant, impacts on the overall morphology of these areas, as discussed below. Additionally, the slopes of the inshore borrow areas (Cat Island, Ship Island, Petit Bois-AL, and Petit Bois-MS) are designed to be dredged to a 1V:5H slope, which would be expected to flatten as the borrow area perimeter slopes slump and settle and backfill with sand and finer-grained material over time (Appendix C). The resulting bathymetric changes would be relatively insignificant given that, compared to the adjacent seafloor, excavation of the borrow material would not result in the formation of significant depressions or basins in relation to the surrounding seafloor surface elevation. The impacts to bathymetry, therefore, would not be significant.

For the Ship Island borrow site, due to the small size and limited excavation depth, use of this site would not have, long-term impacts on the overall morphological development of Ship Island. Any changes in waves would lessen and dissipate at the inshore borrow sites, as slopes flatten and the borrow area naturally fills in over time (Appendix C). These impacts are therefore considered not significant.

For the Horn Island borrow area, an analysis of 20 years of shoreline change shows negligible difference between the dredged and existing cases (Appendix D).

Analysis of PBP-AL borrow indicates West Dauphin Island would experience small dredging-induced decreases in erosion and accretion in areas where they occur (Appendix D). Additional analysis of sediment transport and morphological change demonstrated that maintaining a minimum 1,000-foot buffer around the pipeline infrastructure and eliminating two of the eastern most subcuts of the western PBP-AL borrow reduced the potential for significant bathymetric changes along the pipeline (Appendix G). As with the Ship Island borrow site, long-term impacts would lessen and dissipate at inshore borrow sites, as slopes flatten and the borrow area naturally fills in over time (Appendix D).

The PBP-OCS borrow sites are located primarily along northwest-southeast-trending shoals. The shoals generally taper at the ends, with slope angles at the seaward tips up to 1.4 and flattening out with decreasing water depth. These shoals were formed during the most recent transgression and continued to evolve during early high stand, similar to the shoal field offshore of the Florida panhandle. However, progradation of the St. Bernard Delta complex of the Mississippi River altered wave climate in this area, impacting their dynamic nature. Therefore, sediment transport through the PBS-OCS area is not active like the barrier island littoral transport system and removal of parts of the shoals should not affect the sediment budget of any downdrift areas. In general, the shoals in the eastern half of the area are smaller than those in the western half. Dredging at the borrow sites on these smaller shoals will remove portions of these shoals, decreasing their overall volume; however, such dredging will not result in development of "borrow pits" because these shoals are bathymetric highs relative to adjacent seafloor. Overall, the resulting bathymetric changes will be relatively insignificant given that the shoal crests are not very high compared to the seafloor and most of the resulting borrow area cut elevations are at, or only a few feet below, the surrounding seafloor surface elevation.

The shoals in the western half of the PBS-OCS area are much larger and the borrow areas will be removing smaller percentages of each shoal. The resulting cuts will be similar to those in the east in that they will be removing parts of the shoal down to, and, in few cases, below the seafloor surface.

There is a buried deposit of relict sandy Pleistocene channel fill adjacent to the northern-most shoal that is not part of the modern shelf environment (Flocks et al., 2014). This deposit is approximately 4 to 8 meters thick and borrow areas cut into it will create seafloor depressions, unlike borrow areas situated on shoal and other seafloor bathymetric features. The deepest depression will be approximately 15 feet. It is anticipated, however, that these dredging depressions will recover more slowly than those on shoal sand bodies.

Cat Island Restoration

At Cat Island, approximately 305 acres of eastern shoreline and nearshore areas of Cat Island would be filled and converted to upland habitat. This placement would address ongoing erosion and would result in beneficial impacts to Cat Island.

Removal of material for placement on Cat Island would cause a long-term change in bathymetry at the Cat Island borrow area (Figure 3-4). Near Cat Island, bottom depth would increase by approximately 5 feet to a depth of approximately -20 feet NAVD88 (from current average depths of -15 feet NAVD88) across an area of approximately 429 acres. Modeling of removal sites associated with the Ship Island restoration found no significant impacts (Appendix D), and modeling results would be expected to be similar at the Cat Island borrow site (Appendix E). The slopes of the inshore borrow area would be expected to flatten and backfill with sand over time. Therefore, bathymetric impacts would not be significant.

Littoral Placement of Dredged Material

DA-10 would continue to be used for disposal of material from the Pascagoula Harbor Navigation Channel. However, placement would primarily occur in a different part of the site. This continued use, focused in the south and west parts of the disposal area (Figures 3-16 and 3-17) would maintain bathymetry that is conducive to sediment transport to the downdrift barrier islands.

5.2.4.2 Other Alternatives Considered

Borrow Site Option 1

Borrow Site Option 1 would cause long-term changes to bathymetry in the Ship Island, DA-10/ Sand Island, and PBP-AL sediment borrow areas (Figure 3-5, 3-7, and 3-10, respectively). The maximum sizes of the areas that could be affected and the maximum new depths that could occur post-dredging are shown in Table 3-6. As with Borrow Site Option 4, the maximum dredging depths presented here include 2 feet of allowable overdepth to compensate for dredging inaccuracies. An additional disturbance layer of up to 5 feet beyond dredging depths presented in Table 3-6. Due to the potential of this layer possibly being disturbed by equipment, the disturbance layer has been included in the maximum total depth considered but is not considered a layer that would be fully removed. The removal at DA-10/Sand Island would include the removal and permanent conversion of 105 acres of existing island habitat to submerged land. The removal would not result in significant changes in currents, tides, or natural water movement in the Mississippi Sound (Appendix D and Appendix F). Furthermore, as described in Section 5.2.3.2, removal of material would significantly affect island morphology, the movement of sand, or hydrological processes. The resulting bathymetric changes are relatively insignificant given that, compared to the adjacent seafloor, excavation of the borrow material would not result in the formation of significant depressions or basins in relation to the surrounding seafloor surface elevation. The slopes of the inshore borrow areas would be expected to flatten and backfill with sand and finer-grained material over time (Appendix C). Therefore, these impacts to bathymetry would not be significant.

Hydrodynamic and sediment transport analysis indicates that tidal flows through Horn Island pass are more channelized and sediment transport potential between DA-10/Sand Island and Petit Bois Island is higher with the current location of Sand Island (Appendix D and Appendix F). This increase in channel velocities has likely contributed to the scour in and near the channel up to 20 feet deeper than the authorized channel depths (Appendix B). With the removal of over 50 percent of the subarial portion of DA-10 more area for tidal flow to pass through the inlet would be provided, which could result in less flows and souring within the inlet channel.

Borrow Site Option 2

Borrow Site Option 2 would cause a long-term change in bathymetry at the Ship Island, Horn Island Pass, DA-10/Sand Island, PBP-AL, PBP-MS, and PBP-OCS borrow sites (Figures 3-5, 3-6, 3-7, 3-10, 3-11, and 3-12, respectively). The maximum sizes of the areas that could be affected and the maximum new depths that could occur post-dredging are shown in Table 3-6. As with Borrow Site Option 4, the maximum dredging depths presented here include 2 feet of allowable overdepth to compensate for dredging inaccuracies and an additional disturbance layer of up to 5 feet beyond dredging depths presented in Table 3-6. Due to the potential of this layer possibly being disturbed by equipment, the disturbance layer has been included in the maximum total depth evaluated but is not considered a layer that would be fully removed.

Impacts to the Ship Island, Horn Island Pass, PBP-MS, PBP-AL, and PBP-OCS borrow sites would be similar to those described under Borrow Site Option 4.

Impacts to the DA-10/Sand Island borrow area would be similar to those described under Borrow Site Option 1.

As described in Section 5.2.3.2, removal of material would not significantly affect island morphology, the movement of sand, or hydrological processes. The resulting bathymetric changes are relatively insignificant given that, compared to the adjacent seafloor, excavation of the borrow material would not result in the formation of significant depressions or basins in relation to the surrounding seafloor surface elevation. The slopes of the inshore borrow areas would be expected to flatten and backfill with sand and finer-grained material over time (Appendix C).Therefore, these impacts to bathymetry would not be significant.

Borrow Site Option 3

Borrow Site Option 3 would cause long-term changes in bathymetry at the Ship Island, Horn Island Pass, DA-10/Sand Island, PBP-AL, PBP-MS, and PBP-OCS borrow sites (Figures 3-5, 3-6, 3-8, 3-10, 3-11, and 3-12, respectively). Impacts at these locations would be similar to those that would occur under Borrow Site Option 2. The maximum sizes of the areas that could be affected and the maximum new depths that could occur post-dredging are shown in Table 3-6. As with Borrow Site Option 4, the maximum dredging depths presented here include 2 feet of allowable overdepth to compensate for dredging inaccuracies and an additional disturbance layer of up to 5 feet beyond dredging depths presented in Table 3-6. Due to the potential of this layer possibly being disturbed by equipment, the disturbance layer has been included in the maximum total depth evaluated but is not considered a layer that would be fully removed.

At the DA-10/Sand Island borrow area, the removal would include the permanent conversion of 58 acres of existing upland habitat to submerged land. The removal would not result in significant changes in currents, tides, or natural water movement in the Mississippi Sound (Appendix D and Appendix F). The resulting bathymetric changes are relatively insignificant given that, compared to the adjacent seafloor, excavation of the borrow material would not result in the formation of significant depressions or basins in relation to the surrounding seafloor surface elevation. Furthermore, the slopes of the inshore borrow areas would be expected to flatten and backfill with sand over time. Therefore, these impacts would not be significant.

Hydrodynamic and sediment transport analysis indicates that tidal flows through Horn Island pass are more channelized and sediment transport potential between DA-10/Sand Island and Petit Bois Island is higher with the current location of Sand Island (Appendix D and Appendix F). This increase in channel velocities has likely contributed to the scour in and near the channel up to 20 feet deeper than the authorized channel depths (Appendix B). With the removal of over 30 percent of the subarial portion of DA-10 more area for tidal flow to pass through the inlet would be provided, which could result in less flows and souring within the inlet channel.

5.2.4.3 No-Action Alternative

Under the No-Action Alternative, changes in bathymetry would occur along the barrier islands as a result of continuing erosion and land loss. Relative sea level rise would cause already eroded portions of the barrier islands such as those next to Camille Cut to further erode, altering bathymetry around the islands, due to disruption of island-forming processes (such as the natural sediment transport). The coastline retreat due to historical rates of relative sea level rise has been estimated at about 0.76 ft/yr (0.25 meter/yr) (Appendix C).

Cat Island would continue to experience beach erosion and the gradual conversion of upland areas to shallow sub-aqueous areas.

DA-10/Sand Island and the littoral zone would continue to be used for disposal of dredged material. The material would not be placed primarily in the portion of the sites within the littoral transport zone to transport sand downdrift barrier islands, resulting in the continued alteration of sediment availability and sediment transport to the downdrift islands.

5.2.5 Sediment Characteristics

The significance criteria for sediments would be a change in sediment characteristics that results in a permanent decline in sediment quality; a change in grain size permanently impacting biological communities; a permanent decline in water quality as a result of sediment/water interactions; or a decline in sediment quality that causes permanent impacts to biological resources.

For all components of the TSP, as well as the other alternatives considered, sediment quality would not be impacted. USACE would coordinate all work activities at the restoration areas with the USCG and other appropriate entities. During project construction, USACE would have an inspector aboard the dredge platform during operations to ensure that if oil and tar products are encountered, the dredged material will not be used for the project. In the event that a borrow area is contaminated, it will be reported to the USCG and the dredge will be decontaminated as necessary and moved to another designated borrow area. In the event that contaminated material is used in the fill, the USCG will be notified and proper cleanup measures will be taken. Consequently, no significant impacts to sediment quality would be anticipated.

5.2.5.1 Tentatively Selected Plan

As summarized in Section 3.2.1.1, beach sand compatibility investigations were conducted to characterize the beach sand on the barrier islands and sand from prospective borrow sites. Samples of beach sand were analyzed for color, angularity, grain size (based on diameter), and gradation (Table 3-1). For compatibility with the native material on the island and fill stability, well sorted to poorly sorted subangular sands, light gray to gray in color, with median grain size greater than 0.28 mm and percent fines less than 10 percent were considered to be optimum for barrier island restoration efforts. Other material was considered provided that the overfill ratio, which is a principal value in comparing the general suitability of fill material, as a function of grain size compatibility, was equal to or less than 1.3. The sediments placed on Ship Island and Cat Island were selected based on these criteria.

Ship Island Restoration

The sediments placed on Ship Island would be consistent in grain size, as measured by the D50 size, and color found on the existing East Ship Island and West Ship Island (Appendix A). The sediment used for the final application, removed from the Ship Island borrow area, would be similar in color, but slightly smaller in grain size. The placement of material would not negatively impact the overall sediment characteristics of the restored Ship Island.

Borrow Site Option 4

Borrow Site Option 4 would result in long-term reductions in the amount of sediment at the Horn Island Pass, PBP-AL, PBP-MS, PBP-OCS, and Ship Island borrow areas. The slopes of inshore borrow areas would be expected to flatten and backfill over time (Appendix D). In general, the overall characteristics of the sediment already present would not be impacted because the borrow area cut elevations are designed to leave a 2-foot buffer of sandy substrate on the seafloor to prevent clays or silts from being exposed and altering the benthic environment. However, sedimentation and dredging are not always precise and some sand bodies may be thicker or thinner than the vibracores and geophysics indicate.

As such, the dredging runs could cut below the buffer on rare occasions, locally exposing finer-grained material. Dredging shoals or other curved surfaces (such as the Horn Island Pass borrow area disposal mounds) can also introduce difficulties in predicting what the final exposed sediment will be. Because clays and silts stay suspended in water and are more mobile through wave action and ocean currents, the backfill of the nearshore borrow areas could consist of finer-grained material, resulting in a shift to a greater amount of silts and clays in the borrow area perimeters.

Cat Island Restoration

The sediments placed on Cat Island would be consistent in color and grain size, although slightly finer as measured by the D50 size, with the sediments currently found on Cat Island. The placement of material would not negatively impact the overall sediment characteristics of the restored island.

Littoral Placement of Dredged Material

Modification of the placement of dredged material at the combined DA-10/littoral zone site would not result in changes to sediment characteristics or sediment quality. As a result, there would be no impacts on sediment in the project area.

5.2.5.2 Other Alternatives Considered

Borrow Site Option 1

Borrow Site Option 1 would result in a reduction in the amount of sediment present at the current DA-10/Sand Island site; however, dredged sediment would continue to be added to the modified DA-10/littoral zone site, which is in the active littoral drift area, every 18 months in the amount of approximately 1 mcy. Borrow Site Option 1 would result in long-term reductions in the amount of sediment at the PBP-AL, Cat Island, and Ship Island borrow areas. The overall impacts to the characteristics of the sediment would be the same for these offshore sites as those described in Borrow Option 4. For the same reasons noted in the discussion of Borrow Site Option 4, backfill would be native to the area and would not cause significant impacts.

Borrow Site Option 2

Under Borrow Site Option 2, there would be a reduction in the amount of sediment present at DA-10/Sand Island, as discussed under Borrow Site Option 1 and long-term reductions in the amount of sediment at the Horn Island Pass, PBP-AL, PBP-MS, PBP-OCS, and Ship Island borrow areas. The overall impacts to the characteristics of the sediment would be the same for these offshore sites as those described in Borrow Option 4. For the same reasons noted in the discussion of Borrow Site Option 4, backfill would be native to the area and would not cause significant impacts.

Borrow Site Option 3

Borrow Site Option 3 would cause impacts similar to those that would occur under Borrow Site Option 2.

5.2.5.3 No-Action Alternative

Under the No-Action Alternative, there would be no changes in sediment characteristics.

5.3 Water Quality

The significance criteria for water quality would be a permanent change in water quality from organic and inorganic chemicals; and/or a temporary change in water quality that results in the loss of a commercially viable or protected species, loss of foraging habitat for coastal birds, or loss of important habitats (e.g., SAV).

5.3.1 Tentatively Selected Plan

5.3.1.1 Ship Island Restoration

Potential impacts on water quality associated with the restoration of Ship Island could occur during sand placement activities and post-restoration through the closure of Camille Cut.

Changes in DO and nutrients could occur due to mixing and release of sediments into the water column during sediment placement. DO could be affected by short-term increases in organic material and associated aerobic decomposition. Any impacts would likely be restricted to the immediate vicinity of the placement areas. Once activities cease and disturbed material settles, DO concentrations would return to pre-disturbance levels. Any impacts would be temporary and minor, and therefore not significant.

Construction could temporarily impact localized turbidity around the placement areas. The generation of turbidity could reduce light penetration through the water column, thereby reducing photosynthesis and affecting surface water temperatures and aesthetics in the vicinity. These conditions could also alter visual predator-prey relations and result in respiratory stresses in fish. During construction, turbidity levels around the placement locations would be monitored, as appropriate, to confirm that turbidity levels outside the 750-foot mixing zone do not exceed the background turbidity levels by more than the typical state standard of 50 NTUs (see Appendix S). Modeling of impacts indicates that exceedances of the standard outside the mixing zone could occur (Appendix C). MDEQ can grant exemptions to the turbidity standard in cases of emergency to protect public health and welfare, and for environmental restoration projects. A waiver could be required and will be requested. Project activities that would result in reasonable and temporary deviations from the standard are allowed if approved by MDEQ (MDEQ, 2007).

Existing SAV areas are located on the Sound side of West and East Ship Islands (Appendix H), and the sand placement would occur on the Gulf side of Ship Island. Therefore, the potential for direct impacts on SAV areas from sand placement and associated turbidity would be limited. However, during short periods of construction (i.e., less than 2 percent of the simulated 2-week time period or less than 1 week of the Phase 1 construction period) turbidity plumes could approach or exceed the state standard within the SAV areas. This is based on conservative estimates utilizing the material containing the highest percent fines within the borrow site (see Appendix C for details on turbidity modeling). Turbidity modeling analysis of placement activities identified no exceedances of the state standard using average borrow material characteristics. To avoid potential turbidity impacts, the amount of fines would be managed during borrow material collection, either through overflowing the hopper dredge (to allow fines to be removed) or by avoiding locations within borrow areas with higher fines content when placement is occurring in the vicinity of existing SAV areas. In the event that such best management practices (BMPs) are deemed necessary, the USACE will install a turbidity barrier similar to that used during the implementation of the West Ship Island northshore sand placement activities.

To assess the potential for water quality effects post-restoration of Ship Island and the closure of Camille Cut, ERDC developed a hydrodynamic (CH3D) and water quality model (CEQUAL-ICM) of the study area to evaluate potential changes in circulation and water quality in the Mississippi Sound (Appendix D). The following three scenarios were considered:

1. Base conditions (Pre-Katrina);
2. East Ship Island eroded to -1 foot NAVD88 (without the TSP); and
3. Ship Island restored (with the TSP).

A fourth scenario was simulated to look at cumulative impacts, which is discussed further is Section 5.14 of the SEIS and Appendix D. Results were evaluated at three main locations, including Station 2 in the northwest Sound south of Bay St. Louis, Station 5 in the central Sound south of Biloxi Bay, and Station 10 near the mainland Harrison County beach north of Ship Island near Gulfport, Mississippi (Table 5-2). Changes in DO, chlorophyll *a*, and salinity were evaluated at each station described (Appendix D).

TABLE 5-2
Maximum Percent Change for DO, Chlorophyll *a*, and Salinity

	DO Max & Min % Change			Chlorophyll a Max & Min % Change			Salinity Max & Min % Change		
Station	**1***	**2***	**3***	**1**	**2**	**3**	**1**	**2**	**3**
2	1.67	1.84	1.50	15.04	21.10	12.11	2.16	2.90	1.43
	-0.18	-0.31	-1.85	-3.71	-3.15	-4.09	-8.42	-8.76	-8.41
5	8.85	9.50	9.29	48.95	51.23	49.53	7.72	8.17	8.02
	-1.59	-1.56	-1.44	-14.08	-11.17	-13.13	-15.24	-14.77	-10.99
10	5.52	5.61	5.53	40.12	41.47	40.71	16.22	17.91	16.90
	-4.53	-5.16	-4.81	-36.37	-36.45	-38.13	-14.83	-13.00	-8.72

*1 = ((Post – Pre) / Pre)*100
2 = ((Eroded – Pre) / Pre)*100
3 = ((Restored – Pre) / Pre)*100

Minus sign indicates scenario value less than “Pre” (base) value

Water quality modeling results showed changes from baseline conditions for all sand placement (restoration) scenarios. In Table 5-2, the percent changes from the base condition (pre-Katrina) are summarized for each scenario for each of the three locations. Positive values represent increases in maximum values from the base case and negative values are decreases in minimum values from the base case. The important variable in this analysis is the magnitude of the percent change.

The restored scenario (number 3) resulted in the least amount of salinity change at all three locations compared to pre-Katrina conditions. At Station 2, in the northwest part of the Sound in the vicinity of the major oyster reefs, the modeling indicates that the maximum salinity levels remain near pre-Katrina conditions (1.4 percent increase) while the minimum salinity levels drop by approximately 8.4 percent. Under the eroded scenario (number 2), salinity variations increase more than under the restored scenario at all three locations in the Sound (Table 5-2). This modeling suggests that further degradation of the barrier islands results in regional increases in salinity inland of Ship Island. The closure of Camille Cut would reduce the movement of higher-salinity water into the Sound, resulting in salinities near pre-Katrina conditions (see Appendix D).

DO changes under the restored scenario were greatest in the central of the Sound (Station 5), with an overall increase in DO as a result of the increased chlorophyll *a* levels and associated photosynthesis. In the northwest Sound (Station 2), the DO changes were less substantial, with changes from pre-Katrina conditions of only a 1.5 percent increase to a 1.85 percent decrease. North of Ship Island near Gulfport (Station 10), the percent change in DO levels was approximately a 5 percent increase and decrease (Table 5-2). Overall, the impacts to average DO levels from restoration of Camille Cut would be minor, and therefore not significant. Modeling results indicate that DO levels would remain within the Mississippi state standards for ocean waters (or a daily average of not less than 5.0 mg/L with an instantaneous minimum of not less than 4.0 mg/L) (Appendix D). Chlorophyll *a* changes for the restored scenario showed a greater range than the other parameters, with increases from 12.1 percent at Station 2 to 40.7 percent at Station 10 and decreases ranging from 4.09 percent at Station 2 to 38.12 percent at Station 10. Overall, the modeling indicates that the restored scenario (with the TSP) would not have significant impacts on water quality and would produce water quality conditions close to pre-Katrina conditions in the Sound.

The potential water quality impacts are summarized below:

- Placement Activities – There would be temporary and minor impacts during placement activities, primarily due to increased turbidity in the immediate vicinity of construction activity. SAV areas are located north and west of East Ship and West Ship Islands and would be unlikely to be directly affected by placement activities. In addition, monitoring for turbidity levels would be used to identify the potential for impacts on SAV areas and appropriate turbidity barrier would be used around sensitive habitats, if needed. Additional practices to minimize water quality impacts would include plantings of native vegetation to stabilize new barrier island habitat areas, inspection of construction equipment for leaks, and establishment of containment areas for the storage of equipment fuels and lubricants. No significant water quality impacts would be anticipated from placement activities.

- Post-Restoration – There would be beneficial impacts on salinity in the Sound by restoring the structure (i.e., an intact barrier island) that prevents saltwater exchange with the Mississippi Sound. Reducing saltwater exchange through Camille Cut would help to maintain estuarine conditions. Compared to the No-Action Alternative, the TSP would better protect the estuarine regime required by oysters and other estuarine-dependent species (see Section 5.4.3). Minor changes in DO and chlorophyll *a* would not be significant based on the modeling results.

5.3.1.2 Borrow Site Option 4

Potential impacts on water quality associated with Borrow Site Option 4 would occur during dredging at the Ship Island, PBP-AL, Horn Island, PBP-MS, and PBP-OCS borrow sites.

During sediment removal, temperature, salinity, and DO profiles would be affected as a result of water column mixing. However, profiles would return to background conditions following completion of activities. Any impacts to these water quality profiles would be temporary and minor. Changes in DO and nutrients could also occur due to mixing and release of sediments into the water column during sediment removal and placement. DO concentrations could decrease during and immediately following dredging due to the movement of low-DO water and sediments through the water column. DO could also be affected by short-term increases in organic material and associated aerobic decomposition. Any impacts would likely be restricted to the immediate vicinity of the removal. Once activities cease and disturbed material settles, DO concentrations would return to pre-disturbance levels. Any impacts would be temporary and minor, and therefore not significant.

The borrow areas are designed to remove sands with low fine sediment (silts and clays) content. These fine sediments contribute most to turbidity because they can stay suspended in the water column for extended periods of time if there are active currents and waves. Construction could temporarily impact localized turbidity around borrow areas by inadvertently exposing and mobilizing these fine sediments during the dredging process. The type of equipment used will greatly affect the depth of disturbance during dredging. Hydraulic cutterhead dredges have a deeper zone of disturbance as compared to a hopper dredge. The generation of turbidity could reduce light penetration through the water column, thereby reducing photosynthesis and affecting surface water temperatures and aesthetics in the vicinity. These conditions could also alter visual predator-prey relations and result in respiratory stresses in fish.

Because impacts would be temporary and localized, no significant water quality impacts would be anticipated from the borrow activities.

5.3.1.3 Cat Island Restoration

Potential impacts on water quality associated with the restoration of Cat Island could occur during sand borrow placement activities.

During sediment dredging and placement activities, temperature, salinity, and DO profiles would be affected as a result of water column mixing. However, profiles would return to background conditions following completion of activities. Any impacts to these water quality profiles would be temporary and minor. Changes in DO and nutrients could also occur due to mixing and release of sediments into the water column during sediment dredging and placement. DO concentrations could decrease during and immediately following dredging due to the movement of low-DO water and sediments through the water column. DO could also be affected by short-term increases in organic material and associated aerobic decomposition. Any impacts would likely be restricted to the immediate vicinity of the borrow and placement areas. Once activities cease and disturbed material settles, DO concentrations would return to pre-disturbance levels. Any impacts would be temporary and minor, and therefore not significant.

Construction could temporarily impact localized turbidity around the placement areas. The generation of turbidity could reduce light penetration through the water column, thereby reducing photosynthesis and affecting surface water temperatures and aesthetics in the vicinity. These conditions could also alter visual predator-prey relations and result in respiratory stresses in fish. During construction, turbidity levels around the placement locations would be monitored, as appropriate, to confirm that turbidity levels outside the 750-foot mixing zone do not exceed the background turbidity levels by more than the typical state standard of 50 NTUs. Modeling of impacts indicates that exceedances of the standard outside the mixing zone could occur (Appendix C). MDEQ can grant exemptions to the turbidity standards in cases of emergency to protect public health and welfare, and for environmental restoration projects. A waiver could be required and will be requested. Project activities that would result in reasonable and temporary deviations from the standard are allowed if approved by MDEQ (MDEQ, 2007).

In summary, there would be temporary and minor impacts during placement and dredging activities, as demonstrated by the water quality modeling, primarily due to increased turbidity in the immediate vicinity of construction activity. SAV areas are located north, south, and west of Cat Island and would not be directly affected by placement activities on the eastern beach. However, monitoring for turbidity levels would be used to identify potential for impacts on SAV areas and appropriate turbidity barrier would be used around sensitive habitats, if needed. Additional practices to minimize water quality impacts would include plantings of native vegetation to stabilize restored barrier island habitat areas, inspection of construction equipment for leaks, and establishment of containment areas for the storage of equipment fuels and lubricants. No significant water quality impacts would be anticipated from placement activities.

5.3.1.4 Littoral Placement of Dredged Material

Modification of dredged material placement into the combined DA-10/littoral zone site would not result in changes to water quality.

5.3.2 Other Alternatives Considered

5.3.2.1 Borrow Site Option 1

Potential impacts on water quality associated with Borrow Site Option 1 would occur during dredging at the Ship Island, PBP-AL, and DA-10/Sand Island.

During sediment removal, temperature, salinity, and DO profiles would be affected as a result of water column mixing. However, profiles would return to background conditions following completion of activities. Any impacts to these water quality profiles would be temporary and minor. Changes in DO and nutrients could also occur due to mixing and release of sediments into the water column during sediment removal and placement. DO concentrations could decrease during and immediately following dredging due to the movement of low-DO water and sediments through the water column. DO could also be affected by short-term increases in organic material and associated aerobic decomposition. Any impacts would likely be restricted to the immediate vicinity of the removal. Once activities cease and disturbed material settles, DO concentrations would return to pre-disturbance levels. Any impacts would be temporary and minor, and therefore not significant.

Construction could temporarily impact localized turbidity around borrow areas. The generation of turbidity could reduce light penetration through the water column, thereby reducing photosynthesis and affecting surface water temperatures and aesthetics in the vicinity. These conditions could also alter visual predator-prey relations and result in respiratory stresses in fish.

Because impacts would be temporary and localized, no significant water quality impacts would be anticipated from the borrow activities.

