COVER SHEET

Responsible Agency and Lead Federal Agency: U.S. Army Corps of Engineers

Title: Mobile Harbor, Mobile, Alabama Draft Integrated General Reevaluation Report with Supplemental Environmental Impact Statement, Mobile County, Alabama (Draft GRR/SEIS)

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The Mobile Harbor, Mobile, Alabama Integrated General Reevaluation Report with Supplemental Environmental Impact Statement, Mobile County, Alabama is available at: http://www.sam.usace.army.mil/Missions/Program-and-Project-Management/Civil-Projects/Mobile-Harbor-GRR/

Abstract: The study area encompasses Mobile Bay, Alabama which is bounded by the Morgan Peninsula to the east and Dauphin Island, a barrier island to the west. Mobile Bay is triangularly shaped with an area of approximately 413 square miles. At its largest dimensions it is 31 miles long and 24 miles wide. The deepest areas, 50 feet (ft), are located within the Federal navigation channel, which serves Alabama's only port for ocean-going vessels. The Mobile Bay Watershed is the sixth largest river basin in the U.S. The study evaluated a range of alternative plans that would improve the safety and efficiency of the existing navigation system. Navigation concerns include three main types of problems: larger size vessels experience transit delays due to existing width of channel; existing channel depths limit vessel cargo capacity; and, existing traffic congestion has increased safety concerns. The Tentatively Selected Plan includes the following navigation improvements: 1) deepen the existing Bar, Bay, and River Channels by 5 ft to project depths of 52, 50, and 50 ft, respectively, including an additional 2 ft for advanced maintenance plus 2 ft of allowable overdepth; 2) incorporate bend easings in the Bar Channel; 3) widen the Bay Channel from 400 feet to 500 ft for 3 nautical miles to provide a two-way traffic area for passing; and 4) expand the Choctaw Pass Turning Basin 250 ft to the south to better accommodate safe turning of the design vessel and other large vessels. Placement areas for the new work material include the Relic Shell Mined Area, Sand Island Beneficial Use Area (SIBUA), and the Ocean Dredged Material Disposal Site (ODMDS). Placement areas for future maintenance will remain unchanged with the exception of proposed extensions to the SIBUA and the ODMDS. The TSP is economically justified with a benefit-to-cost ratio (BCR) of 3.0. The estimated project costs are $387.8 million.

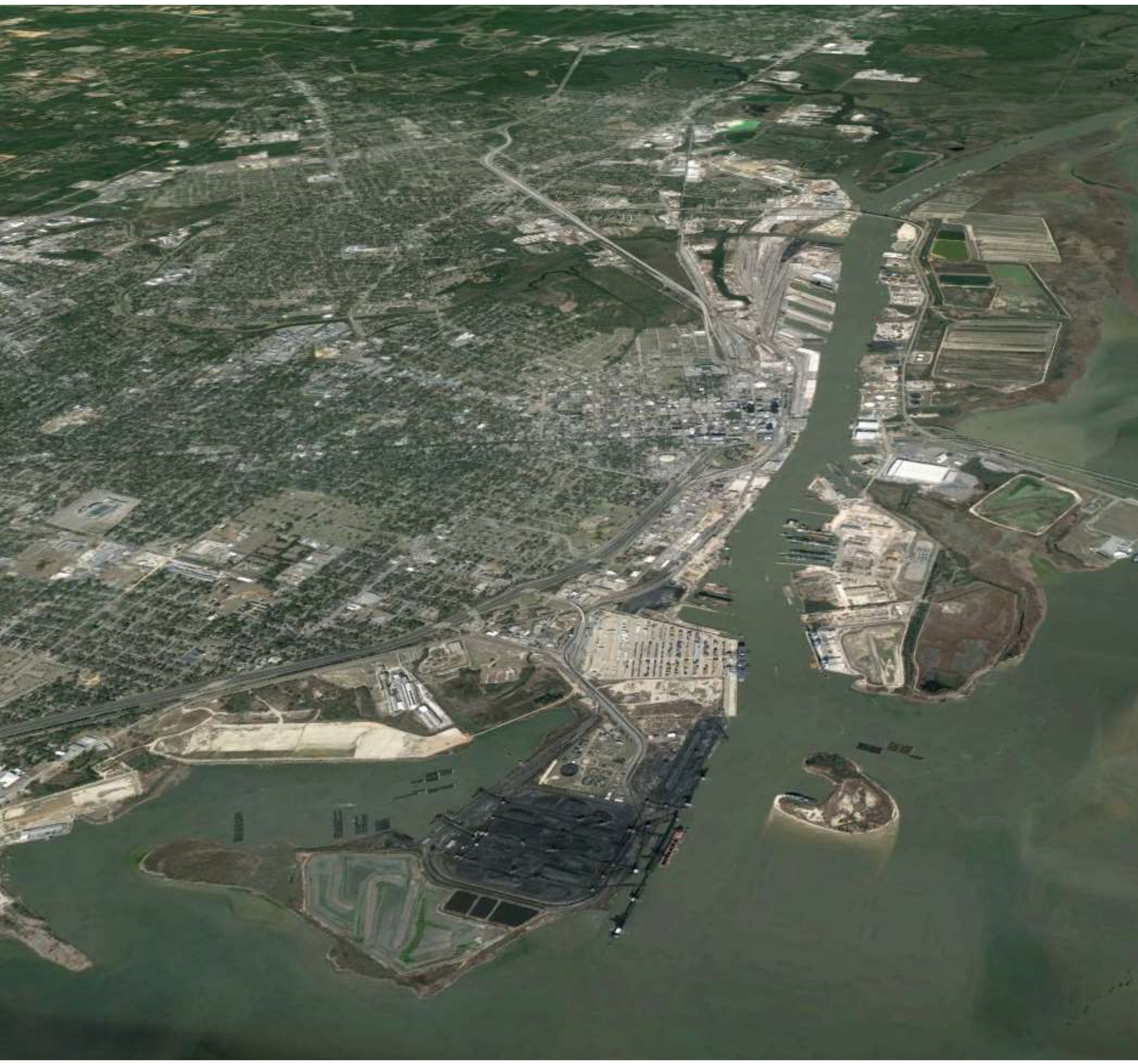
Public Comments: Prior to preparation of the Draft GRR/SEIS, public involvement was conducted through the publishing of the Notice of Intent and a public scoping meeting on January 12, 2016. Additionally, meetings and workshops with resource agencies and the public were held throughout the study process. Three general public meetings have been held (March 16, 2017, September 14, 2017, and February 22, 2018). Two of the general public meetings were in an open house format, and one was in the town-hall format. The meeting locations were in downtown Mobile, South Mobile County, and Daphne, Alabama on the eastern shore of Mobile Bay. The slides/information boards presented at these meetings can be found on the Mobile Harbor GRR website listed above. A number of meetings were held with the cooperating agencies to keep them informed on the progress of the study, obtain comments and information regarding natural resources of concern, and beneficial use opportunities. Additionally, focus group meetings were held throughout the study process. Focus groups have included Seafood interests and commercial fisherman, environmental non-governmental organizations, Dauphin Island property owners and interests, and Environmental Justice communities. The U.S. Army Corps of Engineers considered all comments received throughout this public involvement process in preparing the Draft GRR/SEIS. A 45-day comment period begins with the publication of the U.S. Environmental Protection Agency Notice of Availability in the Federal Register. Individuals and agencies may present comments relevant to the Draft GRR/SEIS by mail at the address above or email (MobileHarborGRR@usace.army.mil) by September 10, 2018 or request a public hearing. The comments received during the comment period will be considered in the preparation of the Final GRR/SEIS.

MOBILE HARBOR, MOBILE, ALABAMA

DRAFT

Integrated General Reevaluation Report With Supplemental Environmental Impact Statement

July 2018



US Army Corps of Engineers
Mobile District

ALABAMA STATE PORT AUTHORITY

RESPONSIBLE AGENCIES: The lead agency for the navigation study is the U.S. Army Corps of Engineers (USACE), Mobile District. The Alabama State Port Authority (ASPA) is the non-Federal sponsor (NFS).

ABSTRACT: The study area encompasses Mobile Bay, Alabama which is bounded by the Morgan Peninsula to the east and Dauphin Island, a barrier island to the west. Mobile Bay is somewhat triangularly shaped with an area of approximately 413 square miles. At its largest dimensions it is 31 miles long and 24 miles wide. The deepest (about 50 feet (ft)) areas of the bay are located within the Federal navigation channel, which serves Alabama's only port for ocean-going vessels, but the average depth of the bay is 10 ft. The Mobile Bay Watershed is the sixth largest river basin in the U.S.

The study evaluated a range of alternative plans that would improve the safety and efficiency of the existing navigation system. Navigation concerns include three main types of problems: larger size vessels experience transit delays due to existing width of channel; existing channel depths limit vessel cargo capacity; and, existing traffic congestion has increased safety concerns. The Tentatively Selected Plan (TSP) includes the following navigation improvements:

- Deepen the existing Bar, Bay (including the Choctaw Pass Turning Basin), and River Channels (south of station 226+16) by 5 ft to project depths of 52, 50, and 50 ft, respectively, with an additional 2 ft for advanced maintenance plus 2 ft of allowable overdepth for dredging (total depths of 56, 54, and 54 ft, respectively).
- Incorporate minor bend easings at the double bends (at stations 1857+00 and 1775+26) in the Bar Channel approach to the Bay Channel.
- Widen the Bay Channel from 400 ft to 500 ft from the mouth of Mobile Bay northward for 3 nautical miles to provide a two-way traffic area for passing.
- Expand the Choctaw Pass Turning Basin 250 ft to the south (at a depth of 50 ft) to better accommodate safe turning of the design vessel and other large vessels.

Placement areas for the new work material dredged for the proposed navigation improvements are as follows:

- Relic Shell Mined Area
- Sand Island Beneficial Use Area (SIBUA)
- Ocean Dredged Material Disposal Site (ODMDS)

Placement areas for material dredged during maintenance will remain unchanged with the exception of the proposed extensions to the SIBUA and the ODMDS.

The TSP is economically justified with a benefit-to-cost ratio (BCR) of 3.0. The estimated project costs are $387.8 million.

EXECUTIVE SUMMARY

The results of engineering, economic, environmental, and real estate investigations performed for this General Reevaluation Report (GRR) are being used to determine if the Federal Government should participate in design and construction of potential navigation improvements at Mobile Harbor, Alabama. The ASPA requested the USACE, Mobile District initiate a study to evaluate widening and deepening Mobile Harbor as authorized under Section 201 of the Water Resources Development Act (WRDA) of 1986 (Public Law (PL) 99–662, Ninety-ninth Congress, Second Session), which was approved on 17 November 1986, and subsequently amended by Section 302 of the WRDA of 1996.

DESCRIPTION OF THE REPORT

Included with this report is a Draft Supplemental Environmental Impact Statement (Draft SEIS). The Draft SEIS is a supplement to the Environmental Impact Statement (EIS) originally prepared for the USACE 1980 Survey Report on Mobile Harbor. The Draft GRR is integrated with the Draft SEIS (Draft GRR/SEIS) and documents the study process and presents the results of investigations and analyses conducted to evaluate modifications to the existing Federal navigation system to improve its ability to efficiently serve the current and future vessel fleet. It presents: (1) a survey of existing and future conditions; (2) an evaluation of related problems and opportunities; (3) development of potential alternatives; (4) a comparison of costs, benefits, potential adverse impacts, and feasibility of those alternatives; and (5) identification of the TSP.

PURPOSE AND NEED

The cargo transportation industry continues its shift to increased use of standardized containers used for multimodal (marine, rail, and truck) freight transportation systems. Additionally, the marine vessel fleet is trending to larger, deeper-draft vessels, particularly for containerships and dry bulk carriers. The Federal navigation channel serving Mobile Harbor's major terminals is currently constructed to a depth of 45 feet (ft) mean lower low water (MLLW). The existing dimensions of this channel place constraints on deeper-drafting containerships and coal carriers, which result in reduced efficiency and increased costs.

The principal navigation problem is larger vessels are experiencing transportation delays and inefficiencies due to limited channel depth and width. This problem is a result of increasing number and size of vessels entering and departing Mobile Harbor. The existing channel depths and widths limit vessel cargo capability, restrict many vessels to one-way traffic and in some areas limit transit operations to daylight hours only.

EXISTING AND AUTHORIZED CHANNEL DIMENSIONS

Figures 1 thru 8 at the end of this summary provide key information and illustrate the general locations of the most important project features.

The project is currently constructed to a depth of 47 ft x 600 ft wide in the Bar Channel; 45 ft deep x 400 ft wide in the Bay Channel; 45 ft deep x 1,570 ft long x 715 ft wide in the Choctaw Pass Turning Basin; 45 ft deep x 600 ft wide in the Mobile River Channel south of station 226+16 (i.e., the lower 1,850 ft of the River Channel); and 40 ft deep x 600 ft wide in the River Channel above station 226+16.

The fully authorized channel dimensions per Section 201 of WRDA of 1986, PL 99-662, are: 57 ft deep x 700 ft wide in the Bar Channel; 55 ft deep x 550 ft wide in the Bay Channel, except for the upper 3.6 miles which are authorized to 650 ft wide; 55 ft deep x 1,500 ft square turning basin near Little Sand Island; 55 ft deep x 600 ft wide below station 226+16 in the River Channel; and 40 ft deep x 600 ft wide above station 226+16 in the River Channel. The Choctaw Pass Turning Basin was further evaluated in a 2007 GRR and ultimately authorized and constructed to its current dimensions.

ALTERNATIVES AND TSP

After determination of the problems and needs of the study area the Project Delivery Team (PDT) identified specific measures that could, or in combination with other measures, be used to address the problems. Subsequently, the PDT developed an initial array of alternatives and refined them through a screening process that evaluated their completeness, effectiveness, efficiency, and acceptability in order to maximize overall benefits and minimize costs and adverse impacts. The resulting focused array included a deepening measure with alternative depths ranging from 47 to 50 ft (an additional 2 ft of depth in the Bar Channel), and a widening measure that added 100 ft of width to the Bay Channel for 3 to 5 nautical mile lengths for each deepening alternative.

To determine whether the Federal Government should participate in implementing navigation improvements, the expected returns to the national economy (National Economic Development (NED) benefits) are calculated. Net benefits are calculated by subtracting the total cost to construct and maintain the improvements over a 50-year study period from the total transportation cost savings that would be generated by the proposed improvements over that period. The NED Plan is the alternative that reasonably maximizes net NED benefits while remaining consistent with the Federal objective of protecting the Nation's environment.

Further refinement of the focused array indicated that the 5-nautical mile widener would not be feasible for the depths under consideration; therefore, the PDT eliminated it from further consideration. Based on the project objectives and NFS input, both deepening and widening were to be desired outcomes. The analysis of the alternatives also established potential construction costs. The NFS used the cost data to determine the maximum project cost it could support given the requirement to cost share construction. With this information, the NFS indicated that deepening to 50 ft appeared to be the maximum that it could support. Based on analysis of the final array, the PDT narrowed the array to an alternative that appeared likely to satisfy the project objectives and be considered for selection as the TSP. That plan is the 50-foot deepening alternative with 100 ft of channel widening for a distance of 3 nautical miles. This alternative has greater net benefits than smaller scale plans (47, 48, and 49 ft), and, considering categorical exemption from the NED Plan per paragraphs 3-2b(10) of Engineering Regulation (ER) 1105-2-100, the PDT analyzed a sufficient number of alternatives to insure that net benefits do not maximize at a scale smaller than the 50-foot plan. The recommended TSP modifications consist of the following:

- Deepen the existing Bar, Bay (including the Choctaw Pass Turning Basin), and River Channels (south of station 226+16) by 5 ft to project depths of 52, 50, and 50 ft, respectively, with an additional 2 ft for advanced maintenance plus 2 ft of allowable overdepth for dredging (total depths of 56, 54, and 54 ft, respectively).
- Incorporate minor bend easings at the double bends (at stations 1857+00 and 1775+26) in the Bar Channel approach to the Bay Channel.
- Widen the Bay Channel from 400 ft to 500 ft from the mouth of Mobile Bay northward for 3 nautical miles to provide a two-way traffic area for passing.
- Expand the Choctaw Pass Turning Basin 250 ft to the south (at a depth of 50 ft) to better accommodate safe turning of the design vessel and other large vessels.

Placement areas for the new work material dredged for the proposed navigation improvements are as follows:

- Relic Shell Mined Area
- Sand Island Beneficial Use Area (SIBUA) Extension
- Ocean Dredged Material Disposal Site (ODMDS) Expansion

Placement areas for material dredged during maintenance will remain unchanged with the exception of the proposed extensions to the SIBUA and the ODMDS.

COSTS AND BENEFITS

The USACE employed the traditional providers of commodity and fleet projections to study the Mobile Harbor project. Based on existing and future vessel traffic, vessel fleet mix, trade route allocations, and liner services currently associated with the port, the PDT identified two design vessels: (1) a 1,100-foot long, 158-foot beam, 50-foot draft containership; and (2) a 851-foot long, 141-foot beam, 51.6-foot draft bulk carrier. The containership dimensions correspond with the range of vessels comprising Post-Panamax Generation 3 class. The Harborsym economic model was used to calculate benefits. The PDT used the characteristics of the design vessels to develop channel dimension and alignment needs. Refinement of the dimensions and alignment is expected through application of further ship simulation analysis prior to developing final designs.

The projected growth of containerized traffic and coal allocated primarily between the time-modified mix of the two design vessels (without inducing traffic from other ports) has provided average annual net benefits of $34.5 million for the TSP. The project is economically justified with a BCR of 3.0. The estimated project costs are $387.8 million. The benefits are achieved by transportation savings through the use of larger ships to transport the projected cargo volumes.

The cost estimate shown in Table 1 for the TSP reflects all project features, including the maintenance costs, real estate costs, and associated costs.

Table 1. Cost Allocation for the Tentatively Selected Plan

Description	Total Costs (K)	Implementation of Costs (K)			
General Navigation Features (GNF)		Federal	%	Non-Federal	%
Dredging: Deepening including Bend Easing and Turning Basin	$350,372	$262,779	75	$87,593	25
Dredging: 100' Widening 3 Nautical Mile Lane	$12,773	$9,580	75	$3,193	25
Lands Easements Rights of Way and Relocation (LERR)	$40	$0	0	$40	100
Preconstruction, Engineering & Design	$8,542	$6,406	75	$2,136	25
Construction Management	$4,029	$3,022	75	$1,007	25
Subtotal of GNF	$375,756	$281,791	75	$93,969	25
10% of GNF		($37,576)	-	$37,576	-
GNF LERR credit		$40		($40)	
Associated Costs:					
Local Service Facilities: Berthing (ASPA)	$11,397	$0	0	$11,397	100
Aids to Navigations (U.S. Coast Guard)	$609	$609	100	$0	0
Total Estimated Costs:	$387,762	$244,860	63	$142,981	37
Incremental Annual Maintenance Cost (FY18 Price Level)					
Deepening, Bend Easing, Widening, Turning Basin	$2,358	$2,358	100	$0	0

ENVIRONMENTAL IMPACTS

Results of the detailed analyses suggest that, overall, no substantial impacts in aquatic resources within the study area are anticipated due to channel modifications. This is likely because the area of greatest potential changes to environmental conditions are already adapted to natural shifts in salinity. Although sea level rise (SLR) has the potential to alter aquatic resource habitats within Mobile Bay, additional impacts related to project implementation remain negligible under the 0.5 meter SLR scenario. Modeling of monthly water quality parameters specifically focusing on salinity and dissolved oxygen (DO) indicates that differences between the With-Project and Without-Project conditions show minimal changes and the changes are well within tolerance levels for the aquatic resources. All water quality standards will be adhered to during construction activities to ensure minimal adverse effects.

The USACE has determined that overall effects to essential fish habitat and protected species would be temporary in nature associated with the dredging and placement activities. These determinations are being coordinated with the National Marine Fisheries Service, Habitat Conservation Division according to the Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. 1801-1882). The USACE has initiated consultation with the U.S. Fish and Wildlife Service under Section 7 coordination of the Endangered Species Act. It is expected that this consultation will be completed prior to the release of the Final GRR/SEIS Report.

Results of the wave climate assessments indicate that implementation of the project would result in negligible changes to the general wave climate. Additionally, the results of the analysis conducted for vessel generated waves show that there would actually be a reduction in ship generated wave energy when compared between the future With- and Without-Project conditions. This is because fewer vessels will be expected to call on the port in the future with implementation of the TSP, which results in less vessel generated wave energy affecting the study area.

Results and conclusions for sediment transport considerations predicted no discernable impacts to sediment transport throughout the project area and no expected erosion or changes to the position of the Mobile Bay shorelines resulting from implementation of the TSP. The evaluations considered probable effects on shoreline changes within 10 miles east and west of the channel and predicted minimum difference in bed level changes on the ebb tidal shoal that feeds Dauphin Island.

Several sites were evaluated for placement of new work material for the TSP. These included six relic shell mining areas, the ODMDS, and the SIBUA (if new work sand sources are found within the Bar Channel). All of the proposed placement sites were found to be acceptable. Results of modeling indicate that material placed within the Relic Shell Mined Area will remain stable and not be transported outside of the placement area.

Furthermore, placement of material may help to restore bay bottoms within this site. The USACE, Mobile District is currently pursuing certification for extensions to the SIBUA and the ODMDS. Future maintenance dredged material will continue to be placed in the existing approved placement areas and the proposed extensions.

Sediment testing of new work material will be conducted during the design phase. The study assumes that new work material associated with the TSP would be similar to that already tested and should be suitable for placement in the ODMDS. When considering underwater noise associated with construction activities, it is anticipated that the maintenance dredges presently being used in the harbor would also be used for harbor modifications. It has been determined that the noise levels, both air and underwater, for the TSP during the construction period would be comparable to current activities and impacts would be less than significant. Since channel modification activity emissions would not take place along the channel at the same location for a long duration, they are considered temporary resulting in less than significant air quality impacts to the community along the channel.

As a result of construction, there is no anticipated significant change to existing transit methods, routes of goods entering and exiting the harbor, and no changes in surface transportation routes used to and from the harbor. Under the TSP, direct impacts to harbor traffic and surrounding transportation systems would be minor. Therefore, impacts to transportation as a result of construction activity in the harbor would be minimal. The general absence of significant adverse impacts to human health, environmental health risks, and safety risk indicates the proposed project would not have disproportionately high and adverse impacts to any communities, including environmental justice communities or children.

Phase I level maritime cultural resource surveys (Phase I) have been previously conducted on some portions of the TSP. A new Phase I of the Bay Channel widening and bend easing areas as well as the SIBUA northwest extension was conducted in the Summer of 2018 and USACE is awaiting the results. Phase II evaluations may be necessary, dependent upon the Phase I findings. Section 106 coordination and consultation with the Alabama State Historic Preservation Office (SHPO) and the USACE, Mobile District Tribal Partners will be necessary and completed prior to the Final GRR/SEIS.

AREAS OF CONCERN AND UNRESOLVED ISSUES

<u>Areas of Concern:</u> The public has raised a number of issues through letters, e-mails and public involvement meetings. They include the following:

Channel dredging disrupts the sediment transport to Dauphin Island. Impacts of channel dredging on Dauphin Island remains a controversial issue. The modeling results presented in this study indicate minimal differences in morphologic change in the nearshore areas of Dauphin Island and Pelican Island as a result of the channel modifications. See Section 5.3.3 Sediment Transport and Section 6.1 Cumulative Impacts within the main report and Section 6.3.2, Appendix A for additional information.

Placement location of Bar Channel material. The placement location of the material dredged from the Bar Channel, in particular during maintenance operations, is an area of controversy. Dauphin Island residents and members of the public have expressed concerns that the material dredged from the Bar Channel during maintenance is not placed in an area that benefits the island. This study includes an assessment of a proposed extension to the SIBUA. See Section 4.2.2.3 SIBUA for the Bar Channel and Section 5.7 Dredging and Placement Areas within the main report for additional information.

Placement of new work dredged material within the Relic Shell Mined Area. The public has expressed concern that the proposed placement of material within the formerly shell mined area could impact fishing. They also have concerns that material placed in the site may drift out of the relic shell mined area onto the living oyster reefs within the bay. This study has found the Relic Shell Mined Area to be a suitable placement site. See Sections 4.2.1 New Work Material Placement Options, 4.2.3 Construction Methodology, 5.4.2 Soils, 5.4.4 Sediment Quality, 5.7 Dredging and Placement Areas, 5.8.10 Essential Fish Habitat, 5.8.6 Benthic Invertebrates, 5.12 Fisheries Resources, 5.17 Cultural and Historic Resources, and 6.1 Cumulative Impacts within the main report for additional information.

Environmental impacts caused by channel modifications. The results of the modeling data and environmental impact analysis are another area of controversy. The environmental impact analyses associated with this study indicate minimal impacts of the aquatic resources supported by Mobile Bay and Mobile-Tensaw River Delta areas resulting from predicted changes in water quality. The overall general water quality changes from the modeling efforts are presented in Section 5.5 Water Quality. The water quality changes specific to the aquatic resource impacts are addressed in Sections 5.8.2 Wetlands, 5.8.3 Submerged Aquatic Vegetation (SAV), 5.8.6 Benthic Invertebrates, 5.8.7 Fish, and 5.8.8.4 Oysters. Comments received by Environmental Non-Governmental Organizations expressed desire for the study to address the impacts associated with prolonged drought conditions. The USACE, Mobile District has determined due to the minimal nature of the predicted impacts to these resources, they are not sufficient enough to warrant mitigative measures.

Shoreline erosion caused by ship wake. Shoreline erosion and impacts to aquatic resources caused by the ship wake of larger vessels transiting the channel are an area of concern. The ship wake analysis associated with this study indicates a reduction in vessel generated wave energy when compared between the future With- and Without-

Project conditions. Additional information can be found in Section 5.3.1 Waves in the main report and Section 6.4, Appendix A.

Impacts to Environmental Justice (EJ) Communities. Impacts associated with the growth of the harbor on the air quality, traffic, and safety of the EJ communities adjacent to the harbor remain an area of concern. This study has found that the proposed project would not have disproportionately high and adverse impacts to any communities, including EJ communities or children. See Sections 2.5.12 Air Quality, 2.5.13 Hazardous and Toxic Materials, 2.5.14 Noise, 2.5.19 Socioeconomics, and 2.5.20 Transportation for additional information on the existing conditions. See Sections 5.14 Air Quality, 5.15 Hazardous and Toxic Materials, 5.16 Noise, 5.20 Socioeconomics, 5.21 Transportation, and 5.23 Environmental Justice for additional information on the environmental effects of the TSP.

<u>Issues to be Resolved:</u> The USACE, Mobile District will continue to coordinate the proposed action and the associated impacts identified above as well as any new concerns that are identified during the review period with the USACE, South Atlantic Division and Headquarters, as well as the NFS, state and Federal agencies, stakeholders, and concerned public. Several commitments require additional coordination with resource agencies. They include:

- Further consideration of potential beneficial use of dredged material projects
- Location and analysis of oyster reefs not documented by the Alabama Department of Conservation and Natural Resources, Marine Resources Division
- ODMDS placement area
- Section 106 consultation with Alabama State Historic Preservation Office and the appropriate Native American Tribes for the Area of Potential Effect. Initiation of full formal consultation is dependent upon receipt of the cultural resource survey reports and the EPA/USACE coordination efforts on ODMDS area expansion.
- Certification of the proposed extensions to the SIBUA and the ODMDS
- Certification of the Project

In addition, there are several Design (Preconstruction Engineering and Design) Phase actions that will be accomplished prior to construction. They include:

- Continued coordination with environmental agencies and the public for beneficial use opportunities with the new work dredged material
- A refined ship simulation analysis to ensure widening measures safely accommodate meeting vessels and to determine if the magnitude of modifications could be reduced in the bend easing and turning basin
- Sediment testing of the new work material prior to placement within the proposed locations
- Additional geotechnical investigation within the navigation channel
- Surveys to confirm that there are no underwater utilities/pipeline crossing obstructions

AREAS OF RESIDUAL RISK

Risk and uncertainty exist in the potential fluctuation of the Federal interest rate, changes in vessel operating costs, deviations from vessel or cargo forecasts, and unexpected construction costs. The conservative assumptions used during the study make it more likely that impacts will be lower than those presented in the Draft GRR/SEIS. Additional analysis that will be conducted during design will reduce the likelihood of unexpected increases in construction costs such as discovery of cultural artifacts, pipeline relocations, or contaminated sediments. Any additional beneficial uses of dredged material would be implemented at the option of the USACE and any associated cost differences would likely be paid by a NFS requesting the use of the material. Furthermore, ship simulation may present opportunities to reduce channel modification measures. Decreasing the size of the bend easing and turning basin channel modifications would reduce the quantities and costs.

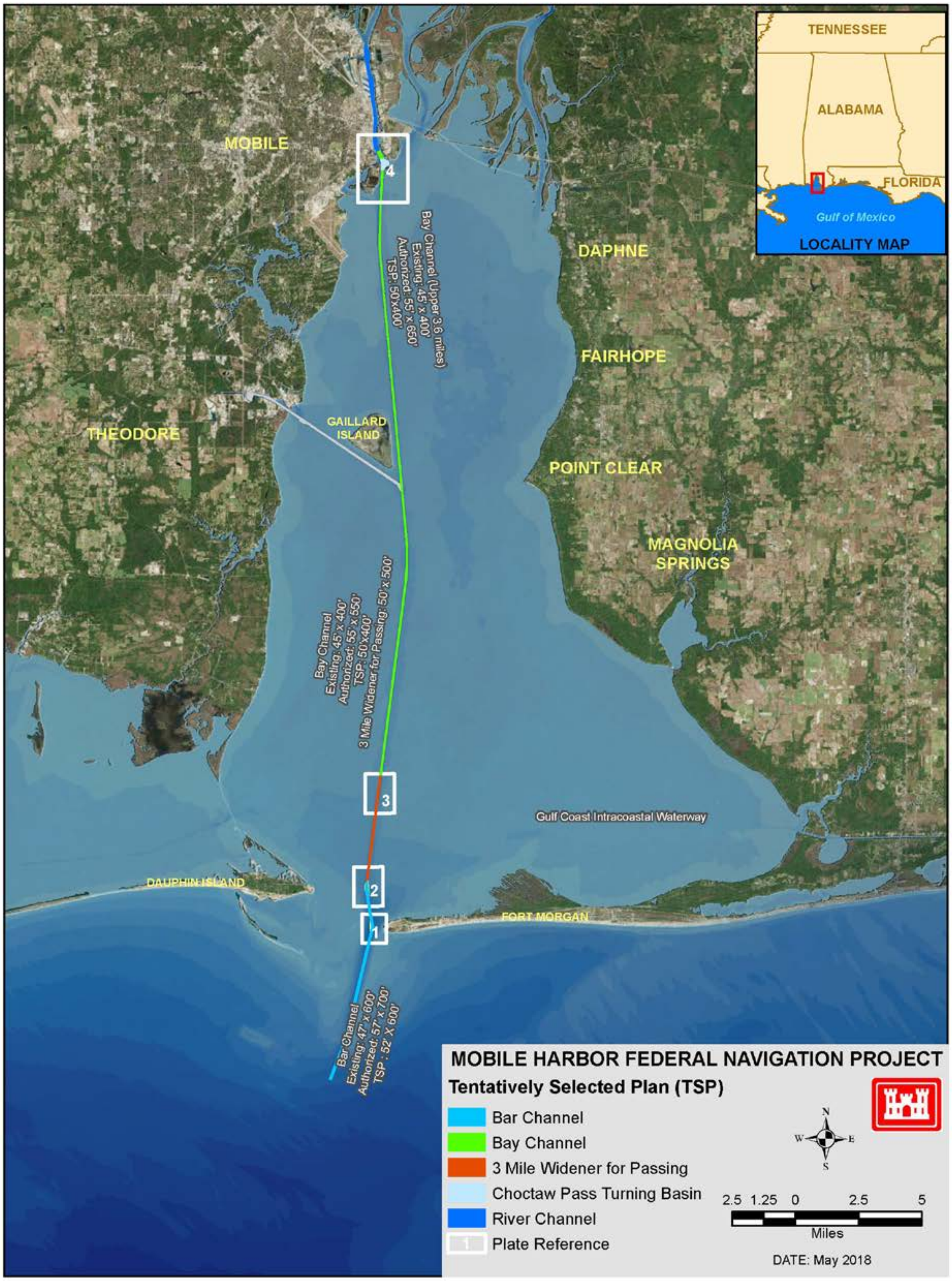


Figure 1. Tentatively Selected Plan (TSP) for the Mobile Harbor Federal Navigation Project

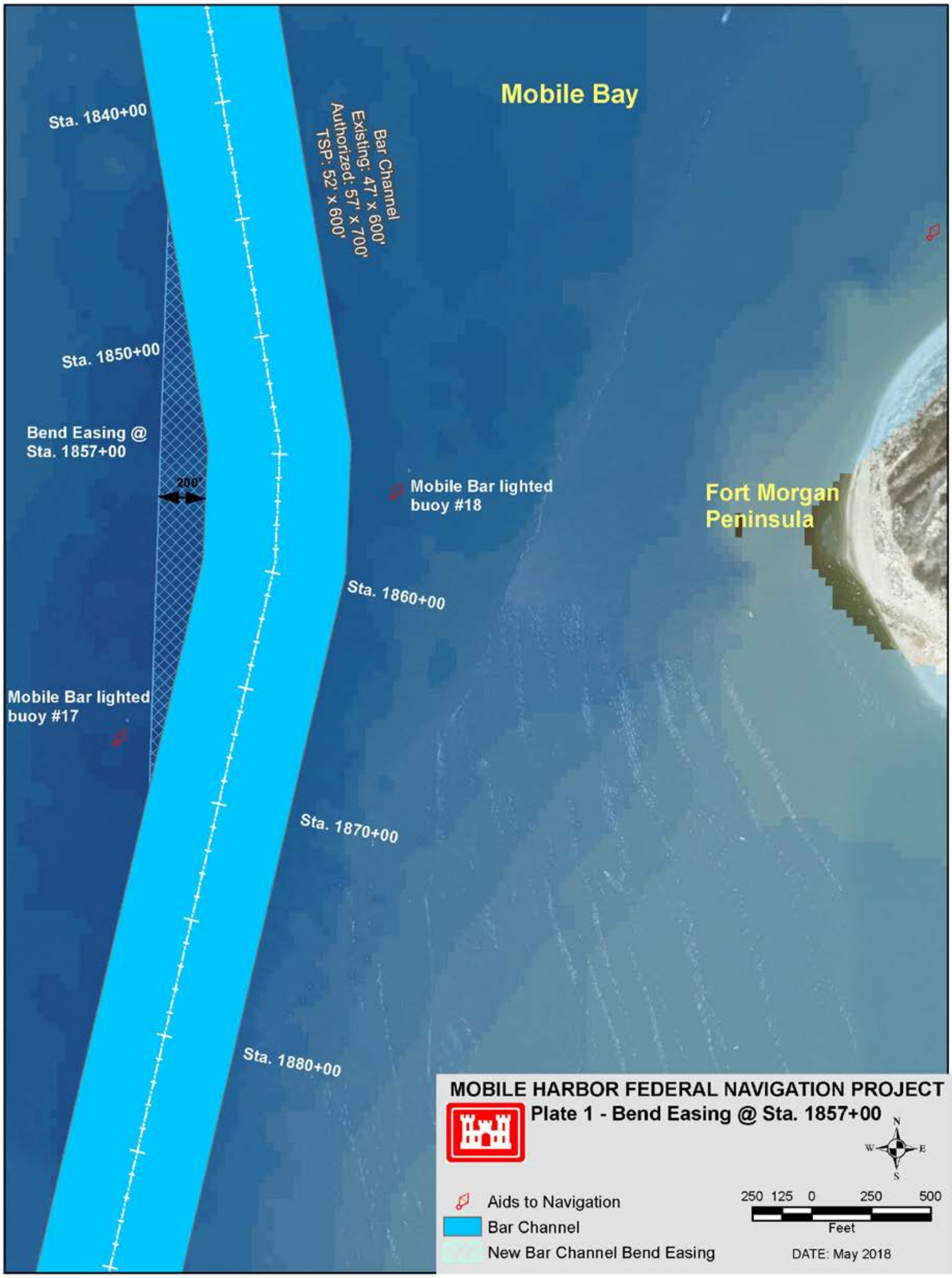


Figure 2. Bend Easing in Bar Channel at Station 1857+00

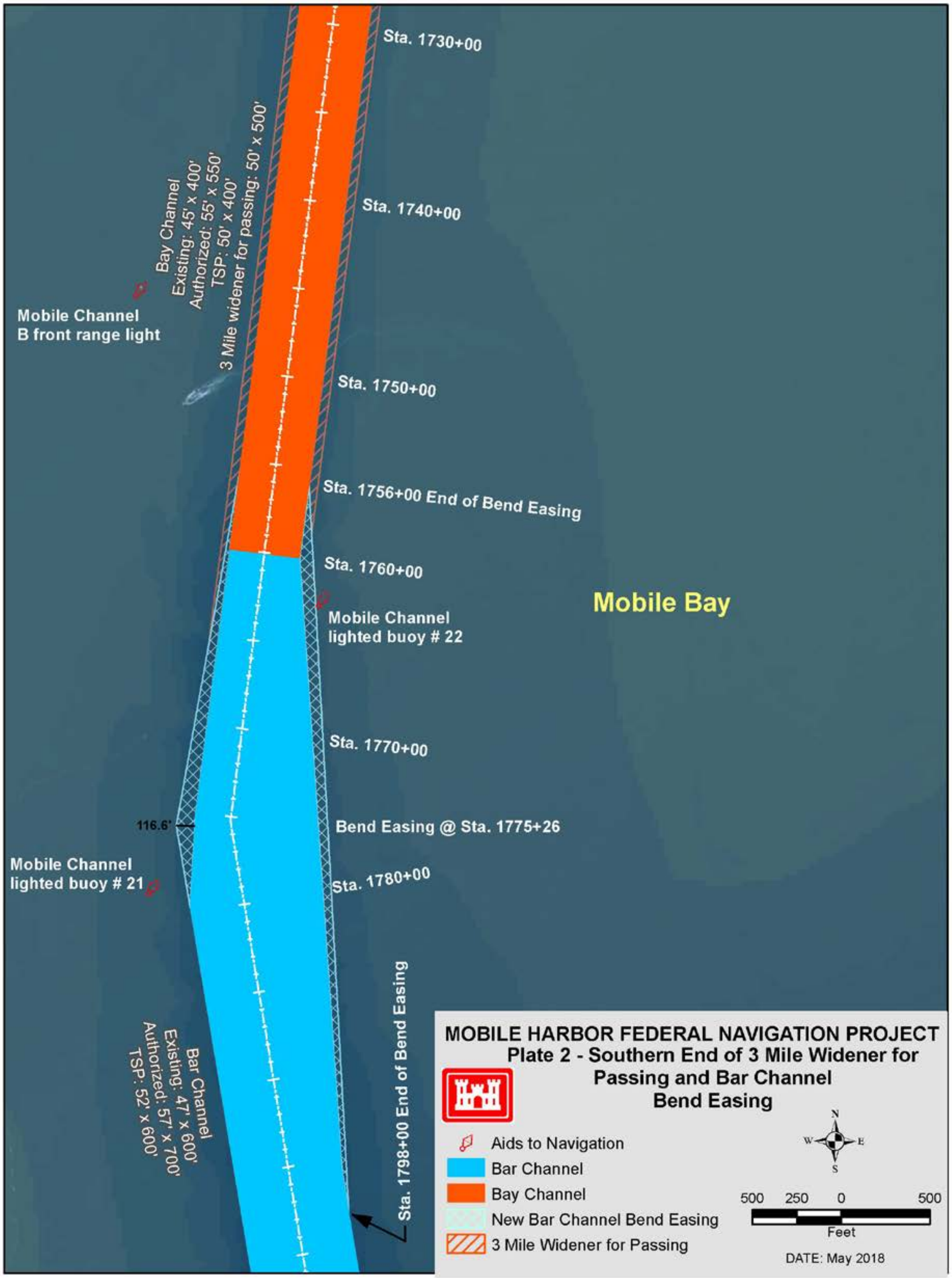


Figure 3. Bend Easing in Bar Channel at Station 1775+26 and Southern End of 3 Mile Channel Widener for Passing in Bay Channel