5.3.2.2 Borrow Site Option 2

Impacts associated with Borrow Site Option 2 would be similar to those that would occur under Borrow Site Option 1 with the following exceptions. Additional minor temporary impacts to water quality during sand removal, similar to those described in Borrow Site Option 1, would also occur during removal activities at the Horn Island, PBP-MS, and PBP-OCS borrow sites. The temporary and minor impacts during borrow activities would be fewer at the PBP-AL borrow area compared to removal at that location under Borrow Site Option 1, due to the reduced amount of material that would be obtained from that location—0 mcy under Borrow Site Option 2 versus 12.2 mcy under Borrow Site Option 1. Because impacts would be temporary and localized, no significant water quality impacts would be anticipated from the borrow activities.

5.3.2.3 Borrow Site Option 3

Impacts associated with Borrow Site Option 3 would be similar to those that would occur under Borrow Site Option 2 with the following exceptions. At PBP-AL borrow area, 1 mcy would be obtained under Borrow Site Option 3 versus 0 mcy under Borrow Site Option 2, resulting in greater potential for water quality impacts at the site. Volumes at DA-10/Sand Island would be 5.1 mcy under Borrow Site Option 2 compared to 3.7 mcy under Borrow Site Option 3, resulting in a reduced potential for water quality impacts at that site. Because impacts would be temporary and localized, no significant water quality impacts would be anticipated from the borrow activities.

5.3.3 No-Action Alternative

Under the No-Action Alternative, salinity would increase in the Sound over time as more high-salinity Gulf waters are pushed into the Sound through the expansion of Camille Cut and the continued loss of island mass. These changes in salinity would have a negative impact on oyster reefs in the Sound (see Section 5.4.3). In addition, the continued loss of barrier island area would result in additional surge and wave impacts on coastal mainland and wetland habitat (see Sections 5.2.1 and 5.2.3 and Appendix C). Turbidity in the Mississippi Sound would be similar to existing conditions due to continued wave action disturbance of sediments in the shallow areas. These impacts would be likely to reduce the overall area of wetlands available to filter upland runoff before it enters the Sound, and water quality could be impacted over time.

5.4 Biological Resources

Except where noted in specific sub-sections below, the significance criterion for biological resources would be a permanent change in one of the following:

- Health of populations: changes in biomass;
- Community structure and composition: changes in the number or kinds of species;
- Trophic structure: changes in proportion of various trophic levels and functional feeding groups; and

- System function: changes in productivity and material cycling.

The following sections evaluate the biological effects associated with sediment borrow and placement.

5.4.1 Coastal Habitats

As noted in Section 4.5.1, coastal habitats in the proposed area include both barrier island beaches, dry beach and dune systems on barrier islands, coastal wetlands, wet habitats on barrier islands, SAV, estuarine shrublands, coastal forests, and mainland beaches. Impacts to affected habitats are discussed below.

5.4.1.1 Tentatively Selected Plan

Ship Island Restoration

Placement of sediment on the nearshore and frontal dune area of East Ship and West Ship Islands would result in short-term disruption to barrier island beach habitats (i.e., barrier island beaches and dry beach and dune systems) and associated flora and fauna within the footprint of the construction areas, including the loss of 12.75 acres of marine intertidal habitat and 1.3 acres of estuarine intertidal habitat. Although flora and fauna occupying these habitats would be lost, the various habitats would become re-established and re-colonized following restoration. The newly created island segment would be planted with native dune vegetation, including sea oats, gulf bluestem, and or other grasses and forbs, to restore stable dune habitat. Planting would include vegetation similar to that found in the existing coastal habitats (Section 4.5.1). Losses would be ongoing during the entire project construction period, but would be limited to the specific locations undergoing restoration at any given time. Re-colonization would begin as soon as construction in a given area is completed and would continue during the post-construction period.

Placement of sand in Camille Cut would result in the permanent loss of approximately 800 acres of nearshore open water habitat at that location. Upon completion of restoration, the amount of coastal habitats, which could include barrier island beaches, and dry beach and dune systems, and eventually wet habitats, estuarine shrublands, coastal forests, would be increased on East Ship and West Ship Islands. Coastal flora and fauna would be beneficially impacted by the addition of approximately 800 acres of new beach habitats from the placement of sand in and revegetation of Camille Cut and degraded beach habitats on East Ship Island. The restored barrier island would provide reduced saltwater intrusion into freshwater systems, as well as greater protection to coastal habitats in Mississippi from the intensity of storm waves. This would result in a long-term positive impact to coastal barrier island habitat, wetland habitat, and SAV that is expected to be lost under the No-Action Alternative.

Placement of dredged material could result in temporary disruption to the unconsolidated shoreline habitat (swash zone habitat) in the vicinity of the placement activities. Such effects could cause temporary direct impacts to reproduction and foraging habitats for wildlife. Placement could also create a short-term impact to both habitat and available nutrients for marine invertebrates, fishes, and wading birds.

Closure of Camille Cut between East Ship and West Ship Islands would result in a long-term beneficial impact from the creation of 93.39 acres of unconsolidated shoreline habitat for a net gain of 71.64 acres of such habitat (Appendix M). The action would also result in a loss of 1.3 acres of estuarine pond on the west end of East Ship Island. In addition, the restored barrier islands would sustain the productive estuary of the Mississippi Sound as well as provide a greater protection to coastal wetland habitats in Mississippi from the intensity of storm waves.

Direct placement of materials could damage SAV areas through smothering or drift of suspended sediments onto plants if the material were placed in their vicinity. However, no SAV beds have been mapped in locations proposed for sediment removal or placement (Vittor and Associates, 2011). Placement of sand near, but not directly in, the current SAV areas as part of the TSP has the potential to provide a long-term benefit through an increase in the areas available for colonization of SAV. Restoration of Ship Island could further enhance potential habitat for SAV in the newly protected littoral areas that would occur north of Camille Cut (Appendix D).

Staging of construction equipment would not occur in areas of mapped SAV. However, construction activities could result in temporary disruption and negligible impacts to nearby SAV as a result of increased turbidity (Appendix C). BMPs and monitoring as described in Section 5.3 would be implemented to prevent impacts to SAV.

Potential impacts to coastal habitats are summarized below:

- Significant beneficial impacts would occur from a change in habitat type at Camille Cut and restoration of East Ship Island. Approximately 800 acres of open water habitat would be lost and 800 acres of new beach and barrier island habitats would be created, resulting in greater protection for coastal habitats and an increase in less common barrier island habitat.
- Short-term to long-term minor impacts would occur to barrier island beach vegetation. These losses would occur at the tips of East Ship and West Ship Islands around Camille Cut. Re-vegetation would occur via plantings and natural recruitment on newly added upland. Therefore, these impacts are not significant.
- Temporary to short-term moderate impacts to unconsolidated shoreline habitat (swash zone habitat) would occur in the vicinity of the placement activities. Marine invertebrates, fishes, and wading birds could be affected until completion of construction activities. Because these impacts would be temporary to short-term, and because there would be a net increase in shoreline habitat after construction, these impacts are not significant.
- Long-term, moderate, beneficial impacts to SAV would occur through natural recruitment from the addition of new habitat suitable for SAV colonization.

Borrow Site Option 4

Under Borrow Site Option 4, no impacts to coastal habitats would occur.

Cat Island Restoration

Placement of sandy material on the frontal dune area of Cat Island would result in short-term disruption to barrier island beach habitats (i.e., barrier island beaches and dry beach and dune systems) and associated flora and fauna within the footprint of the construction areas, including 2.52 acres of marine intertidal habitat. Although flora and fauna occupying these habitats would be lost, the various habitats would become re-established and re-colonized following restoration. Losses would be ongoing during the entire restoration project construction period, but would be limited to the specific locations undergoing restoration at any given time. Re-colonization would begin as soon as construction in a given area is completed and would continue during the post-construction period.

Upon completion of restoration, the amount of beach habitats, which could include barrier island beaches, dry beach and dune systems, and eventually wet habitats, would be increased on Cat Island. Approximately 305 acres of currently degraded beach habitats would be enhanced by restoration activities, including an expanded shoreline and planting of native beach and dune vegetation. In addition, restoration of the eastern beach and dune system of Cat Island would provide greater protection to various habitats in the lee, including South Bayou, Smuggler Cove, and wetlands along Middle Spit from storm waves. Although restoration was not specifically modeled, storm wave sensitivity modeling conducted for the existing islands demonstrates the significance of Cat Island in blocking wave energy within the Mississippi Sound and mainland coast in the lee of the island (Appendix C).

Placement of sandy material on Cat Island would result in the loss of 2.13 acres of unconsolidated shoreline habitat and could result in temporary disruption to adjacent unconsolidated shoreline habitat (Appendix M). Such effects could cause temporary direct impacts to reproduction and foraging habitats for wildlife. This could create a short-term impact to both habitat and available nutrients for marine invertebrates, fishes, and wading birds.

The restored barrier island would provide greater protection to coastal wetland habitats in Mississippi from the intensity of storm surges and storm waves, as well as saltwater intrusion into freshwater systems.

Potential impacts to coastal habitats are summarized below:

- Short-term minor impacts to barrier island beach vegetation would occur. Re-vegetation would occur via plantings and natural recruitment on newly added upland. Long-term beneficial impacts would include restoration of 305 acres of beach dune habitat. Eroding habitat would be restored and coastal habitats would be better protected.

- Temporary to short-term impacts to unconsolidated shoreline habitat (swash zone habitat) would occur in the vicinity of the placement activities. Marine invertebrates, fishes, and wading birds could be affected until completion of construction activities.

Littoral Placement of Dredged Material

The southern portion of DA-10 would continue to be used for disposal of material from the Pascagoula Harbor Navigation Channel in the combined DA-10 and littoral zone site. This continued use, focused in the south and west parts of the disposal area (Figures 3-16 and 3-17), would maintain bathymetry that is conducive to sediment transport to the downdrift barrier islands. Ensuring continual placement within the most active littoral transport system would benefit the biological species that utilize the barrier island system.

5.4.1.2 Other Alternatives Considered

Borrow Site Option 1

Under Borrow Site Option 1, removal of material from DA-10/Sand Island would result in the long-term to permanent loss of approximately 105 acres of island habitat (i.e., the man-made Sand Island located within DA-10). Sand Island contains a variety of barrier island habitats, including tidal flats, open beach, vegetated beach dune, tidal marsh, marsh meadow, and interior relic dune. These habitats support a variety of wildlife, including mammals, reptiles, and resident and migratory birds. Approximately 60 acres of island habitat at Sand Island would remain after sediment removal. Although the loss of 105 acres of habitat at DA-10/Sand Island is considered by the NPS a significant impact to emergent wetland resources, the creation of 800 acres of new island conditions at Ship Island would represent a net increase of 695 acres of opportunity for marine intertidal habitat development.

Borrow Site Option 2

Impacts to coastal habitats under Borrow Site Option 2 would be identical to those under Borrow Site Option 1.

Borrow Site Option 3

Impacts to coastal habitats under Borrow Site Option 3 would be similar to those under Borrow Site Option 2 with the exception of potential impacts to DA-10/Sand Island.

Removal of material from this area would result in the long-term to permanent loss of approximately 58 acres of upland habitat at Sand Island. Sand Island contains a variety of barrier island habitats, including tidal flats, open beach, vegetated beach dune, tidal marsh, marsh meadow, and interior relic dune. Approximately 107 acres of island habitat would remain on Sand Island after sediment removal. Although the loss of 58 acres of habitat at DA-10/Sand Island is considered by the NPS a significant impact to emergent wetland resources, the creation of 800 acres of new island conditions at Ship Island would represent a net increase of 742 acres of opportunity for marine intertidal habitat development

5.4.1.3 No-Action Alternative

Under the No-Action Alternative, barrier islands would continue to erode, causing the loss and degradation of barrier island habitat and could result in the loss of wetland habitats and SAV (Morton et al., 2004). In addition, the continued loss of barrier island habitat would result in ongoing potential for storm surge and wave damage on the mainland, including beaches and coastal and interior wetland habitats. Under the No-Action Alternative, continued placement of dredged material at DA-10/Sand Island and the littoral zone would result in the material not being placed within the sites' most active littoral transport zone. Thus, limited sand transport to downdrift barrier islands would be anticipated, which would further compromise the barrier islands' future existence.

5.4.2 Plankton

5.4.2.1 Tentatively Selected Plan

Ship Island Restoration

Elevated turbidity levels and decreased light transmission caused by suspended material during placement activities could result in a temporary localized reduction in phytoplankton and zooplankton abundance.

Turbidity and suspended solids were measured as part of a 1975 USACE study of dredging and disposal activities. The study included an evaluation of water quality and plankton in dredging and disposal areas over a 40-square-mile grid centered on the Gulfport Shipping Channel in the Mississippi Sound. That study found that plumes from sediments consisting of a mix of silts, clays, and sands were small and localized and that solids tended to settle rapidly. Levels of turbidity and suspended solids, even from sediments with a high percentage of fines, returned to background levels at disposal sites within 2 to 3 hours. Samples were collected before and after dredging activities. No observable effects on the resident plankton community were observed in terms of stimulatory effects, species composition, or community structure (USACE, 1975).

The release of nutrients from sediments during the placement process could indirectly support a localized temporary increase in phytoplankton.

Planktonic organisms would be carried into and out of the project area via currents during and after sediment removal and placement activities. Because impacts would be restricted to localized patches of plankton, any impacts would not be significant. As a result, there would be no potentially adverse change in the health of populations, community structure and composition, trophic structure, or system function.

The closure of Camille Cut would reduce the movement of higher-salinity water into the Sound, resulting in salinities near pre-Katrina conditions (see Appendix D). As salinity influences the distribution and diversity of phytoplankton, a restoration to the pre-Katrina salinity regime would have a positive impact on phytoplankton in the Mississippi Sound.

Borrow Site Option 4

Elevated turbidity levels and decreased light transmission caused by suspended material during dredging activities could result in a temporary localized reduction in phytoplankton and zooplankton abundance. Impacts would be similar to those described above for the restoration of Ship Island and would occur at the Ship Island, Horn Island Pass, PBP-AL, PBP-MS, and PBP-OCS borrow areas.

Cat Island Restoration

Elevated turbidity levels and decreased light transmission caused by suspended material during dredging and placement activities could result in a temporary localized reduction in phytoplankton and zooplankton abundance. Impacts would be similar to those described above for the restoration of Ship Island.

Littoral Placement of Dredged Material

Modification to the disposal of dredged material within the combined DA-10/littoral zone site would not result in changes to the plankton community.

5.4.2.2 Other Alternatives Considered

Borrow Site Option 1

Elevated turbidity levels and decreased light transmission caused by suspended material during dredging activities could result in a temporary localized reduction in phytoplankton and zooplankton abundance. Impacts would be similar to those described above for Borrow Site Option 4, but would occur in fewer locations (Ship Island, DA-10/Sand Island, and PBP-AL borrow sites). Impacts would be greater at the PBP-AL borrow location, reflecting the greater amount of material that would be removed from the site under Borrow Site Option 1, as reflected in Table 3-6.

Borrow Site Option 2

Impacts to plankton under Borrow Site Option 2 would be similar to those for Borrow Site Option 4. However, temporary localized impacts from elevated turbidity levels and decreased light transmission would also occur at DA-10/Sand Island. Impacts would be fewer at the PBP-AL borrow location, reflecting the smaller amount of material that would be removed from the site under Borrow Site Option 2, as reflected in Table 3-6.

Borrow Site Option 3

Impacts to plankton under Borrow Site Option 3 would be similar to those for Borrow Site Option 2. Impacts would occur in the same locations but would be fewer at the PBP-AL and DA-10/Sand Island borrows areas, reflecting the smaller amount of material that would be removed from the sites under Borrow Site Option 3, as reflected in Table 3-6.

No-Action Alternative

Under the No-Action Alternative, further degradation of the barrier islands would result in regional increases in salinity inland of Ship Island. This change in salinity would have a negative impact on plankton in the area.

5.4.3 Benthic Environment

The bottom sediments in the Mississippi Sound provide habitat for multiple species of infaunal and epifaunal invertebrates. Dredging and placement activities will cause disturbances in the benthic communities in the placement and borrow areas in which species tend to be either tolerant of disruption or capable of rapidly re-colonizing disturbed areas. Table 5-3 provides a summary in acreages of the submerged areas that will be disturbed in placement and borrow area alternatives.

TABLE 5-3
Total Area in Acres Impacted at the Placement and Borrow Sites

Alternatives	Submerged Acreage Impacted (acres)
Tentatively Selected Plan	4115
Borrow Option 1	1,805
Borrow Option 2	4,472
Borrow Option 3	4,419

The impacts to the benthic environment at the placement sites will occur at the areas being covered by the placement activities. At the borrow areas, impacts will be directly related to the dredging and excavation activities in the submerged bottoms. The benthic species of concern within these sites include a variety on invertebrates, mollusks, and crustaceans as discussed in Section 4.5.3. The mollusk community is dominated by *Donax sp.* and *Gemmea sp*. (Appendix I and Section 4.4.2). The primary crustaceans found in the area are shrimp, crabs, and amphipods. The following sections discuss the impacts to these benthic communities resulting from the placement and dredging activities.

5.4.3.1 Tentatively Selected Plan

Ship Island Restoration

Placement of sediments for restoration uses would cause long-term or permanent impacts to benthic communities as a result of changes in the bathymetric profiles in those locations.

Use of staging areas for construction equipment would also temporarily disrupt benthic communities. During staging, both infauna and epifauna invertebrates including mollusks and crustaceans would be displaced.

Placement of sediments for restoration purposes would cause direct impacts to the benthic community. In areas converted to uplands, permanent losses would occur. In littoral placement areas and in newly created littoral habitat, recovery of the communities could range from a few months to several years (Bolam and Rees, 2003; USACE, 1999). There are no oyster or clam beds in the immediate area, so there would be no potential for direct impact on these species. Motile mollusks would likely leave the area during these activities and return after operations cease. The crabs and shrimp are fairly mobile and during placement operations could avoid impact, although there would be some mortality and displacement. Most of these organisms would likely leave the area during placement activities and return after operations cease.

Several studies have shown no significant long-term effects on benthic communities from beach restoration. Saloman and Naughton (1984) studied the effect of beach restoration with offshore excavated sand on the nearshore macorinfauana at Panama City Beach, Florida. They concluded that placement of sand in the nearshore had minor, short-term effects on benthic macroinvertebrates, noting that populations appeared to stabilize within 2 to 3 months after restoration. As noted in previous studies, intertidal benthic assemblages declined in abundance and diversity immediately following restoration. It is reasonable to anticipate some non-motile and motile invertebrate species will be physically affected through placement operations but would recover within a few months (Cutler and Mahadevan, 1982). Non-motile benthic fauna within the area would be destroyed by placement operations, but should repopulate within 12 months of project completion (Culter and Mahadevan, 1982; Saloman et al., 1982).

Approximately 800 acres of open water shallow benthic habitat at Ship Island would be converted to a combination of barrier island and intertidal habitat from the placement of material. Given the size of open water habitat within the Mississippi Sound (approximately 1,184,000 acres), this permanent loss of benthic habitat would result in a negligible impact to ecosystem function. The addition of barrier island and intertidal habitat would represent a significant increase in this habitat within the barrier island system and would be essentially a replacement of habitats lost since Hurricane Camille in 1969. Restoration of Ship Island would result in a long-term positive effect on benthic macroinvertebrate communities by protecting coastal ecotone habitat, including intertidal and subtidal habitats used by benthic invertebrate communities, which would likely be lost under the No-Action Alternative.

Short-term impacts could also occur from the placement of construction equipment, including pipelines and anchoring spuds, and construction of temporary moorings. These areas would be expected to recover within a few months to a few years depending on the extent and duration of construction equipment impacts.

Although benthic organisms would be lost, losses would not be significant because the benthic community would become re-established in areas not converted to upland and these benthic areas would be re-colonized following restoration. Losses would be ongoing during the entire construction period of the project, but would be limited to the specific locations undergoing restoration at any given time. Re-colonization would begin as soon as removal or construction in a given area is completed and would continue during the post-construction period (Saloman et al., 1982).

Freshwater marshes serve as havens for shrimp and crabs. The closure of Camille Cut would protect these marshes from saltwater intrusion and provide additional habitat for shrimp and crabs. Additionally, the reduced salinity, inland of the barrier islands, would protect oysters from increased predation and disease. Therefore, long-term beneficial impacts to shrimp, crabs, and oysters would result from the restoration of Ship Island.

Borrow Site Option 4

Impacts to benthic invertebrates from removal activities would occur. Dredging sediments for restoration uses would cause direct short-term to long-term disruptions to the benthic community in borrow areas. Such changes would occur due to the loss of organisms, changes in the bathmetric profiles, and changes in sediment characteristics in those locations. During dredging, both infauna and epifauna invertebrates would be displaced. Benthic invertebrate communities of the in-shore borrow areas (PBP-MS, PBP-AL, Ship Island, and Horn Island Pass) were dominated by polychaetes or polychaete/crustacean assemblages, and the OCS sites were dominated by polychaetes (Section 4.5.3.1). There are no oyster or clam beds in the immediate area, so there would be no potential for direct impact on these species. Motile mollusks would likely leave the area during these activities and return after operations cease. Bivalves and semi-sessile mollusks could be displaced by restoration activities. However, bivalves (through larval recruitment) would re-colonize the area. The crabs and shrimp are fairly mobile and during placement operations could avoid impact, although there would be some mortality and displacement. Most of these organisms would likely leave the area during placement activities and return after operations cease. There would likely be some incidental loss of juvenile crustaceans during placement operations; however, these would represent a very limited portion of the population and not have long-term adverse effects on the crustacean community.

Findings from studies on re-colonization of the benthic substrates vary depending upon the nature of the substrate (Chessa et al., 2007; Newell et al., 2004; Bolam and Rees, 2003; and Bemvenuti et al., 2005). Each of these studies evaluated changes in the benthic community associated with dredging activities. Sections 5.2.4 and 5.2.5 established impacts to the bathymetry and sediment characteristics at the offshore borrow areas. The resulting bathymetric changes will be relatively insignificant compared to the adjacent seafloor, and excavation of the borrow material would not result in the formation of depressions or basins in relation to the surrounding seafloor surface since the material will be excavated from existing shoals and not from areas of natural seafloor elevations. The borrow sites, once excavated, will be reworked through natural processes, i.e., waves and currents. Overall, the sediment already present would still consist of sandy material because the borrow area cut elevations are designed to leave a 2.0-foot buffer of sandy substrate on the seafloor. However, the remaining material may consist of finer-grained sandy material.

The studies listed above found an initial reduction in the species biomass, composition, and abundance and reported a recovery of species abundance, diversity, and biomass, with the rate of the recovery dependent upon the habitat conditions. Recovery of species abundance and diversity was more readily accomplished than recovery of biomass. Recovery of 86 percent of species diversity can occur within 20 days and full recovery within 80 days (Newell et al., 2004). However, recovery of biomass can take in excess of 18 months. The authors also indicate that there is little evidence of indirect impacts on the community structure outside of the immediate dredging boundaries. Because of the change in depth or deepening at the borrow areas, species preferring greater depths would colonize in the post-dredged areas, resulting in a more diverse benthic community that prefers finer sand.

Among the considerations in benthic recovery are the bathymetric features and sediment characteristics created by the offshore dredging process (Byrnes et al., 2004). Reworking of exposed sediments is an important process in benthic recovery after dredging because it promotes diffusion of DO into soft substrata exposed during dredging. Byrnes at al. (2004) also found that offshore sediments along coastal Alabama are continually being reworked to depths up to 60 meters. This process is likely due to storms and sediment influxes of material associated with river discharges. The recovery and re-establishment of impacted communities would not necessarily return conditions to pre-dredged species composition. While levels of diversity and abundance may be reached or exceeded within a relatively short time after dredging, the pertinent goal of recovery success is for infaunal assemblages to become equivalent to those in nearby non-dredged areas within a relatively brief interval after dredging (Byrnes et al., 2004).

The MMS (2010) conducted a study to examine and evaluate the potential biological and physical effects of offshore dredging within the ridge and swale features within the OCS. Their study concluded that seabed topography and benthic communities can be altered when sediment is removed by dredging bathymetric peaks such as ridges or shoals rather than level sea bottoms or depressions. An investigation by Burlas et al. (2001) monitored borrow sites with bathymetric high points off northern New Jersey and found that infaunal assemblage patterns generally recovered within 1 year after dredging. Because of greater exposure to dynamic hydrographic processes, the benthic community generally recovers more rapidly in areas located on shoal crests, compared to lower areas of the shoals. In higher areas where depressions do not form, greater sediment mobility occurs that may result in rapid sediment reworking and infilling of dredged sites.

Given the naturally dynamic waters and unconsolidated sandy nature of the local Gulf of Mexico coast, organisms inhabiting the offshore areas adapt well to reasonable environmental changes such as moderate increases in turbidity. Dredging activities would result in significant mortality of non-motile benthic organisms. However, as described by Byrnes et al. (2004) in their investigations along coastal Alabama, impacts to the benthic community are expected from physical removal of sediments and infauna; however, assuming that dredging does not produce deep pits causing very fine sediment deposition or hypoxic or anoxic conditions, levels of infaunal abundance and diversity generally recover within 1 to 3 years, though recovery of species composition may take longer. Some offshore areas may recover more quickly due to opportunistic life history characteristics of dominant infauna.

At borrow areas associated with Borrow Site Option 4, existing benthic habitat would experience the same short-term impacts as those described above from sediment removal, as reflected in Table 3-6. No impacts at the DA-10/Sand Island borrow area would occur.

Although benthic organisms would be lost, the benthic community would become re-established and benthic areas would be re-colonized following restoration. Losses would be ongoing during the entire construction period of the project, but would be limited to the specific locations dredged for borrow material at any given time. Re-colonization would begin as soon as removal in a given area is completed and would continue during the post-construction period (Saloman et al., 1982). Because of the short-term nature of the recovery, impacts would be negligible, and therefore not significant.

Cat Island Restoration

Potential impacts to benthic invertebrates including various species of mollusks and crustaceans from both removal and placement activities would occur. Impacts and recovery would be similar to those described for Ship Island restoration and Borrow Site Option 4 above.

At the Cat Island borrow area, approximately 429 acres of existing benthic habitat would experience short-term impacts from sediment removal. Approximately 305 acres of barrier island and shallow water habitat along the beach at Cat Island would be converted to a combination of restored barrier island and intertidal habitat from the placement of material. Given the size of open water habitat within the Mississippi Sound (approximately 1,184,000 acres), any loss of benthic habitat associated with placement activities would result in a negligible impact to ecosystem function. The addition of restored barrier island and intertidal habitat would represent a significant increase in this habitat within the barrier island system and would be essentially a replacement of habitats.

Although benthic organisms would be lost during removal and placement, losses would not be significant. There would also be long-term positive effects due to the protection of coastal ecotone habitat, including intertidal and subtidal habitats, used by benthic invertebrate communities, that would likely be lost under the No-Action Alternative.

Littoral Placement of Dredged Material

Modification of the placement of dredged material at DA-10/littoral zone would result in littoral movement of newly placed dredged material; thus, benefiting benthic invertebrates by sustaining the habitat rather than filling from retained dredged material at DA-10/Sand Island as past practices had done.

5.4.3.2 Other Alternatives Considered

Borrow Site Option 1

Under Borrow Site Option 1, impacts would be similar to those described under Borrow Site Option 4. However, potential impacts to borrow areas would occur over a smaller area.

At borrow areas, approximately 1805 acres of existing benthic habitat would experience short- to long-term impacts from sediment removal, as reflected in Table 3-6.

At DA-10/Sand Island, approximately 105 acres of new benthic invertebrate habitat would be created from the removal of an equivalent amount of island habitat. This would result in the creation of a negligible amount of new benthic habitat.

The area of impact would be greater at the PBP-AL borrow area compared to Borrow Site Option 4, reflecting the greater amount of sand that would be removed under Borrow Site Option 1 (12.2 mcy) compared to 4.7 mcy under Borrow Site Option 4. This would cause impacts over a longer duration and greater area and would result in slower recovery of the area.

Although benthic organisms would be lost, the benthic community would become re-established and benthic areas would be re-colonized following restoration. Losses would be ongoing during the entire construction period of the project, but would be limited to the specific locations dredged for borrow material at any given time. Re-colonization would begin as soon as removal in a given area is completed and would continue during the post-construction period (Saloman et al., 1982). Because of the short-term nature of the recovery, impacts would be negligible, and therefore not significant.

Borrow Site Option 2

Under Borrow Site Option 2, impacts would be similar to those described under Borrow Site Option 1. However, potential impacts to borrow areas would occur over a larger geographic area.

At borrow areas within Option 2, up to 4,492 acres of existing benthic habitat could experience short- to long-term impacts from sediment removal, as reflected in Table 3-6. Under Option 2, no sand would be removed from PBP-AL sites unless contingencies (as discussed in Section 3.4.3) are needed to account for background erosion and/or losses during construction from unforeseen events such as tropical and winter storms. This would result in no impacts or impacts occurring over a shorter duration and smaller area than those of Option 1 for the PBP-AL sites.