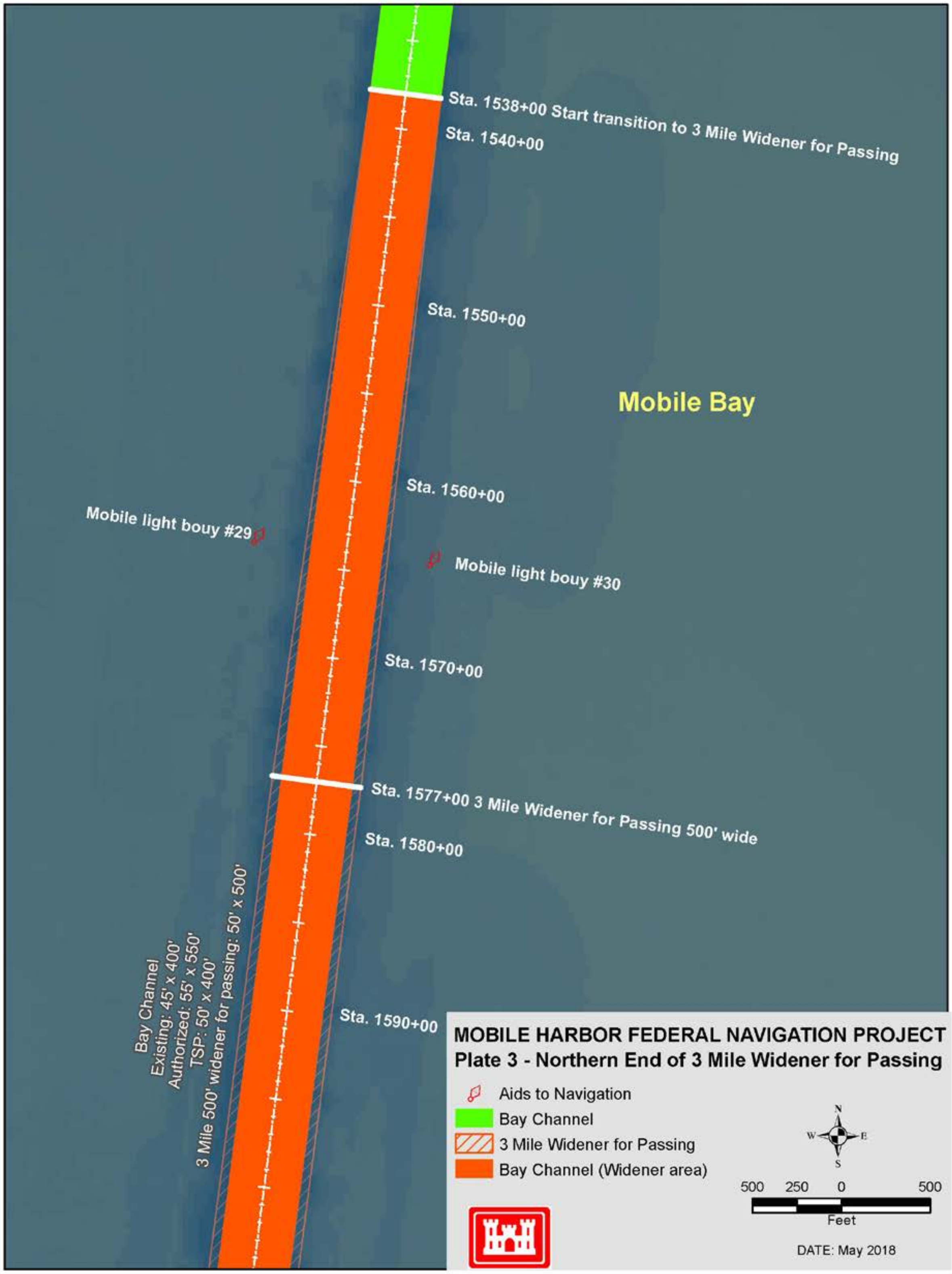


Figure 4. Northern End of 3 Mile Widener for Passing in Bay Channel

Figure 5. Choctaw Pass Turning Basin Expansion

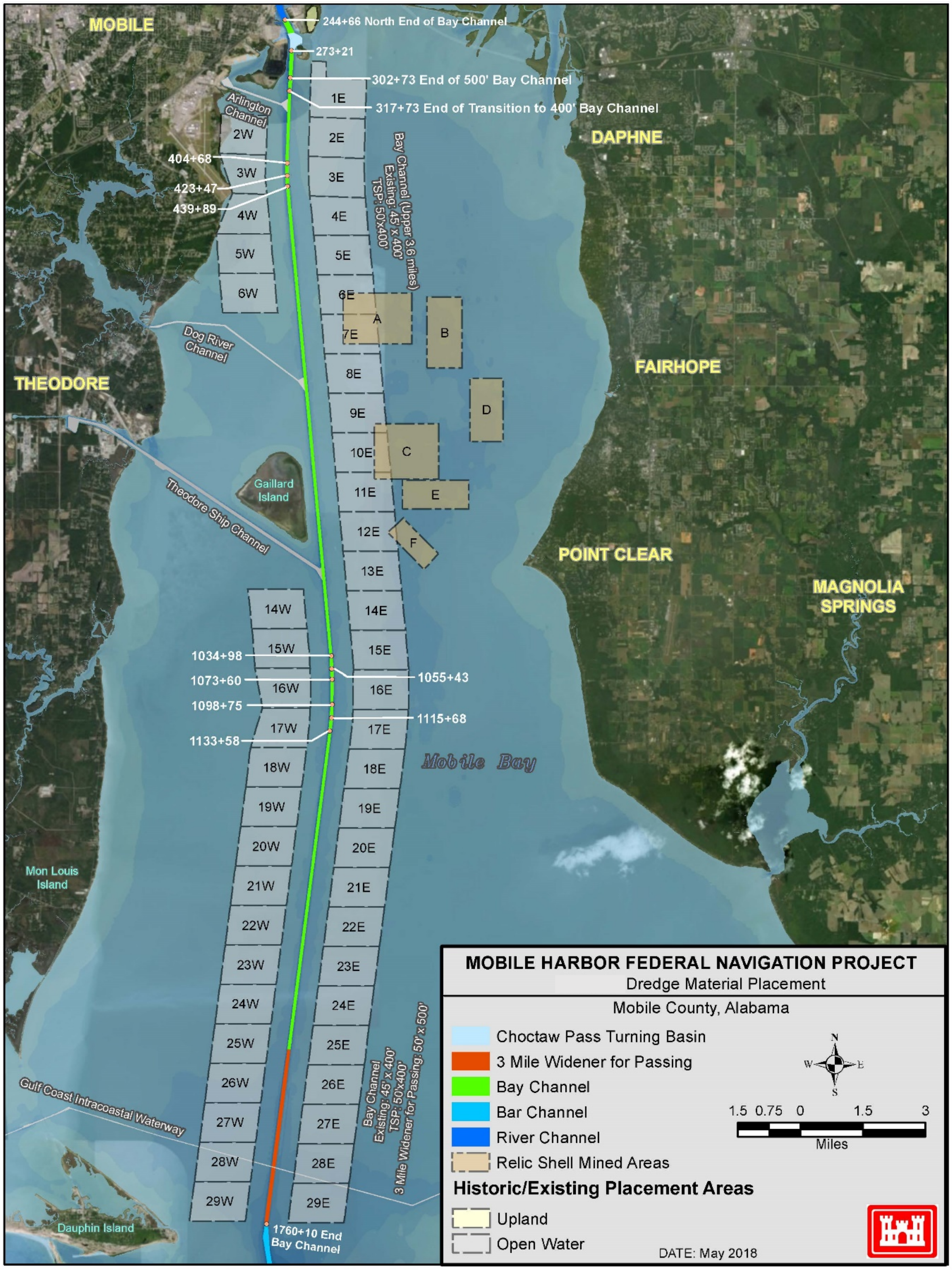


Figure 6. Relic Shell Mined Areas

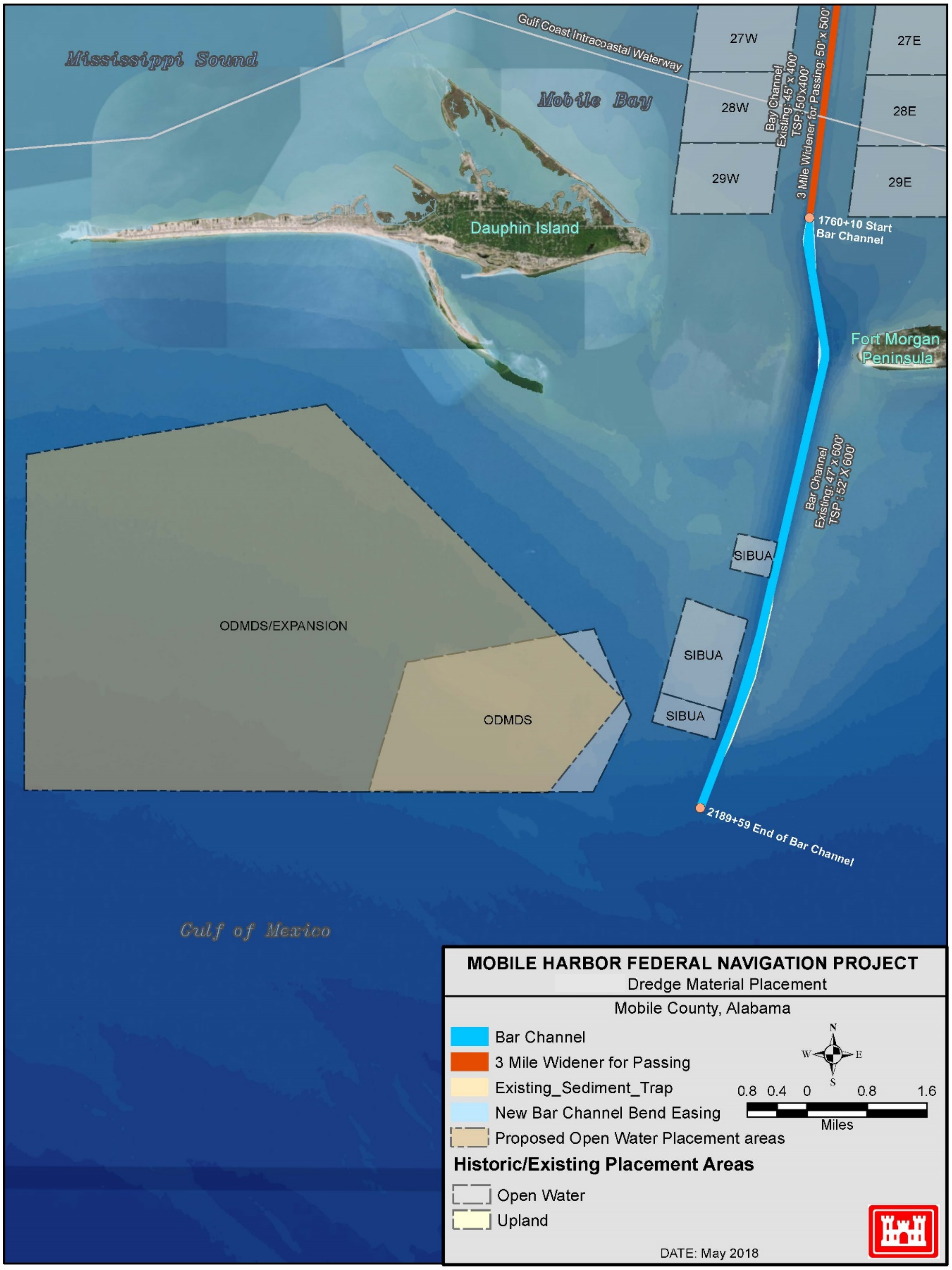


Figure 7. Expanded ODMDS Boundary

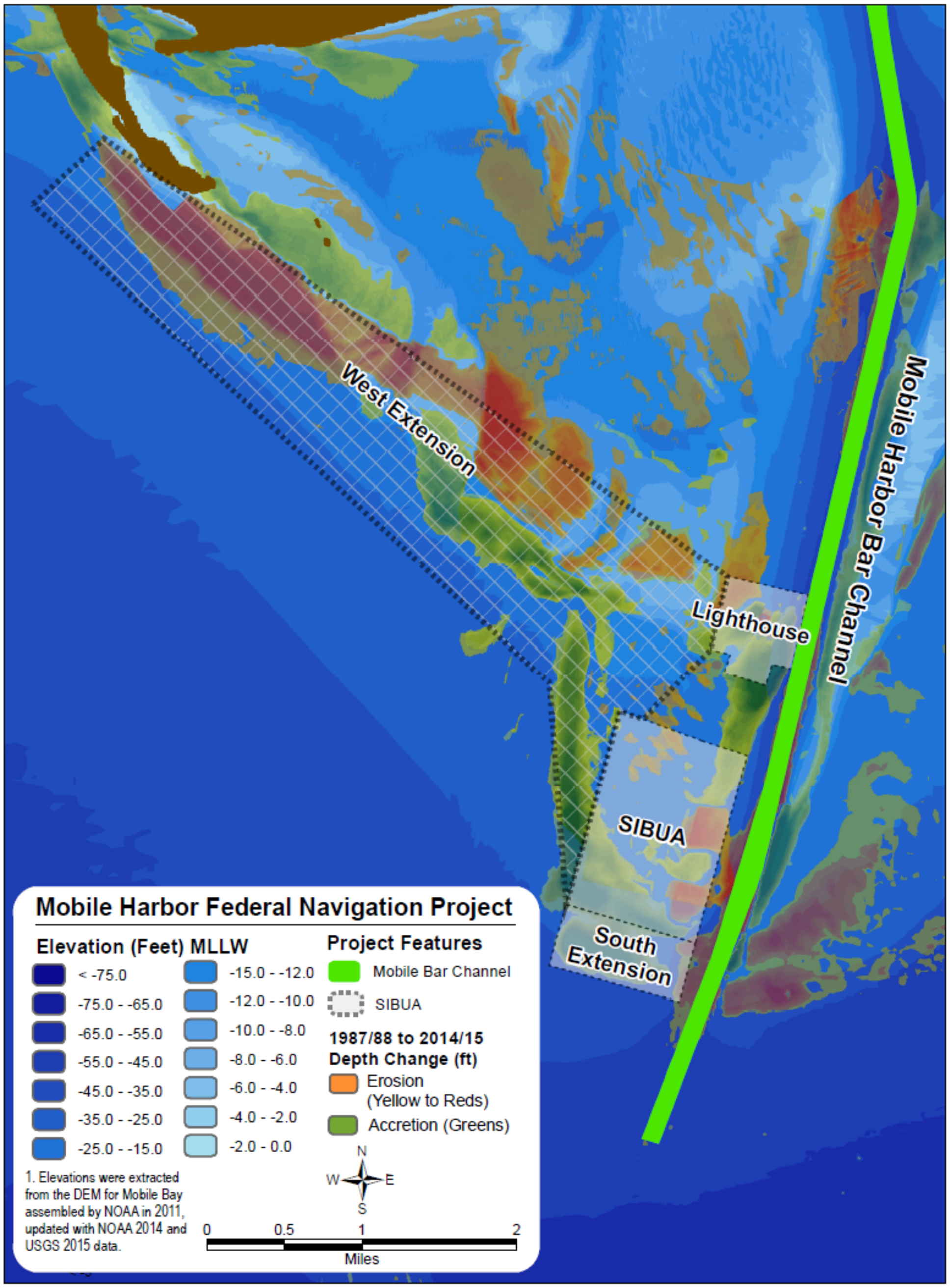


Figure 8. SIBUA Northwest Extension Limits

Mobile Harbor

Mobile, Alabama

Integrated General Reevaluation Report

With Supplemental Environmental Impact Statement

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APPENDICES

Abbreviations and Acronyms			
ADEM	Alabama Department of Environmental Management	EM	Engineer Manual
ADCNR	Alabama Department of Conservation and Natural Resources	EO	Executive Order
AEO	Annual Energy Outlook	EPA	Environmental Protection Agency
ALDOT	Alabama Department of Transportation	EQ	Environmental Quality
AOI	Area of Influence	ER	Engineer Regulation
APE	Area of Potential Effect	ERDC	Engineering Research and Development Center
ASA	American Sportfishing Association	ESA	Endangered Species Act
ASA(CW)	Assistant Secretary of the Army for Civil Works	FAMP	Fisheries Assessment and Monitoring Program
ASPA	Alabama State Port Authority	FHWA	Federal Highway Administration
BCR	Benefit-to-Cost Ratio	FMC	Fishery Management Council
BCR	Benefit-to-Cost Ratio	FMP	Fishery Management Plan
CAA	Clean Air Act	FR	Federal Register
CBRA	Coastal Barrier Resources Act	FWCAR	Fish and Wildlife Coordination Act Report
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act	FY	Fiscal Year
CEQ	Council on Environmental Quality	GDP	Gross Domestic Product
CFR	Code of Federal Regulation	GI	Global Insight
CFS	Cubic Feet Per Second	GIS	Geographic Information System
CWA	Clean Water Act	GIWW	Gulf Intracoastal Waterway
CY/YR	Cubic Yards Per Year	GMFMC	Gulf of Mexico Fishery Management Council
CZMA	Coastal Zone Management Act	GNF	General Navigation Features
dBA	A-Weighted Decibel	GRR	General Reevaluation Report
DO	Dissolved Oxygen	GRR/SEIS	General Reevaluation Report With Supplemental Environmental Impact Statement
DOE	Department of Energy	GSA	Geological Survey of Alabama
DWT	Deadweight Tonnage	LERR	Lands, Easements, Rights-of-way and Relocations
EFH	Essential Fish Habitat	LOA	Length Overall
EIS	Environmental Impact Statement	LRR	Limited Reevaluation Report
EJ	Environmental Justice	MAWSS	Mobile Area Water & Sewer System

MBNEP	Mobile Bay National Estuary Program	PIMS	Public Involvement Management Strategy
MBTA	Migratory Bird Treaty Act	PL	Public Law
MFR	Memorandum for Record	PPA	Project Partnership Agreement
MMPA	Marine Mammal Protection Act	PPM	Parts Per Million
MPRSA	Marine Protection, Research, and Sanctuaries Act	PPT	Parts Per Thousand
MOA	Memorandum of Agreement	PSD	Prevention of Significant Deterioration
MRD	Marine Resources Division	PSU	Practical Salinity Unit
MSFCMA	Magnuson-Stevens Fishery Conservation and Management Act	RCRA	Resource Conservation and Recovery Act
MWL	Mean Water Level	RED	Regional Economic Development
MLLW	Mean Lower Low Water	REP	Real Estate Plan
MT/YR	Million Tons/Year	Ro-Ro	Roll on/Roll off
NAAQS	National Ambient Air Quality Standards	ROI	Region of Interest
SAV	Submerged Aquatic Vegetation	U.S.	United States
SHPO	State Historic Preservation Office	USACE	U.S. Army Corps of Engineers
SIBUA	Sand Island Beneficial Use Area	USCG	U.S. Coast Guard
SLA	Sea Level Rise	USDA	U.S. Department of Agriculture
SMCA	Sunken Military Craft Act	USDOC	U.S. Department of Commerce
SST	Sea Surface Temperature	USFWS	U.S. Fish and wildlife Service
STS	Ship-to-Shore	USGS	U.S. Geological Survey
SWAN	Simulating Waves Nearshore	VGWE	Vessel Generated Wave Energy
TEU	Twenty Equivalent Units	WCSC	Waterborne Commerce Statistics Center
TPCS	Total Project Cost	WIS	World Industry Service
TSP	Tentatively Selected Plan	WRDA	Water Resources Development Act
UKC	Underkeel Clearance	WRRDA	Water Resources Reform and Development Act
		WTS	World Trade Service

SECTION 1.0 PURPOSE AND NEED

1.1. Introduction

This report documents and presents the results of investigations and analyses conducted by the U.S. Army Corps of Engineers (USACE), Mobile District, to evaluate navigation improvements including widening and deepening of Mobile Harbor, Mobile, Alabama. The harbor project provides access for deep draft vessel traffic to use terminal facilities located along the Mobile River as shown in Figure 1-1 and Figure 1-2. The investigations described in this report evaluate the feasibility of options to address navigation concerns and provide navigation improvements.

1.1.1. Study Authority

Improvements to the existing Federal project were most recently reauthorized in Section 201 of the Water Resources Development Act (WRDA) of 1986 (Public Law (PL) 99 – 662, Ninety-ninth Congress, Second Session), which was approved 17 November 1986, and subsequently amended by Section 302 of the WRDA of 1996, to read:

> *(a) "AUTHORIZATION OF CONSTRUCTION - The following projects for harbors are authorized to be prosecuted by the Secretary substantially in accordance with the plans and subject to the conditions recommended in the respective reports designated in this subsection:*
>
> *The project for navigation, Mobile Harbor, Alabama: Report of the Chief of Engineers, dated November 18, 1981, at a total cost of $451,000,000, with an estimated first Federal cost of $255,000,000 and an estimated first non-Federal cost of $196,000,000. In disposing of dredged material from such project, the Secretary, after compliance with applicable laws and after opportunity for public review and comment, may consider alternatives to disposal of such material in the Gulf of Mexico, including environmentally acceptable alternatives for beneficial uses of dredged material and environmental restoration."*

The report referenced by this authorization recommended the following improvements to the Federal project: deepening and widening the Bar Channel to 57 feet (ft) deep by 700 ft wide, deepening and widening the Bay Channel from the mouth of the bay to south of the Mobile River to 55 ft deep by 550 ft wide, deepening and widening the upper 3.6 miles of the Bay Channel to 55 ft deep by 650 ft wide; providing a 55-foot deep anchorage area and turning basin in vicinity of Little Sand Island; and, deepening the Mobile River Channel to 55 ft deep to a point about 1 mile below Interstate 10 (I-10) and the U.S. Highway 90 tunnels.

1.1.2. Study Sponsor:

The non-Federal sponsor (NFS) is the Alabama State Port Authority (ASPA). On June 12, 2014, the ASPA requested that the USACE undertake additional studies to determine the feasibility of deepening and widening the channel to its full authorized depth and width. Per letter dated October 20, 2014, the Assistant Secretary of the Army for Civil Works (ASA(CW)) approved redirecting General Investigations funds to initiate a General Reevaluation Report (GRR) to evaluate deepening and widening of the channel to its full authorized dimensions.

1.2. Study Area/Scope

Mobile Harbor is located in the southwestern part of Alabama at the confluence of the Mobile River and the head of Mobile Bay. Mobile Harbor is approximately 28 miles north of the bay entrance from the Gulf of Mexico and 170 miles east of New Orleans, Louisiana. The current dimensions of the existing navigation channel are 47 ft deep by 600 ft wide across the Mobile Bar, 45 ft deep by 400 ft wide in the bay, and 45 ft deep by 600 ft wide in the Mobile River to a point about 1 mile below the I-10 tunnel. The channel then becomes 40 ft deep and proceeds north over the I-10 and U.S. Highway 90 tunnels to the Cochrane-Africatown Bridge. The Mobile River, on which ASPA facilities are located, is formed some 45 miles north of the city with the joining of the Alabama and Black Warrior/Tombigbee Rivers. The Mobile River also serves as the gateway to international commerce for the Tennessee/Tombigbee Waterway. In the southern region of Mobile Bay, access can be gained to the Gulf Intracoastal Waterway (GIWW) which stretches from St. Marks, Florida to Brownsville, Texas. The Theodore Ship Channel provides for a 40 ft deep, 400 ft wide channel, branching from the main ship channel in Mobile Bay at a point about 2.8 miles north of Middle Bay Lighthouse and extending northwesterly about 5.3 miles to the west shore of Mobile Bay. Figure 1-1 and Figure 1-2 show the authorized limits of the Mobile Harbor Federal Navigation Channel.

This feasibility study includes: (1) survey of existing and future conditions; (2) evaluation of related problems and opportunities; (3) development of potential alternatives; (4) evaluation of alternatives; (5) comparison of costs, benefits, adverse impacts, environmental acceptability, and feasibility of those alternatives; and, (6) identification of a Tentatively Selected Plan (TSP). Information for the study came from land and hydrographic surveys, hydrodynamic surveys, available water quality information, socio-economic projections, sediment sampling, and numerous other data collection efforts. The study includes data from previous studies augmented with information from the ASPA, Mobile Harbor Bar Pilots, Waterborne Commerce Statistics Center (WCSC), commercial shippers, Federal, state, and local resource agencies, as well as Geographic Information System (GIS) mapping of significant resources and features. Analyses conducted for this feasibility study include forecasts of waterborne cargo volumes, traffic

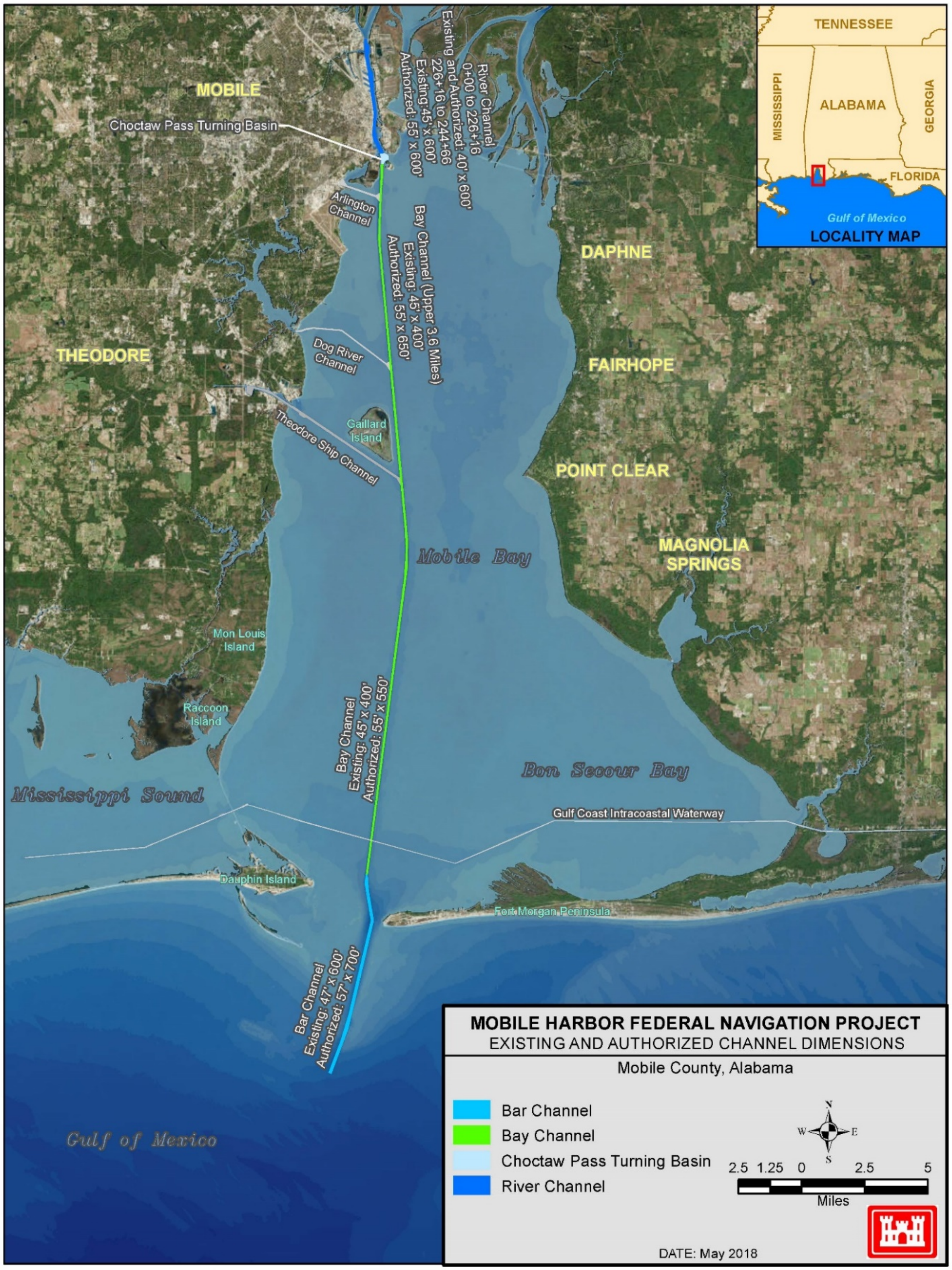


Figure 1-1. Project Map

Figure 1-2. Project Map Waterfront Area

patterns and vessel fleets, and evaluation of the need for navigation system improvements over a 50-year period of analysis. The study considered a range of structural measures within the harbor that could address inefficiencies within the system. The study concentrated on potential changes to water-based transportation system components that are within the scope of the study authority described previously. Throughout this study, the main factors influencing the total cargo throughput of Mobile Harbor revolve around land-based factors such as population growth, industrial and manufacturing changes, and regional maritime shipping trends limited by the capacity of the land-based infrastructure to process it.

The tentative results of the feasibility study are presented in this Draft GRR. Included with this report is a Draft Supplemental Environmental Impact Statement (Draft SEIS). The Draft SEIS is a supplement to the Environmental Impact Statement (EIS) originally prepared for the USACE 1980[1] Survey Report on Mobile Harbor. The Draft SEIS and the Draft GRR are combined to provide a Draft Integrated GRR with Draft SEIS (Draft GRR/SEIS). The Draft GRR/SEIS documents the study process and presents the tentative results of investigations and analyses conducted to evaluate modifications to the existing Federal navigation system to improve its ability to efficiently serve the current and future vessel fleet.

1.3. Problems and Opportunities

1.3.1. Problems

The principal navigation problem is larger vessels are experiencing transportation delays and inefficiencies due to limited channel depth and width. This problem is a result of increasing number and size of vessels entering and departing Mobile Harbor. The ASPA's newest two facilities are located at the lower end of the Mobile River (at the upper portion of Mobile Bay) -- the Choctaw Point container terminal and the Pinto Island Terminal. Both facilities have increased the amount of traffic into Mobile Harbor. The existing channel depths limit vessel cargo capability, particularly container vessels calling at the Choctaw Point container terminal and coal carriers calling at the McDuffie Coal Terminal. The existing channel dimensions also restrict many vessels to one-way traffic and in some areas limittransit operations to daylight only. These problems can be

[1] The 1980 EIS for the 1980 Survey Report can be found on the Mobile Harbor GRR Website at the following link: http://www.sam.usace.army.mil/Missions/Program-and-Project-Management/Civil-Projects/Mobile-Harbor-GRR/Mobile-Harbor-GRR-Downloads/

summarized by the following statements which were used by the Project Delivery Team (PDT) in developing the planning objectives:

- Larger size vessels experience transit delays due to existing width of channel.
- Existing channel depths limit vessel cargo capacity.
- Existing traffic congestion has increased safety concerns.

1.3.2. Opportunities

Mobile Harbor's ranking as a global trading port is consistently in the top twelve nationally. In 2016, Mobile Harbor handled a total of 58 million tons (mt) of commerce making it the 10th largest port in the U.S. in terms of total tonnage. Shipping trends for Mobile Harbor show adherence to projections for growth in ship size, in all three dimensions, draft, beam, and length. As economies of scale and improved vessel technologies have driven ship sizes larger, the world's port infrastructure must be expanded in channel depths and widths and terminal capacity to accommodate larger ships. The number of ports able to handle larger vessels around the world is growing, and, most importantly, the Panama Canal has expanded lock capacity to handle ships of 25% greater draft (up to 50-foot), 52% greater beam (up to 160-foot wide), and 30% greater length (up to 1,250-foot long). Ships have been under construction for several years to take advantage of the increased canal capacity realized with the 2016 opening of the new Panama Canal locks.

There is opportunity to bring the forecasted volume of goods into the harbor on fewer ships and reducing delays resulting in transportation cost savings. Particularly important is the great increase in the deployment of those vessels, which is occurring now and expected to continue with the Panama Canal expansion project completed in 2016. These larger vessels, primarily containerships commonly referred to in the shipping industry as the "Super Post-Panamax" vessels, are expected to comprise greater percentages of the vessel fleet composition over the next several decades.

The McDuffie coal shipments are currently utilizing Cape/Post-Panamax size vessels. At the current channel depth, some vessels cannot fully utilize vessel capacity. Coal shippers forecast that availability of deeper draft vessels along with the expanded Panama Canal will increase the U.S. coal competitiveness in Asia.

In addition to the economic opportunities afforded by a larger channel, there also exists safety and potential environmental opportunities. Hazards of traffic moving in and out of Mobile Harbor as well as navigation features of the channel would be improved by a larger channel. There is also potential for beneficial use of sediment material that would be obtained from the channel dredging.

The opportunities noted above can be summarized by the following statements which, in addition to the problem statements, were used by the PDT to develop the planning objectives:

- Eliminate or reduce navigational restrictions and inefficiencies (*i.e.*, channel width and depth limitations)
- Beneficially use dredged material for the protection, restoration, and creation of environmental resources
- Improve navigational safety

1.4. Purpose: Objectives and Constraints

The National or Federal objective of water and related land resources planning is to contribute to National Economic Development (NED) consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders (EO), and other Federal planning requirements.

1.4.1. Study Objectives

To achieve the goal of the Federal objective noted above, water and related land resources project plans shall be formulated to alleviate problems and take advantage of opportunities in ways that contribute to study planning objectives and, consequently, to the Federal objective of this study. Specific study planning objectives for the feasibility study for Mobile Harbor were:

- Reduce vessel congestion.
- Improve the efficiency of operations for containerships, bulk, and other cargo vessels within Mobile Harbor.
- Accommodate current and anticipated growth in containerized and bulk cargo vessel traffic.
- Provide navigation improvements to improve vessel transit safety.
- Support environmental resources through beneficial use of dredged material.

1.4.2. Constraints

The formulation of alternatives to address study objectives is limited by planning constraints. Constraints are statements of effects that the alternative plans should avoid. Constraints are designed to avoid undesirable changes between future With- and Without-Project conditions. Constraints could include resources, legal, or policy constraints. Factors considered for this project included the history of and interest in shoreline erosion, the area's rich natural and cultural resources and biodiversity, as well as the need for adequate dredged material placement capacity. Based on these factors, the PDT developed the constraints, shown below, considered applicable to this study that could possibly limit the planning process and therefore should be avoided.

- Avoid or minimize negative impacts on coastal and sediment transport processes.
- Avoid or minimize shoreline erosion.
- Avoid or minimize negative impacts to:
    - Protected Species.
    - Submerged Aquatic Vegetation (SAV).
    - Essential Fish Habitat (EFH).
    - Existing Natural Resources (marshes, wetlands, and bay bottoms).
    - Water Quality.
    - Cultural resources.
    - Adjacent Communities.
- Must have adequate Dredged Material Placement Area Capacity.
- Dredged material for the Ocean Dredge Material Disposal Site (ODMDS) and open water placement must meet suitability criteria.

1.5. Prior Reports and Studies

The USACE has been involved with the navigation channel at Mobile Harbor since 1826. Subsequently, the navigation channel has been progressively deepened from a depth of 10 ft to its current dimensions. There have been numerous studies and Congressional Authorizations leading up to this current investigation. An abbreviated list of reports on Mobile Harbor in the last 40 years is provided below.

U.S. Army Corps of Engineers. (1975). *Final Environmental Impact Statement, Mobile Harbor (Maintenance Dredging) Mobile County, Alabama.* Mobile: U.S. Army Corps of Engineers, Mobile District.

U.S. Army Corps of Engineers. (1977). *Special Report, Mobile Harbor, Alabama, Theodore Ship Channel (approved as General Design Memorandum-Phase I).* Mobile: U.S. Army Corps of Engineers, Mobile District.

U.S. Army Corps of Engineers. (1977). *Theodore Ship Channel & Barge Channel Extension, Mobile Harbor, Alabama, Phase II, General Design Memorandum, Design Memorandum No. 1.* Mobile: U.S. Army Corps of Engineers, Mobile District.

U.S. Army Corps of Engineers. (1978). *Draft Feasibility Report for Beach Erosion Control and Hurricane Protection, Mobile County, Alabama (Including Dauphin Island).* Mobile: U.S. Army Corps of Engineers, Mobile District.

U.S. Army Corps of Engineers. (1980). *Survey Report, Mobile Harbor, Alabama,* Mobile: U.S. Army Corps of Engineers, Mobile District.

U.S. Army Corps of Engineers. (1981). *A Report of the Chief of Engineers, Department of the Army, Mobile Harbor, Alabama,* Mobile: U.S. Army Corps of Engineers, Office of the Chief of Engineers.

U.S. Environmental Protection Agency. (1982). *Environmental Impact Statement (EIS) for the Pensacola, FL., Mobile, AL., and Gulfport, MS. Dredged Material Disposal Site Designation (Including Appendix A).* Washington: U.S. Environmental Protection Agency.

U.S. Army Corps of Engineers. (1984). *Draft Supplemental Environmental Impact Statement, Mobile Harbor, Alabama, Channel Improvements, Offshore Dredged Material Disposal.* Mobile: U.S. Army Corps of Engineers, Mobile District.

U.S. Army Corps of Engineers. (1985). *General Design Memorandum, Mobile Harbor Deepening, Alabama, General Design Memorandum No. 1, Main Report.* Mobile: U.S. Army Corps of Engineers, Mobile District.

U.S. Army Corps of Engineers. (1985). *Mobile Harbor, Alabama Channel Improvements, Offshore Dredged Material Disposal, Environmental Impact Statement.* Mobile: U.S. Army Corps of Engineers, Mobile District.

Department of the Army, Assistant Secretary of the Army (Civil Works). (1986). *A Report of the Chief of Engineers, Department of the Army, on Mobile Harbor, Alabama, Together with Other Pertinent Reports 99th Congress, 2d Session, House Document 99-241.* Washington: U.S. Government Printing Office.

U.S. Army Corps of Engineers. (1986). *General Design Memorandum, Mobile Harbor Deepening, Alabama, Design Memorandum No. 1, Appendix H, Design Analysis.* Mobile: U.S. Army Corps of Engineers, Mobile District.

U.S. Army Corps of Engineers. (1991). *Mobile Harbor Deepening, Design Supplement No. 1, General Design Memorandum, Turning Basin Basin Development Plan.* Mobile: U.S. Army Corps of Engineers, Mobile District.

U.S. Army Corps of Engineers. (1995). *Mobile Harbor Deepening, Design Supplement No. 2, General Design Memorandum, Turning Basin Basin Development Plan.* Mobile: U.S. Army Corps of Engineers, Mobile District.

U.S. Army Corps of Engineers. (1997). *Limited Reevaluation Report, Mobile Harbor Project Extension.* Mobile: U.S. Army Corps of Engineers, Mobile District.

U.S. Army Corps of Engineers. (2000). *Mobile Harbor 2100-foot Project Extension, Limited Reevaluation Report.* Mobile: U.S. Army Corps of Engineers, Mobile District.