At DA-10/Sand Island, impacts would be identical to those of Borrow Site Option 1. Approximately 105 acres of new benthic invertebrate habitat would be created from the removal of an equivalent amount of island habitat.

Because of the short-term nature of the recovery that would occur following dredging, impacts would be negligible and therefore not significant.

Borrow Site Option 3

Under Borrow Site Option 3, impacts would be similar to those described under Borrow Site Option 2. However, potential impacts to borrow areas would occur over a smaller area.

At borrow areas within Option 3, approximately 4,419 acres of existing benthic habitat would experience short-term to long-term impacts from sediment removal, as shown in Table 3-6.

Under Borrow Site Option 3, the area of impact at PBP-AL would be the same as under Borrow Site Option 2, but a greater quantity of sand would be removed compared to Borrow Site Option 2. This would result in impacts occurring over a longer duration at this borrow area and would result in slower recovery of the area. At DA-10/Sand Island, less material would be removed from a smaller area compared to Borrow Site Option 2, as reflected in Table 3-6. This would result in impacts occurring over a shorter duration and faster recovery of the area.

At DA-10/Sand Island, approximately 58 acres of new benthic invertebrate habitat would be created from the removal of an equivalent amount of island habitat. This would result in the creation of a negligible amount of new benthic habitat.

Because of the short-term nature of the recovery that would occur following dredging, impacts would be negligible, and therefore not significant.

5.4.3.3 No-Action Alternative

Continued loss and alteration of coastal ecotone habitat, including intertidal and subtidal habitats used by benthic invertebrate communities, would occur under the No-Action Alternative as a result of continuing erosion of the barrier islands and increasing salinities of the Mississippi Sound. The increase in salinity in the Mississippi Sound, and resulting change in ecological habitats, would impact, if not devastate, shellfish and many other forms of marine life (USACE, 2009a). Oysters currently found in concentrated Mississippi Sound areas would possibly cease to exist, and there would be a decline in shrimp and crab populations inland of the barrier islands.

5.4.4 Fish

In addition to the significance criteria described above for biological resources (introduction to Section 5.4), additional noise-related significance criteria apply to potential impacts to fish communities. NMFS has proposed the development of acoustic threshold levels for the onset of both temporary (TTS) and permanent hearing threshold shifts (PTS) in protected fish species (NOAA, 2013b); however, these criteria are yet to be developed. Therefore, the interim criteria for the onset of physiological effects (see Normandeau Associates Inc., 2012 for details) were used to assess significance. These include a peak sound pressure level of 206 dB re 1 µPa or a cumulative sound exposure level from multiple sources of 187 dB re 1 microPascal over a 1-second period ($\mu Pa^2 sec$) for fishes >2 grams or 183 dB re 1 $\mu Pa^2 sec$ for fishes <2 grams.

5.4.4.1 Tentatively Selected Plan

Ship Island Restoration

Impacts to fish from Ship Island restoration would include noise, some localized, short-term water quality impacts, such as decreased DO, and increased turbidity. The dredging and placement activities for the Camille Cut and East Ship Island Restoration are estimated to be ongoing for 2.5 years from start to finish, as described in Section 3.2.3.3.

Placement of sandy material to create barrier island habitat on Ship Island would result in temporary disruption to the mature fish community in the vicinity. Placement could cause behavioral impairment (e.g., disruption of migration patterns), physical impairment (e.g., turbidity-induced clogging of gills resulting in suffocation, or abrasion of sensitive epithelial tissue), and potentially acute and chronic effects (on growth, reproduction, behavior, etc.) related to exposure to elevated concentrations of suspended sediment (Newcombe and Jensen, 1996). Specific sites on the barrier islands would be used for placement of clean material; therefore, acute and chronic effects to aquatic organisms related to chemical contaminants would not occur. The closure of Camille Cut would eliminate a direct pathway for fish to move from the Sound to the Gulf side of Ship Island; therefore, some species would have to navigate around the island to move offshore. Potential effects to finfish and shellfish associated with placement activities would largely be related to contact with turbidity plumes (placement-induced elevated concentrations of TSS). Although water column turbidity would increase during placement activities, such effects would be temporary and local. Fish would be expected to return after operations cease. Direct impacts to mature fish would be minor and not significant.

Low-mobility lifestages could be impacted through direct burial during placement of sediment. This could include ichthyoplankton suspended in the water column. Egg, embryonic, and larval stages of finfish would be most susceptible to mortality and injury (Blaxter, 1969, 1974; McGurk, 1986; Black et al., 1988; Chambers et al., 1988). Some incidental losses could occur; however, these would represent a very limited portion of the population, and would not result in long-term adverse effects on the fish community. Any impacts would be minor, and therefore not significant.

Indirect impacts to the food web could occur as a result of the placement. In a study by Bolam and Rees (2003), changes in the benthic community were assessed to determine the effects of a change in community structure on bottom-dwelling or demersal species. The review indicated that, based on benthic and fish diet information, the altered benthic community (dominated by small surface-dwelling taxa representative of the early re-colonizers) offered an enhanced trophic structure for the fish community. Any impacts from sediment placement would be minor, and therefore not significant.

Restoration of Ship Island would result in a short-term negative impact to shallow foraging areas and nursery areas during construction. However, it would also result in long-term beneficial impacts to fish habitat by enhancing shallow foraging areas, nursery areas, and SAV areas around the barrier islands in the Mississippi Sound.

Some fish would be lost due to entrainment by dredging equipment. A literature review in the late 1990s (Reine and Clarke, 1998 and references therein) compiled entrainment rates for a variety of species during dredging of estuarine and riverine sites with hopper, pipeline, and clamshell dredges. Fish entrainment rates, regardless of fish size, ranged from 0.001 to 0.135 fish/yd^3 for both pipeline and hopper dredges, with a mortality rate of 37.6 percent (Armstrong et al., 1982 in Reine and Clarke, 1998). Most adult fish and mobile demersal fish species are likely to escape injury by avoiding areas of active sediment removal (BOEM, 2013).

Underwater noise would occur in association with placement activities, including: (1) ship/machinery—associated with onboard machinery and propeller and thruster noise, (2) pumps—associated with pump driving the suction through the pipe, (3) collection—associated with equipment operation and collection of material on the sea floor, (4) deposition—associated with the placement of the material within the barge or hopper and at the restoration location, and (5) transport—associated with transport of material up the suction pipe.

To assess the impacts of underwater noise on biological resources, sound pressure levels (SPLs) are used. The SPL is defined as 10 times the logarithm of the ratio of the intensity of a sound wave to a reference intensity. Based on data collected by the USACE (Reine et al., 2014), SPLs during all five types of noise events above averaged 142.31 dB at a distance of 50 meters from the source. Peak frequencies during the three transition phases ranged from 1.7 to 3 kilohertz (kHz). Peak frequencies of dredging are discussed under Borrow Option 4.

Most fish species can detect sounds in frequencies from 50 Hz to 1,500 Hz (Reine et al., 2014), which is in the range of the dredging activities. Because Mississippi Sound waters and offshore waters near the barrier islands are shallower than the channel, much of the underwater noise in the lower frequencies would have no potential to affect fish, as those lower frequencies would not propagate. Since noise decreases with distance, noise levels would be about 40 dB lower at 100 meters and about 53 dB lower at 0.25 mile (Kipple and Gabriele, 2007). Additionally, underwater noise associated with placement activities is not expected to be much greater than existing ambient underwater noise from shipping traffic. Therefore, underwater noise from Ship Island restoration would be unlikely to cause injury, temporary or permanent, to fish. Impacts would not be significant.

In summary, potential impacts to fish form the Ship Island restoration include:

- Adult fish could experience temporary minor (and therefore not significant) impacts from turbidity plumes and construction-related noise.
- Egg, embryonic, and larval stages of fish could be susceptible to mortality due to placement of material. However, given the amount of habitat and the sizes of fish populations in the Mississippi Sound, impacts would be minor, and therefore not significant.
- Benthic habitat and shallow foraging areas/nursery areas in and near Camille Cut would be permanently lost or experience short-term alteration during construction. Foraging areas, including SAV habitat, would be enhanced north of the closed Camille Cut following restoration. Given the amount of habitat available, impacts would not be significant.

Borrow Site Option 4

Temporary impacts and avoidance activities associated with underwater noise would be similar to impacts described under Ship Island restoration above. Removal of material from Ship Island, PBP-MS, PBP-AL, Horn Island Pass, PBP-MS, and PBP-OCS, and near Cat Island would result in temporary disruption to the mature fish community in the vicinity. Placement or removal of the material could cause behavioral impairment (e.g., disruption of migration patterns), physical impairment (e.g., turbidity-induced clogging of gills resulting in suffocation, or abrasion of sensitive epithelial tissue), and potentially acute and chronic effects (on growth, reproduction, behavior, etc.) related to exposure to elevated concentrations of suspended sediment (Newcombe and Jensen, 1996). Water column turbidity would increase during dredging activities and would result in temporary local effects. Fish would be expected to return after operations cease. Direct impacts to mature fish would be minor and therefore not significant.

Of the five noise event types discussed for Ship Island restoration, dredging activities produced the highest SPLs (144.9 dB) at a distance of 50 meters, followed by the transition from transit to pump-out (144.72 dB). Sediment dredging operations produce noise at frequencies between 100 and 1,100 Hz (Reine et al., 2014), which is within the audible range of many fish species. Suction hopper dredges emit sound levels at peak frequencies generally below 500 Hz, which is within the range commonly associated with cargo ships traveling between 8 and 16 knots. Some dredging activities produce sounds at between 700 and 1,000 Hz (Reine et al., 2014).

Sound generated by dredging is continuous rather than punctuated, and peak intensity from dredging occurs at frequencies between 100 and 1,100 Hz (Reine et al., 2014). The two quietest dredging activities were seawater pump-out (flushing pipes) (SPL = 132.45 dB at 50 meters) and the empty dredge in transit to the borrow site (SPL = 134.74 dB at 50 meters).

Because the dredging noise would occur at a low-frequency range, the fish located around the project area could be susceptible to noise and their activity patterns could be disturbed. Exposure to underwater sound may potentially affect communication, foraging, predator evasion, and navigation of marine organisms, which to various degrees rely on sound to communicate and to derive information about their environment. Dredging-induced sound could affect fish species' migration, communication, and/or foraging behavior (Reine et al., 2014).

At a distance 50 meters from the source, dredging activities would produce SPLs, in the audible hearing range of many fish species, of up to 144.9 dB, Therefore, levels produced by dredging activities would not exceed the onset of physiological effects to fish species (183 to 206 dB re 1µPa) (Normandeau Associates Inc., 2012). Additionally, based on attenuation rates observed by Reine et al. (2014), underwater sounds generated by the dredges would attenuate to background levels at approximately 2 to 2.5 km (1.2 to 1.6 miles) from the source. Assuming the same attenuation distances for the project site, underwater noise levels would attenuate to less than 75 dB re 1µPa at 2.5 km from the source. Wind, rain, and surf conditions would also play a major role in determining the distance to which project related underwater sounds would be potentially audible to nearby receptors. Since dredging produces low levels of sound energy, of short duration, that is attenuated over less than 1.6 miles, the impacts of underwater sound on fish populations are expected to be temporary and localized (Michel et al., 2013) and therefore not significant.

Other sounds occurring in the project area are discussed in Section 4.10, which summarizes the existing conditions. These include fishing/shrimp boats, pleasure craft, dredges, shipping traffic, oil/natural gas rigs, and aircraft from Keesler Air Force Base and Gulfport-Biloxi International Airport. Underwater noise associated with dredging would likely not be much greater than existing ambient underwater noise from these anthropogenic sources. Therefore, underwater noise from dredging would not be expected to cause injury, temporary or permanent, to fish. Impacts would not be significant.

Cat Island Restoration

Placement of sandy material on Cat Island and removal of material from Cat Island borrow area would result in minor impacts to the mature fish community and incidental losses to low-mobility lifestages in the vicinity of the dredging and placement work, similar to those described in the Ship Island/Borrow Site Option 4 restoration discussion above. As with Ship Island, these impacts would be minor (and therefore not significant).

Littoral Placement of Maintenance Dredged Material

Modification to the placement of dredged material at the combined DA-10/littoral zone site would not result in changes to fish communities.

5.4.4.2 Other Alternatives Considered

Borrow Site Option 1

Under Borrow Site Option 1, impacts to fish would be similar to those under Borrow Site Option 4 except that temporary disruptions to adult fish, minor losses to low-mobility lifestages, and potential indirect impacts to the food web would only occur at PBP-AL, DA-10/Sand Island, and Ship Island. Fewer locations and a smaller area would be impacted under Borrow Site Option 1 compared to Borrow Site Option 4. However, impacts would occur over a longer duration and greater area at PBP-AL associated with the greater amount of material that would be removed from that location. Any impacts from sediment removal would be minor, and therefore not significant.

Borrow Site Option 2

Under Borrow Site Option 2, impacts to fish would be similar to those under Borrow Site Option 1 except that temporary disruptions to adult fish, minor losses to low-mobility lifestages, and potential indirect impacts to the food web would occur over a greater area. Impacts would also occur in more locations, including Horn Island Pass, PBP-MS, and PBP-OCS borrow areas. Disruptions would occur over a shorter period at the PBP-AL borrow site compared to Borrow Site Option 1, reflecting the smaller amount of material that would be removed from the site as shown in Table 3-6.Any impacts from sediment removal would be minor, and therefore not significant.

Borrow Site Option 3

Under Borrow Site Option 3, impacts to fish would be similar to those under Borrow Site Option 2. However, disruptions would occur over a longer period at PBP-AL compared to Borrow Site Option 2, reflecting the greater amount of material that would be removed from that location. At PBP-AL, increased quantities of sand would be removed compared to Borrow Site Option 2. At DA-10/Sand Island, a smaller area would be affected and less material removed as reflected in Table 3-6. Any impacts from sediment removal would be minor, and therefore not significant.

5.4.4.3 No-Action Alternative

Under the No-Action Alternative, barrier islands could continue to erode. This could cause permanent impact from the loss of shallow fisheries nursery habitat around the barrier islands and increasing salinity in the estuarine environment of the Mississippi Sound. There would be no impacts to fish at proposed borrow sites.

5.4.5 Marine Mammal Communities

Potential impacts to marine mammals resulting from the dredging, conveyance, and placement of material would be associated with short-term physical disturbances to their habitats, relatively greater exposure to vessel strike, and a relatively greater exposure to noise from vessel activities (dredging, pump-out, etc.).

However, given that additional dredging and placement would occur within areas with existing fishing vessel and ship traffic, and considering the relatively slow speed at which the dredges would operate, the behavior of the species of concern, and implementation of the MAM (Appendix S), only short-term and minor impacts to marine mammal communities are anticipated.

Under the MMPA described in Section 6.10, NMFS has defined noise-related levels of harassment for marine mammals with exceedances of both Level A and Level B thresholds considered “takes” by NOAA. The current Level A (injury) thresholds are 190 and 180 dB rms for pinnipeds and cetaceans, respectively. The current Level B (disturbance) threshold for underwater impulse noise is 160 dB rms and 120 dB rms for continuous noise (e.g., dredging) for cetaceans and pinnipeds, respectively.

In addition to the significance criteria described for biological resources (in the introduction to Section 5.4) and above related to noise, the following significance criteria apply to potential impacts to marine mammal communities:

- A localized loss of a species;
- A permanent habitat change that would make the area unsuitable to meet life history requirements; and
- A disruption that would cause permanent interference with the movement of native resident or migratory marine mammals.

5.4.5.1 Tentatively Selected Plan

Ship Island Restoration

As discussed in Section 4.5.8, there are six threatened or endangered whale species (i.e., whale species protected under both the ESA and MMPA) that are known to occur in the Gulf of Mexico. However, the occurrence of any whale species in any portion of the project area is highly unlikely.

Ship Island restoration would protect coastal ecotone habitats that would likely be lost under the No-Action Alternative. This would have a positive long-term effect on marine mammal communities that utilize estuarine habitats, including manatees and dolphin. It is unlikely that localized sediment removal and placement operations would affect migration, feeding, or reproduction of marine mammals. Three marine mammals commonly found along the continental shelf of the northern Gulf include Atlantic bottlenose dolphin, Atlantic spotted dolphin, and spinner dolphin (MMS, 2000).

Manatee could occur within the Mississippi Sound, but would be unlikely to occur beyond the immediate nearshore coastal areas. Given their slow-moving behavior, manatees could be less likely than other marine mammals to quickly avoid placement operations. However, to minimize contact and potential injury to manatees in shallow water/placement areas, the Manatee Construction Conservation Measures as specified by the USFWS would be observed (Appendix N).

While Atlantic bottlenose dolphin, Atlantic spotted dolphin, and spinner dolphin could pass through the placement and borrow areas associated with the Ship Island restoration, passage would not be geographically restricted to these areas. Other marine mammal species are inhabitants of the deeper waters off the continental shelf and would be unlikely to occur in the location of this alternative. Any species in the vicinity would likely avoid the removal and placement sites during construction and move to other areas within the Sound.

The project area includes no known mating or breeding habitat. No impacts to reproduction would be expected. Any impacts to foraging during removal and placement would be temporary and minor, and, therefore, impacts would not be significant. The dredging and placement activities for the Camille Cut and East Ship Island Restoration are estimated to be ongoing for 2.5 years from start to finish, as described in Section 3.2.3.3. Underwater noise would occur in association with the placement activities as described in the discussion of noise with regard to fish above (Section 5.4.4). Manatees, which may be found in the shallower project areas (i.e., the placement areas), have a functional hearing range from 400 to 46,000 Hz, with peak sensitivities between 16,000 and 18,000 Hz (Michel et al., 2013).

Therefore, dredging and placement activity noise is not within the peak sensitivity range for manatees. Studies by Gerstein (2002) and Miksis-Olds et al. (2007) suggest that manatees may detect underwater sounds generated during dredging and placement activities, but are not likely to be affected by them (Michel et al., 2013).

Only three protected species of dolphins commonly occur in nearshore waters of the Gulf of Mexico, including bottlenose dolphins, Atlantic spotted dolphins, and Risso's dolphins, all of which have functional hearing in high frequencies. SPLs from dredging and placement activities would occur at peak frequencies below that of the bottlenose, Atlantic, and spotted dolphins. Additionally, SPLs from dredging and placement activities, at a distance of 50 meters, are estimated to be less than or equal to 144.9 dB (Reine et al., 2014), which is below the Level A (180 dB re1µPa rms) acoustic threshold for cetaceans and the Level B (160 dB re1µPa rms and 120 dB re1µPa rms) acoustic thresholds for cetaceans. Therefore, no impacts to marine mammals from the proposed project would be expected.

As noted in Section 4, there are no areas critical for migration, feeding, or reproduction of marine mammals in the placement or dredging areas. Therefore, noise generated by dredging and placement activities would not be expected to affect the migration, nursing/breeding, feeding/sheltering, or communication of marine mammals. Because of the ability of these species to relocate, it is unlikely that noise from sediment removal and placement operations would affect them. A key auditory effect would be an increase in background noise levels, which could cause auditory masking: a diminished ability of an animal to detect a relevant sound signal. Masking of marine mammal vocalizations could disrupt the ability to find prey, navigate, and maintain social cohesion (Compton et al., 2008). Based on this analysis, impacts to marine mammals would likely be minor and localized, and therefore not significant.

Other sounds occurring in the project area are discussed in Section 4.10, which summarizes the existing conditions. These include fishing/shrimp boats, pleasure craft, dredges, shipping traffic, oil/natural gas rigs, and aircraft from Keesler Air Force Base and Gulfport-Biloxi International Airport. Underwater noise associated with placement activities would likely not be much greater than existing ambient underwater noise from these anthropogenic sources. Therefore, underwater noise from Ship Island restoration would not likely cause injury, temporary or permanent, to fish. Impacts would not be significant.

Borrow Site Option 4

Underwater noise would occur in association with the dredging activities as described in the discussion of noise with regard to fish above (Section 5.4.4).

Impacts under Borrow Site Option 4 would be similar to those described above for Ship Island restoration but would also include marine mammal species that could occur in the deeper OCS areas. NOAA Fisheries issued the Gulf Regional Biological Opinion for Dredging of Gulf of Mexico Navigation Channels and Sand Mining Areas Using Hopper Dredges by USACE Galveston, New Orleans, Mobile, and Jacksonville Districts (Gulf of Mexico Regional Biological Opinion [GRBO]) (Consultation Number F/SER/2000/01287) dated November 19, 2003. This document stated that the blue, fin, or sei whales would not be adversely affected by hopper dredging operations, since these are deepwater species and unlikely to be found near hopper dredging sites. Additionally, NOAA Fisheries has determined that there are no resident stocks of these species in the Gulf of Mexico, and therefore these species are not likely to be adversely affected by projects in the Gulf (NOAA, 2003). Therefore, no significant impacts would occur.

For hopper dredging activities, to minimize and avoid impacts such as collisions, injury, or losses to marine mammals from the dredge, endangered species observers would be on board and would record all marine mammal sightings and note any potential behavioral impacts. In accordance with the standard USACE specifications for dredging projects, the USACE and the observer would record the date, time, and approximate location of all marine mammal sightings. Care would be taken not to closely approach any whales, manatees, or other marine mammals during removal operations or transport and placement of dredged material. An observer would serve as a lookout to alert the dredge operator or vessel pilot (or both) of the occurrences of the animals. If any marine mammals are observed during other operations, including vessel movements and transit to the dredged material disposal site, collisions would be avoided through reduced vessel speed, course alteration, or both. During the evening hours, when there is limited visibility due to fog, or when there are sea states of greater than Beaufort 3, the dredges would reduce speed to 5 knots or less when transiting between areas if whales have been spotted within 15 nautical miles of the vessel's path in the previous 24 hours. Sightings of whales or manatees (alive, injured, or dead) during the project would be reported to the NMFS Whale Stranding Network.

Cat Island Restoration

Potential impacts to marine mammals at the Cat Island restoration site and borrow area would be similar to those described above for the Ship Island restoration.

There are no areas critical for migration, feeding, or reproduction of marine mammals in the placement or dredging areas. Because of the ability of these species to relocate, it is unlikely that localized sediment removal and placement operations would affect them. No significant impacts would occur.

Littoral Placement of Dredged Material

Modification to the placement of dredged material to the combined DA-10/littoral zone area would not result in changes in potential impacts to marine mammals.

5.4.5.2 Other Alternatives Considered

Impacts under Borrow Site Options 1, 2, and 3 would be similar to those described above for Ship Island restoration. No significant impacts to marine mammals would occur, and there would be positive long-term effects due to the preservation of coastal ecotone habitats.

5.4.5.3 No-Action Alternative

Under the No-Action Alternative, marine mammals would continue to utilize the area without disruption from identified localized temporary impacts (Section 5.4.5.1). However, the continued loss and degradation of coastal ecotone habitats could negatively affect marine mammal communities that utilize estuarine habitats.

5.4.6 Marine and Coastal Birds

Impacts to birds covered under the ESA that may occur in the project area (i.e., piping plover and red knot) are discussed in Section 5.4.8. All other marine and coastal birds are discussed below. Marine and coastal birds could be affected by noise in the air, and could also be transiently affected by underwater noise while diving. Both instances are discussed below. For above air noise, typically, a noise level considered low is less than 45 dB, a moderate noise level is 45-60 dB, and a high noise level is above 60 dB (California State Lands Commission [CSLC] et al., 2005). Noise levels that cause permanent or long-term population avoidance of the area; cause a TTS or PTS in hearing; or cause organ damage or death, would be considered significant.

Seabirds and shorebirds may be sensitive to noise from sediment placement and dredging activities. Sensitive bird species could occur within the project area. Bird species could be displaced from some potential foraging, nesting, and resting areas by noise from equipment on East Ship Island and West Ship Island. Impacts to breeding and roosting areas, including nest abandonment, could occur during placement activities on and adjacent to East and West Ship Islands. Any displacement would be limited to the duration of the restoration activities. Birds would be expected to resume use of these areas following completion of the work.

Impacts from above-ground noise could disrupt nesting behavior in birds, resulting in temporary to long-term impacts. Activities conducted on or immediately adjacent to barrier islands during the nesting season would be preceded by appropriate shorebird nesting surveys. Appropriate steps, including development of buffer areas around identified nesting sites, would be implemented where practical to reduce impacts. Noise impacts to birds are further discussed in Section 5.4.6. Impacts to piping plover and red knot are discussed in Section 5.4.8.

5.4.6.1 Tentatively Selected Plan

Underwater noise would occur in association with the placement and dredging activities as described in the discussion of noise with regard to fish above (Section 5.4.4). As mentioned, dredge noise occurs at frequencies between 100 and 1,100 Hz (Reine et al., 2014).

Air noise associated with restoration would occur from ship operations, use of machinery and heavy equipment, and sand collection/deposition. Mechanical dredging produces noise between 58 and 70 dB at a distance 50 feet from the operation (USEPA, 2003). These fall in the moderate and high noise level ranges mentioned above.

BOEM conducted a literature review for the *Review of Biological and Biophysical Impacts from Dredging and Handling of Offshore Sand* (Michel et al., 2013) and found no measurements of underwater hearing of any diving bird and no studies on the potential impacts of sound from OCS sand dredging and conveyance operations on foraging seabirds. Additionally, there was no assessment of these potential impacts in the reviewed Biological Opinions, EISs, or EAs. However, data collected from terrestrial bird species indicate that birds have hearing capabilities at frequencies from 1 kHz to 5 kHz, with the most sensitive frequencies being between 2 and 3 kHz. Therefore, based on hearing capabilities of terrestrial birds in air, no impacts on foraging seabirds from underwater noise would likely occur, since sounds generated by dredges are lower in frequency than the frequency at which birds can hear.

Air noise effects could occur for the duration of construction. However, perceptions of construction noise would be attenuated by background sounds from wind and surf. Seabirds and shorebirds may be sensitive to air noise from sediment placement and dredging activities. Bird species could be displaced from some potential foraging, nesting, and resting areas by noise from equipment on East Ship Island and West Ship Island.

Impacts to breeding and roosting areas, including nest abandonment, could occur during placement activities on and adjacent to East and West Ship Islands. Any displacement would be limited to the duration of the restoration activities (i.e., 2.5 years). Birds would be expected to resume use of these areas following completion of the work.

Impacts from above-ground noise could disrupt nesting behavior in birds, resulting in temporary to long-term impacts. Activities conducted on or immediately adjacent to barrier islands during the nesting season would be preceded by appropriate shorebird nesting surveys. Appropriate steps, including development of buffer areas around identified nesting sites, would be implemented where practical to reduce impacts. Noise associated with removal activities could disrupt birds foraging in the vicinity. However, these birds are not dependent upon the removal and placement sites for survival. Foraging habitat is readily available in the northern Gulf and the Mississippi Sound, and plunging and diving birds would likely shift to other nearby areas if temporarily displaced.

Ship Island Restoration

Marine and coastal birds are common in the area and could utilize the placement sites at Camille Cut and East Ship Island for foraging, nesting, roosting, or stopovers during migration. Nesting birds typically occupy the area between April and August. Monthly surveys have also identified April to October as the period of greatest overall use of the island by birds (Appendix J). Migrants are typically present from mid-April through early May and early September through mid-October (Moore et al., 1990). Resident species are present year-round.

Migratory birds, which use the barrier islands as critical stopover locations, specifically those migrating north, normally arrive in a stressed condition due to low body reserves of fat. Disturbance from sediment placement could cause some migrants to avoid portions of the barrier islands during restoration activities and could cause additional stress. These migrants would likely seek other unaffected nearby areas.

Birds could temporarily be displaced during sediment dredging as well as during island placement of the sand. Locations used for sediment discharge could serve as an attractant to some species of birds due to the increase in potential food supply. Impacts to breeding and roosting areas, including nest abandonment, could occur during placement activities on and adjacent to East and West Ship Islands. Activities conducted on or immediately adjacent to barrier islands during the nesting season would be preceded by appropriate shorebird nesting surveys. Appropriate steps, including development of buffer areas around identified nesting sites, would be implemented where practical to reduce impacts. Birds would be expected to resume use of these areas following completion of the work.

Work would likely occur during nesting, and appropriate monitoring and surveying would occur as recommended in the MAM Plan (Appendix S). Appropriate steps, including implementation of buffers, would be utilized where practical; however, due to logistical constraints, work would have to continue. For example, once the placement of fill in Camille Cut is initiated, the process would have to continue through completion or the fill material would be susceptible to rapid erosion through the original Camille Cut.