U.S. Army Corps of Engineers. (2004). *Final Environmental Impact Statement for Choctaw Point Terminal Project, Mobile, Alabama.* Mobile: U.S. Army Corps of Engineers, Mobile District.

U.S. Army Corps of Engineers. (2007). *Mobile Harbor Turning Basin, General Reevaluation Report.* Mobile: U.S. Army Corps of Engineers, Mobile District.

1.6. Report Organization

This Draft GRR/SEIS provides the tentative results of the feasibility study and serves as the USACE draft decision document for the TSP and provides the draft SEIS prepared pursuant to National Environmental Policy Act (NEPA). The remainder of the report is organized as follows:

REPORT

Section 2.0: Current and Future Conditions

Section 3.0: Plan Formulation

Section 4.0: TSP

Section 5.0: Environmental Effects

Section 6.0: Environmental Compliance

Section 7.0: Recommendation

APPENDICES

APPENDIX A - ENGINEERING

APPENDIX B – ECONOMICS

APPENDIX C – ENVIRONMENTAL

APPENDIX D – REAL ESTATE

APPENDIX E – PUBLIC COMMENTS

APPENDIX F – ADDITIONAL DOCUMENTATION

APPENDIX G - REFERENCES

SECTION 2.0 CURRENT AND FUTURE CONDITIONS

2.1. General Setting

Mobile Harbor is comprised of both public and private port facilities located in Mobile, Alabama. Figure 1-1 illustrates the study area. Due to the nature of the cargo, vessel types and sailing drafts, Mobile Harbor, for economic analysis purposes only, can be segmented into three areas: Upper Harbor; Lower Harbor; and, Theodore Industrial Park. The Upper Harbor serves public and private terminals. The Lower Harbor serves the public terminals of the ASPA: Pinto Steel; McDuffie Coal; Intermodal Container Terminal; and, the Mobile Cruise Terminal. The Theodore Industrial Park serves publicly- and privately-owned and operated facilities.

2.2. Port Facilities

2.2.1. Facilities and Infrastructure

Mobile Harbor consists of facilities to handle both foreign and domestic cargo. The main imports are heavy lift and oversized cargo, containers, coal, aluminum, iron, steel, copper, lumber, wood pulp, plywood, fence posts, veneers, toll and cut paper, cement and chemicals. Main exports are heavy lift and oversized cargo, containers, coal, lumber, plywood, wood pulp, laminate, flooring, roll and cut paper, iron, steel, frozen poultry, soybeans and chemicals. The largest facility operator at Mobile Harbor is the ASPA. The ASPA has a total of 41 berths and its facilities include the main complex, McDuffie Island, Choctaw Point and other sites. According to Martin Associates (2017), Mobile Harbor's vessel and cargo activity generates approximately 153,278 direct and indirect jobs, $568 million annually in direct and indirect tax impact, and a total economic impact annually of more than $25 billion in Alabama.

2.2.1.1. Upper Harbor Terminals

ASPA Main Docks Complex extends approximately 2.2 miles along the west bank of the Mobile River and is bordered by the Terminal Railway tracks to the west, Three Mile Creek to the north, and the I-10 tunnel to the south. The navigation channel in this area is 40 ft deep. The 570-acre terminal includes approximately 2.4 million square ft of warehouse space and a 22-acre Bulk Handling Plant at the north end. The Terminal Railway, which is owned by the ASPA, interchanges with five Class 1 Railroads. The complex has immediate access to I-65 and I-10. The primary commodities handled within the main dock complex are forest products, soybeans, iron and steel products, aluminum, and roll on/roll off (ro-ro) cargoes. The facility is capable of handling 75,000 Twenty-foot Equivalent Units (TEUs)[2].

Blakeley Island Terminals Blakeley Island Terminals are comprised of both public and private terminals located on the eastern shore of the Mobile River across from the northern end of the ASPA Docks. These terminals handle general cargo, equipment, crude oil, asphalt and fuel oil, dry bulk commodities and shipbuilding.

The Water Resources Reform and Development Act of 2014 designated the Port of Mobile as an energy transfer port, which are ports of strategic significance to the national energy security interest of the U.S. There are six private petroleum/petroleum products terminals at various locations along the west and east banks of the Upper Harbor.

Vehicle Processing Ro-Ro Facility is a new facility that will allow vehicles to be driven on and off ships at Mobile. The ASPA is partnering with a joint venture out of South America to build and operate the facility. The new processing and logistics terminal will be built at the location of a former bulk material handling facility utilizing approximately 57 acres.

2.2.1.2. Lower Harbor Terminals

The Lower Harbor terminals are located south of the I-10 and U.S. Highway 90 tunnels (Wallace and Bankhead tunnels, respectively). The facilities located on this segment of the navigation channel are the Alabama Cruise Terminal, McDuffie Coal Terminal, Pinto Island Terminal and APM Terminals Mobile.

Alabama Cruise Terminal offers a two-story, 66,000 square foot terminal located adjacent to I-10, 6 miles from I-65 and in proximity of Mobile's Downtown tourism, entertainment and business districts. Carnival Cruise Lines began passenger service at the Port of Mobile in 2004. Carnival launched its Fantasy Class service at the Port of Mobile in November 2009. In 2011, Carnival canceled its Mobile service for commercial reasons, but resumed the Fantasy class service in November of 2016.

APM Terminals Mobile (an independent division within the A.P. Moller-Maersk Group) is located at Choctaw Point near the mouth of the Mobile River and opened in 2008. Subsequent investment in the container terminal has extended annual throughput capacity to 750,000 TEUs when land and rail are considered. Ongoing expansion of the terminal and a dock extension will deliver an annual throughput capacity of 950,000 TEUs by year-end 2019, when land and rail are considered. The container intermodal investment at Choctaw Point has sufficient land available to support further expansion. At full build out, the marine and rail terminal could accommodate an estimated annual

[2] A Twenty-foot Equivalent Unit is a unit of cargo capacity often used to describe the capacity of containerships and container terminals. It is based on the volume of a 20-foot long intermodal container.

throughput capacity of 2 million TEUs. The inland trade region includes the southeast, in particular, Georgia, Birmingham, Alabama and Knoxville/Memphis Tennessee, but extends as far as Chicago, Illinois. The terminal improves capability in the U.S. Gulf for reaching Midwest markets as well as Alabama and neighboring states. The 115-acre terminal has a 45 foot channel and 2,000 feet of deep water berth to handle Post Panamax vessels. In 2016, the ASPA completed construction of a $32-million 80-acre rail terminal that permits direct and fluid transfer of containers between vessels and rail cars. APM Terminals also contributed an additional $50 million toward surface improvements, equipment and technology. The dock has a depth of 45 feet MLLW and is equipped with two Post Panamax ship-to-shore (STS) cranes capable of a 19-row reach. In addition, two super Post Panamax cranes that span 22-rows of containers were delivered in June 2017.

The terminal has nine shipping lines that customers can utilize in Mobile. The regions served are North Europe, Asia and Gulf of Mexico. Two additional services are expected by 2019. In 2018, a South America to Gulf service is expected and in 2019, a West Coast South America to Gulf of Mexico service is expected.

In 2016, it was announced that Walmart will be building an import distribution center (IDC) in Mobile County, Alabama. The IDC will be approximately 2,500,000 square ft on 400 acres of land in Irvington, Alabama. The IDC will be Walmart’s sixth import facility in the U.S. The purpose of the IDC is to receive containers from Asia to distribute the products to Walmart stores across the southeast. The containers will come through APM Terminals located approximately 15 miles from the IDC site. The Walmart IDC will be a hub for the southeast region of the U.S. serving around 800 stores and several regional distribution centers in Alabama, Mississippi and other areas to the north. The IDC was opened in May 2018. The capacity of the IDC is around 160,000 TEUs annually.

McDuffie Coal Terminal is the 3rd largest export terminal in the nation serving primarily an export metallurgical coal market. McDuffie is capable of handling both import and export coal volumes with a total annual throughput of approximately 23 million tons[3]. McDuffie services waterborne and rail coal shipments and is equipped with three ship berths capable of receiving 45-ft. draft vessels. These ship berths are equipped with three Post-Panamax unloaders and two loaders. Supporting equipment at the facility includes stacker/reclaimers, barge loading/unloading stations, rail loading/unloading stations, conveyance systems and three loop tracks supporting four storage yards.

Pinto Island Terminal located near the mouth of the Mobile River, is capable of handling annually in excess of five mt of semi-finished steel slabs. The 20-acre terminal provides 1,000 ft of deep-water dock dredged to a depth of 45 ft, as well as an automated barge loading system position between the ship berth and the shoreline. The terminal is

[3] All reference to commodity shipments in “tons” refer to “short tons” of 2,000 pounds.

equipped with three Post Panamax ship-to-shore gantry cranes that are able to unload steel from ships to waiting barges or to the terminal storage yard possessing 150,000 metric tons of storage capacity.

2.2.1.3. Theodore Industrial Park

Access to the Theodore Industrial Park from the Mobile Harbor Federal Navigation Channel is available through the Theodore Ship Channel. The Federal channel was constructed by the USACE in 1981 and provides water access for an industrial complex at a former military ammunition depot. In the bay, the Theodore Ship Channel is 5.9 miles in length with a 40-foot depth and a 400-foot width. At the western shoreline of Mobile Bay the channel becomes a landcut with a length of 1.9 miles, a depth of 40 ft, and a width of 300 ft. The Theodore Industrial Park is situated on a site that comprises 4,000 acres. The primary commodities and industries handled through the port terminals of this complex are cement, aggregates, chemicals, over-dimensional cargoes. It also supports offshore oil and gas production and installation projects, including subsea umbilicals, rigid spooled pipe and risers.

2.3. Economic Conditions

Mobile Harbor serves the economy by moving millions of tons of cargo including both domestic and foreign cargo. The cargo is imported and exported in various types of ships including bulk carriers, containerships, general cargo, ro-ro and tankers. While domestic cargo is roughly half of the tonnage received or shipped through Mobile Harbor, this analysis focuses on the movement of foreign tonnage.

Figure 2-1 shows the general trend of domestic verses foreign tonnage over the time period of 2007 through 2014. Although domestic and foreign tonnage have been fairly balanced, foreign tonnage has exceeded domestic tonnage for all years in this timeframe except 2009

2.3.1. Foreign Commodity Shipments

For detailed analysis, the data set is limited to the most recent five years of data available at this time (2010 – 2014). Based on this data set, foreign shipments averaged 31.2 million short tons. Coal shipments have varied over the period, but remains the largest commodity with 47% of total foreign commerce. Primary manufactured goods came in second at 16% of the overall distribution and then crude materials, which averaged 13% of the total. Petroleum products accounted for 12% of total shipments and the remaining commodity categories accounted for 5% or less of total commerce. Figure 2-2 shows the commodity distribution from 2010 to 2014.

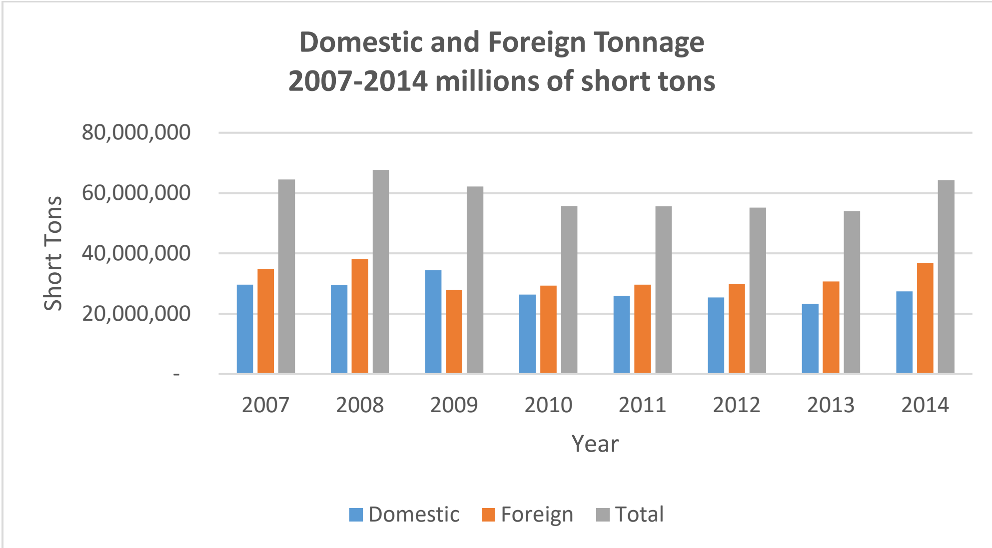


Figure 2-1. Domestic and Foreign Tonnage

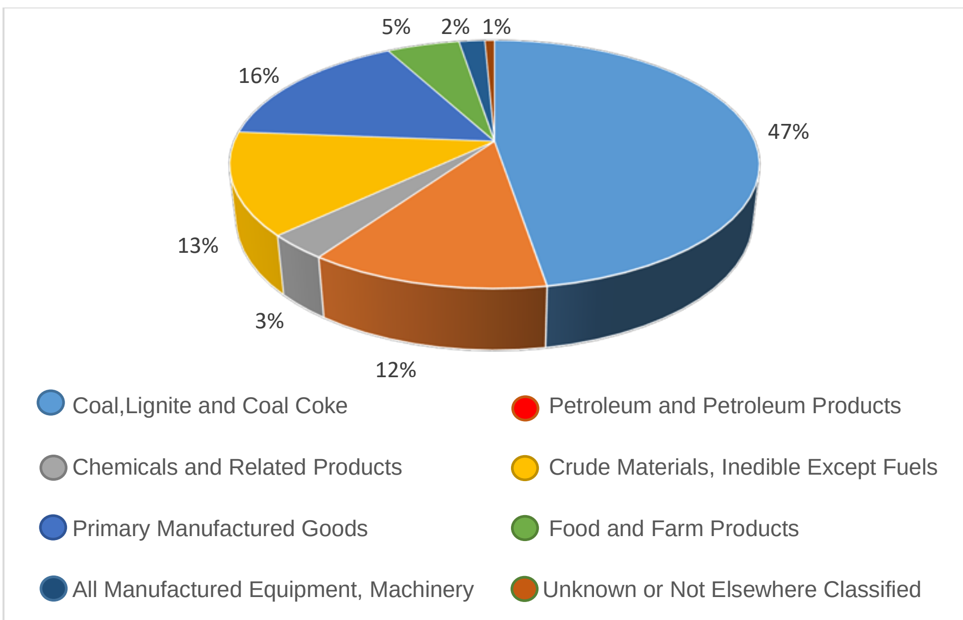


Figure 2-2. Mobile Harbor Commodity Distribution

Within foreign commodity shipments, imports account for approximately 47% while exports account for 53% of the foreign trade at Mobile during the time period 2010 – 2014. Figure 2-3 shows total foreign commerce and imports and exports.

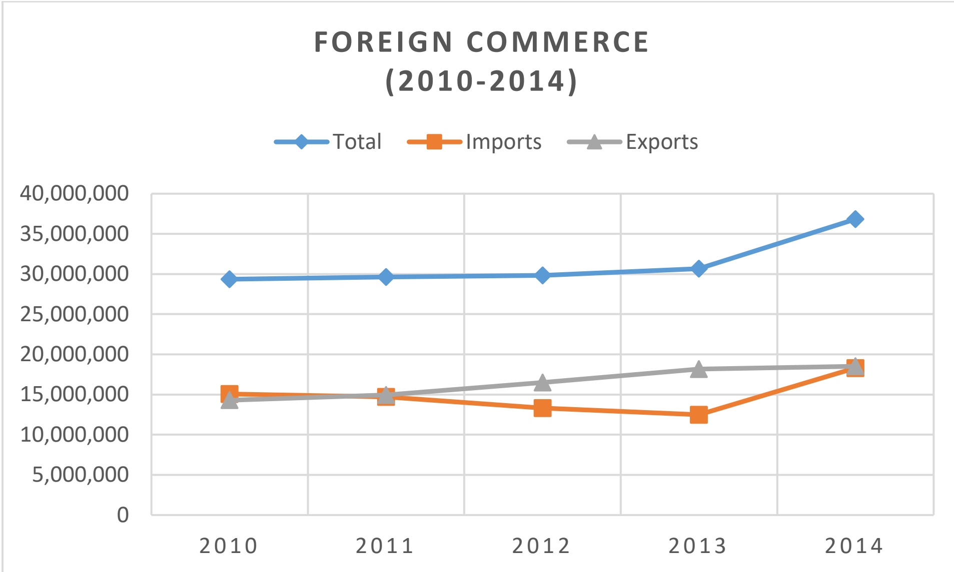


Figure 2-3. Foreign Commerce 2010-2014

Figure 2-4 shows foreign imports by commodity type from 2010 through 2014. As illustrated, the volume of coal has fluctuated, primary manufactured goods increased, and petroleum imports significantly increased from 2013 to 2014. The increase in petroleum products was due to the construction of a pipeline from a dock at Mobile Harbor to Pascagoula, MS to transport crude oil. Other commodities did not experience significant changes.

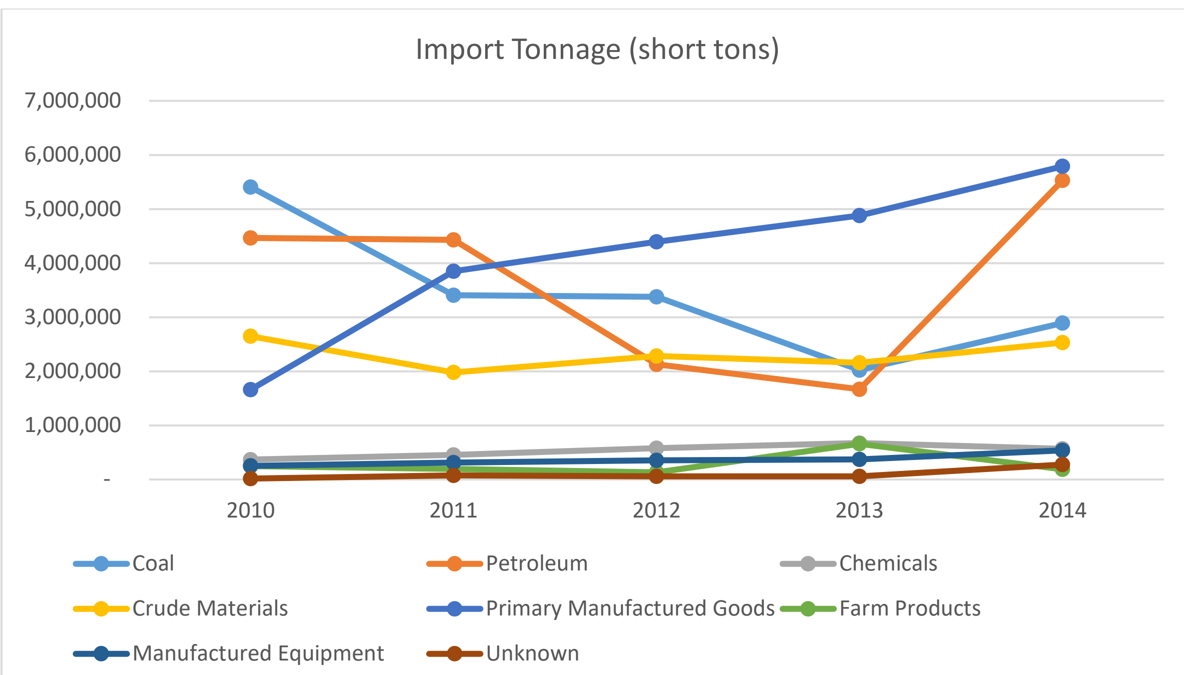


Figure 2-4. Historical Imports by Commodity Type (short tons)

Figure 2-5 shows foreign export short tons from 2010 through 2014 by commodity type. Coal has historically been the largest commodity exported.