Long-term beneficial impacts to birds, including the recently de-listed eastern brown pelican, following restoration would result from the improved island stability, enhanced nearshore foraging habitat, and an increase of 800 acres of barrier island habitat on Ship Island. However, the proposed placements would result in a beneficial impact to migratory birds from the creation of new barrier island habitat, along with associated new forage and nesting areas, and protection of other adjacent barrier island habitats (e.g., interior wetlands, shrub/scrub, and forested habitats). Proposed vegetation plantings on the new dunes in Camille Cut would provide additional food supply for these coastal, marine, and migratory species. In addition, the restored barrier islands would help protect vital bird habitat along the Mississippi coast from the intensity of storm surges and storm waves (Appendix D).

Borrow Site Option 4

Increased turbidity associated with sediment removal at the Cat Island, Ship Island, PBP-AL, Horn Island Pass, PBP-MS, and PBP-OCS borrow areas could temporarily decrease foraging success of diving and plunging birds that feed in deepwater areas. In addition, noise associated with removal activities could disrupt birds foraging in the vicinity. However, these birds are not dependent upon the removal and placement sites for survival. Foraging habitat is readily available in the northern Gulf and Mississippi Sound, and that plunging and diving birds would likely shift to other nearby areas if temporarily displaced. Following sediment removal and placement, birds would be expected to resume normal use of the area. Any impacts would likely be localized, temporary, and minor, and therefore not significant.

Cat Island Restoration

Marine and coastal birds are common in the area and could utilize the placement sites at Cat Island for foraging, nesting, roosting, or stopovers during migration. Impacts from removal and placement of sediment at Cat Island would be similar to those described for the Ship Island restoration above. These impacts include:

- Foraging, nesting, roosting, and migration stopover habitat would experience significant impacts during restoration. Habitat on and adjacent to restoration areas would be disrupted during mating, nesting, and migration periods. In addition, birds could be disrupted by turbidity plumes, noise, and construction activity.
- Long-term significant beneficial impacts to birds would occur following restoration as a result of improved island stability, enhanced nearshore foraging habitat, and 305 acres of enhanced barrier island habitat. The restored barrier islands would also help protect migratory bird habitat along the Mississippi coast from the intensity of storm surges and storm waves.

When practical, construction activities that can be delayed would be conducted outside of peak breeding and migration periods to reduce potential impacts to marine and coastal birds.

Littoral Placement of Dredged Material

Modification to dredged material placement to the combined DA-10/littoral zone area could result in the gradual erosion of Sand Island. Placement of future dredged material primarily to the south and west would not provide sand to replenish Sand Island; however, this change would provide needed sand to the downdrift Horn Island.

5.4.6.2 Other Alternatives Considered

Borrow Site Option 1

Marine and coastal birds could utilize DA-10/Sand Island for foraging, nesting, roosting, or stopovers during migration. Birds could be displaced during sediment dredging and deterred from using areas in the immediate vicinity of equipment during active periods.

Increased turbidity and elevated noise levels associated with sediment removal at the Ship Island, DA-10/Sand Island, and PBP-AL borrow areas could temporarily decrease foraging success of diving and plunging birds that feed in deepwater areas; however, these birds are not dependent upon the sediment removal and placement sites for survival. Foraging habitat is readily available in the northern Gulf and the Mississippi Sound, and plunging and diving birds would likely shift to other nearby areas if temporarily displaced. Following sediment removal and placement, birds would be expected to resume normal use of the area. Any impacts would likely be localized, temporary, and minor, and therefore not significant.

Borrow Site Option 1 would disrupt resident birds and breeding migrants at DA-10/Sand Island. In addition to short-term impacts to nesting, foraging, and roosting behavior in the vicinity of removal activities, approximately 105 acres of habitat for birds would be permanently lost, representing 69 percent of the available island habitat. Species known to nest at DA-10 include least terns, black skimmers, royal terns, sandwich terns, gull-billed terns, willet, American oystercatcher, snowy plover, and Wilson's plover (NPS, 2011). These species would likely experience a permanent decline in population at Sand Island.

However, long-term beneficial impacts to birds following restoration would result from the improved island stability, enhanced nearshore foraging habitat, and an increase of 800 acres of barrier island habitat on Ship Island. Because of this newly created habitat, impacts to birds from the project would be localized, short-term, and minor, and therefore not significant.

Potential impacts to birds are summarized below:

- Foraging, nesting, roosting, and migration stopover habitat on Sand Island in DA-10 would experience significant impacts during restoration. About 105 acres of habitat would be lost and adjacent areas would experience disruptions during mating, nesting, and migration periods.
- Birds could be temporarily disrupted by turbidity plumes, noise, and dredging activity at all borrow areas.
- Long-term beneficial impacts to birds would occur following restoration from the improved island stability, enhanced nearshore foraging habitat, and an increase of 800 acres of barrier island habitat on Ship Island. Because of this newly created habitat, overall impacts to birds from the project would be localized, short-term, and minor (and therefore not significant).

Borrow Site Option 2

Under Borrow Site Option 2, impacts to birds would be similar to those under Borrow Site Option 1 except that increased turbidity associated with sediment removal would also occur at the Horn Island Pass, PBP-MS, and PBP-OCS borrow areas and could also cause temporary disruptions to birds feeding in those areas. Because of the newly created habitat at Ship Island, impacts to birds would be localized, short-term, and minor, and therefore not significant.

Borrow Site Option 3

Under Borrow Site Option 3, impacts to birds would be similar to those under Borrow Site Option 2 except that the amount of potential nesting habitat lost at DA-10/Sand Island would be less. Approximately 58 acres of habitat for birds would be permanently lost, representing 38 percent of the available island habitat. Nesting species would likely experience a permanent decline in population at Sand Island. However, because of the newly created habitat at Ship Island, impacts to birds would be localized, short-term, and minor, and therefore not significant.

5.4.6.3 No-Action Alternative

Under the No-Action Alternative, barrier islands would continue to degrade and erode and the Mississippi coastal habitats would be at increased risk from storm surges and storm waves. This would reduce the amount and quality of breeding, foraging, and roosting habitat available for migratory, marine, and coastal birds.

5.4.7 Hard Bottom Habitats

The significance criterion for hard bottom habitats would be the permanent loss of hard bottom habitat.

5.4.7.1 Tentatively Selected Plan

No hard bottom habitat is known from the locations associated with the TSP. No impacts would occur.

5.4.7.2 Other Alternatives Considered

No hard bottom habitat is known from the locations associated with any of the borrow site options. No impacts would occur.

5.4.7.3 No-Action Alternative

No change in existing conditions would occur under the No-Action Alternative.

5.4.8 Rare, Threatened, and Endangered Species

In addition to the significance criteria described above for biological resources, additional noise-related significance criteria apply to potential impacts to fish communities. NMFS has proposed the development of acoustic threshold levels for the onset of both TTS and PTS in protected sea turtles (NOAA, 2013b); however, these criteria are yet to be developed. Therefore, to assess significance to threatened or endangered sea turtle species, noise levels that cause permanent or long-term population avoidance of the area; cause a TTS or PTS in hearing; or cause organ damage or death, would be considered significant. For threatened or endangered fish and bird species, impact significance is assessed as outlined in Sections 5.4.4 and 5.4.6, respectively.

5.4.8.1 Tentatively Selected Plan

Ship Island Restoration

Several rare, threatened, or endangered species could occur in the project area, including protected turtle, fish, bird, and mammal species. Marine mammal species are discussed in Section 5.4.5.

Sea Turtles

The hearing threshold for sea turtles ranges from 100 to 1,000 Hz (Ketten and Bartol, 2005), which is within the frequency of sounds produced by dredging and placement activities. However, there are limited data on the sound level that would adversely impact the physiology or behavior of sea turtles or cause potential hearing loss. The U.S. Department of the Navy developed acoustic thresholds and criteria for sea turtles during development of the EIS for Atlantic Fleet Training and Testing (2012). Based on historical data, the U.S. Navy estimated that a temporary reduction in hearing sensitivity would result from continuous sound exposure levels of 178 dB re 1 μPa^2sec, and a permanent reduced sensitivity to sound would occur at sound exposure levels of 198 dB re 1 μPa^2sec. As previously discussed, SPLs from dredging and placement activities, at a distance of 50 meters, are estimated to be less than or equal to 144.9 dB (Reine et al., 2014), which is below the acoustic thresholds developed by the U.S. Department of the Navy (2012). Therefore, no impacts to sea turtles due to noise are anticipated.

Protected turtle species potentially occurring in the area include green, Kemp's ridley, leatherback, hawksbill, and loggerhead sea turtles. Placement activities that could disturb sea turtles include the use of pipelines, barges, anchors, and booster pumps.

Although the islands are not widely used for nesting, at the Camille Cut and East Ship Island placement sites, sea turtle nesting habitat could be affected. In 2012, three loggerhead turtle nests were documented on Cat, West and East Ship Islands, and several additional nests were observed on Horn and Petit Bois Islands. During construction, access would be obtained from the southern and possibly the northern sides of East and West Ship Islands. Land-based equipment and pipelines could temporarily be used on the existing beach. To avoid and minimize potential impacts to nesting sea turtles, daily surveys would be conducted for nests within the construction zone, and the work area would be monitored for potential conflicts with nesting activity throughout the nesting season (April 15 to November 30). If nests are discovered within the work area, the nests would be relocated by appropriate personnel where necessary.

Long-term benefits to potential sea turtle nesting would result from the net increase of 800 acres of new barrier island habitat at Ship Island. No significant long-term impacts to turtle nesting habitat would be anticipated from the sand placement activities.

Localized temporary impacts would occur during the restoration timeframe from the operation of equipment and vessels in borrow and placement areas. The dredging and placement activities for the Camille Cut and East Ship Island Restoration are estimated to be ongoing for 2.5 years from start to finish, as described in Section 3.2.3.3. Normal behavior patterns of sea turtles are not likely to be significantly disrupted by the project activities because of the short-term localized nature of the activities and the ability of sea turtles to avoid the immediate area. Additional discussion of these species and potential impacts are included in a BA prepared for the project (Appendix N).

Gulf Sturgeon

Impacts to Gulf sturgeon from noise would be similar to those described in Section 5.4.4. Noise generated from placement and dredging activities would fall within the range of background noises that already exist in the environment. Gulf sturgeon would be able to move away from the immediate noise sources. The noise levels and durations generated by dredging and placement activities would not be expected to affect the migration, nursing/breeding, or feeding/sheltering of this species. SPLs from dredging and placement activities, at a distance of 50 meters, are estimated to be less than or equal to 144.9 dB (Reine et al., 2014), in the audible hearing range of many fish species. However, levels produced by dredging activities would not exceed the onset of physiological effects to fish species (183 to 206 dB re 1μPa) (Normandeau Associates Inc., 2012). Additionally, based on attenuation rates observed by Reine et al. (2014), underwater sounds generated by the dredges would attenuate to background levels at approximately 2 to 2.5 km (1.2 to 1.6 miles) from the source. Since dredging produces low levels of sound energy, of short duration, that is attenuated over less than 1.6 miles, the impacts of underwater sound on Gulf sturgeon populations are expected to be temporary and localized (Michel et al., 2013) and therefore not significant.

The Gulf sturgeon migrates through the Mississippi Sound and could occur in the Sound at any time. However, recent monitoring has determined that the species appears in greater numbers around East and West Ship Islands in November and December (Appendix K). Sturgeon are a highly mobile species and would likely avoid placement areas due to noise and project activities. The species tends to concentrate around the barrier islands when in the project area (Ross et al., 2009), so it would likely be displaced from some preferred areas by placement activities. Following the completion of placement activities, displaced animals would be expected to resume use of the general area.

The placement activities would result in a loss of approximately 511 acres of GSCH within the Camille Cut and East Ship placement areas, and -168 acres of GSCH at Cat Island. There would be an overall net loss of 0.08 percent of designated critical habitat for the project area. However, beneficial impacts would occur from the creation of new sheltered foraging habitat north of the newly closed 3.5-mile-wide Camille Cut.

Placement and borrow activities could result in bottom disturbance and turbidity that could temporarily affect water quality and prey abundance. Turbidity levels would be monitored during construction to ensure compliance with the state water quality certification. In addition, minor, short-term changes in DO would likely occur during dredging and placement activities. However, no long-term changes in temperature, salinity, pH, hardness, or other chemical characteristics would likely occur. No permanent alteration of critical habitat as a result of changes in water quality would be expected.

Long-term benefits to critical habitat water quality could result from replenishment of barrier islands, which could aid in maintaining the salinity gradient between the Mississippi Sound and the open ocean. The material to be used during the restoration would be predominantly sand-sized particles and would be compatible with adjacent habitats. No change in sediment characteristics would be expected and placement activities would not likely alter critical habitat due to changes in sediment quality. Consequently, no significant impacts to the Gulf sturgeon or their critical habitat would be expected.

Migration of Gulf sturgeon would be permanently altered at Camille Cut, and sturgeon would not be able to move between East and West Ship Islands once the initial berm is established. Consequently, this would be an adverse impact to the Gulf sturgeon and their critical habitat. As mentioned above, the overall net loss is small compared to availability of critical habitat within the entire Mississippi Sound. In addition, placement activities at East Ship Island may temporarily disrupt their movement around the southern shoreline of the island. However, Horn Island Pass to the west and Dog Keys Pass to the east would remain unaffected by the action.

Additional discussion of these species and potential impacts are included in a BA prepared for the project (Appendix N).

Piping Plover and Red Knot

Aboveground noise could cause disruptions to piping plover and red knot, similar to those discussed in Section 5.4.6. That is, based on hearing capabilities of terrestrial birds in air, impacts from underwater noise to foraging seabirds would be unlikely, since sounds generated by dredges are lower in frequency than the frequency at which birds can hear. Impacts from above-ground noise could disrupt nesting behavior in birds, resulting in temporary to long-term impacts. Activities conducted on or immediately adjacent to barrier islands during the nesting season would be preceded by appropriate shorebird nesting surveys. Appropriate steps, including development of buffer areas around identified nesting sites, would be implemented where practical to reduce impacts.

USFWS has designated critical habitat for the wintering piping plover. The project area includes critical habitat for Unit 14. The restoration at Camille Cut and East Ship Island would add approximately 599 acres of usable designated piping plover critical habitat to the existing 139 acres; as a result, there would be 738 acres after the project is completed. This would consist of additional acres of island habitat, including new shoreline and swash zone habitat for the birds to use.

The proposed design for closure of Camille Cut (Figure 5-1) was developed to avoid, to the extent practical, the tips of East and West Ship Islands, which are more heavily utilized by piping plover; however, some portions of the habitat would be temporarily covered during construction activities. In addition, as the land mass of barrier islands and the amount of tidally exposed land increases and becomes colonized by prey items, the amount of potential foraging habitat would increase. Protecting the wintering habitat of the piping plover would result in a long-term positive impact.

Suitable wintering habitat for the red knot, a threatened species under the ESA, exists on East Ship and West Ship Islands and would be temporarily affected. The impacts to Red knots and their wintering habitat is similar to that described for the piping plovers. Aboveground noise could cause disruptions to piping plover and red knot. Typical noise levels produced by construction operations are in the 80- to 95-dB range (CSLC et al., 2005). Mechanical dredging produces noise between 58 and 70 dB for a person 50 feet from the operation (USEPA, 2003). The potential noise effects would occur for the duration of construction. Perceptions of construction noise would be attenuated by background sounds from wind and surf.

North

0 3,000 6,000 9,000
Approximate scale in feet

FIGURE 5-1
CAMILLE CUT AND SHIP ISLAND PLACEMENT AREAS
MsCIP COMPREHENSIVE BARRIER ISLAND RESTORATION SEIS

ES041513031852KNV F5-1_CamilleCut 10/9/14 lk

Birds could be sensitive to noise from sediment placement and dredging activities. Bird species could be displaced from some potential foraging, nesting, and resting areas by noise from equipment at East Ship Island and West Ship Island. Impacts to breeding and roosting areas, including nest abandonment, could occur during placement activities on and adjacent to East and West Ship Islands. Any displacement would be limited to the duration of the restoration activities. Birds would be expected to resume use of these areas following completion of the work.

Impacts from aboveground noise could disrupt nesting behavior in birds, resulting in temporary to long-term impacts. Activities conducted on or immediately adjacent to barrier islands during the nesting season would be preceded by appropriate shorebird nesting surveys. Appropriate measures, including the terms and conditions described in the USFWS BO, dated September 8, 2015, would be implemented to reduce impacts.

Borrow Site Option 4

As noted above in the Ship Island restoration discussion, several species could occur in the project area, including protected species. Noise impacts to these species in borrow areas would be similar to those described in the Ship Island discussion.

Protected turtle species potentially occurring in the area include green, Kemp’s ridley, leatherback, hawksbill, and loggerhead sea turtles. Project implementation could include the use of hydraulic, hopper, or mechanical dredges, pipelines, barges, anchors, and booster pumps. The NOAA Fisheries Service GRBO (2003) determined that a hydraulic cutterhead dredge was not known to impact Gulf sturgeon or sea turtles. The GRBO also identified conditions to minimize the potential for impacts to protected species when using a hopper dredge. The GRBO was amended in 2005 and 2007. Since that time, the NOAA Fisheries Service issued a BO (SER-2012-09304) specifically for this project. The USACE would comply with the terms and conditions in the BO during dredging activities.

Dredging activities would adhere to the reasonable and prudent measures in the NOAA Fisheries Service’s BO (SER-2012-09304) to minimize potential adverse impacts to these protected species.

The Gulf sturgeon migrates through the Mississippi Sound and could occur in the Sound at any time. The Gulf sturgeon feeds on the bottom and could be captured or entrained by some types of dredging equipment (e.g., hopper dredges). Temporary displacement could result from the disturbance associated with dredging activities at the Ship Island Horn Island Pass, PBP-AL, PBP-MS, and PBP-OCS borrow areas. Gulf sturgeon occur regularly in the project area, but dredging impacts would likely be limited to incidental contact during foraging and subsequent avoidance of active work areas. Sturgeon are a highly mobile species and are likely to avoid the project area due to noise and project activities. Following the completion of dredging activities, any displaced animals would be expected to resume use of the general area. Although it would be unlikely, incidental mortality could result from entrainment by dredging equipment, but would not result in large population reductions. The species tends to concentrate around the barrier islands when in the project area (Ross et al., 2009), so it would likely be displaced from some preferred areas by placement activities.

The NOAA Fisheries'sBO (SER-2012-09304) terms and conditions for hopper dredging and relocation trawling limit the incidental take of Gulf sturgeon in the USACE Mobile District to eight (observed and unobserved) fish from hopper dredging and one lethal capture and 30 non-lethal from relocation trawling in state and OCS waters. Because work would comply with the BO, only minor temporary impacts to Gulf sturgeon would be expected and the impacts would not be significant.

The borrow areas in Borrow Site Option 4 do not include any GSCH. However, dredging the borrow areas could cause indirect short- and long-term impacts to the Gulf sturgeon outside of designated critical habitat areas due to impacts to benthic invertebrates (part of their food supply). The portions of the borrow areas that would be impacted are small (4,115 acres) relative to the available habitat in and near the Mississippi Sound and are located outside of critical habitat. Therefore, this change would be unlikely to alter food supply within critical habitat as a result of reduction of prey items. Any impacts would be negligible. Previous studies have found that benthic communities recover rather quickly from these types of disturbances and suggest that impacts on potential prey species would be short-term (Saloman et al., 1982).

Dredging activities could result in bottom disturbance and turbidity that could affect water quality, but impacts from sediment disturbance during dredging would likely be temporary and minor. Suspended particles would settle quickly and have no measurable effects on water quality. Minor, short-term changes in DO and turbidity would likely occur during dredging activities. However, no long-term changes in temperature, salinity, pH, hardness, or other chemical characteristics would likely occur. During dredging activities, turbidity levels would be monitored to ensure compliance with the state water quality certification. No alteration of critical habitat as a result of changes in water quality would be expected. Migration of individual Gulf sturgeon could be temporarily disrupted by dredging activities within the project footprint. However, Horn Island Pass to the west and Dog Keys Pass to the east would remain unaffected by the action. Consequently, no significant impacts to the Gulf sturgeon or their critical habitat would be expected.

Because upland areas would not be impacted, no impacts to piping plover or red knot habitat would occur.

Cat Island Restoration

Potential impacts to threatened and endangered species from placement activities on Cat Island and dredging of the Cat Island borrow area would be similar to those described for the Ship Island restoration. Protective measures utilized for threatened and endangered species would be identical to those described for the Ship Island restoration. When practical, construction activities that can be delayed would be conducted outside of nesting periods for sea turtles. Long-term benefits to potential sea turtle nesting would result from the enhancement of barrier island habitat at Cat Island. No significant long-term impacts to turtle nesting habitat would be anticipated from the sand placement activities.

Temporary displacement could result from the physical and noise disturbances associated with dredging activities at the Cat Island borrow area. Noise impacts would be similar to those described for Ship Island. The BO terms and conditions for hopper dredging and relocation trawling would be followed as described above in the Ship Island restoration discussion. Because work would comply with the BO, only minor temporary impacts to Gulf sturgeon would be expected and the impacts would not be significant.

Activities associated with placement would cover epibenthic crustaceans and infaunal polychaetes that serve as potential prey items for the Gulf sturgeon. The placement activities would result in a loss of approximately 168 acres of GSCH at Cat Island and would contribute to an overall net loss of designated habitat in the Mississippi Sound and near the barrier islands (Appendix N).

Dredging the borrow areas would cause both short- and long-term impacts to the benthic invertebrate food supply for the Gulf sturgeon through a temporary loss of benthic invertebrate populations and disruption of benthic community structure. Approximately 429 acres of benthic habitat associated with the Cat Island borrow area would be affected. Dredging would be unlikely to alter critical habitat as a result of reduction of prey items.

Potential impacts to water quality, sediment quality, and noise would be similar to those described above for the Ship Island restoration. No significant impacts to the Gulf sturgeon or their critical habitat would be expected.

The restoration project would add 162 acres of usable piping plover habitat; as a result, there would be a total of 261 acres of usable habitat once the project is completed and the shoreline has reached equilibrium. Potential habitat for the red knot exists on Cat Island and would be impacted; short-term noise impacts similar to those described for Ship Island could occur. Temporary displacement of red knots and losses and gains to potential habitat would occur during construction, but no significant long-term impacts would be anticipated. During restoration activities, existing swash zone, shoreline, and other upland habitat along Cat Island would be covered. The restoration at Cat Island would result in 305 acres of new enhanced barrier island habitat.

Littoral Placement of Dredged Material

Future placement of suitable sandy material from the Horn Island Pass portion of the Pascagoula Harbor Navigation Channel would be placed farther south and west in the combined DA-10/littoral zone site along the shallow shoals exposed to the open Gulf waves with the greatest sand transport potential (Figure 3-17). The area of potential direct placement would encompass 1,600 acres at depths of 5 to 30 feet.

Summary

The overall potential impacts from the TSP to threatened and endangered species are summarized in the BA and Biological Opinions (Appendix N).

The BA prepared to evaluate impacts from the proposed project on protected species made the following determinations (Appendix N):

- Gulf Sturgeon—may be affected, but not likely to be adversely affected. Continued existence of the species would not likely be jeopardized. The activities associated with this project will not adversely modify designated GSCH. However, NOAA Fisheries did not concur with USACE, Mobile District and concluded in their BO that the project is likely to adversely affect but is not likely to jeopardize the continued existence of the Gulf sturgeon. Additionally, NOAA Fisheries did agree with USACE that the activities associated with this project may affect but are not likely to destroy or adversely modify

Gulf sturgeon critical habitat. The USACE, Mobile District accepts NOAA's opinion, and the associated terms and conditions of their BO.

- Sea turtles (loggerhead, leatherback, green, Kemp's Ridley, and hawksbill)—operations associated with this project may affect, but are not likely to adversely affect and will not jeopardize the continued existence of the species. However, NOAA Fisheries did not concur with USACE, Mobile District and concluded in their BO that the project is likely to adversely affect, but is not likely to jeopardize the continued existence of the loggerhead, Kemp's ridley sea turtle, green sea turtle, and leatherback sea turtle. The USACE, Mobile District accepts NOAA's opinion, and the associated terms and conditions of their BO.
- Piping plover—operations associated with this project are likely to be adversely affected but will not jeopardize the continued existence of the species (Amended BA for USFWS, January 20, 2015, Appendix N). The activities associated with this project will not adversely modify designated Piping plover critical habitat. Project activities would result in a net gain of usable piping plover habitat.

5.4.8.2 Other Alternatives Considered

Borrow Site Option 1

Impacts to the protected species would be similar to those described in Borrow Site Option 4 with the exception of impacts at Sand Island within DA-10. The DA-10 borrow area is located within piping plover and GSCH.

Based on 2010 shoreline data, 240 acres of DA-10/Sand Island borrow area is within the designated piping plover critical habitat, and 112 of these acres are usable (above MLLW). Use of material from this area would result in a loss of 102 acres of piping plover critical habitat. However, only 10 of the 102 acres are considered usable by piping plovers, with elevations from 4 to 5 feet and tidal flats along the perimeter. This portion that is primarily used by birds is located along the southern shoreline and would not be affected by the project.

Based on 2010 shoreline data, 345 acres of DA-10/Sand Island borrow area is within GSCH, and 258 of these acres are usable (below MHW). There would be beneficial impacts from borrow activities at this borrow area, which would result in the restoration of approximately 106 acres of GSCH to the system.

Potential habitat for the red knot, a candidate species for listing under the ESA, exists on the Mississippi barrier islands and Sand Island within DA-10. Sand Island, within DA-10, would be altered by removal of part of the island to use as a sand source for restoration. A total of 105 acres from the northern part of Sand Island, including nearshore areas, would be lost from sand borrow activities. Temporary displacement of red knots and losses of potential habitat would occur from sediment removal but no significant long-term impacts would be anticipated since additional new habitat would be added on Cat Island and the restored Ship Island.

Borrow Site Option 2

Potential impacts to threatened and endangered species under Borrow Site Option 2 would be similar to those under Borrow Site Option 1 with the following exception: use of the Horn Island Pass and PBP-MS borrow areas could also result in short- and long-term negligible indirect impacts to the benthic invertebrate food supply for the Gulf sturgeon through a temporary loss of benthic invertebrate populations and disruption of benthic community structure at those locations. The total amount of impact to potential foraging areas would be 2,501 acres. As with Borrow Site Option 1, only the aquatic portion of DA-10 is within GSCH. Impacts at that location would be identical to those of Borrow Site Option 1. No significant impacts to Gulf sturgeon foraging habitat would be expected.

Borrow Site Option 3

Potential impacts to threatened and endangered species under Borrow Site Option 3 would be similar to those under Borrow Site Option 2 with the following exceptions:

- Removal of material from all areas would total 4,419 acres. This would result in a proportional reduction in potential impacts to the Gulf sturgeon compared to Borrow Site Option 2. As with Borrow Site Option 2, no significant impacts would be expected to Gulf sturgeon foraging habitat under Borrow Site Option 3.
- Removal of material from a different part of DA-10/Sand Island would result in impacts to 58 acres of Sand Island, compared to 105 acres under Borrow Site Option 2. This would result in a proportional reduction in potential impacts to the piping plover and red knot compared to Borrow Site Option 2.

5.4.8.3 No-Action Alternative

Under the No-Action Alternative, the barrier islands could continue to erode, resulting in the potential loss and degradation of habitat for protected species, such as wintering habitat for the piping plover, foraging habitat for the Gulf sturgeon, and foraging and nesting habitat for sea turtles.

5.5 Essential Fish Habitat

The significance criterion for the EFH in the project area would be a permanent change in or loss of the habitat designated as critical to fish species of concern in the Mississippi Sound.

5.5.1 Tentatively Selected Plan

5.5.1.1 Ship Island Restoration

Placement of sand in Camille Cut and on the southern shoreline of East Ship Island could temporarily reduce the quality of EFH in the vicinity and individuals may be displaced. However, ample habitat is available in the vicinity to accommodate these displaced individuals. As noted above, estuarine emergent wetlands (Section 5.4.1), oyster reefs (Section 5.4.3), and SAV (Section 5.4.1) would not likely be adversely affected. Placement operations would cover benthic organisms; however, as detailed in Section 5.4.3, no significant long-term impacts to this resource would likely occur as a result of the TSP. Due to the relatively small area of ecosystem that would be affected (less than 1 percent of the Mississippi Sound), no significant long-term impacts would be expected.

As noted above and notwithstanding the potential harm to some individual organisms, no significant impacts to managed finfish (Section 5.4.4) or shellfish (Section 5.4.3) populations would likely result from sand placement operations. No mitigation would be required for the temporary disruptions to EFH, as the fish would move out of the area during placement activities and would be able to return to the area after activities cease.

Following completion of restoration activities, long-term beneficial impacts to fish and shellfish habitat for breeding and foraging would result from stabilization and enhancement of the shallow water nursery and foraging habitat around the barrier islands and the protection from increasing salinity provided to estuarine waters in the Mississippi Sound.

Borrow Site Option 4

Dredging of the Ship Island, PBP-AL, Horn Island Pass, PBP-MS, and PBP-OCS borrow areas could temporarily reduce the quality of EFH in the vicinity of Borrow Site Option 4. Non-motile individuals would be lost via the dredging activities. The foraging habitat within the disturbed sites may be temporarily unavailable or reduced. Additionally, the diversity of species within that habitat could change. However, ample habitat is available in the vicinity to accommodate these displaced individuals. As noted in Section 5.3, increased water column turbidity during dredging would be temporary and localized. The dredging and placement activities for the Camille Cut and East Ship Island Restoration are estimated to be ongoing for 2.5 years from start to finish, as described in Section 3.2.3.3. Invertebrates relate directly to the concept of EFH because some of the federally managed fishery species and invertebrates form the forage base for benthic feeding fishes that are also federally managed (MMS, 2004). In addition, some invertebrate species form structures or habitats that are used by fishes of varying life stages. Dredging operations would remove or disrupt benthic organisms; however, as discussed in Section 5.4.3, temporary impacts to benthic communities would occur due to dredging activities in the borrow areas, resulting in changes to the local bathymetry and sediment characteristics. However, no significant long-term impacts to this resource would likely occur. The resulting bathymetric changes would be relatively insignificant compared to the adjacent seafloor, as excavation of the borrow material would not result in the formation of significant depressions or basins in relation to the surrounding seafloor surface since the material would be excavated from existing shoals and not from areas of natural seafloor elevations. The borrow sites, once excavated, will be reworked through natural processes, i.e. waves and currents. Overall, the sediment already present would still consist of sandy material because the borrow area cut elevations are designed to leave a buffer of sandy substrate on the seafloor. However, the remaining material may consist of finer-grained sandy material. Because of the change in depth or deepening at the borrow areas, species preferring greater depths would colonize in the post-dredged areas, resulting in a more diverse benthic community that prefers finer sand.

Due to the relatively small area of ecosystem that would be affected (less than 1 percent of the Mississippi Sound) and given the rapid benthic recovery rates as discussed in Section 5.4.3.1, no significant long-term impacts to EFH would be expected. No mitigation would be required for the disruptions to EFH, as the fish would move out of the area during dredging activities and would be able to return to the area after activities cease. Upon recovery of the benthic communities, the borrow areas will approach the natural productivity that existed prior to dredging activities, thus returning the areas into productive EFH.

5.5.1.2 Cat Island Restoration

Dredging of the Cat Island borrow area and placement of sand on the eastern shoreface of Cat Island could temporarily reduce the quality of EFH in the vicinity and individuals may be displaced. However, as with the Ship Island restoration discussed above, ample habitat is available in the vicinity to accommodate these displaced individuals. Estuarine emergent wetlands, oyster reefs, and SAV would not likely be adversely affected. Placement operations would cover benthic organisms; however, as discussed in Section 5.4.3, no significant long-term impacts to this resource would likely occur. Increased water column turbidity during dredging would be temporary and localized. Due to the relatively small area of ecosystem that would be affected (less than 1 percent of the Mississippi Sound), no significant long-term impacts would be expected.

No significant impacts to managed finfish or shellfish populations would likely result from the borrow area dredging and sand placement operations. No mitigation would be required for the temporary disruptions to EFH, as the fish would move out of the area during placement activities and would be able to return to the area after activities cease.

Following completion of restoration activities, long-term beneficial impacts to fish and shellfish habitat for breeding and foraging would result from stabilization and enhancement of the shallow water nursery and foraging habitat around Cat Island.

5.5.1.3 Littoral Placement of Maintenance Dredged Material

Modification of the placement of dredged material to the combined DA-10/littoral zone site would not result in changes in potential impacts to EFH.

5.5.2 Other Alternatives Considered

Borrow Site Option 1

Dredging of the Ship Island, PBP-AL, and DA-10/Sand Island borrow areas could temporarily reduce the quality of EFH in the vicinity of Borrow Site Option 1 and individuals may be displaced. Impacts to the offshore borrow sites will be the same as those described for Borrow Site Option 4. Ample habitat is available in the vicinity to accommodate these displaced individuals. Increased water column turbidity during dredging would be temporary and localized. Due to the relatively small area of ecosystem that would be affected (less than 1 percent of the Mississippi Sound), no significant long-term impacts would be expected.

Although individual organisms could be impacted, no significant impacts to managed finfish or shellfish populations would likely result from the borrow area dredging operations. No mitigation would be required for the temporary disruptions to EFH, as the fish would move out of the area during dredging activities and would be able to return to the area after activities cease.

Borrow Site Option 2

Impacts under Borrow Site Option 2 would be similar to those under Borrow Site Option 1, except that additional short-term impacts to the quality of EFH and displacement of individuals would also occur at the Horn Island Pass, PBP-MS, and PBP-OCS borrow areas as described for Borrow Site Option 4. Because of the amount of habitat available in the Mississippi Sound and along the continental shelf, no significant impacts would be expected. Less material would be dredged from the PBP-AL borrow site compared to Borrow Site Option 1, which would result in impacts occurring over a shorter duration at that borrow area compared to Borrow Site Option 1.

Borrow Site Option 3

Impacts under Borrow Site Option 3 would be similar to those under Borrow Site Option 2, except that more material would be dredged from the PBP-AL borrow site compared to

Borrow Site Option 2, which would result in impacts occurring over a longer duration at that borrow area. No significant impacts to EFH would occur.

5.5.3 No-Action Alternative

The No-Action Alternative could result in continued erosion of the barrier islands and increasing salinity in the Mississippi Sound. Permanent loss or degradation of important breeding and foraging habitat could occur.

5.6 Special Aquatic Sites

The significance criterion for special aquatic sites would be any permanent or long-term adverse impact to such a site.

5.6.1 Tentatively Selected Plan

A portion of the TSP is within the GUIS and is therefore considered a special aquatic site. The TSP was developed in compliance with NPS regulations and management policies for the GUIS. Restoration of the barrier islands would enhance protection for sites, such as the Grand Bay NERR and the Grand Bay National Wildlife Refuge in Jackson County, and Hancock County Marshes by reducing the intensity of storm-related tidal surges.

Because of the distance between the locations associated with the TSP and the nearest marine sanctuaries and NEP, implementation of this alternative would not negatively affect any special aquatic sites in the vicinity of the project.

5.6.2 Other Alternatives Considered

Impacts to special aquatic sites from other alternatives considered would be identical to impacts from the TSP.

5.6.3 No-Action Alternative

The No-Action Alternative would not affect any marine sanctuaries in the Gulf of Mexico.

5.7 Cultural Resources

This section describes the potential impacts on cultural resources from the proposed barrier island restoration project. Federal regulations require consideration of how the TSP, in comparison to the No-Action Alternative, might affect cultural resources. These regulations (36 C.F.R. § 800) also require consultation with the SHPO and other interested parties on the potential effects to cultural resources. The PEIS lists the federally recognized tribes associated with southern Mississippi, and USACE, as the federal agency, consulted with those tribes on that document. Additional consultations for the barrier island restoration are currently ongoing.

The ACHP has developed regulations that guide federal agencies on how to assess effects of their undertakings on cultural resources and to mitigate those effects, if necessary. Effects to cultural resources are defined in the following ways:

No Cultural Resources Affected. Either no cultural resources are present, or there is no effect of any kind, neither harmful nor beneficial, on those resources.

No Adverse Effect. There is an effect, but the effect is not harmful to those characteristics that qualify the property for inclusion in the NRHP.

Adverse Effect. There is an effect, and that effect diminishes the qualities of significance that qualify the property for inclusion in the NRHP.

Effects to cultural resources may be direct or indirect. The planned activities are assessed to determine the likely effect of those activities on the cultural resources and on the qualities that make them NRHP-eligible. In the context of this project, the criteria used to evaluate impacts on submerged or marine archaeological resources would be related to potential impacts to the resources from dredging operations.

In accordance with 36 C.F.R. § 800.5, an adverse effect is found when an undertaking may alter, directly or indirectly, any of the characteristics of a historic property that qualify the property for listing in the NRHP in a manner that would diminish the integrity of the property's location, design, setting, materials, workmanship, feeling, or association. Direct effects are generally defined as the physical destruction or modification of all or part of a resource. Indirect effects vary, but are typically characterized as the introduction of audible, visual, and atmospheric elements that alter the qualities that make a property eligible for listing in the NRHP. Indirect effects, in the context of cultural resources, are primarily defined as effects that are not caused by a physical impact on the property. Potential adverse effects on cultural resources include, but are not limited to, the following:

- Physical destruction of or damage to all or part of the property;
- Alteration of a property (for example restoration, rehabilitation, or repair that is not consistent with the Secretary of the Interior's standards for the treatment of cultural resources);
- Removal of the property from its historic location;
- Change of the character of the property's use or of physical features within the property's setting that contribute to its historic significance; and
- Introduction of visual, atmospheric, or audible elements that diminish the integrity of the property's significant historic features.

For the borrow areas, all magnetic and acoustic anomalies are to be avoided by 50 meters (164 feet) from the edge of the contacts. Thus, borrow activities will have No Effect to cultural resources. For the magnetic anomalies within the proposed access corridors: targets that were investigated by divers and determined to be modern debris are not eligible for the National Register of Historic Places and movement or destruction of that modern debris (less than 50 years old) will have No Effect on cultural resources. Those targets that were probed to at least the required 12 feet of depth required for the access corridors with negative results will not be directly impacted by the construction of the access corridors, but must still be considered potentially significant cultural resources. Thus the construction of the access corridors will have No Effect on those potential cultural resources. Those magnetic anomalies that were not probed, as well as those that were probed with positive returns at less than 12 feet of depth will be considered as potentially eligible and avoided.

Thus, construction activities will have No Effect on those potential cultural resources (Table 5-4).

After consultation with archaeologists with the National Park Service it was determined that, provided no disturbance occurs below 2 feet on the seafloor, there will be No Adverse Effect on the Quarantine Station site (22HR639) on East Ship Island. There are no other terrestrial sites on East or West Ship Island that will be impacted by the proposed barrier island restoration. Consequently, this undertaking will have No Effect on terrestrial cultural resources.

A recent survey located magnetic anomalies in the placement area for the restoration of Cat Island. A final report is to be delivered by the contractor following data analysis. These are considered potentially eligible at this time (pending the report) and no work on Cat Island restoration will proceed until these can be further investigated or avoided. As of now, activities will have No Effect on these potential cultural resources.

A summary of cultural resource effects determinations is provided in Table 5-4.

TABLE 5-4
USACE Effects Determinations

Potential or Eligible or Ineligible Historic Property	USACE Effects Determinations
Magnetic or acoustic anomalies in Borrow Areas	No Effect - Avoidance
Magnetic Anomalies, Diver Investigated (Modern)	No Effect - Ineligible Sites
Magnetic Anomalies, Diver Investigated to at least 12 feet	No Effect - Avoidance by depth
Magnetic Anomalies, Not Investigated	No Effect - Avoidance
Quarantine Station	No Adverse Effect-NPS Effects Determination-Mitigation through Documentation
Terrestrial	No Effect - Avoidance
Cat Island	No Effect - Avoidance

5.7.1 Unanticipated Discoveries of Archaeological Sites, Historic Sites, and Submerged Cultural Resources Including Human Remains

Although a project area may undergo a complete and thorough cultural resource assessment survey, it is impossible to guarantee that all cultural resources have been discovered. Even at sites that have been previously identified and assessed, there is a potential for the discovery of previously unidentified archaeological components, features, or human remains that may require investigation and assessment. Therefore, a procedure has been developed for the treatment of any unexpected discoveries that may occur during site development.

If unexpected potential cultural resources are discovered, the following steps will be taken:

1. All work in the immediate area of the discovery should cease and reasonable efforts should be made to avoid or minimize impacts to the cultural resources.

2. The USACE District Tribal Liaison should be contacted immediately and should evaluate the nature of the discovery.
3. The USACE should then contact the State Historic Preservation Office (SHPO) and if necessary, the National Park Service and/or BOEM.
4. As much information as possible concerning the cultural resource, such as resource type, location, and size, as well as any information on its significance, should be provided to the SHPO or other agencies as applicable.
5. Consultation with the SHPO should occur in order to obtain technical advice and guidance for the evaluation of the discovered potential cultural resource in terms of the State Preservation and Historic Management Plan.
6. If necessary, a mitigation plan should be prepared for the discovered cultural resource. This plan should be sent to the SHPO and/or other agencies as applicable for review and comment. The SHPO should be expected to respond with preliminary comments within two working days, with final comments to follow as quickly as possible.
7. If a formal data recovery mitigation plan is required, development activities in the near vicinity of the cultural resource should be avoided to ensure that no adverse effect on the resource occurs until the mitigation plan can be executed.

In the event that unrecorded shipwreck sites and/or other underwater archaeological resources are discovered (adapted from The Commonwealth of Massachusetts, Board of Underwater Archaeological Resources, Office of Coastal Zone Management), the following steps will be taken:

1. In the event that a suspected shipwreck or other site is u encountered during construction activity, that activity shall immediately be halted in the area of the find until it can be determined whether the object is a shipwreck or other underwater archaeological resource and if it represents a potentially significant feature or site.
2. The project field staff will immediately notify the USACE District Archaeologist upon the suspension of work activities in the area of the find. Notification will include the specific location in which the potential feature or site is located.
3. The USACE will immediately ensure a qualified Maritime Archaeologist reviews the information. On-site personnel will provide information on the location and any discernible characteristics of the potential cultural resource (the target), and any survey data depicting the find. USACE will forward this information to the qualified Maritime Archaeologist for review
4. If the qualified Maritime Archaeologist determines that the site, feature, or target is not potentially cultural, the USACE will be notified that work may resume.
5. If, based upon both previously acquired and current remote sensing survey data, or other indications (e.g., timbers, etc.), it is determined that the new target is possibly a shipwreck or other potential submerged cultural resource, the qualified Maritime Archaeologist will inform the USACE, who will inform the project field staff that work may not resume at the given location until notified in writing by the USACE. The

cognizant review agencies, SHPO, Advisory Council (if applicable), and other agencies as applicable will be notified of this determination within 2 working days.

6. A visual inspection by archaeological divers or remotely operated vehicle (ROV) will be conducted to determine if the site is potentially eligible for listing in the National Register. The results of the survey will be formally submitted to cognizant review agencies, SHPO, and the Advisory Council (if applicable) for final review and comment. The SHPO and USACE will endeavor to respond within 2 working days of receiving the inspection results and recommendations.

7. If it is determined that the target, feature, or site does not represent a potentially significant resource, and USACE is in receipt of written comment from the review agency(s), work may resume in that area.

8. If a National Register determination cannot be made in accordance with Step 6, the USACE may either undertake additional research to satisfy Step 6 or exercise Step 9 (avoidance).

9. If agency review concurs or concludes that the site may be important and is potentially National Register eligible, the USACE will develop avoidance measures to eliminate the site from the Area of Potential Effects. Any proposed avoidance measures will be made available to the cognizant review agencies for review and comment.

10. If avoidance measures cannot be developed and executed, the resource may be excavated and/or removed only under a memorandum of agreement with all interested parties including the State Archaeologist, SHPO, USACE, and, if applicable, the Advisory Council subject to appropriate state permits and appropriate federal jurisdictions. This memorandum will outline an adequate data recovery plan that specifies a qualified research team and an appropriate research design.

5.7.2 Tentatively Selected Plan

5.7.2.1 Ship Island Restoration

Known terrestrial sites would be avoided. As a result, there would be no direct impact to Fort Massachusetts on the north shore of West Ship Island, or to the French Warehouse site on the north shore of East Ship Island. After consultation with archaeologists with the National Park Service it was determined that provided that no disturbance occurs below two feet on the seafloor there will be No Adverse Effect on the submerged portions of the Quarantine Station site (22HR639) on East Ship Island. Due to the immediate threat to Fort Massachusetts, an early restoration was accomplished in 2011 to 2012 that resulted in the placement of 600,000 cubic yards of sand on the north shore of West Ship Island (USACE, 2011b). The comprehensive barrier island restoration would add a greater land area between these resources and the Gulf waters. This increase in land area, while not eliminating the threat of erosion to the resource, would substantially reduce that threat. Sediments that would be used for restoration are similar to the existing shoreline sand and would be compatible with the historical viewshed of the fort. This would be considered a beneficial effect to this cultural resource and would reduce threats from natural disasters and normal wave action (USACE, 2010b). There would be no adverse effect to Fort Massachusetts, or the French Warehouse site, or any other known site from the proposed barrier island restoration project. Site 22HR1106, identified as a NAGPRA site, will be avoided by all construction activities. All other activities regarding this particular site are being coordinated by the NPS.

At potential placement areas (Camille Cut, East and West Ship Island), remote sensing surveys to identify any potential anomalies have been completed. Following coordination with the NPS, these surveys were coordinated with the Mississippi SHPO and Federally recognized Tribes. Additionally, NPS guidance regarding areas to avoid during implementation and construction will be followed to the maximum extent practicable. These surveys have been coordinated with the Mississippi SHPO and Federally recognized Tribes. All coordination letters received to date are located in Appendix T.

Borrow Site Option 4

At borrow sites associated with Borrow Site Option 4 (Ship Island, PBP-AL, PBP-MS, PBP-OCS, and Horn Island Pass), remote sensing surveys have been completed to identify any potential anomalies. Following these surveys, coordination with the Mississippi SHPO, NPS, and interested tribal governments occurred. Due to avoidance of any potentially eligible sites, no effects on significant cultural resources would occur from the borrow activities. However, should any newly identified cultural resources be discovered that were not located by earlier surveys, they will be addressed with appropriate measures identified in consultation with the SHPO.

5.7.2.2 Cat Island Restoration

There are a number of known cultural sites on Cat Island, only two of which are within the APE (22Hr1174 and 22Hr1177). All known cultural sites will be avoided to the maximum extent practicable; however, if they cannot be avoided due to engineering constraints, a path forward will be coordinated with the NPS, the Mississippi SHPO, and Federally recognized Tribes as appropriate. Based on existing information, no effects on significant cultural resources would occur from sand placement at Cat Island. At borrow sites, within contractor access corridors, and within the final footprint of the restoration efforts associated with Cat Island, remote sensing surveys have been completed. These surveys indicate the presence of four magnetic anomalies within the aquatic portion of the restoration footprint. Upon delivery of the final maritime Phase I survey report of the submerged bottomlands around Cat Island, the USACE maritime archaeologist will determine whether these four anomalies require further investigation. If they do not, the project can move forward with No Effect on cultural resources. If the targets merit further investigation, a Phase II maritime survey will be conducted by professional maritime archaeologists to assess NRHP eligibility of the anomalies. The USACE maritime archaeologist will use this data to determine whether the anomalies are potentially eligible for the NRHP. If they are not potentially eligible, the project can move forward with No Effect to cultural resources. If the anomalies are found to be potentially eligible for the NRHP, the USACE maritime archaeologist will coordinate with the Mississippi SHPO and the Advisory Council of Historic Preservation on how best to mitigate the site or sites. Mitigation measures could involve Phase III data recovery, mitigation by documentation, encapsulation in compliance with NPS Technical Brief No. 5 (Intentional Site Burial: A Technique to Protect against Natural or Mechanical Loss), or a combination of the three options. The results of this coordination will be documented in the ROD.

5.7.2.3 Littoral Placement of Dredged Material

Modification of the placement location for maintenance dredged material to the combined DA-10/littoral zone site would enhance littoral transport of sand out of the area and to barrier islands located to the west. This material could help nourish those islands and could help protect the cultural resources located there.

5.7.3 Other Alternatives Considered

Various combinations of borrow sites were identified as summarized in Table 5-1. Borrow Site Options 1 through 3 all include the removal of sand from the area identified as DA10/Sand Island, Option 4 (Preferred Alternative) does not include this site. Other differences in borrow site use is that Option 1 does not use sand from Horn Island Pass, PBP-MS, and PBP-OCS and Option 2 does not use sand from PBP-AL. Since all identified anomalies within the borrow sites are being avoided the impacts on cultural resources are similar except for the use of DA-10/Sand Island as described below.

Borrow Site Option 1

Under Borrow Site Option 1, no significant impacts would occur. DA-10/Sand Island is an existing dredged material disposal site and would not be excavated below the grade of historical fill. There would be no potential for impacts on cultural resources. At other potential borrow sites (Ship Island and PBP-AL), remote sensing surveys have been completed to identify any potential anomalies. Following these surveys, coordination with the Mississippi SHPO, BOEM, and interested tribal governments occurred. Based on existing information, no effects on cultural resources from the borrow activities would occur. All potential cultural resources including a buffer of 50 meters around the resource are to be avoided, thus there will be No Effect on cultural resources. This plan has been coordinated with both the Mississippi and Alabama SHPOs.

Borrow Site Option 2

Under Borrow Site Option 2, no significant impacts would occur. DA-10/Sand Island is an existing dredged material disposal site and would not be excavated below the grade of historical fill. There would be no potential for impacts on cultural resources. At other borrow sites (Ship Island, PBP-AL, PBP-MS, PBP-OCS, and Horn Island Pass), remote sensing surveys are have been completed to identify any potential anomalies. Following these surveys, coordination with the Mississippi SHPO, BOEM, and interested tribal governments occurred. Based on existing information, no effects to significant cultural resources from the borrow activities would occur. All potential cultural resources and a buffer of 50 meters are to be avoided, thus there will be No Effect to cultural resources. This plan has been coordinated with both the Mississippi and Alabama SHPOs.

Borrow Site Option 3

Under Borrow Site Option 3, impacts to cultural resources would be identical to those under Borrow Site Option 2.

5.7.4 No-Action Alternative

Fort Massachusetts and the French Warehouse site, over the long-term, are threatened by increased wave action and erosion from both Gulf and Mississippi Sound waters. Part of the warehouse site is covered by maritime forest, which is likely slowing erosion in that area, but it is still susceptible to storm damage and other natural elements. The fort suffered extensive damage from Hurricane Katrina, including to the earthen berm, the interior, domed surfaces, cannon carriages, and individual artifacts associated with the fort. The fort has been damaged by tropical weather over the decades and the continued threat of additional storms, storm surge, and continued erosion indicates that the survival of the fort over the long-term is unlikely under the No-Action Alternative. There would likely be an adverse effect to existing historic and cultural resources from the No-Action Alternative.

5.8 Visual and Aesthetic Resources

The significance criteria for visual and aesthetic resources would be a permanent impairment to the viewshed or permanent loss of aesthetic resources.

5.8.1 Tentatively Selected Plan

5.8.1.1 Ship Island Restoration

Temporary impacts to aesthetics would occur in the immediate vicinity of placement activities during construction. Many people utilize the Mississippi Sound and the barrier islands within the project area and would likely be disturbed by the presence of heavy equipment and working vessels during the restoration. However, overall sediment placement activities would be short-term and individual placement activities would be temporary. Impacts would be minor, and therefore not significant.

The barrier island restoration project would likely provide residents and visitors with an overall more aesthetically pleasing view as activities are completed and would result in long-term improvements to visual and aesthetic resources.

Borrow Site Option 4

As with the Ship Island restoration above, impacts to aesthetics would occur in the immediate vicinity of sediment removal activities as a result of the presence of working vessels during sediment removal activities. However, impacts from sediment dredging activities would be temporary and minor, and therefore not significant.

5.8.1.2 Cat Island Restoration

Temporary impacts to aesthetics at the Cat Island placement and borrow areas would be similar to those described for the Ship Island restoration above. Sediment dredging and placement activities would be temporary and impacts would be minor, and therefore not significant.

5.8.1.3 Littoral Placement of Dredged Material

Modification of the placement of dredged material to the combined DA-10/littoral zone site would not result in any change in the existing aesthetic environment in the Horn Island Pass vicinity.

5.8.2 Other Alternatives Considered

Borrow Site Option 1

Temporary impacts to aesthetics similar to those described under the Ship Island restoration would occur in the immediate vicinity of sediment removal activities. Many people utilize the Mississippi Sound within the project area and would likely be disturbed by the presence of working vessels during the restoration. However, sediment dredging activities would be temporary and impacts would be minor, and therefore not significant.

Borrow Site Option 2

Impacts under Borrow Site Option 2 would be similar to those under Borrow Site Option 1, except that temporary impacts would also occur at the PBP-MS, PBP-OCS, and Horn Island Pass borrow areas.

Borrow Site Option 3

Impacts under Borrow Site Option 3 would be similar to those under Borrow Site Option 2.

5.8.3 No-Action Alternative

Under the No-Action Alternative, gradual alteration of the visual aesthetic quality of the barrier islands would occur as a result of continuing island erosion, vegetative changes, and island land loss.

5.9 Noise

This section evaluates changes to air noise levels that would impact human receptors. Impacts to non-human receptors were discussed in Sections 5.4.4., 5.4.5, 5.4.6, and 5.4.8.

Humans have a relatively low sensitivity to noise with a frequency lower than 1 kHz. When sound pressure doubles, the A-weighted decibel scale (dBA) level increases by 3. Psychologically, most humans perceive a doubling of sound as an increase of 10 dBA (USEPA, 1974). Sound pressure decreases with distance from the source. Typically, the amount of noise from a continuous source is halved (reduced by 3 dBA) as the distance from the source doubles (USEPA, 1974).

The significance criteria for air noise impacts would be a permanent elevation of above-surface noise levels compared to existing ambient conditions or temporary creation of a high noise level (>85 dB) in the vicinity of sensitive human receptors. Typically, a noise level considered low is less than 45 dB, a moderate noise level is 45 to 60 dB, and a high noise level is above 60 dB (CSLC et al., 2005). For determination of impacts on human receptors, noise measurements are weighted to increase the contribution of noises within the normal range of human hearing and to decrease the contribution of noises outside the normal range of human hearing. Human hearing is best approximated by using a dBA scale. This scale takes into account the lower sensitivity of the human ear to noise with a frequency lower than 1 kHz. When sound pressure doubles, the dBA level increases by 3. Psychologically, most humans perceive a doubling of sound as an increase of 10 dBA (USEPA, 1974). Sound pressure decreases with distance from the source and would be dependent on wind and wave conditions in the vicinity

The significance criteria for noise impacts would be a permanent elevation of above-surface noise levels compared to existing ambient conditions or temporary creation of a high noise level (>85 dB) in the vicinity of sensitive human receptors.

Significance criteria for non-human receptors are discussed in Sections 5.4.4., 5.4.5, 5.4.6, and 5.4.8.

5.9.1 Tentatively Selected Plan

There are no sensitive human noise receptors in the open water of the Mississippi Sound or in the OCS. There are only limited sensitive human noise receptors on the Mississippi barrier islands (i.e., vacation houses on Cat Island). The next nearest significant human receptors are residential areas and schools along the coastline. In addition to these, temporary park visitors and NPS staff within the GUIS and pleasure boaters and fishermen in the Mississippi Sound are present periodically within the project area.

There are non-human sensitive receptors of concern in the project area, including fish, marine mammals, marine and coastal birds, and threatened and endangered sea turtle and bird species. Impacts to each of these receptors are discussed below.

5.9.1.1 Ship Island Restoration

Underwater noise would occur in association with placement and dredging activities, as described in Section 5.4. There would be no impacts to human receptors due to increases in underwater noise.

Air noise that would occur during construction is detailed in Section 5.4.6. Mechanical dredging produces noise between 58 and 70 dB at a distance of 50 feet from the operation (USEPA, 2003). These fall in the moderate and high noise level ranges mentioned above.

There are limited numbers of sensitive-noise receptors within a 1-mile radius of any locations in the Ship Island restoration. These receptors consist of people recreating or working in the vicinity of sediment placement and dredging locations and could be temporarily impacted by elevated noise levels. Typically, the amount of noise from a continuous source is halved (reduced by 3 dBA) as the distance from the source doubles (USEPA, 1974). Additionally, wind and surf conditions would play a major role in determining the distances at which the construction-related sounds could be heard by nearby receivers. Studies have shown that the effects of wind on sound propagation can be substantial, with upwind attenuation approaching 25-30 dB more than downwind attenuation at the same distance from the source (Wiener and Keast, 1959).Thus, construction-related noise levels would vary, but would likely not be substantial.

The potential noise effects would occur for the duration of construction, which is estimated to be 2.5 years. Perceptions of construction noise would be attenuated by background sounds from wind and surf. Because noise impacts would be limited to the duration of construction and would occur only in restoration areas, no significant noise impacts would occur.

Above Surface Noise

Noise in the outside environment associated with restoration activities would be expected to minimally exceed normal ambient noise levels. Surface noise associated with restoration would occur from ship operations, use of machinery and heavy equipment, and sand collection/deposition.

There are limited numbers of sensitive noise receptors within a 1-mile radius of any locations in the Ship Island restoration. These receptors consist of people recreating or working in the vicinity of sediment placement and dredging locations and could be temporarily impacted by elevated noise levels. Typical noise levels produced by construction operations are in the 80- to 95-dB range (CSLC et al., 2005). Mechanical dredging produces noise between 58 and 70 dB for a person 50 feet from the operation (USEPA, 2003). The potential noise effects would occur for the duration of construction, which is estimated to be 2.5 years. Perceptions of construction noise would be attenuated by background sounds from wind and surf.