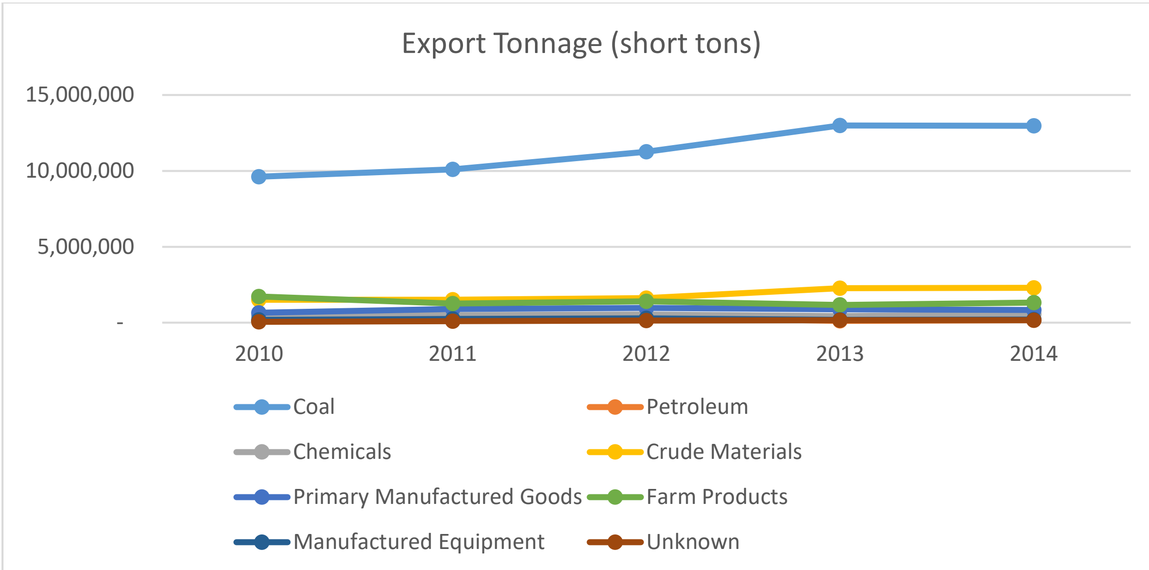


Figure 2-5. Historical Exports by Commodity Type

2.3.2. Cargo Imports

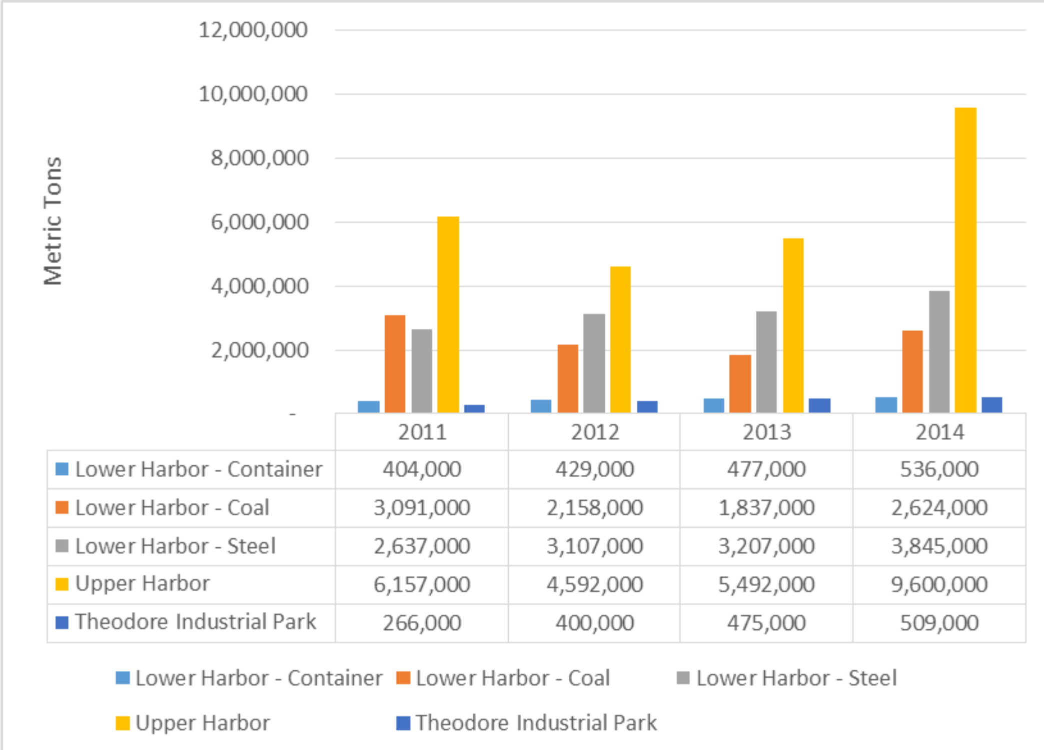
For detailed analysis, the data set is limited in years due to projections being based on latest years of data available at the time of analysis, 2010 to 2014. As discussed in Section 2.1, one criteria of the segmentation of the harbor for the economic analysis was nature of the cargo. Since carrying capacity of a vessel is in metric tons, the remainder of the analysis will use metric tons[4]. Figure 2-6 displays the historical imports by channel segment moving through Mobile Harbor from 2011 to 2014. As shown, containerized cargo and steel imports increase each year. Imported coal has decreased from 2011 to 2013, then increased in 2014.

The Upper Harbor cargo varied by year and the overall Theodore tonnage continues to increase each year. The non-containerized import volumes include coal, steel, manufactured equipment machinery and products, food and farm products, fertilizers, crude materials and petroleum products that move through the Mobile Harbor.

2.3.3. Cargo Exports

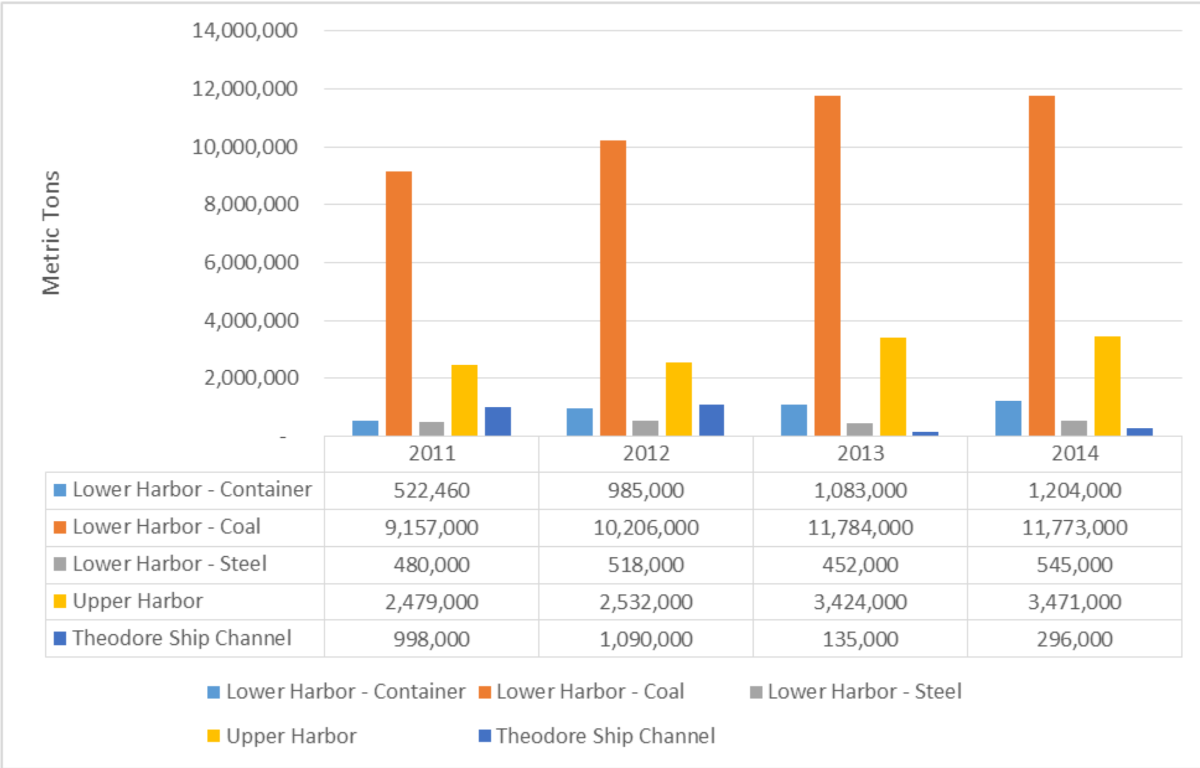
Figure 2-7 shows historical exports moving through Mobile Harbor from 2011 to 2014. Containerized cargo and coal exports increase each year, and steel exports vary by year. The Upper Harbor cargo and Lower Harbor Container cargo have also increased.

[4] A short ton equals 2,000 pounds; a metric ton weighs 2,204 pounds.



	2011	2012	2013	2014
Lower Harbor - Container	404,000	429,000	477,000	536,000
Lower Harbor - Coal	3,091,000	2,158,000	1,837,000	2,624,000
Lower Harbor - Steel	2,637,000	3,107,000	3,207,000	3,845,000
Upper Harbor	6,157,000	4,592,000	5,492,000	9,600,000
Theodore Industrial Park	266,000	400,000	475,000	509,000

Figure 2-6. Cargo Historical Imports



	2011	2012	2013	2014
Lower Harbor - Container	522,460	985,000	1,083,000	1,204,000
Lower Harbor - Coal	9,157,000	10,206,000	11,784,000	11,773,000
Lower Harbor - Steel	480,000	518,000	452,000	545,000
Upper Harbor	2,479,000	2,532,000	3,424,000	3,471,000
Theodore Ship Channel	998,000	1,090,000	135,000	296,000

Figure 2-7. Cargo Historical Exports

2.3.4. Containerized Cargo

As of 2016, nine shipping lines were calling at APM Terminals at Mobile Harbor. Table 2-1 shows the operator, vessel TEU capacity and trade area. Routes include services to the Far East, Europe and transshipments in the Caribbean.

2.3.4.1. Container Facility and Capabilities

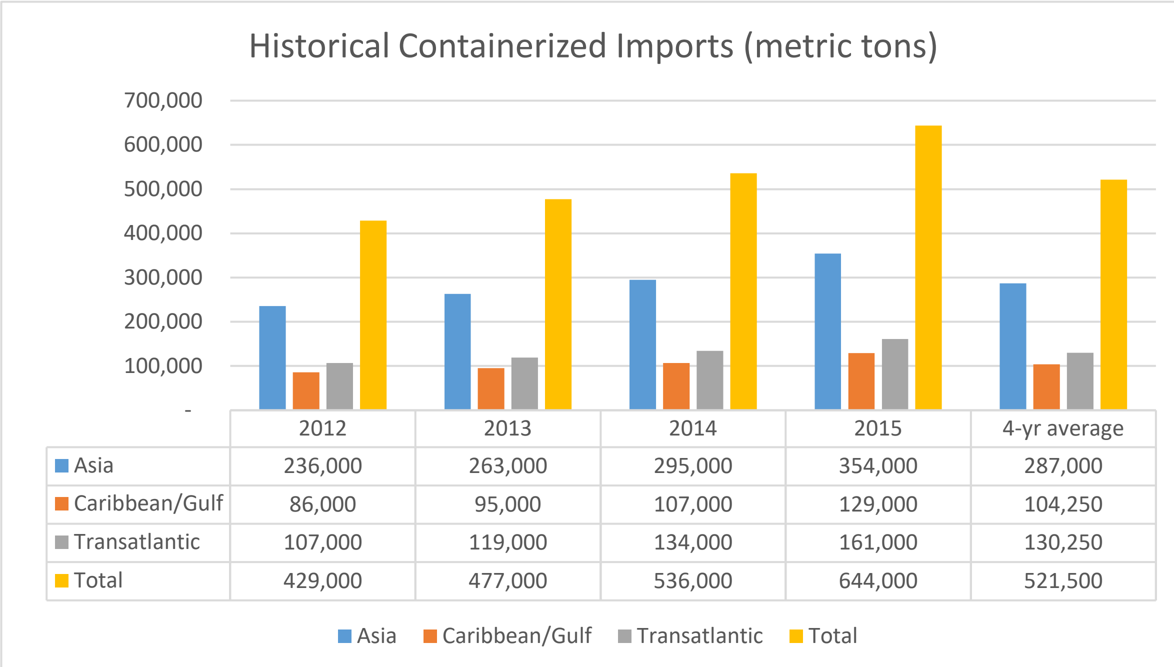
In 2015, 186,619 loaded TEUs were handled through Mobile Harbor. Imports accounted for 82,379 TEUs and exports account for 104,240 TEUs. Imports and exports varied, but exports were higher overall in terms of TEUs. Figure 2-8 shows import and export loaded TEUs from 2008 to 2015.

2.3.4.2. Containerized Imports

Figure 2-9 illustrates historical containerized imports that moved through Mobile Harbor by trade lane. As shown, in the time period 2012 to 2015 containerized imports continued to increase. Trade with Asia dominates containerized cargo for imports, followed by transatlantic trade and then Caribbean/Gulf trade. Top import commodities include auto parts, general consumer goods and hard woods. From Europe, tile floor, auto parts and general consumer goods are imported. The Caribbean is a transshipment hub for Latin America, Mediterranean and West Africa. From these regions produce, textiles and raw materials are imported. Average imports from all the world regions were estimated to total 522 thousand metric tons. The average trade volume from 2012 to 2015 represents the baseline from which commerce was forecasted.

Table 2-1. APM Container Terminal Services

Operator	Service	Vessel TEUs	Routes	Trade Areas
Maersk & MSC	TA-3	6,000-7,000	Europe/ Transatlantic	North Europe • Charleston • Freeport • Central America • New Orleans • Mobile
MSC	Lone Star Express	4,000-5,000	Far East	Asia • *Panama Canal* •Houston • Mobile • Miami • Freeport
CMA CGM & Evergreen	PEX3	5,000	Far East	China • *Panama Canal* • Houston • Mobile • Miami • Jacksonville • South Africa • Singapore
Maersk	TP-18	4,000-5,000	Far East	Houston • Mobile • Miami • *Panama Canal* • East Asia
COSCO/CS	GME	4,250	Far East	China • *Panama Canal* • Houston • Mobile
ZIM	CGX	2,700-3,400	Caribbean/Gulf	Caribbean • Mobile • New Orleans • Houston



	2012	2013	2014	2015	4-yr average
Asia	236,000	263,000	295,000	354,000	287,000
Caribbean/Gulf	86,000	95,000	107,000	129,000	104,250
Transatlantic	107,000	119,000	134,000	161,000	130,250
Total	429,000	477,000	536,000	644,000	521,500

Figure 2-8. Loaded TEUs

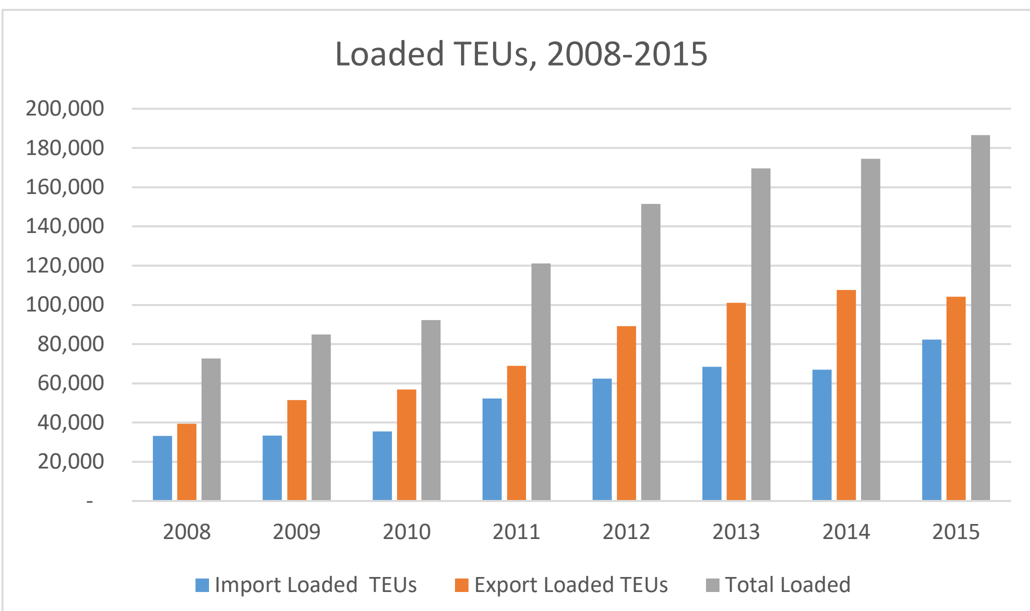
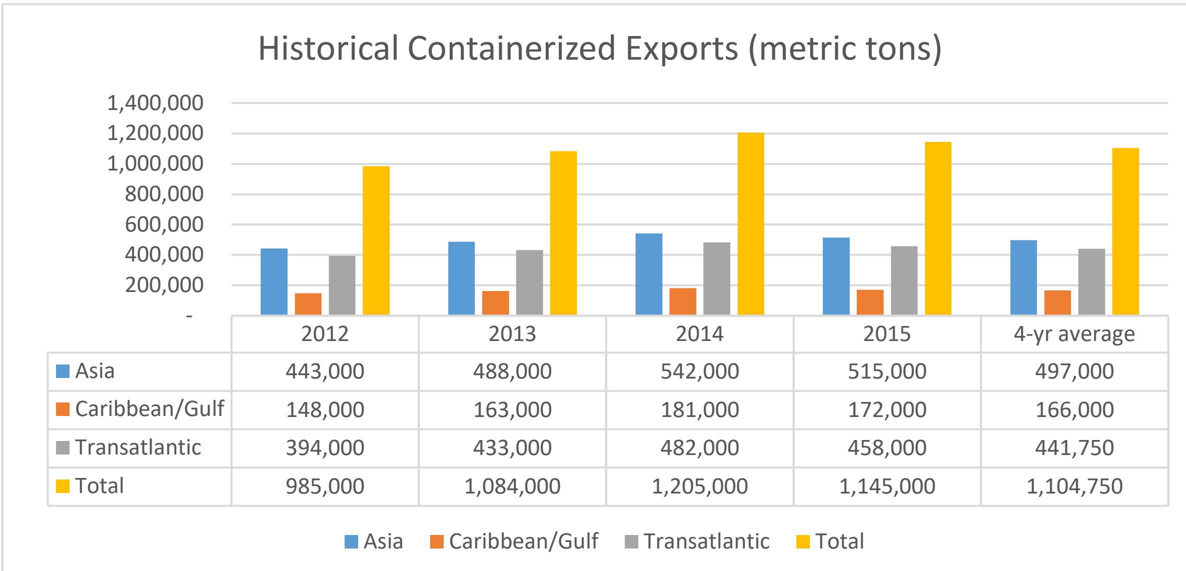


Figure 2-9. Historical Containerized Imports by Trade Lane

2.3.4.3. Containerized Exports

Figure 2-10 illustrates historical containerized exports that moved through Mobile Harbor by trade lane. As shown, in the time period 2012 to 2015 containerized exports continued to increase. Trade with Asia also leads containerized cargo for exports, followed by transatlantic trade and then Caribbean/Gulf trade. Top export commodities include forestry products, petrochemicals and frozen poultry. To Europe, forestry products, petrochemicals and peanuts are exported. The Caribbean is a transshipment hub for Latin America, Mediterranean and West Africa. Vehicles, frozen poultry, cotton and raw materials are exported to these regions. Average exports from all the world regions were estimated to total 1.1 million metric tons. The average trade volume from 2012 to 2015 represents the baseline from which commerce was forecasted.