Underwater Noise

Underwater noise would occur in association with placement and dredging activities as described in the Sand Island discussion of noise with regard to fish above.

The primary species of concern for underwater noise impacts during construction are marine mammals, turtles, and finfish. Underwater noises could trigger avoidance reactions in those marine species. However, noise would not occur at levels known to cause injury, temporary or permanent, to marine life and significant impacts would not occur. Potential noise impacts to these species are discussed in the following sections:

- 5.4.4 Marine Mammals;
- 5.4.7 Sea Turtles;
- 5.4.3 Finfish; and
- 5.4.7 Gulf Sturgeon.

Because noise impacts would be limited to the duration of construction and would occur only in restoration areas, no significant noise impacts would occur.

5.9.1.2 Borrow Site Option 4

Under Borrow Site Option 4, noise associated with sand removal would occur at the Ship Island, PBP-AL, Horn Island Pass, PBP-MS, and PBP-OCS borrow areas. Noise would not occur near any sensitive human receptors. Therefore, impacts would not be significant.

Impacts to bird and marine species are described under the individual discussions for those species (see Ship Island restoration discussion above for references to section numbers). Noise impacts under Borrow Site Option 4 would occur at the Ship Island, PBP-AL, Horn Island Pass, PBP-MS, and PBP-OCS borrow areas. Noise would not occur at levels known to cause injury, temporary or permanent, to marine life and significant impacts would not occur.

Because noise impacts would be temporary—limited to the duration of dredging activities—and would not occur at levels that would cause injury, no significant noise impacts would occur.

5.9.1.3 Cat Island Restoration

Impacts at the Cat Island placement and borrow areas would be similar to those described under the Ship Island restoration above. Noise receptors within a 1-mile radius of any locations associated with restoration include vacation homes on Cat Island, which would be temporarily impacted by elevated noise levels. In addition, receptors include people recreating or working in the vicinity of the Cat Island sediment borrow area. These receptors would experience temporary to long-term impacts, but impacts would not be significant. Because noise impacts would be limited to the duration of construction (2.5 years) and would occur only in restoration areas, no significant noise impacts would occur.

Impacts at the Cat Island placement and borrow areas would be similar to those described under the Ship Island restoration above. Noise receptors within a 1-mile radius of any locations associated with restoration include vacation homes on Cat Island, which would be temporarily impacted by elevated noise levels. In addition, receptors include people recreating or working in the vicinity of the Cat Island sediment borrow area. These receptors would experience temporary to long-term impacts, but impacts would not be significant.

Impacts to bird and marine species are described under the individual discussions for those species (see Ship Island restoration discussion above for references to section numbers). Noise would not occur at levels known to cause injury, temporary or permanent, to marine life and significant impacts would not occur. Impacts from above-ground noise including, human presence, equipment and dredging and placement of dredged material activities, could disrupt nesting behavior in birds, resulting in temporary to long-term impacts.

Because noise impacts would be limited to the duration of construction and would occur only in restoration areas, no significant noise impacts would occur.

5.9.1.4 Littoral Placement of Dredged Material

Modification to the placement of navigation dredged material to the combined DA-10/ littoral zone site would not result in any change in the existing noise environment of the area.

5.9.2 Other Alternatives Considered

5.9.2.1 Borrow Site Option 1

Under Borrow Site Option 1, noise impacts could occur as described above under the Ship Island restoration discussion. Noise levels would not be elevated near any above-surface sensitive receptors. Therefore, impacts would not be significant.

Impacts to bird and marine species are described under the individual discussions for those species (see Ship Island restoration discussion above for references to section numbers). Noise impacts would occur at the Ship Island, DA-10/Sand Island, and PBP-AL borrow areas. Noise would not occur at levels known to cause injury, temporary or permanent, to marine life and significant impacts would not occur. Impacts from above-ground noise at DA-10/Sand Island could disrupt nesting behavior in birds, resulting in temporary to long-term impacts.

Because noise impacts would be temporary—limited to the duration of dredging activities—and would not occur at levels that would cause injury, no significant noise impacts would occur.

5.9.2.2 Borrow Site Option 2

Noise impacts under Borrow Site Option 2 would be similar to those under Borrow Site Option 1. However, noise impacts could also occur at the Horn Island Pass, PBP-MS and PBP-OCS borrow areas. As with Borrow Site Option 1, the noise under Borrow Site Option 2 at these additional locations would not occur at levels known to cause injury, temporary or permanent, to marine life and would not be elevated near any above-surface sensitive receptors.

5.9.2.3 Borrow Site Option 3

Noise impacts under Borrow Site Option 3 would be similar to those under Borrow Site Option 2. However, dredging would occur over a shorter duration and result in decreased disruptions of breeding birds at borrow area DA-10/Sand Island, reflecting the time it would take to remove the sand due to the smaller size of that site under Borrow Site Option 3.

5.9.3 No-Action Alternative

The No-Action Alternative would cause no new or increased noise conditions. Therefore, no noise-related impacts would occur.

5.10 Air Quality

The significance criterion for air quality impacts would be an exceedance of a chronic or acute state air quality standard. The coastal counties of Mississippi are currently in attainment for all NAAQS.

5.10.1 Tentatively Selected Plan

5.10.1.1 Ship Island Restoration

Air emissions associated with sediment removal and placement operations would likely be minor. Sediment removal and placement would be conducted using dredging equipment. The USACE Mobile District has historically dredged the navigation channels for Gulfport, Biloxi, and Pascagoula Harbors, including several improvement projects, without violating an air emission standard. In addition, detailed air quality analyses have been performed for dredging locations in nonattainment areas in San Diego, California and Texas City, Texas. Analysis of those operations determined that they would not cause significant air quality impacts (USACE, 2002; USACE, 2007b). Similar equipment and methods would be used for restoration activities, and any air quality impacts would not be significant.

Appropriate technologies would be used to minimize air emissions in the project area, including the use of electric equipment, low sulfur diesel fuel in equipment (such as dredges, tugs, and other diesel-powered equipment), fuel additives, and particulate filters.

Borrow Site Option 4

Under Borrow Site Option 4, potential air quality impacts would occur as described above under the Ship Island restoration discussion. In addition to placement locations at East Ship Island, West Ship Island, and Camille Cut, air impacts would occur at the Ship Island, PBP-AL, Horn Island Pass, PBP-MS, and PBP-OCS borrow areas. Air emissions would not occur at significant levels.

5.10.1.2 Cat Island Restoration

Impacts at the Cat Island placement and borrow areas would be similar to those described under the Ship Island restoration above. These impacts would not be significant.

5.10.1.3 Littoral Placement of Dredged Material

Modification to the placement of navigation dredged material to the combined DA-10/ littoral zone site would not result in any change in the existing air quality in the area.

5.10.2 Other Alternatives Considered

Borrow Site Option 1

Under Borrow Site Option 1, air quality impacts could occur as described above under the Ship Island restoration discussion. In addition to placement locations at East Ship Island, West Ship Island, and Camille Cut, air impacts would occur at the Ship Island, DA-10/Sand Island, and PBP-AL borrow areas. Air emissions would not occur at significant levels.

Borrow Site Option 2

Impacts to air quality under Borrow Site Option 2 would be similar to those for Borrow Site Option 1. However, emissions would occur over a longer duration due to increased travel and operation time associated with dredging at additional borrow areas (Horn Island Pass, PBP-MS and PBP-OCS).

Borrow Site Option 3

Impacts to air quality under Borrow Site Option 3 would be similar to those for Borrow Site Option 2.

5.10.3 No-Action Alternative

Under the No-Action Alternative, no impacts to air quality would occur.

5.11 Recreation

A permanent disruption, limitation, or alteration of recreation potential would be considered a significant impact.

5.11.1 Tentatively Selected Plan

5.11.1.1 Ship Island Restoration

During placement activities, recreational activities such as sunbathing, nature viewing, boating, sailing, and fishing along the barrier islands may be temporarily disrupted, limited, or altered. Potential temporary impacts may include noise, visual intrusion, and turbidity. Minor impacts for the lifetime of the restoration project would include the loss of fishing areas in Camille Cut between East Ship and West Ship Islands and the loss of Camille Cut as an access point to the Gulf of Mexico.

There would be a significant long-term benefit to recreation on Ship Island from the TSP. The TSP would provide storm damage reduction to two historic sites on East and West Ship Islands and increase the amount of land available for shore fishing, wildlife observation, hiking, and similar recreational activities. Filling of Camille Cut, however, would reduce the area available for recreational boat fishing. In addition, the placement of sand as proposed would help protect the ecological integrity of the Mississippi Sound estuary, resulting in significant benefit to the recreational sector, as described in Section 5.11.

5.11.1.2 Borrow Site Option 4

Under Borrow Site Option 4, temporary impacts to recreational boating and fishing could occur at the Ship Island, PBP-AL, Horn Island Pass, PBP-MS, and PBP-OCS borrow areas. These impacts could include temporary nuisance noise and visual intrusion from the presence of dredging equipment and would not be significant.

5.11.1.3 Cat Island Restoration

Minor (and therefore not significant) impacts to recreation associated with the restoration of Cat Island would be similar to those described under the Ship Island restoration above. During the borrow and placement activities, recreational activities such as sunbathing, nature viewing, boating, sailing, and fishing along the barrier islands could be temporarily disrupted, limited, or altered.

Restoration of Cat Island would enhance the amount of land available for fishing, wildlife observation, hiking, and similar recreational activities. In addition, the placement of sand as proposed would help protect the ecological integrity of the Mississippi Sound estuary, resulting in significant benefit to the recreational sector, as described in Section 5.11.

5.11.1.4 Littoral Placement of Dredged Material

Modification of the continuing operations at the combined DA-10 and littoral zone site could result in a change to the existing recreational environment at Sand Island since dredged material would not be utilized to replenish the island as has been done in the past.

5.11.2 Other Alternatives Considered

5.11.2.1 Borrow Site Option 1

Under Borrow Site Option 1, temporary minor, and therefore not significant, impacts to recreational boating and fishing could occur at the Ship Island, DA-10/Sand Island, and PBP-AL borrow areas. These impacts could include nuisance noise and visual intrusion. Removing portions of the subaerial Sand Island, within DA-10, could impact recreational activities such as sunbathing and hiking.

5.11.2.2 Borrow Site Option 2

Impacts to restoration under Borrow Site Option 2 would be similar to those under Borrow Site Option 1, except that temporary minor impacts to recreational boating and fishing could occur at the additional borrow areas associated with Borrow Site Option 2 (Horn Island Pass, PBP-MS, and PBP-OCS). These impacts could include nuisance noise and visual intrusion, but would not be significant.

5.11.2.3 Borrow Site Option 3

Impacts to restoration under Borrow Site Option 3 would be similar to those under Borrow Site Option 2.

5.11.3 No-Action Alternative

Continued erosion and loss of the Mississippi barrier islands within GUIS could result in significant adverse consequences not only to the natural and cultural resources managed by NPS and used for recreation, but also to the overall health of the Mississippi Sound ecosystem and mainland coastal communities. Under the No-Action Alternative, barrier island land loss would continue to increase. Significant resources managed by NPS, including Fort Massachusetts, could be lost. The MsCIP PEIS economics study estimated that the average annual value of recreation lost under the No-Action Alternative would be $466,341 (USACE, 2009a).

5.12 Socioeconomic Resources

Socioeconomic impacts would be significant if the TSP were to result in a direct or indirect effect upon demographics, economics, land or water use, utilities, public safety, or coastal infrastructure and ports in the project area or within the region. Significance criteria are discussed by resource area below.

5.12.1 Demographics

Demographic impacts would be significant if the selected alternative were to result in a substantial effect upon demographics in the project area or within the ROI.

5.12.1.1 Tentatively Selected Plan

Given the distance of the offshore borrow and placement areas from populated areas, construction activities associated with the TSP would not have an impact upon demographics within the ROI.

With implementation of this alternative, there could be a beneficial effect upon population and housing as a result of the Barrier Island Restoration project. In the event of a major tropical storm or hurricane, restoration of the Mississippi barrier islands could result in reduced impact to not only the mainland coastal communities, but also the overall health of the Mississippi Sound ecosystem (USACE, 2009a).

5.12.1.2 Other Alternatives Considered

Impacts to demographics from implementation of Borrow Site Options 1, 2, or 3 would be identical to those of the TSP.

5.12.1.3 No-Action Alternative

Under the No-Action Alternative, measures to restore the barrier islands would not be taken and the barrier islands would continue to experience erosion and loss of land mass.

The barrier islands are the first line of defense for the mainland as tropical storms, hurricanes, and dominant southeast winds pass through the region. After Hurricane Katrina, the total population within the ROI decreased. Given the likelihood of another direct hit from a hurricane, the No-Action Alternative could increase the potential for wave damage and storm surge along the coast, affecting demographics along the coast (similar to Hurricane Katrina). Modeling has shown that wave height is reduced as much as several feet by the presence of the islands. Loss of the barrier islands would leave a portion of the densely populated shoreline subject to larger sea waves (USACE, 2009a).

5.12.2 Economics

Economic impacts are would be significant if implementation of the alternative were to result in a substantial effect upon employment, income, or housing in the project area or within the region.

5.12.2.1 Tentatively Selected Plan

Construction activities associated with the TSP could temporarily increase local commerce by employing local residents and increasing traffic and activity around the project area. This increased activity would likely benefit businesses in the region. No accelerated residential or commercial development would likely occur.

The TSP would likely preserve or possibly enhance property values in the project area. In the event of a tropical storm or hurricane, restoration of the Mississippi barrier islands could result in protection of not only the mainland coastal communities, but also the overall health of the Mississippi Sound ecosystem. Increased confidence in the barrier islands providing storm surge risk reduction to the area would have a positive effect on property values, and thus tax revenues, in the vicinity (USACE, 2009a).

The MsCIP PEIS economic impact forecasting system (EIFS) model estimated that the restoration of the islands would result in an increase of $798,984,000 in sales volume, an increase of $167,849,530 in local income, and an increase of 4,920 new jobs (USACE, 2009a). The EIFS model outputs are based on a 5-year (60-month) construction duration and a 50-year period of analysis.

The cost that would be associated with implementation of the TSP has been estimated at $368 million.

5.12.2.2 Other Alternatives Considered

Economic impacts to demographics from implementation of Borrow Site Options 1, 2, or 3 would be similar to those of the TSP, but would have different estimated costs.

Estimated rough order of magnitude costs are:

- Borrow Site Option 1 = $402 million;
- Borrow Site Option 2 = $314 million; and
- Borrow Site Option 3 = $307 million.

5.12.2.3 No-Action Alternative

Under the No-Action Alternative, the economy within the ROI would not receive any benefits associated with construction activities.

The restoration of the barrier islands described in this SEIS is an integral part of the MsCIP Comprehensive Plan, as it would enhance the barrier islands and the first line of defense to provide coastal storm damage risk reduction. Taking no action on the barrier islands would result in a significant gap in the MsCIP Comprehensive Plan, and without the TSP the long-term economic benefits associated with the storm surge damage risk reduction would not be fully realized.

5.12.3 Commercial and Recreational Fishing

The significance criteria for commercial and recreational fishing in the project area would be an effect to the species or a change to the habitat structure that would lead to a change in species composition or long-term changes in revenue for fisheries in the Mississippi Sound. It should be noted that only recreational fishing is allowed within the GUIS boundaries.

5.12.3.1 Tentatively Selected Plan

Ship Island Restoration

Sediment removal and placement would temporarily disrupt fish distribution and localized commercial and recreational fishing in the immediate vicinity of East Ship and West Ship

Islands. However, once operations were completed, the fish community would return to the area and fishing activities would return to previous conditions. In addition, during the operations, fishing activities could be conducted at other locations in the Mississippi Sound. Any negative impacts to fisheries from restoration activities would not be significant.

Long-term beneficial impacts to fish habitat would occur from stabilization and enhancement of the shallow water nursery and foraging habitat around the barrier islands. The MsCIP PEIS estimated that over $43 million in fishery losses could be avoided by the restoration of Ship Island and the closure of Camille Cut (USACE, 2009a). The restoration of Ship Island would help limit saltwater intrusion into the Mississippi Sound, as well as helping protect and maintain critical habitat for a variety of estuarine-dependent species (e.g. the Eastern oyster, shrimp, blue crab, and speckled trout).

Borrow Site Option 4

Sediment removal would temporarily disrupt fish distribution and localized commercial and recreational fishing in the Ship Island, PBP-AL, Horn Island Pass, PBP-MS, and PBP-OCS borrow areas. However, once operations were completed, the fish community would return to the area and commercial and recreational fishing activities would return to previous conditions. In addition, during the operations, fishing activities could be conducted at other locations in the Mississippi Sound. Therefore, impacts to commercial and recreational fisheries from restoration activities would not be significant.

Cat Island Restoration

Impacts to commercial and recreational fishing associated with the restoration of Cat Island would be similar to those described under the Ship Island restoration above.

Littoral Placement of Dredged Material

Modification to the placement of navigation dredged material to the combined DA-10/ littoral zone site would not result in any significant change to recreational fishing at the site.

5.12.3.2 Other Alternatives Considered

Borrow Site Option 1

Under Borrow Site Option 1, temporary impacts to commercial and recreational and fishing would occur at the Ship Island, DA-10/Sand Island, and PBP-AL borrow areas. Impacts would be similar to those described under Borrow Site Option 4 and would not be significant.

Borrow Site Option 2

Impacts under Borrow Site Option 2 would be similar to those under Borrow Site Option 1, except that non-significant disruptions to fish and fishing opportunities would also occur at the Horn Island Pass, PBP-MS, and PBP-OCS borrow areas.

Borrow Site Option 3

Impacts under Borrow Site Option 3 would be similar to those under Borrow Site Option 2.

5.12.3.3 No-Action Alternative

Under the No-Action Alternative, continued loss and alteration of coastal ecotone habitat and increasing salinity in the Mississippi Sound could negatively impact important commercial and recreational fisheries.

5.12.4 Land and Water Use

Land and water use impacts would be significant if the selected alternative were to do one or more of the following:

- Substantially conflict with established land and water uses in the area;
- Be incompatible with surrounding land uses; and
- Substantially conflict with applicable land and water use goals, objectives, policies, guidelines, or adopted environmental plans.

Applicable land and water use goals, objectives, and policies applicable to the project area are summarized in Section 4.13.4 and include the 1964 Wilderness Act, the NPS Organic Act, and NPS *Management Policies* (2006).

5.12.4.1 Tentatively Selected Plan

The TSP would be carried out in a manner that is consistent with NPS's purposes (16 U.S.C. § 459h-5). NPS, in collaboration with other agencies (USACE, USGS, NOAA Fisheries Service, USEPA, NOAA, USFWS, and MDMR), has concluded that long-term restoration of the sediment transport system and budget is crucial for preserving and protecting the Mississippi barrier islands' natural and cultural resources (USACE, 2009a). This Mississippi barrier island restoration represents the results of extensive interagency consultation and collaboration and would not have a significant impact on land resources. Details on specific components of the TSP, as they relate to land and water resources, are provided below.

Ship Island Restoration

Restoration of Ship Island would not introduce new or different land uses, and it would support the NPS goal of preserving and protecting the natural processes affecting the barrier islands. Significant storm events and a reduction in sand supply contributed to substantial land area losses between 1847 and 2005, ranging from 24 percent at Horn Island to 64 percent at East and West Ship Islands. Petit Bois Island, which is located east (updrift) of Horn Island Pass, experienced a 56 percent reduction in land area between 1847 and 2005 (USACE, 2009a).

Borrow Site Option 4

Borrow Site Option 4 would not introduce new or different land uses and it would not affect any existing land use plans or policies. As a result, there are no impacts on land or water use from Borrow Site Option 4.

Cat Island Restoration

Restoration of Cat Island would not introduce new or different land uses. The restoration of Cat Island is intended to preserve and protect the natural processes affecting the barrier islands and protect them from further land losses. The restoration would have no adverse impacts on land use and would not conflict with any other land use policy or goal.

Littoral Placement of Maintenance Dredged Material

Modification to the placement of dredged material at the combined DA-10/littoral zone site would not introduce new or different land uses. Material currently being placed on Sand Island, within DA-10, would be placed into the littoral system, to preserve and protect the natural processes affecting the barrier islands. The placement of material in the new location would not conflict with any land use policy or goal and would have no adverse impacts on land use.

5.12.4.2 Other Alternatives Considered

Under Borrow Site Options 1, 2, and 3, conflicts with land and water use would occur. These borrow options include the use of the DA-10/Sand Island borrow area, which includes the subaerial feature, Sand Island. This borrow area is within the boundary of the GUIS.

Borrow Site Option 1

Under Borrow Site Option 1, 5.1 mcy of sand would be borrowed from DA-10/Sand Island, which is protected under the NPS *Management Policies* related to use of borrow areas on NPS lands. Utilizing material from DA-10, and specifically from Sand Island within DA-10, would be considered an impairment of NPS resources, which is prohibited under NPS policy. The use of borrow material from Ship Island and PBP would not affect existing land use plans or policies.

Borrow Site Option 2

Impacts under Borrow Site Option 2 would be the same as those under Borrow Site Option 1. The use of borrow material from Horn Island Pass would not affect existing land use plans or policies.

Borrow Site Option 3

Impacts under Borrow Site Option 3 would be the same as those under Borrow Site Options 1 and 2.

5.12.4.3 No-Action Alternative

The loss of land mass on the barrier islands has been documented, and the continued loss would result in a change in the ecology of the Mississippi Sound (USACE, 2009a).

Continued erosion and loss of the Mississippi barrier islands could result in significant adverse consequences not only to the natural and cultural resources managed by NPS, but also to the overall health of the Mississippi Sound ecosystem and mainland coastal communities (USACE, 2009a). Under the No-Action Alternative, barrier island land loss would continue to increase. Significant natural and cultural resources managed by NPS, including Fort Massachusetts, could either be lost as a result of erosion or substantial measures could be required for their preservation.

Other existing land and water uses within the ROI could also be compromised under the No-Action Alternative.

5.12.5 Utilities

Utility impacts would be significant if the TSP were to result in the interruption of local or regional utility services so as to pose a substantial inconvenience to the affected population.

5.12.5.1 Tentatively Selected Plan

The TSP would not directly impact utility services in the area. No utility lines are known to be located within any potential borrow or placement areas; therefore, no known utility lines would be significantly impacted or relocated.

Unknown abandoned lines could be present and could be disturbed. If utility lines are discovered during dredging, the appropriate permits would be obtained before utilities are relocated. No significant impacts would be expected.

In the event of a major tropical storm or hurricane, restoration of the Mississippi barrier islands could result in some protection of the existing utility infrastructure associated with the mainland coastal communities (USACE, 2009a).

5.12.5.2 Other Alternatives Considered

Impacts to utilities from implementation of Borrow Site Options 1, 2, or 3 would be identical to those of the TSP.

5.12.5.3 No-Action Alternative

Under the No-Action Alternative, the barrier islands would not be restored. Therefore, in the event of a major tropical storm or hurricane, the lack of storm damage reduction provided by the barrier islands could result in the interruption of local or regional utility services so as to pose a substantial inconvenience to the affected population.

5.12.6 Oil and Gas Utilities

Impacts to oil and gas utilities would be significant if the TSP were to result in the interruption of pipeline services that causes a substantial inconvenience to offshore resource extraction.

5.12.6.1 Tentatively Selected Plan

Ship Island Restoration

Placement activities at Camille Cut and East Ship Island would not occur near any oil and gas utilities and therefore would have no impacts.

Borrow Site Option 4

Borrow Site Option 4 has been designed such that it would not directly impact oil and gas pipelines in the area. The only known pipelines in the area that could be affected are near the PBP-MS, PBP-AL, and PBP-OCS borrow areas. At the PBP-AL site, the east borrow locations would be prioritized to reduce the need to work near the pipelines. An approximately 1,000-foot buffer based on modeling would be established on both sides of the pipeline corridors to further avoid potential impacts.

Cat Island Restoration

Placement and dredging activities at Cat Island and Cat Island borrow area are not located near any oil and gas utilities and would not result in any impacts.

Littoral Placement of Dredged Material

Modification to the placement of navigation dredged material into the combined DA-10/littoral zone site would not result in any impacts to oil and gas utilities.

5.12.6.2 Other Alternatives Considered

Impacts to oil and gas utilities from implementation of Borrow Site Options 1, 2, or 3 would be identical to those of the TSP.

5.12.6.3 No-Action Alternative

Under the No-Action Alternative, no impacts to oil and gas utilities would occur.

5.12.7 Public Safety

Public safety impacts would be significant if the TSP were to do one or more of the following:

- Cause response times for fire or law enforcement to increase beyond acceptable levels;
- Interfere with emergency response plans or emergency evacuation plans; and
- Create a potential public health risk or involve the use, production, or disposal of materials that pose a safety hazard to people in the affected area.

5.12.7.1 Tentatively Selected Plan

Under the TSP, the barrier islands would be restored via dredging in the borrow areas, followed by the transport of sand to the placement areas. To reduce potential public safety impacts and conflicts with dredging equipment, warning buoys would be placed a safe distance from the work area to provide notice to vessel traffic and boaters, and all vessels would be equipped with markings and lights in accordance with USCG regulations. The dredging contractors would participate in an orientation session with the USCG to address safety operating procedures and protocol, and ensure coordination with marine traffic in the area. In addition, a Notification to Mariners would be included in the USCG's weekly publication. The dredging contractor would also participate in a safety orientation with USACE and would be required to keep the public informed of dredging activities. Signs and fencing would be used to deter the public (including children) from entering the work zone. No significant impacts to emergency responders for recreational boaters would likely occur.

Long-term benefits to public safety from restoration of the barrier islands and littoral placement of future dredged material would occur. The restoration would help reduce the intensity of storm waves and storm surges along the Mississippi Coast (Appendix D).

5.12.7.2 Other Alternatives Considered

Impacts to public safety from implementation of Borrow Site Options 1, 2, or 3 would be identical to those of the TSP.

5.12.7.3 No-Action Alternative

Under the No-Action Alternative, existing public safety services would not change.

Taking no action on the barrier islands would result in a significant gap in the MsCIP Comprehensive Plan, and without the TSP the long-term public safety benefits associated with the storm surge risk reduction would not be fully realized.

5.12.8 Coastal Infrastructure/Ports

The significance criterion for coastal infrastructure/ports would be a significant change to the current coastal infrastructure and shipping operations at any commercial port in the ROI.

5.12.8.1 Tentatively Selected Plan

Construction activities associated with the TSP would not directly impact any coastal infrastructure or ports.

Modification to the placement of navigation dredged material at the combined DA-10/ littoral zone site would result in the placement of material within an area of high wave-induced currents, which would transport sediments downdrift within the littoral system. Thus, Sand Island's current footprint would be altered by the lack of future dredged material on the island. The change in dredged material placement practices and the resulting reduction in the size of Sand Island are expected over time to reduce constricted flows through the pass that have increased scour in and near the navigation channel between Sand and Petit Bois Islands.

Under average conditions, impacts to the Gulfport Navigation Channel would likely be minor based on sediment transport and morphologic model simulations. However, minor indirect impacts to the Gulfport Navigation Channel could occur from increased transport of sand into the channel during hurricane events. The amount of material moved under such conditions could result in an increase of up to 4 percent to 6 percent over historical dredging volumes (Appendix C). However, no expected increase in maintenance dredging frequency would be anticipated and, therefore, impacts would not be significant.

In the event of a major tropical storm or hurricane, restoration of the Mississippi barrier islands could indirectly result in reduced risk of damage of not only the mainland coastal infrastructure and ports, but also the overall health of the Mississippi Sound ecosystem. The loss of Ship Island would leave a portion of the heavily developed Harrison County shoreline, including the Port of Gulfport, subject to larger sea waves (USACE, 2009a). In addition, modeling has indicated that over a wide range of storms, some storm surge risk reduction would be provided to the eastern coast of Mississippi along the Jackson County shoreline if the barrier islands were restored as proposed (USACE, 2009a).

5.12.8.2 Other Alternatives Considered

Impacts to coastal infrastructure and ports from implementation of Borrow Site Options 1, 2, or 3 would be identical to those of the TSP.

5.12.8.3 No-Action Alternative

Under the No-Action Alternative, no efforts to restore the existing barrier islands would be undertaken. Therefore, coastal infrastructure and ports within the ROI would not realize the long-term benefits associated with the enhanced storm damage risk reduction. In the event of a major tropical storm or hurricane, the lack of enhanced storm damage risk reduction could result in impacts to coastal infrastructure and the interruption of shipping operations.

5.13 Environmental Justice and Protection of Children

A disproportionate environmental health and safety risk to children, minority, or low-income populations would be a significant impact.

5.13.1 Tentatively Selected Plan

Due to their location of the borrow areas and the undeveloped nature of the barrier islands, construction activities associated with the TSP would not adversely affect or disproportionately impact minority populations, health and safety of children, or low-income populations.

Contractors are required to take are appropriate safety measures.

Implementation of this alternative could have a beneficial effect on population and housing on the mainland. The presence of the islands reduces wave height as much as several feet (USACE, 2009a). In the event of a major tropical storm or hurricane, restoration of the Mississippi barrier islands could result in some reduced risk of not only the mainland coastal communities, but also the overall health of the Mississippi Sound ecosystem (Appendix D).

5.13.2 Other Alternatives Considered

Impacts to minority populations, children, or low-income populations from implementation of Borrow Site Options 1, 2, or 3 would be identical to those of the TSP.

5.13.3 No-Action Alternative

Under the No-Action Alternative, measures to restore the barrier islands would not be taken. No disproportionate impacts would occur to minority populations, children under the age of 17, or families below the poverty level in the ROI.

The barrier islands are the first line of defense for the mainland during tropical storms, hurricanes, and dominant southeast winds that pass through the region. After Hurricane Katrina, the total population within the ROI decreased. Given the likelihood of another direct hit from a hurricane, the No-Action Alternative could increase the potential for wave damage and storm surge along the coast, affecting minorities, children, and low-income families along the coast (similar to Hurricane Katrina). Loss of the barrier islands would leave the densely populated shoreline subject to larger sea waves (USACE, 2009a).

5.14 Monitoring and Adaptive Management Plan

The MAM Plan was developed for the ecosystem restoration plan consistent with the requirements of the WRDA 2007, Section 2039 (a) and implementation guidance "CECW-PB Memorandum dated August 31, 2009, Implementation Guidance for Section 2039 of the Water Resources Development Act of 2007 (WRDA 2007) – Monitoring Ecosystem Restoration "and included as Appendix S. The primary purpose for implementing a MAM Plan is to determine progress toward restoration success and to increase the likelihood of achieving desired project outcomes in the face of uncertainty. Monitoring results will be used through an assessment process to determine whether the project outcomes are consistent with original project goals and objectives. The MAM Plan provides an organized and documented process that defines management actions in relation to measured project performance and establishes a feedback loop between continued project monitoring and corresponding project management, operation, and adjustments. The MAM Plan describes the monitoring design proposed to determine barrier island restoration success and avoid impacts to threatened and endangered species, describes the organization structure for the MAM process, describes the developed Conceptual Ecological Model, identifies key uncertainties, and provides potential adaptive management/contingency actions that may be needed to ensure project success. The MAM Plan is a living document and will be regularly updated to reflect monitoring-acquired and other new information as well as resolution of and progress on resolving key uncertainties and/or discovering lessons learned to help with management of coastal resources.

5.15 Cumulative Impacts

Federal regulations implementing NEPA (40 C.F.R. § 1500–1508) require that the cumulative impacts be assessed. NEPA defines a cumulative impact as an impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions (40 C.F.R. § 1508.7). Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. This analysis considers the impacts of the TSP in conjunction with other projects in the Mississippi Sound, the northern Gulf of Mexico, and along the Mississippi Gulf coast.

The following discussion addresses the potential for cumulative impacts resulting from interaction of the TSP and other restoration alternatives considered with other past, present, and reasonably foreseeable actions occurring since Hurricane Katrina. This powerful storm altered the barrier islands, coastal Mississippi, and the floor of the Gulf of Mexico. In conjunction with other major hurricanes (Ivan, Dennis, and Rita) in 2004 and 2005, residual effects from earlier projects would have little potential for interaction with the TSP.

Within coastal Mississippi, recovery work to clean up and rebuild following the landfall of Hurricane Katrina in August 2005 would continue. Because all of this work would occur onshore, there would be limited potential for interaction with the TSP or other restoration alternatives, confined primarily to socioeconomic resources.

Mitigation and restoration activities associated with the April 20, 2010 Deepwater Horizon spill are ongoing. Current projects include an oyster clutch restoration and artificial reef installation in the western part of the Mississippi Sound (NOAA, 2013a). Additional projects are likely to be developed as further restoration funds become available through natural resource damage assessment settlements, RESTORE Act funding (Clean Water Act fines), and criminal penalties.

Construction is planned by the USACE to improve the Pascagoula Harbor - Bar Channel from 450 feet wide to its federally authorized project dimension of 550 feet wide. Plans are also underway to widen the Bayou Casotte Channel an additional 100 foot to the west beyond its 350 foot wide federally authorized project dimension. The construction of the improvement project will be funded 100 percent by the non-Federal sponsor, Jackson County Port Authority. The USACE is conducting a Feasibility Study of the Bayou Casotte Harbor Channel Improvement Project in accordance under authority of Section 204 of the Water Resources Development Act of 1986 (PL 99-662; 33 U.S.C. 2232, as amended). Should the Section 204 study conclude, then the future operation and maintenance would be undertaken by the USACE as part of its routine maintenance efforts. The Mississippi State Port Authority has plans to upgrade the Port of Gulfport.

The Federal navigation channels were excluded from GSCH (68 Fed. Reg. 53). Portions of the navigation channels extend between the barrier islands and work could occur at the same time, resulting in temporary cumulative impacts to recreation activities, water quality, and biological resources in those areas. A modeling assessment to look at the combined effects of implementing the TSP, widening the Gulfport and Pascagoula Federal Navigation channels to their federally authorized dimensions and closure of Katrina Cut on water quality conditions in the Mississippi Sound were conducted (Appendix D). Maximum and minimum changes in DO were well above state standards with the largest drop of

5.52 percent (7.75 to 7.3 mg/L) occurring near Gulfport. Chlorophyll *a* concentrations for all scenarios showed maximum increases of 40 to 50 percent over Pre Katrina conditions near Gulfport and south of Biloxi Bay. With increased chlorophyll *a,* more photosynthesis produced additional DO resulting in the increased DO values during those periods of the simulation. Maximum and minimum percent change of salinity values for the Cumulative scenario showed the largest maximum south of Bay St. Louis and the minimum near Gulfport. However, the changes in salinity at the three nearshore observation sites were within the variability of salinity values occurring during the simulation period for Pre-Katrina conditions. Although results from the analysis demonstrated that the cumulative scenario showed the most deviation from Pre-Katrina conditions, the observed water quality changes were within the state standard for constituents of interest for ocean's waters (Appendix D).

Future maintenance dredging associated with the Pascagoula Harbor Upper Sound Channel segment will be used for the creation of a 425-acre wetland adjacent to Singing River Island. This project, combined with the proposed barrier island restoration and modification of the placement plan for material dredged from the Horn Island Pass Channel segment, could result in a cumulative benefit to littoral, wetland, and island habitats in the Mississippi Sound and the northern Gulf of Mexico.

Following the devastation incurred by Hurricane Katrina, the USACE restored the 28-mile long Mississippi Harrison County Hurricane and Storm Damage Reduction project. An additional project feature, dunes and dune plantings, was later constructed on that project as part of an MsCIP Interim project. Over the last four years, an additional 14 MsCIP interim projects have been constructed along the three coastal counties of Mississippi. These projects were intended to aid in the immediate recovery of the coast following Katrina, and to meet the criteria for inclusion, each project had to no significant impact on the environment. These projects were aimed at restoring what had been damaged and in many instances resulted in re-establishment of pre-hurricane conditions. In addition to dune creation and dune planting, these projects included repairs or reconstruction of seawalls, restoring tidal exchange into wetland areas, removal of debris and sedimentation from local flood control channels, repair of a bridge on an evacuation route, creation of a beach for seawall protection, and property acquisition and relocation of 29 families from a floodprone community. The area acquired will be restored in the near future to its former wetpine savannah condition, providing increased habitat for a number of species of national significance as well as increasing flood storage capacity.

Another significant restoration effort has been completed on Deer Island located within the Mississippi Sound just south of Biloxi. This mainland barrier has suffered significant erosion in the past from storm activity, including the creation of a breach on the western end, erosion of the southern shoreline, and loss of wetlands. Restoration efforts included the filling of the 1-mile-wide breach, including planting of native vegetation, restoration of the southern shoreline with the creation of an interior lagoon to be used in the future for placement of dredged material and wetland creation, and the re-establishment of wetlands on the northern shoreline of the island. All these efforts have yielded significant benefits to the coastal ecosystem which will be magnified in the future with the restoration of Ship and Cat Islands and the modification of dredged material placement as proposed in the TSP.

As part of the first phase of the barrier island restoration effort, the placement of sand along the northern shore of West Ship Island, was recently completed (USACE, 2011b). The project entailed placement of sand along approximately 10,350 feet of shoreline to a width of 150 to 550 feet to help protect the shoreline around Fort Massachusetts. This project could result in cumulative short-term adverse effects to biological resources in the area from repeated disturbances associated with dredging and placement activities. Beneficial long-term cumulative impacts to biological and recreational resources on and near Ship Island would result upon completion of both projects.

Future projects in coastal Mississippi are planned as part of the Mississippi Beneficial Use Group to beneficially utilize material from maintenance and new work dredging of segment(s) of navigation channel(s) and approved upland site(s) to create beaches and emergent tidal marsh habitats. These projects could occur close to or during the same timeframe as the proposed barrier island restoration. No significant adverse cumulative impacts would likely result.

Global climate change is predicted to result in sea level rise and more intense storm activity. The rate of barrier island loss could increase in the future as a result of global climate change (Morton, 2008). Under the No-Action Alternative, processes would continue to allow Ship Island to be vulnerable to storm damage, and existing water quality regime would be maintained in the Mississippi Sound. Under the TSP and other restoration alternatives, the sand added to the existing sediment budget of the barrier islands and the change in the use of the existing DA-10/Sand Island disposal area for placement of future dredged material would result in a healthier state for the islands, thus making them more resilient to global climate change. Since one goal of the restoration plan is to enhance the sediment budget of the islands, they would be more able to adapt to changes in sea level over time.

5.16 Relationship between Short-term and Long-term Impacts

This section discusses the relationship between local short-term uses of the environment and any long-term impacts arising from those uses. It also examines long-term adverse cumulative impacts that may narrow the range of options for future use of resources. Potential impacts of the TSP and the other three restoration alternatives and the No-Action Alternative are discussed in Sections 5.2 through 5.13. Cumulative impacts are identified in Section 5.14.

Overall, there would be short-term minor (and therefore not significant) impacts on water quality and aquatic resources, including benthic invertebrates, fish, mollusks, crustaceans, and marine mammals. These would be outweighed by long-term maintenance of water quality (salinity) and improvements to nearshore and littoral habitats as a result of implementation of any of the restoration alternatives.

There would be short-term and long-term improvements in cultural resources due to the placement of additional sand in key locations, as this material would provide additional protection during future storm events. Short-term and long-term benefits to socio-economic conditions from the restoration alternatives would be expected due to the temporary increase in local construction jobs and long-term hurricane and storm damage risk reduction benefits.

5.17 Irreversible or Irretrievable Commitment of Resources

This section describes the irreversible and irretrievable commitment of resources associated with implementing the TSP or any of the other restoration alternatives considered. An irreversible commitment of resources occurs when a resource would be committed permanently to the project and unavailable for other use. An irretrievable commitment of resources refers to a use of a resource that would cause that resource to be unavailable for use in the future. Irretrievable resources could include minerals, cultural resources, or permanent changes in land use.

Restoration activities would result in the consumption of sand deposits in the Mississippi Sound and the Gulf of Mexico, as well as fossil fuels for operation of dredging and placement equipment. The sand used would remain in the Mississippi Sound but be located elsewhere in that system.

In general, impacts to biological resources would occur to individual organisms and small portions of populations. They would not constitute an irreversible commitment of resources, since the biological systems would be expected to recover. However, restoration activities on East Ship Island and West Ship Island would cause the conversion of approximately 800 acres of Mississippi Sound littoral habitat, including 365 acres of habitat at Camille Cut, to barrier island and wetland habitats. This change would cause a long-term alteration of the island habitat for biological resources and local hydrology and currents around the island.

5.18 Summary and Conclusions

A summary of the specific impacts of the TSP and the other alternatives considered in this SEIS is presented in Table ES-1. Implementation of the TSP to restore the Mississippi barrier island system would result in both negative and beneficial impacts to placement and borrow areas and to the users of these areas. These impacts would include the permanent loss of open water habitat at Camille Cut, construction-related disruptions to birds and other wildlife on Ship and Cat Islands, and construction-related disruptions to public use of borrow and placement areas. However, the overall significant long-term system-wide benefits to ecosystems, as well as economic benefits associated with damages and economic losses avoided and regional economic benefits, would outweigh the negative impacts. Most notably, the restoration of the islands, with critical economic, recreational, environmental, and aesthetic benefits, would help maintain and sustain the Mississippi Sound and the coastal mainland. The MsCIP PEIS estimated $18.5 million in potential annual benefits from losses avoided through restoration of the barrier islands (USACE, 2009a [Table 4-2]). In addition, restoration would provide additional nesting habitat for threatened and endangered sea turtles and over-wintering critical habitat for the piping plover as well as habitat for neotropical migrants and waterfowl. Closure of Camille Cut would help to maintain the salinity regime in the Sound and the habitat conditions for oysters and numerous estuarine-dependent fish and crustacean species that are essential for commercial and recreational fishing. In addition, the barrier island restoration would contribute to continued protection of the significant historical and cultural sites within the GUIS. The anticipated reduction in storm surges would also help to protect unique coastal mainland habitats, wetlands, and special aquatic sites (including the Grand Bay NERR).

Based on the analysis of potential impacts in the SEIS, Borrow Site Option 4 was recommended for inclusion in the TSP. Borrow Site Option 1 is not feasible based on the costs of over $400 million, which exceeds the available funding. Borrow Site Option 4 ($386 million) is more costly than Borrow Site Options 2 ($314 million) or 3 ($307 million) due to the reduced use of DA-10 and higher use of sand from the PBP-AL site, which would require payment to the state of Alabama. Borrow Site Options 2 and 3, while less costly than Borrow Site Option 4, have been eliminated due to concerns from the NPS about the potential impacts to Sand Island and conflicts with NPS land use management policy.

6. Compliance with Environmental Requirements

6.1 Introduction

This section provides an overview of the laws, regulations and executive orders reviewed to ensure compliance by this SEIS and implementation of the TSP. If applicable, the compliance actions and consultation activities taken by the USACE are noted.

This SEIS will be used to support the NEPA compliance requirements for the USACE, the NPS, and the BOEM and, therefore, the list of laws, regulations, and Executive Orders included below include regulatory requirements that apply to all three agencies. The proposed project area includes portions of the GUIS, managed by the NPS, and therefore the proposed project must comply with applicable laws (e.g., Organic Act of 1916) and NPS management policies. BOEM, formerly known as the Minerals Management Service (MMS), has jurisdiction over all mineral resources on the Federal OCS, which includes the PBP-OCS borrow area. P.L. 103-426, enacted 31 October 1994, gave the MMS (now the BOEM) the authority to convey, on a noncompetitive basis, the rights to OCS sand, gravel, or shell resources for shore protection, beach or wetlands restoration projects, or for use in construction projects funded in whole or part or authorized by the Federal government. Those resources fall under the purview of the Secretary of the Interior, who oversees the use of OCS sand and gravel resources, and the BOEM as the agency charged with this oversight by the Secretary. After an evaluation required by NEPA, the BOEM may issue noncompetitive negotiated agreements for the use of OCS sand to the requesting entities. Therefore, BOEM, as a cooperating Federal agency, is undertaking a connected action (40 C.F.R. 1508.25) that is related, but unique from the USACE Proposed Action. The Proposed Action of the BOEM is the issuance of a negotiated agreement pursuant to its authority under the Outer Continental Shelf Lands Act. The purpose of that action is to authorize the use of OCS sand resources the Petit Bois OCS borrow site. In parallel with the USACE decision-making process, the BOEM will evaluate whether or not to authorize the use of the offshore borrow area.

Cultural resources and historic properties must be considered in any Federal undertaking. Legal authority for that consideration is derived from several laws. Section 106 of the National Historic Preservation Act requires the lead Federal agency to consider historic resources. The Archaeological Resources Protection Act requires Federal land managers to provide adequate protection of cultural resources under their control and provides legal consequences to those violating that act. The Native American Graves Protection and Repatriation Act requires the return of Native American cultural items to lineal descendants and culturally affiliated Indian tribes and Native Hawaiian organizations. The Abandoned Shipwreck Act provides legal authority for states to manage shipwrecks within their waters and the Sunken Military Craft Act clarifies that the United States military continues to own and manage any sunken military vessel or aircraft in perpetuity.

6.2 Abandoned Shipwreck Act

The Abandoned Shipwreck Act of 1988 asserts title of any abandoned shipwreck embedded in submerged lands of the State, embedded in coralline formations protected by a State on submerged lands of a State, or on submerged lands of a State and is included or determined eligible for inclusion in the National Register. However, the act recognizes that States have a right to manage certain submerged resources, with shipwrecks being one of those resources. The ASA therefore allows States that express an interest in a wreck or wrecks to manage them as long as they are within the waters of that State.

6.3 Anadromous Fish Conservation Act

This act authorizes the Secretary of the Interior to enter into a cooperative agreements with the States and other non-Federal interests for the conservation, development, and enhancement of the Nation's anadromous fishery resources that are subject to depletion from water resources developments and other causes, or with respect to which the Federal government has made conservation commitments concerning such resources by international agreements. The program emphasizes the conservation and enhancement of anadromous fishery resources and the fish in the Great Lakes and Lake Champlain that ascend streams to spawn. The Act established a grant program to provide funding to states for habitat or fish enhancement work, and specifies cost-sharing and appropriation provisions.

Three anadromous fish species (Alabama shad, striped bass, and Gulf sturgeon) occur in the proposed project area. Based on the evaluation of potential impacts (Sections 5.4.4 and 5.4.8); there would be minor and temporary impacts on these fish species. Because the overall impacts would not be significant, the TSP would be in compliance with the Act.

6.4 Archaeological Resources Protection Act

The Archaeological Resources Protection Act of 1979, as amended, recognizes that earlier cultural resource laws were inadequate to protect historic properties. The act makes it illegal to disturb cultural resources on Federal lands without a permit and provides penalties for violating the act. The act also specifies that qualified individuals may conduct research on Federal lands if the researcher first obtains an ARPA permit.

6.5 Bald and Golden Eagle Protection Act

The Bald and Golden Eagle Protection Act of 1940, as amended, makes it illegal to take, transport, or possess bald and golden eagles or to engage in commerce in these species, with limited exceptions allowed. Section 5 includes an evaluation of potential impacts of the TSP on birds, including bald eagles, which are known to occur on the barrier islands. Because the proposed activity would not occur within identified nesting areas, USACE has determined that the TSP complies with the Act.

6.6 Clean Air Act

The CAA of 1990 is a Federal law that authorizes USEPA to regulate emissions of airborne pollutants, although the states do much of the work to implement the Act. Under this law, USEPA sets limits on how much of a pollutant can be present in an area anywhere in the United States. This promotes uniformity in basic health and environmental protections. In addition, the law recognizes that it is appropriate for states to take the lead in implementing the CAA because pollution control problems often require special understanding of local industries, geography, housing patterns, etc.

Under the CAA, States must develop State Implementation Plans (SIPs). An SIP is a collection of regulations to clean up areas that exceed applicable air quality standards.

The potential air quality impacts resulting from this project are discussed in Section 5. The discussion concludes that emissions would be minor and temporary. The area is currently in attainment for all NAAQS. The project would not result in exceedance of chronic or acute state air quality standards; therefore, the TSP is in compliance.

6.7 Clean Water Act

The Federal Water Pollution Control Act of 1972, as amended, commonly called the Clean Water Act, or CWA, authorizes the USEPA to regulate activities resulting in a discharge to navigable waters. Section 401 (33 U.S.C. § 1341) of the CWA specifies that any applicant for a Federal license or permit to conduct any activity that may discharge into navigable waters must obtain a certification that the discharge complies with applicable sections of the CWA. Section 401 of the CWA requires certification that activities, including dredge and fill activities, would not violate State water quality standards. Impacts associated with the discharge of dredged or fill material and for the building of structures in all waters of the United States are evaluated following guidelines implementing Section 404 of the CWA. Evaluation of the impacts associated with the placement of material related to the fill of Camille Cut and restoration of the southern shoreline of East Ship Island and the southern shoreline of Cat Island has been completed and is documented in Appendix P. On March 31, 2009 the MDEQ indicated that they supported the goals of the MsCIP Comprehensive Plan and that the elements described in the PEIS supported the goals of the State Water Quality program. Following review of the specific impacts associated with the TSP in this SEIS and Section 404(b)(1) evaluation (see Appendix P), Section 401 water quality certification will be requested from the MDEQ.

6.8 Coastal Barriers Resources Act

The Coastal Barriers Resources Act (CBRA), Pub. L. 97-348 (96 Stat. 1653; 16 U.S.C. § 3501 et seq.), enacted October 18, 1982, designated various undeveloped coastal barrier islands, depicted by specific maps, for inclusion in the John H. Chafee Coastal Barrier Resources System (CBRS). Areas so designated were made ineligible for direct or indirect Federal financial assistance that might support development, including flood insurance, except for emergency life-saving activities. Exceptions for certain activities, such as fish and wildlife research, are provided, and Otherwise Protected Areas (OPAs) (such as National Wildlife Refuges) are included within the CBRS though the only Federal funding prohibition within OPAs is on Federal flood insurance.

There are two CBRA units designated within the project area. These are CBRA unit R03 (Cat Island) and MS-01P (Ship Island). CBRA unit MS-01P is an OPA, and Federal flood insurance is not applicable to this project. CBRA unit R03 falls within a segment in which dune and beach restoration on Cat Island, including revegetation, would be implemented through the direct placement of 2 mcy of sand on the eastern beach fronting Cat Island. USACE has made the determination that the restoration actions for Cat Island qualifies for an exemption under Section 6 of CBRA. Specifically, Section 6(a)(6)(A) identifies projects relating to the study, management, protection, or enhancement of fish and wildlife resources and habitats. Additionally, Section 6(a)(6)(G) exempts nonstructural projects for shoreline stabilization that are designed to mimic, enhance, or restore natural stabilization systems. The determination that the restoration action at Cat Island meets the exemption criteria under Section 6 and is consistent with the intent of CBRA has been coordinated with the USFWS.

6.9 Coastal Zone Management Act

The Coastal Zone Management Act (CZMA) (16 U.S.C. § 1451 et seq.) was enacted by Congress in 1972 to develop a national coastal management program that comprehensively manages and balances competing uses of and impacts on any coastal area or resource. The program is implemented by individual state coastal management programs in partnership with the Federal government.

According to the CZMA federal consistency requirement, 16 U.S.C. § 1456, federal activities must be consistent, to the maximum extent practicable, with a state's federally approved coastal management program. The federal consistency requirement is an important mechanism to address coastal effects, to ensure adequate federal consideration of state coastal management programs, and to avoid conflicts between states and federal agencies. The Coastal Zone Act Reauthorization Amendments of 1990 (P.L. 106-508), enacted on November 5, 1990, as well as the Coastal Zone Protection Act of 1996, amended and reauthorized the CZMA. The CZMA is administered by the Office of Ocean and Coastal Resource Management, within the NOAA National Ocean Service.

NOAA approved the Mississippi Coastal Program (MCP) in 1980. The MDMR is the lead agency, and the MCP resolves conflicts over local coastal uses. The authority guiding the MCP is the Coastal Marshlands Protection Act, which designates allowable use of the state's tidal wetlands. The MDMR has led a comprehensive planning effort, as described in the Comprehensive Resource Management Plan (NOAA, 2010c), which incorporates stakeholder interests in coastal development issues in Mississippi. On May 5, 2009 the MDMR concurred that the projects in the MsCIP Comprehensive Plan were consistent to the maximum extent practicable with the MCP and that these actions would not have adverse environmental effects on Mississippi coastal resources. The USACE determined that the TSP is consistent with the MCP to the maximum extent practicable and following review of the SEIS, the USACE will request MDMR's concurrence with USACE's determination.

6.10 Endangered Species Act

The ESA of 1973 (16 U.S.C. § 1531–1543), as amended, establishes a national policy designed to protect and conserve threatened and endangered species and the ecosystems upon which they depend. The ESA is administered by the Department of the Interior, through the USFWS, and by the USDOC, through NOAA Fisheries, National Marine Fisheries Service (NMFS), Protected Resource Division. Section 7 of the ESA specifies that any agency that proposes a federal action that could jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species (16 U.S.C. § 1536(a)(2)) must participate in the interagency cooperation and consultation process. The USACE initiated formal consultation with both the USFWS and NOAA Fisheries and submitted a joint BA and an amended BA detailing the impacts associated with the TSP and the other restoration alternatives and proposed means to avoid, minimize, or mitigate impacts (Appendix N). As detailed in the BA, the USACE concluded that the project is in compliance with ESA. The SEIS and BA were reviewed by the USFWS and NOAA Fisheries to determine whether their agency concurs with the USACE's determination. BOEM participated in the review of the BA regarding potential impacts on endangered and threatened species in the OCS. The USFWS submitted a final BO on September 8, 2015. NMFS-PRD submitted their final BO on September 14, 2015 (Appendix N). The BOs on the action identify reasonable and prudent measures to minimize impacts.

6.11 Estuary Protection Act 1968

The Estuary Protection Act of 1968 ((16 U.S.C. §1221–1226; P.L. 90-454; 82 Stat 625) was passed to highlight the values of estuaries and the need to conserve their natural resources while providing a means to achieve a balance between protection of resources and development. It authorized the Secretary of the Interior to take a variety of actions, including study and inventory of estuaries of the U.S., in cooperation with other federal agencies and the states. An adjunct to the Estuary Protection Act was the creation of the National Estuary Program (NEP) in 1987, through amendments to the CWA. The NEP was designed to identify, restore, and protect nationally significant estuaries of the U.S., which are included in the program through a designation process. The USEPA administers the program, with committees consisting of local government officials, private citizens, and representatives from other federal agencies, academic institutions, industry, and estuary user-groups managing program decisions and activities.

Implementation of the barrier island restoration, as outlined in the TSP, would help to maintain the estuarine conditions in the Mississippi Sound and, therefore, the project is fully supportive of the intent of the Act.

6.12 Magnuson-Stevens Fishery Conservation and Management Act

The Fishery Conservation and Management Act of 1976 (16 U.S.C. § 1801 et seq.) established the following:

- A fishery conservation zone between the territorial seas of the U.S. and 200 nautical miles offshore;
- An exclusive U.S. fishery management authority over fish within the fishery conservation zone (excluding highly migratory species); and
- Regulations for foreign fishing within the fishery conservation zone through international fishery agreements, permits, and import prohibitions.

In 1996, Congress enacted amendments to the Act, known as the Sustainable Fisheries Act (P.L. 104-297), to address the substantially reduced fish stocks, which had declined as a result of direct and indirect habitat loss. The Act was renamed the Magnuson-Stevens Fishery Conservation and Management Act (P.L. 94-265), as amended on October 11, 1996. This act provides for the conservation and management of the fisheries, and the identification and protection of EFH (NOAA Fisheries, 1996).

EFH within the project area (including nearshore and OCS areas) and potential impacts on fish species and associated essential habitats are evaluated in Sections 4 and 5 of this SEIS. The proposed TSP complies with the Act.

6.13 Marine Mammal Protection Act

Under the MMPA of 1972 (16 U.S.C. § 1361 et seq.), the Secretary of Commerce is responsible for all cetaceans and pinnipeds, except walruses, and has delegated authority for implementing the Act to the NOAA Fisheries. The Secretary of the Interior is responsible for walruses, polar bears, sea otters, manatees, and dugongs, and has delegated the responsibility for implementing the MMPA to the USFWS. The MMPA established the Marine Mammal Commission and its Committee of Scientific Advisors on Marine Mammals, whose members are responsible for overseeing and providing advice to the responsible regulatory agencies on all Federal actions bearing upon the conservation and protection of marine mammals.

Use of the proposed area (including nearshore and OCS areas) and the potential impacts to marine mammals resulting from the TSP and protective measures to offset the potential impacts are considered in Sections 4 and 5. Agency consultation addressing marine mammals included discussions with both USFWS and NOAA. Incorporation of the safeguards used to protect threatened or endangered species during project implementation would also protect any marine mammals in the area; therefore, the project complies with this act.

6.14 The Marine Protection, Research, and Sanctuaries Act

The Marine Protection, Research, and Sanctuaries Act (MPRSA), also known as the Ocean Dumping Act, was passed in 1972 to prohibit the dumping of material into the ocean that would unreasonably degrade or endanger human health or the marine environment. Ocean dumping cannot occur unless a permit is issued under the MPRSA by the USACE for dredged material, USEPA's and subject to USEPA's concurrence, and by USEPA for all other materials. USEPA is also responsible for designating recommended ocean dumping sites for all types of materials as well as inspection, monitoring and surveillance to ensure compliance with disposal permit conditions.