	2012	2013	2014	2015	4-yr average
Asia	443,000	488,000	542,000	515,000	497,000
Caribbean/Gulf	148,000	163,000	181,000	172,000	166,000
Transatlantic	394,000	433,000	482,000	458,000	441,750
Total	985,000	1,084,000	1,205,000	1,145,000	1,104,750

Figure 2-10. Historical Containerized Exports by Trade Lane

2.3.5. TEU Weight by Route Group

Data from 2012 to 2015 for inbound and outbound containership calls were analyzed in detail to determine the TEU weight by route group. The metric tons imported or exported were divided by the number of TEUs imported or exported to determine an average weight per TEU for import and export and by route group. Results are shown in Table 2-2. The assumed two-ton tare weight for all boxes was not included in this total.

Table 2-2. Tons per TEU by Route

Route Group Description	TEU Weight Import	TEU Weight Export
Far East	8.2	11.5
Caribbean/Gulf	5.5	12.2
Transatlantic	11.8	12.4

2.3.6. Lower Harbor Dry Bulk Services

2.3.6.1. Coal

Mobile serves Alabama and Illinois Basin coal production. Imported thermal coal has declined due to companies using an alternate fuel source to cost-effectively reduce greenhouse gas emissions. However, coal will still be used in the fuel mix at plants that utilize new clean coal technologies, and will continue to be imported through Mobile. Metallurgical grade coal is still being mined in Alabama for export. Figure 2-11 shows the coal hinterland.

Itinerary data from the WSCS indicates bulk coal traffic is considered on a pendulum routes (back-and-forth to-and-from Mobile). These vessels primarily follow routes between Mobile and the following regions:

- Europe
- Africa
- Asia
- South America

The study assigned future vessel call route groups based on historical route groups by vessel class.

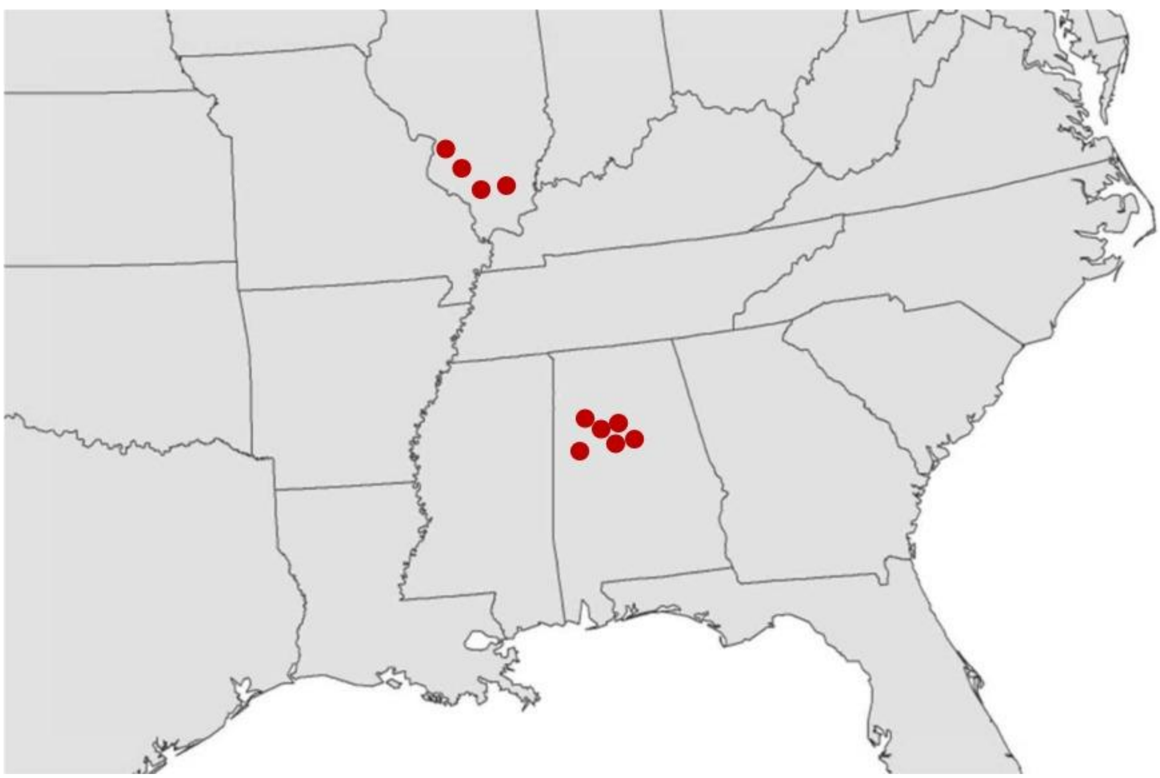


Figure 2-11. Coal Hinterland

2.3.6.2. Iron, Steel and Non-Ferrous Metals

Mobile serves the southeast U.S. iron, steel and non-ferrous metals market. Mobile has emerged as the second largest steel port in the U.S. Pinto Island Terminal primarily serves AM/NS (a joint venture between ArcelorMittal and Nippon Steel & Sumitomo Metal Corporation), a steel processing plant located in Calvert, Alabama. Although vessels that call this terminal draft 45 ft, personnel at AM/NS stated given the quantity and demand of steel shipped, no larger or deeper channel is needed. Therefore, the quantity of tonnage and vessels utilizing the terminal are held constant.

2.3.7. Relative Trade Volume and Trends Baseline Forecast

2.3.7.1. Commodity Forecast

Estimates of Mobile Harbor's future commerce for the period of analysis are linked to the port's hinterland and the extent to which it shares commodity flows with other ports. An essential step when evaluating navigation improvements is to analyze the types and volumes of cargo moving through the port. Trends in cargo history can offer insights into a port's long-term trade forecasts and thus the estimated cargo volume upon which future vessel calls are based. Under future With- and future Without-Project conditions, the same volume of cargo is assumed to move through Mobile Harbor. However, a deepening project will allow shippers to load vessels more efficiently or take advantage of larger vessels. This efficiency translates to savings and is the main driver of NED. Mobile Harbor's share of the commodity projections remain the same as existing condition. Cargo projections ultimately drive vessel fleet projections in terms of the numbers and sizes of vessels for without- and with-project conditions.

The methodology to determine the forecast of import and export tonnage involved three steps. First, the baseline was established. The baseline is an average of historical data. Second, the rates of change for each commodity were established using sources such as the U.S. Department of Energy (DOE), the U. S. Department of Agriculture (USDA) and an effort using IHS Global Insight (GI). Third, the rates of change were applied to the baseline to determine total import and export trade for Mobile Harbor.

It should also be noted that each trade route contains unique characteristics such as cargo volume, cargo weight, ports of call, vessel types, mix of vessels, etc. and therefore, are evaluated separately before being combined as part of the NED analysis. Two of the three trade routes will benefit from channel modification at Mobile Harbor. However, the non-benefitting routes were still carried forward in the evaluation as the number of future calls will contribute to harbor congestion and will influence other benefit categories.

2.3.7.2. Baseline

Empirical data and historical trends were established to serve as a baseline for the commodity forecast. To minimize the impact of potential variances in trade volumes on long-term forecast, four years of data were employed to establish the baseline for the commodity forecast. Empirical data from either 2011 to 2014 or 2012 to 2015 were used to develop a baseline.

Using the data shown in Sections 2.3.3 and 2.3.4, the averages of imports and exports are used to develop the baseline for the commodity forecast as shown in Table 2-3.

Table 2-3. Baseline Tonnage (metric tons)

Commodity Type	Baseline Period (years)	Import Baseline Tonnage	Export Baseline Tonnage
Containerized (total)	2012-2015	522,000	1,104,800
• Asia	2012-2015	287,000	497,000
• Caribbean/Gulf	2012-2015	104,000	166,000
• Transatlantic	2012-2015	130,000	441,800
Coal	2011-2014	2,428,000	10,730,000
Steel	2011-2014	3,119,000	499,000
Mobile River Terminals	2011-2014	6,460,000	2,977,000
Theodore Ship Channel	2011-2014	413,000	630,000

2.3.7.3. Growth Rates

The long-term trade forecast for Mobile Harbor used forecast data from the DOE, the USDA, IHS GI and regression[5]. The forecast applied the rates of change from these sources for each commodity's baseline. This methodology is consistent with the approach used to perform long-term commodity forecast for other USACE deep-draft analyses.

2.3.7.3.1. DOE Forecast

The forecast used the Annual Energy Outlook 2016 (AEO) growth rates for forecasting petroleum and petroleum products and coal at Mobile Harbor. The AEO uses the National Energy Modeling System, an integrated model that aims to capture various interaction of economic changes and energy supply, demand, and prices. The AEO provides multiple

[5] A statistical process for estimating the relationship among variables.

forecast cases based on different scenarios through 2050. This forecast used the "reference" case, which assumes trend improvement in known technologies, along with a view of economic and demographic trends reflecting the current central view of leading economic forecasters and demographers.

2.3.7.3.2. USDA Forecast

The forecast used growth rates from the USDA's Long-term Projections Report AEO-2016-1 to develop forecasts for food and farm products. The USDA uses specific assumptions about macroeconomic conditions, policy, weather, and international developments, with no domestic or external shocks to global agricultural markets to compile a forecast through 2025 by major commodity. The projections are one representative scenario for the agricultural sector for the next decade and reflect a composite of model results and judgment-based analyses. The reference case, used for this study, reflects relatively sluggish economic growth in developing countries, a strong dollar, and low oil prices in the near term, with stronger developing country growth, a somewhat weaker dollar, and rising oil prices in the long-term.[6] The USDA's Long-Term Projections Report summarizes future food and farm trade as follows:

> *Steady world economic growth is projected over the next decade, despite a near-term slowdown in many developing countries. Projected global demand for agricultural products will rise, but at a slower rate than in the past decade. At the same time, world agricultural production is projected to increase more rapidly than world population, enabling a small increase in global per capita use of most agricultural products. Growth in world agricultural trade is projected to continue, albeit at a slower rate than in recent years. Together, these trends result in continued declines in the projected prices of agricultural commodities over the short-term and the persistence of low prices throughout the projection period.*[4]

2.3.7.3.3. IHS GI Trade Forecast

The GI's trade forecast informed the growth rates for containers. The model is based on the IHS World Trade Service (WTS) model. Conceptually, the WTS real value trade model uses a three-level process. **Figure 2-12** provides a schematic of the WTS forecasting process. This multi-stage forecasting uses a combination of bottom-up and top-down approaches. GI combines both approaches to increase forecast accuracy.

Level I forecasts a country's imports of a commodity individually, without any exporter-level detail. The forecast at this stage is a bottom-up approach, which reflects heterogeneous behaviors of countries importing goods in each commodity group.

[6] https://www.ers.usda.gov/webdocs/publications/37809/56729_oce-2016-1.pdf?v=42508

Level II forecasts a country's imports of a commodity from an exporting country under the assumption that the country's aggregated imports of the commodity from all the exporting countries is controlled by this country's imports of the commodity forecasted at Level I. The second stage forecast can be described as a top-down controlled approach and conforms to the WTS demand-driven approach to trade. The IHS World Industry Service (WIS) and IHS other sectoral forecasts are utilized at this level to address the competitiveness and supply capacity of an exporting country. The WIS provides both historical and forecasted industry data by Standard Industrial Classification category across 78 countries.

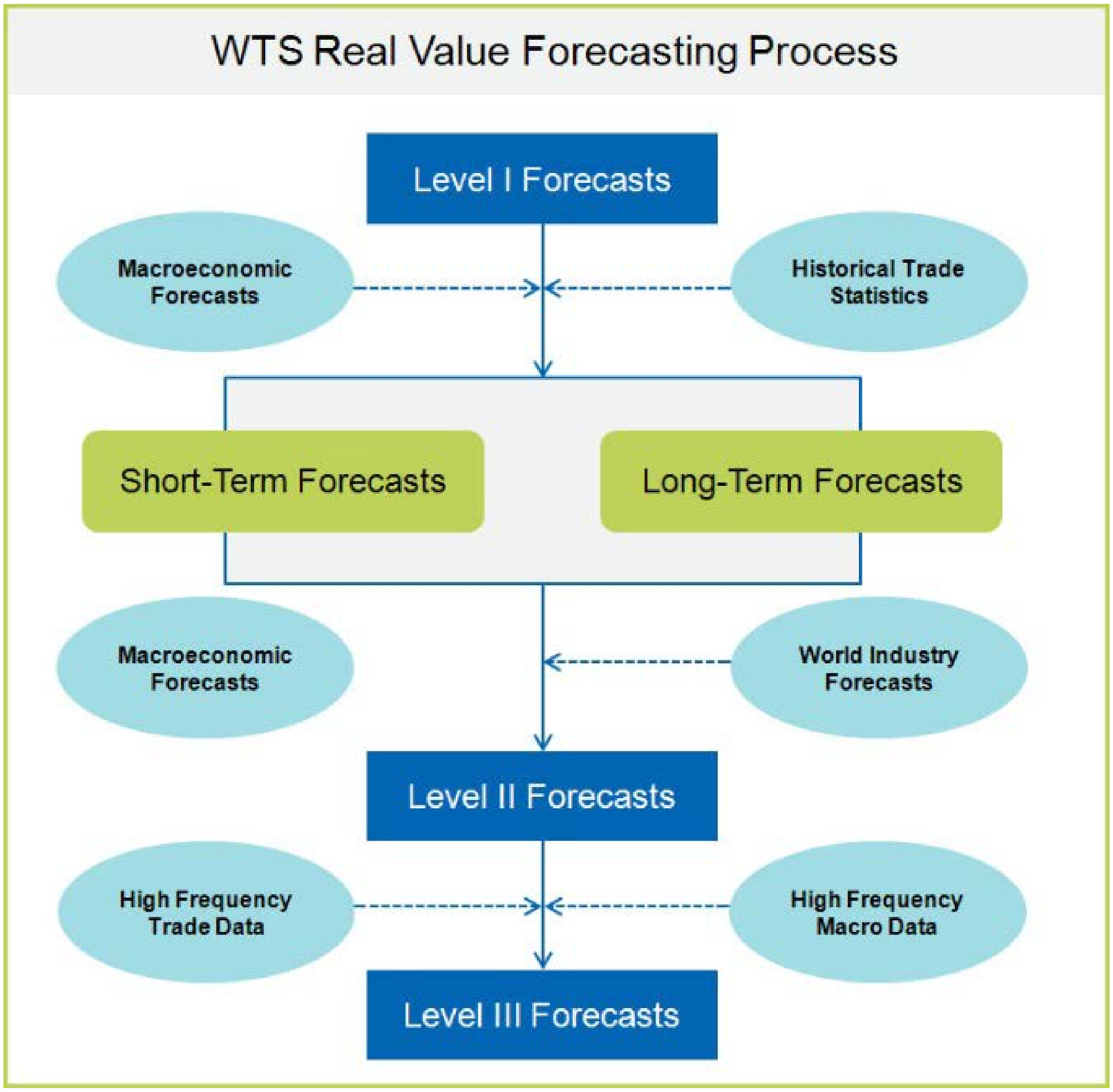


Figure 2-12. WTS Forecasting Process

Level III forecasts and makes adjustments to individual commodity flows between importing and exporting countries given the most updated monthly and quarterly trade statistics collected from a variety of national and international sources, including the U.S. Census

Bureau and Eurostat, to capture the most recent trade developments during the current year. At this stage, GI also takes into account the most up-to-date high-frequency macro data. After the adjustments, the forecasting procedures produce final globally consistent commodity-level trade forecasts between 106 countries/regions for 201 commodity categories.

2.3.7.4. Commodity Grouping for Growth Rates

The following section outlines the growth rates by commodity for Mobile Harbor. The forecast applies these growth rates to the baseline tonnage presented in Table 2-3 to develop a final forecast by commodity, organized by import and export. Table 2-4 lists the major commodities in the study area and the data source used to forecast.

Table 2-4. Commodity Sources

Commodity Name	Forecast Source*
Containers	IHS Global Insight
Coal	AEO
Manufactured Equipment, Machinery and Products	Regression
Grain	USDA
Crude Petroleum	AEO
Petroleum Products	AEO
Iron Ore and Scrap	Regression
Other Agricultural Products	USDA
Other Chemicals and Related Products	Regression
Primary Iron and Steel	Regression
Metal Products	Regression
Primary Wood Products; Veneer; Plywood	Regression
Slag	Regression
Sulphur (Dry), Clay & Salt	Regression
Processed grain and animal feed	USDA
Building Cement & Concrete; Lime; Glass	Regression
Grain	USDA
Fertilizers	Regression
Fish	USDA
Forest Products Wood and Chips	Regression
Non-Ferrous Ores and Scrap	Regression
Oilseeds (Soybean, Flaxseed and Others)	USDA
Other Non-Metal Minerals	Regression
Paper & Allied Products	Regression
Pulp and Waste Paper	Regression
Soil Sand	Regression
Vegetable Products	USDA

*AEO=Annual Energy Outlook; GI=Global Insight; USDA=U.S. Dept. of Agriculture

2.3.7.4.1. Import/Export Growth Rates

Import/export growth rates for Mobile Harbor were calculated from the DOE's AEO, the USDA's Long-Term Projections Report and GI's WTS. A compound average growth rate (CAGR) was applied for the Upper Harbor commodities. Growth rate information can be found in Section 3.1, Appendix B.

2.3.7.5. Forecasts

Using the baseline, the growth rates determined in the preceding section were applied to forecast total import and export tonnage for Mobile Harbor over the study period. The forecast applied these growth rates at a disaggregated level before summarizing commodity totals by commodity group. The following sections summarize the forecast by import and export.

2.3.7.5.1. Containerized Import Trade

The respective world region import rates of change were applied to the baseline to estimate the Mobile Harbor long-term import forecast. For purposes of this analysis, the forecast is held constant after year 2035. Port capacity is not expected to be reached until after 2035. Table 2-6 shows the container import trade forecast. Table 2-7 shows the laden TEU's import forecast.

Table 2-5. Container Import Trade Forecast

Container Imports Trade Forecast (metric tons)			
Region	**2025**	**2030**	**2035**
Far East	1,500,000	1,645,000	1,781,000
Caribbean/Gulf	145,000	170,000	194,000
Transatlantic/Europe	176,000	206,000	235,000

Table 2-6. Laden TEU Imports

Laden TEU Imports			
Region	**2025**	**2030**	**2035**
Far East	183,700	201,500	218,000
Caribbean/Gulf	26,300	30,900	35,300
Transatlantic/Europe	14,900	17,400	19,900
Total	224,900	249,800	273,200

2.3.7.5.2. Coal Imports

Thermal coal is imported through Mobile Harbor. Although imported coal has declined, in the near term it is expected that some will be needed to accommodate power plants in the southeast. Import coal volumes through Mobile Harbor originates from coal mines in Columbia. These mines produce a high grade, low ash and low Sulphur thermal coal desired by the U.S. power generation market. Although a shift from coal is occurring for environmental and cost-effective reasons, coal will still be utilized in its fuel mix at plants that utilize new clean coal technologies. Therefore, coal imports were held constant at 2,428,000 metric tons.

2.3.7.5.3. Upper Harbor Imports

The Upper Harbor terminals import a variety of commodities. As previously mentioned, dock tonnages were combined based on type of commodity and associated vessel type. Table 2-8 displays the Upper Harbor docks forecasted tonnage.

Table 2-7. Upper Harbor Forecasted Import Tonnage

Commodity	2025	2030	2035
General and Dry Bulk Cargo	6,806,000	8,266,300	10,355,300
Chemicals	262,300	290,000	320,000
Petroleum	6,112,000	6,107,000	6,104,000

2.3.7.5.4. Theodore Industrial Park Imports

The Theodore Ship Channel handles multiple commodities as well. For reporting purposes the commodities were aggregated into two categories; general and dry bulk cargo and chemicals based on vessel types. Table 2-9 shows the forecasted commodity tonnage.

Table 2-8. Theodore Industrial Park Forecasted Import Tonnage

Commodity	2025	2030	2035
Chemicals	503,000	707,000	1,005,000
General and Bulk Cargo	281,000	338,000	430,000

2.3.7.5.5. Containerized Export Trade

The respective world region route export rates of change were applied to the baseline to estimate the Mobile Harbor long-term export forecast. For purposes of this analysis, the forecast is held constant after year 2035. Port capacity is not expected to be reached until after 2035. Table 2-10 shows the container export trade forecast. Table 2-11 shows the laden TEU's export forecast.