The TSP includes the collection and placement of sand borrow material to restore Ship and Cat Islands and improve littoral transport of sand from the combined DA-10 and littoral zone site. Borrow investigations have indicated that the material is generally free of oil residue from the Deep Water Horizon oil spill and will not result in the placement of contaminated material. Procedures will be implemented during dredging and placement activities to identify potential oil contamination and avoid distribution of contaminated material. Placed material is for beneficial-use purposes and therefore, not governed by MPRSA but rather the CWA. MPRSA is not applicable to the TSP.

6.15 Migratory Bird Treaty Act

The Migratory Bird Treaty Act (MBTA) of 1918 established Federal responsibilities to protect birds migrating between the United States and Canada. Subsequent treaties with Mexico (1936), Japan (1972), and the Union of Soviet Socialist Republics (1976) expanded the scope of international protection of migratory birds. Each subsequent treaty was incorporated into the MBTA as an amendment. The provisions of the MBTA are implemented domestically within the signatory countries. Under the MBTA, nearly all species of birds occurring in the United States, their eggs, and their nests are protected. There are 836 bird species protected by the MBTA in the United States, 58 of which are legally hunted as game birds. The MBTA makes it illegal to take (to hunt, pursue, wound, kill, possess, or transport by any means) listed bird species, their eggs, feathers, or nests unless otherwise authorized, such as within legal hunting seasons. This SEIS evaluates the benefits and impacts of the TSP to migratory birds as described in Sections 4 and 5. The TSP is in compliance with the Act.

6.16 Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act of 1934, as amended, requires consultation and coordination with the USFWS and state fish and wildlife agencies "whenever the waters of any stream or other body of water are proposed or authorized to be impounded, diverted, the channel deepened, or the stream or other body of water otherwise controlled or modified for any purpose whatever, including navigation and drainage, by any department or agency of the United States, or by any public or private agency under Federal permit or license "(16 U.S.C. § 662(a)). The USFWS prepared an initial Fish and Wildlife Coordination Act Report (FWCAR) during the preparation of the MsCIP PEIS (USACE, 2009a). Information in this FWCAR was instrumental in guiding the development of the initial barrier island restoration plan. The USFWS subsequently prepared a FWCAR addressing the specifics of the barrier island restoration plan (Appendix Q) and complies with the Act.

6.17 National Environmental Policy Act

NEPA requires that all federal agencies use a systematic, interdisciplinary approach to document the potential impacts from federal actions on the environment. This approach promotes the integrated use of natural and social sciences in planning and decision-making that could have an impact on the environment. The NEPA regulations provide for the use of the NEPA process to identify and assess reasonable alternatives to proposed actions that avoid or minimize adverse effects of these actions upon the quality of the environment. Scoping is used to identify the scope and significance of environmental issues associated with a proposed federal action through coordination with federal, state, and local agencies; the general public; and any interested individuals and organizations prior to the development of an EIS. The process also identifies and eliminates from further detailed study issues that are not significant or have been addressed by prior environmental review.

According to 40 C.F.R. § 1502.9, a supplement to either a draft or final EIS (DEIS or FEIS) must be prepared if an agency makes substantial changes in the TSP that are relevant to environmental concerns, or there are significant new circumstances or information relevant to environmental concerns and bearing on the TSP or its impacts. The ROD for the MsCIP PEIS was signed by Assistant Secretary of the Army Jo-Ellen Darcy on January 14, 2010. The ROD, which included restoration of the Mississippi barrier islands, completed the NEPA process.

This SEIS has been prepared in accordance with the NEPA process for federal actions that may impact the environment and addresses new conditions that were not evaluated in the MsCIP PEIS. Specifically, this SEIS evaluates the sediment dredging and placement impacts associated with the following:

- Direct sand placement in Camille Cut between East Ship Island and West Ship Island;
- Direct placement of sand on the southern shore of East Ship Island;
- Direct placement of sand on the eastern shoreline of Cat Island; and
- Borrow of approximately 21 mcy of sand for closure of Camille Cut, restoration of East Ship Island, and restoration of Cat Island.

6.18 National Historic Preservation Act

The NHPA, enacted in 1966 and amended in 1970 and 1980, provides for the NRHP to include districts, sites, buildings, structures, and objects significant in American history, architecture, archaeology, and culture. The law seeks to preserve the historical and cultural foundation of the United States. According to Executive Order 11593 of 1991 (*Protection and Enhancement of the Cultural Environment)*, the federal government will provide leadership in preserving, restoring, and maintaining the historic and cultural environment. The NHPA provides funding for each state to establish a SHPO. The SHPO oversees performance of appropriate surveys to ensure that historic and cultural resources are protected under the law. Consultation with the Mississippi SHPO has been initiated concerning the specific aspects of the TSP, as discussed in Sections 4 and 5 of the SEIS and in compliance with the Act.

The OCS is not federally owned land, and the Federal Government has not claimed direct ownership of historic properties on the OCS; therefore, under Section 106 of the NHPA, BOEM only has the authority to ensure that its funded and permitted actions do not adversely affect significant historic properties. Beyond avoidance of adverse impacts, BOEM does not have the legal authority to manage the historic properties on the OCS.

6.19 National Park Service Regulations

6.19.1 Organic Act of 1916 and NPS Management Policies 2006, Section 1.4: The Prohibition on Impairment of Park Resources and Values

Restoration of the Mississippi barrier islands as part of the MsCIP Comprehensive Plan will involve work within the GUIS and therefore must conform to the requirements of the NPS Organic Act of 1916 (Organic Act). By enacting the Organic Act, Congress directed the U.S. Department of Interior and the NPS to manage units "to conserve the scenery and the natural and historic objects and wildlife therein and to provide for the enjoyment of the same in such a manner and by such a means as will leave them unimpaired for the enjoyment of future generations" (16 U.S.C. § 1). Congress reiterated this mandate in the Redwood National Park Expansion Act of 1978 by stating that NPS must conduct its actions in a manner that will ensure no "derogation of the values and purposes for which these various areas have been established, except as may have been or shall be directly and specifically provided by Congress" (16 U.S.C. 1a-1).

NPS Management Policies 2006, Section 1.4.4, explains the prohibition on impairment of park resources and values:

> While Congress has given the Service the management discretion to allow impacts within parks, that discretion is limited by the statutory requirement (generally enforceable by the federal courts) that the Park Service must leave park resources and values unimpaired unless a particular law directly and specifically provides otherwise. This, the cornerstone of the Organic Act, establishes the primary responsibility of the National Park Service. It ensures that park resources and values will continue to exist in a condition that will allow the American people to have present and future opportunities for enjoyment of them.

The NPS has discretion to allow impacts on Park resources and values when necessary and appropriate to fulfill the purposes of a Park (NPS, 2006; Section 1.4.3). However, the NPS cannot allow an adverse impact that would constitute impairment of the affected resources and values (NPS, 2006; Section 1.4.3). An action constitutes an impairment when its impacts "harm the integrity of Park resources or values, including the opportunities that otherwise would be present for the enjoyment of those resources or values" (NPS, 2006; Section 1.4.5).

In making a determination of whether there would be an impairment, an NPS decision-maker must use his or her professional judgment (NPS, 2006; Section 1.4.7). This means that the decision-maker must consider any EAs or environmental impact statements (EISs) required by NEPA; consultations required under Section 106 of the NHPA; relevant scientific and scholarly studies; advice or insights offered by subject matter experts and others who have relevant knowledge or experience; and the results of civic engagement and public involvement activities relating to the decision (NPS, 2006; Section 1.4.7). At the time that a decision is made, a non-impairment determination will be prepared for the selected action and appended to the NPS decision document.

6.19.2 Director's Order #77-1, Wetland Protection

Executive Order 11990—*Protection of Wetlands*, directs all 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. In the absence of such alternatives, NPS parks must modify actions to preserve and enhance wetland values and minimize degradation. Consistent with Executive Order 11990 and NPS Director's Order #77-1: *Wetland Protection*, NPS has adopted a goal of "no net loss of wetlands." Director's Order #77-1 states that for new actions where impacts to wetlands cannot be avoided, proposals must include plans for compensatory mitigation that restores wetlands on NPS lands, where possible, at a minimum acreage ratio of 1:1.

For the purpose of implementing Executive Order 11990, an area in an NPS unit that is classified as a wetland according to the USFWS "Classification of Wetlands and Deepwater

Habitats of the United States" is subject to Director's Order #77-1 (with the exception of deepwater habitats, which are not subject to Director's Order #77-1) (Cowardin et al., 1979). The Cowardin wetland definition encompasses more aquatic habitat types than the definition and delineation manual used by the USACE for identifying wetlands subject to Section 404 of the CWA. The 1987 "USACE Wetlands Delineation Manual" requires that three parameters (hydrophytic vegetation, hydric soil, wetland hydrology) must all be present in order for an area to be considered a wetland. The Cowardin wetland definition includes such wetlands, but also adds some areas that, though lacking vegetation and/or soils due to natural physical or chemical factors such as wave action or high salinity, are still saturated or shallow inundated environments that support aquatic life (e.g., unvegetated stream shallows, mudflats, and rocky shores). Under the Cowardin definition, a wetland must have one or more of the following three attributes:

1. At least periodically, the land supports predominantly hydrophytes (wetland vegetation);
2. The substrate is predominantly undrained hydric soil; and
3. The substrate is non-soil and is saturated with water or covered by shallow water at some time during the growing season of each year.

The Cowardin wetland definition includes wetlands with one of the three criteria discussed above, but also adds some areas that, though lacking vegetation and/or soils due to natural physical or chemical factors such as wave action or high salinity, are still saturated or shallow inundated environments that support aquatic life (e.g., unvegetated stream shallows, mudflats, rocky shores). As stated above, deepwater habitats are not subject to Director's Order #77-1. The wetland/ deepwater habitat boundary is described in Cowardin et al. (1979) as a depth of 2 meters (6.6 feet) at low water, or at the limits of emergent or woody vegetation extending beyond this depth. The National Wetlands Inventory (NWI) of the USFWS produces information on the characteristics, extent, and status of the nation's wetlands and deepwater habitats. The USFWS definition of wetlands is similar to the NPS definition of wetlands in that only one of three parameters (hydric soils, hydrophytic vegetation, and hydrology) is required to characterize an area as a wetland, based upon the Cowardin Classification of Wetlands (Cowardin et al., 1979). NWI maps are prepared by the USFWS from the analysis of high altitude imagery and wetlands are identified based on vegetation, visible hydrology and geography. The wetlands depicted on NWI maps are based upon the Cowardin wetland definition and classification system (Cowardin et al., 1979), so (subject to ground-truthing) they are considered wetlands by the NPS. Director's Order #77-1 (Wetland Protection) establishes NPS procedures for implementing Executive Order 11990. This includes preparation of a Wetland Statement of Findings (WSOF) with sufficient information for assessing the potential wetland impacts of the proposed actions of NPS managed property. The WSOF for the TSP discussed in this SEIS is located in Appendix M.

6.19.3 Permitting Instrument for NPS Special Park Uses

All of Petit Bois, Horn, East Ship Island, West Ship Island, DA-10/Sand Island, and portions of Cat Island are located within the boundaries of the GUIS Mississippi unit under the jurisdiction of the NPS.

All special park uses that do not have a specific, approved permitting instrument require an NPS Special Use Permit. This SEIS and a separate NPS ROD shall constitute the record of environmental impact analysis and decision-making process for the portions of the MsCIP that directly affects units of the NPS. This means that if approved, the GUIS will undertake a federal action through the issuance of a Special Use Permit to the USACE to implement the portions of the selected action within the jurisdictional boundary of GUIS.

6.20 Native American Graves Protection and Repatriation Act

The Native American Graves Protection and Repatriation Act (NAGPRA), recognizes that curating human remains and sacred objects may be offensive to Native American descendants, sought to return human remains and associated burial goods to the descendants of the tribes of the individual(s). The act calls for the inventory of human remains and associated funerary objects for repatriation to their lineal descendants by Federal agencies and museums that curate these items. In cases where the lineal descendants cannot be ascertained, and in cases of unassociated funerary objects, sacred objects, and objects of cultural patrimony is the property of tribes on whose lands the remains or objects were found, or those tribes who show the closest cultural affiliation with the remains or objects.

The act also calls for more oversight when excavating such remains or items on Federal or tribal lands, including coordination with tribes prior to such excavation. Additionally, the act makes it illegal to sell, purchase, profit, or transport for sale the human remains of Native Americans without the right to possession of such remains as provided in the act.

6.21 Outer Continental Shelf Lands Act

The OSC Lands Act defines the OCS as all submerged lands lying seaward of state coastal waters under U.S. jurisdiction. The law authorizes the U.S. Department of the Interior to lease OCS lands to prevent waste and conserve natural resources, and to grant leases to the highest responsible qualified bidder as determined by competitive bidding procedures. The Deepwater Port Act authorizes the Department of Transportation, after consultation with the Department of the Interior, to waive the removal requirements for a deepwater port if its components can be used in conjunction with a mineral lease sale. OCS leases or permits may be cancelled if continued activity is likely to cause serious harm to life, including fish and other aquatic life. Economic, social, and environmental values of the renewable and nonrenewable resources must be considered in management of the OCS. It is required that an environmental study be done for any region to be included in a lease sale, to assess and manage environmental impacts on the OCS. The TSP is in compliance with the Act.

The BOEM is the agency designated to oversee OCS resources. After an evaluation required by NEPA, the BOEM may issue noncompetitive negotiated agreements for the use of OCS sand to the requesting entities. Therefore, BOEM, as a cooperating Federal agency, is undertaking a connected action (40 C.F.R. 1508.25) that is related, but unique from the USACE Proposed Action. The Proposed Action of the BOEM is the issuance of a negotiated agreement pursuant to its authority under this Act and will evaluate whether or not to authorize the use of offshore borrow areas.

6.22 Rivers and Harbors Act

Section 10 of the Rivers and Harbors Act of 1899 prohibits the construction of structures or obstructions in navigable waters without the consent of Congress (33 U.S.C. § 407). Structures include wharves, piers, jetties, breakwaters, bulkheads, etc. The Rivers and Harbors Act also includes any changes to the course, location, condition, or capacity of navigable waters and includes dredge and fill projects in those waters. The USACE oversees implementation of this law.

This SEIS has been completed in coordination with appropriate entities of the USACE, Mobile District to ensure that no features of the barrier island restoration would obstruct navigation.

6.23 Submerged Lands Act

The Submerged Lands Act was enacted in response to litigation that effectively transferred ownership of the first 3 miles of a state's coastal submerged lands to the federal government. In response, Congress adopted the Submerged Lands Act in 1953, granting title to the natural resources located within three miles of their coastline (three marine leagues for Texas and the Gulf coast of Florida). For purposes of the Submerged Lands Act, the term "natural resources" includes oil, gas, and all other minerals. Mississippi calls the land between the mean low tide (MLT) and mean high tide (MHT) tidelands, and the land below MLT submerged lands (or submerged water bottoms) (Beck et al., 2000).

Because the proposed project includes removal of sand within three miles of the coast (tidelands and submerged lands), it would require agreements with the states of Mississippi and Alabama. The USACE is coordinating with both Mississippi and Alabama in compliance with this act.

The State of Alabama owns the title to lands underlying coastal waters to a line 3 geographical miles distant from its coastline (see 43 U.S.C. § 1301, et seq.). The United States has paramount rights in these waters for purposes of commerce, navigation, national defense, and international affairs, none of which apply to the removal of sand for the purposes of beach or island restoration. The State's position is removal of sand within the state boundaries will be done in accordance with State Law (AL Code 9-15-52) and either a direct sale or royalty payment may be charged for removal.

6.24 Sunken Military Craft Act

The Sunken Military Craft Act (SMCA) was enacted on October 28, 2004. Its primary purpose is to preserve and protect from unauthorized disturbance all sunken military craft that are owned by the United States government, as well as foreign sunken military craft that lie within U.S. waters. The law preserves the sovereign status of sunken U.S. military vessels and aircraft by codifying both their protected sovereign status and permanent U.S. ownership, regardless of the passage of time. The purpose of the SMCA is to protect sunken military vessels and aircraft and the remains of their crews from unauthorized disturbance. The SMCA protects sunken U.S. military ships and aircraft wherever they are located, as well as the graves of their lost military personnel, sensitive archaeological artifacts, and historical information. Its scope is broad, protecting sunken U.S. craft worldwide and sunken foreign craft in U.S. waters defined to include the internal waters, territorial sea, and contiguous zone (up to 24 nautical miles off the U.S. coast).

6.25 Wilderness Act

The Wilderness Act established a National Wilderness Preservation System to be composed of federally owned areas designated by the Congress as "wilderness areas," and these shall be administered for the use and enjoyment of the American people in such manner as will leave them unimpaired for future use and enjoyment as wilderness, and so as to provide for the protection of these areas, the preservation of their wilderness character, and for the gathering and dissemination of information regarding their use and enjoyment as wilderness.

Approximately 1,800 acres of the National Seashore, Horn and Petit Bois Islands were designated wilderness areas in 1978 which prohibits commercial enterprise, permanent road, structures or installations; motorized vehicles and equipment are also prohibited (16 U.S.C. §1133(c)). The SEIS recognizes their Wilderness status and since the activity would not directly affect these areas, no action would be taken that would impact their designation. Therefore, the TSP is in compliance with the Act.

6.26 Water Resources Development Act of 2007 (WRDA 2007)

WRDA 2007, Section 2039, Monitoring Ecosystem Restoration, (a) states "In General, - In conducting a feasibility study for a project (or a component of a project) for ecosystem restoration, the Secretary shall ensure that the recommended project includes, as an integral part of the project, a plan for monitoring the success of the eco-system restoration. (b) Monitoring Plan, - The monitoring plan shall – (1) include a description of the monitoring activities to be carried out, the criteria for ecosystem restoration success, and the estimated cost and duration of the monitoring; and (2) specify that the monitoring shall continue until such time as the Secretary determines that the criteria for ecosystem restoration success will be met." The MAM Plan developed as part of the Barrier Island Restoration Project provides an organized and documented process that defines management actions in relation to measured project performance and establishes a feedback loop between continued project monitoring and corresponding project management, operation, and adjustments. The primary purpose for implementing the MAM Plan is to determine progress toward restoration success and to increase the likelihood of achieving desired project outcomes in the face of uncertainty. Monitoring results will be used through an assessment process to determine whether the project outcomes are consistent with original project goals and objectives.

6.27 Executive Orders

6.27.1 Executive Order 13175—Consultation and Coordination with Indian Tribal Governments

Executive Order 13175 imposes requirements on the development of rules, policy or guidance that have tribal implications or preempt tribal laws. Tribal implications is defined as having substantial direct effects on one or more Indian tribes, on the relationship between the federal government and Indian tribes, or on the distribution of power and responsibilities between the federal government and Indian tribes. Tribal coordination has taken place for the MsCIP barrier island restoration.

The SEIS does not propose the development of rules, policy or guidance nor will it preempt tribal law, thus Executive Order 13175 is not applicable to this Project.

6.27.2 Executive Order 13158—Marine Protected Areas

The purpose of Executive Order 13158 is to help protect the significant natural and cultural resources within the marine environment for the benefit of present and future generations by strengthening and expanding the Nation's system of MPAs. Consistent with domestic and international law, the executive order seeks to:

1. "strengthen the management, protection, and conservation of existing marine protected areas and establish new or expanded MPAs;
2. develop a scientifically based, comprehensive national system of MPAs representing diverse U.S. marine ecosystems, and the Nation's natural and cultural resources; and
3. avoid causing harm to MPAs through federally conducted, approved, or funded activities."

Federal MPAs fall into five categories: (1) marine sanctuaries, (2) national seashores, (3) wildlife refuges, (4) National Estuarine Research Reserves, and (5) National Estuary Programs as discussed in Sections 4 and 5 (Mississippi–Alabama Sea Grant Legal Program, 2003). A portion of the proposed project area is within the GUIS and is therefore considered an MPA. The TSP was developed in compliance with NPS regulations and management policies for the GUIS and is therefore addressed in this executive order.

6.27.3 Executive Order 13112—Invasive Species

Executive Order 13112 was issued to prevent the introduction of invasive species; provide for their control; and minimize the economic, ecological, and human health impacts that invasive species can cause. This order defines invasive species, requires federal agencies to address invasive species concerns and to not authorize or carry out new actions that would cause or promote the introduction of invasive species, and established the Invasive Species Council.

Invasive species were considered during the development of the TSP. Dune plantings would consist of clean seed and/or native vegetation to discourage colonization by invasive species. Therefore, the TSP would not promote invasive species and would comply with this executive order.

6.27.4 Executive Order 13089—Coral Reef Protection

Executive Order 13089 established the interagency U.S. Coral Reef Task Force, co-chaired by the Secretary of the Interior and the Secretary of Commerce through the Administrator of the NOAA. The Task Force is charged with developing and implementing a comprehensive program of research and mapping to inventory, monitor, and "identify the major causes and consequences of degradation of coral reef ecosystems" while the executive order also directs Federal Agencies to expand their own research, preservation, and restoration efforts.

As noted in Sections 4.5.7 and 5.4.6, several fish havens, artificial reefs, and shipwrecks are located in the area; however, there is no hard bottom habitat or coral reefs in the proposed project area. Therefore, this executive order is not applicable.

6.27.5 Executive Order 13045—Protection of Children

On April 21, 1997, President Clinton issued Executive Order 13045, *Protection of Children from Environmental Health Risks and Safety Risks.* This executive order directs each federal agency to ensure that its policies, programs, activities, and standards address disproportionate risks to children that result from environmental health risks or safety risks.

The potential environmental health or safety risks to children resulting from implementation of a restoration alternative are addressed in Section 5. Based on this evaluation, USACE has determined that the TSP addresses Executive Order 13045, *Protection of Children from Environmental Health Risks and Safety Risks.*

6.27.6 Executive Order 12898—Environmental Justice Policy

EJ Policy, based on Executive Order 12898 of 1994, requires agencies to incorporate into NEPA documents an analysis of the environmental effects of their proposed programs on minorities and low-income populations and communities. EJ is defined by the USEPA as the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies." The effects of the TSP on local populations and the resources used by local groups, including minority and low-income groups, are addressed in Section 5. Based on this evaluation, USACE has determined that the TSP addresses Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations.*

6.27.7 Executive Order 11990—Protection of Wetlands

Executive Order 11990 requires that Federal agencies provide leadership and take action to minimize the destruction, loss, or degradation of wetlands; and preserve and enhance the natural beneficial values of wetlands when conducting the following actions:

- Acquiring, managing, and disposing of Federal lands and facilities;
- Providing Federally undertaken, financed, or assisted construction and improvements; and
- Conducting Federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulation, and licensing activities.

Agencies must avoid, to the extent possible, the long- and short-term adverse impacts associated with the destruction or modification of wetlands wherever there is a practicable alternative. As defined in Section 7(c) of Executive Order 11990, wetlands are areas that are inundated by surface or groundwater with a frequency sufficient to support and under normal circumstances do or would support a prevalence of vegetative or aquatic life that requires saturated or seasonally saturated soil conditions for growth and reproduction. Under the TSP, no wetlands meeting this definition would be impacted by sand dredging or placement activities.

6.27.8 Executive Order 11988—Floodplain Management

Executive Order 11988 directs federal agencies to provide leadership and take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health, and welfare, and to restore and preserve the natural and beneficial values served by floodplains in carrying out their responsibilities. In addition, federal agencies are required to avoid to the extent possible adverse impacts associated with the occupation and modification of floodplains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. The executive order applies to the following actions:

- Acquiring, managing, and disposing of federal lands and facilities;
- Providing federally undertaken, financed, or assisted construction and improvements; and
- Conducting federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulation, and licensing activities.

The potential benefits from the Proposed Action on coastal flood risk are described in Section 5. The restoration of Ship and Cat Islands would help reduce the intensity of storm surges and storm waves, as well as the associated coastal flooding, as described in Appendix D. Therefore, the TSP meets the requirements of the floodplain management executive order.

7. Public Involvement

7.1 Introduction

NEPA is intended to ensure full public participation in the EIS process. Public participation includes effective communication between all federal, state, and local agencies, tribal governments, and other persons or organizations that may have an interest in the project. As required by NEPA, the public was invited to attend public scoping meetings and public hearings as part of the development of the MsCIP PEIS. Other methods used to reach the general public and interested stakeholders have included meeting announcements, newsletters, news releases to local print and broadcast news media, and a web site.

Further public communications included maintaining contact with public officials and agency representatives, ensuring that calls from the public were addressed in a timely manner, and contacting stakeholders. In addition, the SEIS was widely circulated and comments were requested. Public involvement materials are presented in Appendix R. These materials include copies of the Notice of Intent (NOI), newsletters, notices of public meetings, and the project mailing list. Agency correspondence is presented in Appendix R.

7.2 Notice of Intent

An NOI to prepare a Draft SEIS was published in the Federal Register at 75 Fed. Reg. 203 on October 21, 2010. The NOI is included in the Public Involvement Report (Appendix R).

7.3 Public Scoping

Extensive public scoping was conducted during the development of the MsCIP Comprehensive Plan, of which the barrier island restoration is one part. According to the CEQ, public scoping is not required during the development of a SEIS (2007). Scoping completed for the PEIS is considered to be sufficient.

7.4 Distribution of the Draft and Final Supplemental Environmental Impact Statement

The Draft SEIS was posted on the MsCIP web site and made available at local libraries for public access. The Final SEIS also will be provided for public information on the web site and made available at local libraries.

7.5 Point of Contact

Written comments regarding this SEIS should be sent to the following contact. Requests for more information may also be sent to the contact.

Susan Ivester Rees, PhD, Program Manager, MsCIP (Susan.I.Rees@usace.army.mil) or at this address:

U.S. Army Corps of Engineers
Department of Defense
ATTN: MsCIP Program
P. O. Box 2288
Mobile, AL 36628

7.6 Cooperating Agencies

Per the CEQ regulations on implementing the NEPA, the USACE, Mobile District requested that several state and federal agencies accept the status of Cooperating Agency on the Integrated Report and Programmatic EIS. In response to this request, dated October 30, 2006, the entities outlined below are participating as cooperating agencies. During development of this SEIS, two Alabama agencies became cooperating agencies.

State

- Mississippi Department of Archives and History
- Mississippi Department of Environmental Quality, Office of Pollution Control
- Mississippi Department of Marine Resources
- Mississippi Department Of Transportation
- Mississippi Emergency Management Agency
- Mississippi Museum of Natural Science
- Mississippi Secretary of State, Public Lands Division
- Alabama Department of Conservation and Natural Resources

Federal

- Federal Emergency Management Agency, Region 4
- U.S. Department of Interior
  - Bureau of Ocean and Energy Management (BOEM), Gulf of Mexico Region
  - National Park Service
  - U.S. Geological Survey
  - U.S. Fish and Wildlife Service
- U.S. Department of Commerce
  - National Oceanic and Atmospheric Administration, National Marine Fisheries Service Southeast Region, Protected Resources and Habitat Conservation Divisions
- U.S. Department of Agriculture
  - Natural Resources Conservation Service
- U.S. Department of Transportation, Federal Highway Administration
- U.S. Environmental Protection Agency, Region 4

7.7 Agency Consultation

Additional consultations and coordination with the USFWS and NMFS were completed, based on the identification of OCS borrow areas. The BA and BO were updated to cover OCS borrow sites and associated impacts. Agency correspondence on the Final SEIS will be summarized in the ROD.

8. List of Preparers and Participants

8.1 USACE, Mobile District

Susan Ivester Rees, PhD/Program Manager

Jennifer Jacobson/Chief/Coastal Environmental Team

Larry Parson/SEIS Project Manager

Justin McDonald/Lead Engineer

Michael Fedoroff/District Archaeologist

Allen Wilson/Archaeologist

Lekesha Reynolds/Biologist

Jason Krick/Civil Engineer

John Baehr/Geologist (ret.)

Michael FitzHarris/Geologist

Elizabeth Godsey/Coastal Hydraulic Engineer

8.2 National Park Service

Daniel Brown/ Superintendent, GUIS

Bruce McCraney/NPS MsCIP Liaison

Rick Clark/ Chief/Science and Resources Management Division, GUIS

Mark Ford/Wetlands Ecologist

Linda York/Coastal Geomorphologist

Steve Wright/Environmental Planner

Jolene Williams/Environmental Planner

Gary Hopkins/Biologist

Dave Conlin/Archaeologist

John Cornelison/Archaeologist

David Morgan/Archaeologist

8.3 BOEM, Gulf of Mexico Region

Kenneth Ashworth/Environmental Scientist

Michael Miner/Geologist

Douglas Piatkowski/Physical Scientist

8.4 CH2M HILL

Doug Baughman/Project Manager and Senior Reviewer/26 years of experience/Master of Science

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Ruth C. Rouse, AICP/Project Scientist/24 years of experience/Master of Environmental Management

Jeremy Scott/Project Scientist/12 years of experience/Master of Science

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David Miller/President, Senior Water Resources Planner/34 years of experience/MBA-Finance and Public Policy

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