Table 2-9. Container Export Tonnage

Container Exports (metric tons)			
Route	2025	2030	2035
Far East	1,924,000	2,206,000	2,568,000
Caribbean/Gulf	237,000	277,000	320,000
Transatlantic/Europe	593,000	697,000	799,000
Total	2,754,000	3,180,000	3,687,000

Table 2-10. Laden TEU Exports

Laden TEU Exports			
Route	**2025**	**2030**	**2035**
Far East	167,100	191,600	223,100
Caribbean/Gulf	19,400	22,700	26,200
Transatlantic/Europe	48,000	56,400	64,700
Total	234,500	270,800	314,000

2.3.7.5.6. Coal Exports

Mobile exports metallurgical coal for the steel markets. Table 2-12 shows the forecasted tonnage for exported coal.

Table 2-11. Coal Export Forecast

Commodity	2025	2030	2035
Coal	9,971,300	10,642,900	12,469,000

2.3.7.5.7. Upper Harbor Exports

The Upper Harbor handles an assortment of commodities. Table 2-13 displays the combined Upper Harbor docks and their associated forecast tonnage.

Table 2-12. Upper Harbor Export Tonnage

Commodity	2025 Export	2030 Export	2035 Export
General and Dry Bulk Cargo	5,836,000	6,689,000	7,813,000
Chemicals	30,000	36,000	43,000

2.3.7.5.8. Theodore Industrial Park Exports

The Theodore Industrial Park commodity export aggregated totals are shown in Table 2-14.

Table 2-13. Theodore Industrial Park Export Tonnage

Commodity	2025	2030	2035
Chemicals	225,000	267,000	317,000
General and Dry Bulk Cargo	507,000	674,000	906,000

2.3.8. Existing Fleet - Characteristics

Both long-term and short-term data was acquired from the WCSC and the Mobile Harbor Pilot's logs to determine vessel characteristics of the fleet calling at Mobile Harbor.

An analysis of the existing fleet data revealed six typical vessels calling at Mobile Harbor in 2014: Bulk Carriers; Containerships; General Cargo; Chemical Tankers; Oil Tankers; and, ro-ro cargo vessels. For the most part, these vessels are representative of historical vessels calling at Mobile Harbor. Other vessel types that call are research/survey, offshore supply vessels and vessels needing repairs. In 2016, the Carnival Cruise ship began year-round sailing from Mobile. Figure 2-13 shows the distribution of the vessel types in 2014. As shown, bulk carriers make up the largest vessel type calling at Mobile Harbor with general cargo vessels and containerships vessels close behind.

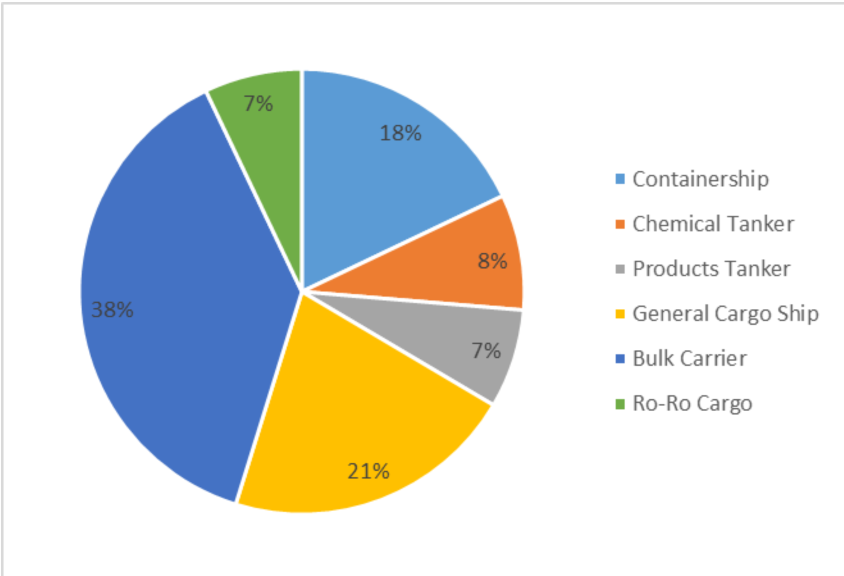


Figure 2-13. Vessel Type Distribution

2.3.8.1. Containership Fleet

From 2011 to 2015, the containership fleet calling at Mobile Harbor consisted of Sub-Panamax (22%), Panamax (61%), and Post-Panamax (17%). Figure 2-14 provides an overview of containerships calls at APM Terminals.

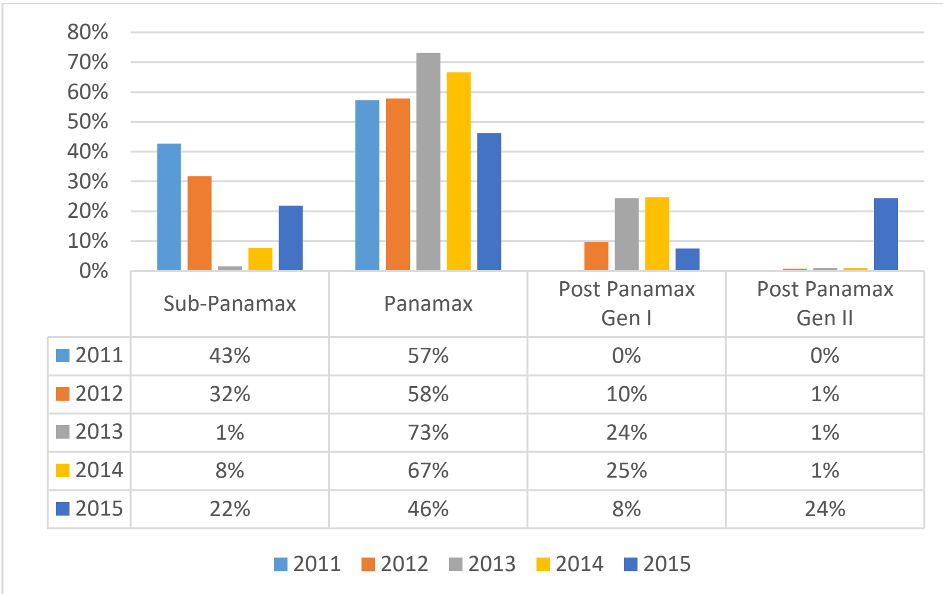


Figure 2-14. Containership Calls

The largest containership by deadweight tonnage to call at Mobile Harbor was the MSC Judith in 2014. Table 2-15 shows characteristics of the largest containership vessels to call in this time frame.

Table 2-14. Largest Mobile Harbor Containership Characteristics

Vessel Name	Beam	Draft	LOA	DWT	TEU Capacity
MSC JUDITH	141.3	47.5	1,065	105,082	8,089
MSC TEXAS	141.3	47.5	1,096	101,898	8,238

2.3.8.2. Bulk Fleet

The bulk fleet includes bulk carriers, chemical tankers, general cargo vessels, ro-ro vessels and tankers. Figure 2-15 provides an overview of total foreign calls by vessel type. Bulk Carriers are the largest and most frequent type of bulk vessel. They carry steel and coal to the Lower Harbor and a variety of other commodities to the Upper Harbor. Tankers declined from 2011 to 2013, but rebounded in 2014 most likely based on the information in Section 2.3.1.

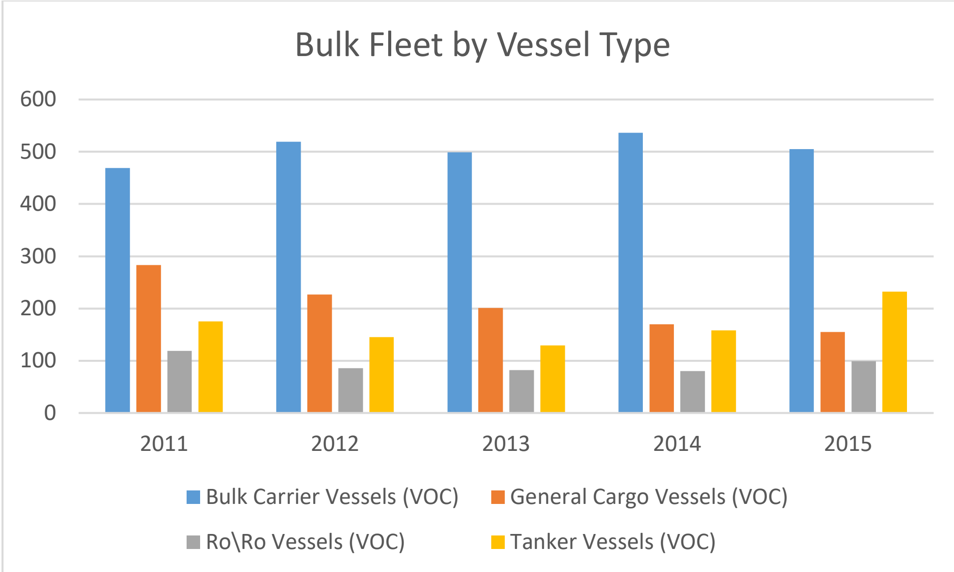


Figure 2-15. Bulk Fleet by Vessel Type

2.3.9. Existing Sailing Operations, Design Drafts Future Vessel Fleet Characteristics

2.3.9.1. Shipping Operations

The Mobile Harbor Bar Pilots have safety guidelines which they follow for safe operation in the channel. The guidelines that are pertinent for this analysis are as follows: traffic is limited to one-way when a vessel whose beam exceeds 115 ft is transiting the channel, the maximum combined draft of two meeting vessels shall not exceed 85 ft, any two vessels with a combined length overall (LOA) of 1,650 ft or greater will not be allowed to meet in the channel if the combined draft is greater than 75 ft, and the maximum combined length of any two vessels that will be allowed to meet in the channel is 1,775 ft, regardless of draft.

2.3.9.2. Underkeel Clearance

Underkeel clearance (UKC) is the minimum clearance available between the deepest point on a ship and the design channel bottom to avoid damage to ship hull, propellers, and rudders from bottom irregularities and debris. The measure of UKC for economic studies is applied according to planning guidance. According to this guidance, UKC is evaluated based on actual vessel operator and pilot practices within a harbor and subject to present conditions, with adjustment as appropriate or practical for With-Project conditions. The practices for UKC were determined through interviews with pilots and vessel operators and analysis of actual past and present practices. It is assumed that the UKC used in the existing condition will be in use with a deepened channel. For Mobile Harbor, clearance required varies by vessel type. The bulk carrier sailing drafts are frequently up to 45 ft. Containerships typically have sailing drafts of 41 ft, however, few have sailings drafts of 42 to 44 ft. Docks that tankers and general cargo vessels call are upriver where the channel converts to 40 ft deep. Sailing drafts for tankers and general cargo vessels are up to 40 ft deep.

2.3.9.3. Tidal Range

The tides in Mobile Bay are chiefly diurnal, occurring once daily. Under ordinary conditions, mean tidal range is 1.2 ft at the lower end and 1.6 ft at the upper end; extreme tidal range is 3.4 ft at the lower end and 3.6 ft at the upper end. Northern winds during the winter months may lower the water surface of the bay by as much as 1.5 ft below mean low water; hurricanes have been known to raise the level by as much as 11.5 ft. According to interviews with the Mobile Harbor Bar Pilots and review of their ship logs, vessels currently calling at Mobile Harbor do not depend on the tide to transit the channel.

2.3.9.4. Sailing Practices

Figure 2-16 and Figure 2-17 show the vessel frequency and sailing drafts for bulk carriers and containerships between 2011 and 2014. These two vessels types are only shown because the other vessels are carrying cargo upriver where the channel transitions to 40 ft deep, therefore, potential deepening of the channel will not provide a benefit to those commodities and resultant vessels.

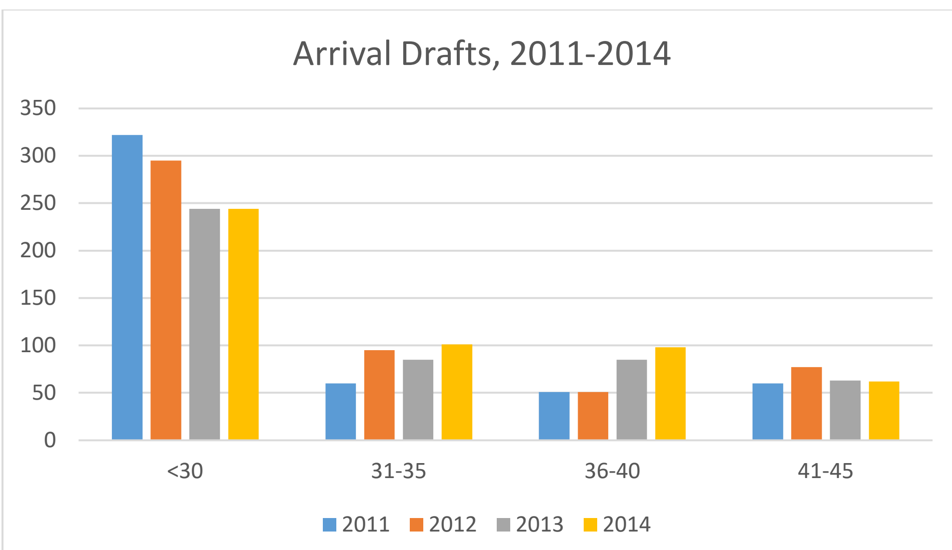


Figure 2-16. Arrival Drafts of Bulk Carriers and Containerships

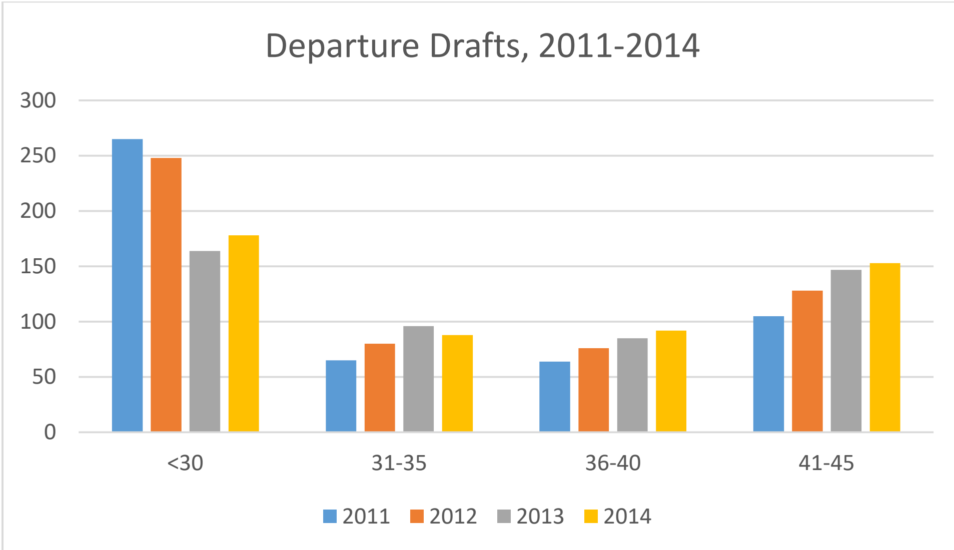


Figure 2-17. Departure Drafts of Bulk Carriers and Containerships

2.3.9.5. Design Vessel

Generally, waterway improvements should be designed for optimization across the entire forecasted fleet. In this case, it would include service by several forms or types of vessels. Where vessel designs are relatively mature (tankers and dry bulk carriers), the task is straightforward. However, fully cellular containership designs are evolving. On a world fleet basis, containership designs continue to change with respect to size and cargo carrying capacity and have not reached a limiting threshold.

The design vessels are defined per USACE guidance from Engineer Manual (EM) 1110-2-1613 stating:

"…*the design ship or ships are selected on the basis of economic studies of the types and sizes of the ship fleet expected to use the proposed navigation channel over the project life*…" The design ship is defined by EM 1110-2-1613 as "…*the largest ship of the major commodity movers expected to use the project improvements on a frequent and continuing basis*…"

Two design vessels were used for this study, a containership and a bulk carrier. Attachments B-1 and B-2, Appendix B describe how the design vessels were selected. Table 2-16 displays the design vessels characteristics.

Table 2-15. Design Vessel Characteristics

Vessel Type	DWT	Beam (ft)	LOA (ft)	Design Draft (ft)	TEU
Containership	119,000	158	1,100	50.8	10,100
Bulk Carrier	120,000	141.2	851.5	51.6	NA

2.3.9.6. Panama Canal Expansion

In June 2016, the Panama Canal expansion was completed and opened a new set of locks with chambers of 1,400 ft long, 180 ft wide, and 60 ft deep, creating a third lane of traffic. The lock expansion provides the capacity to accommodate vessels up to 1,200 ft long, 161 ft wide and 50 ft deep. This amounts to containerships with cargo volumes up to 120,000 deadweight tonnage (DWT) and 13,000 TEU. The Panama Canal's expansion paves the way for larger ships to be deployed to the U.S. Gulf Coast and East Coast from Asia, Oceana, and West Coast of South America. Previously, the Panama Canal restricted container traffic shipments to vessels drafting less than 39.5 ft. This essentially prevented any Far East/Gulf Coast/East Coast U.S. shipments from taking advantage of the economies of scale of loading larger ships to deeper sailing drafts.

In the first seven months of Fiscal Year (FY) 2017 (October 2017 – April 2017), over 1,000 vessels of the new Panamax dimensions transited the new locks. Tonnage through the Panama Canal increased by 22% in the first seven months of FY 2017 over FY 2016.

2.4. Navigation Features

2.4.1. Navigation History

The navigation channel dredging in Mobile Bay and Mobile River began in 1826 with enactment of the River and Harbor Act of 1826. During the period 1826 to 1857, a channel 10 ft deep was dredged through the shoals in Mobile Bay up to the City of Mobile. Subsequently, further modifications to the channel were authorized and the original Federal project was enlarged by the addition of the Arlington, Garrows Bend, and Hollinger's Island Channels within the bay, and a channel into Chickasaw Creek from the Mobile River. Section 104 of the River and Harbor Act of 1954 authorized a 40-foot depth channel with a 400-foot width in Mobile Bay to the mouth of the Mobile River and a 40-foot deep channel in the Mobile River to the Cochrane-Africatown Bridge with the width varying from 400 to 775 ft. The Senate Public Works Committee on 16 July 1970 and the House Public Works Committee on 15 December 1970, under the provisions of Section 201 of the 1965 Flood Control Act, authorized a 40-foot deep by 400-foot wide channel, branching from the main ship channel and extending through a land cut to the Theodore Industrial Park. The Theodore Ship Channel was reauthorized in the WRDA of 1976.

Further improvements to the existing Federal project were initially authorized in the 1985 Energy and Water Resources Appropriation Act, PL 99-88, Ninety-ninth Congress, First Session). The improvements were reauthorized in Section 201 of the WRDA of 1986 (PL 99 – 662, Ninety-ninth Congress, Second Session), which was approved 17 November 1986, and subsequently amended by Section 302 of the WRDA of 1996. The report referenced by this authorization recommended the following improvements to the Federal project: deepening and widening the Bar Channel to 57 ft deep by 700 ft wide; deepening and widening the Bay Channel to 55 ft deep by 550 ft wide, except for the upper 3.6 miles which require a width of 650 ft; deepening the Mobile River Channel to 55 ft to a point about 1 mile below the I-10 highway tunnels; and, constructing a turning basin and anchorage area near Little Sand Island.

The Mobile River, on which the ASPA facilities are located, is formed some 45 miles north of the city with the joining of the Alabama and Black Warrior/Tombigbee Rivers. The Mobile River also serves as the gateway to international commerce for the Tennessee/Tombigbee Waterway.

2.4.2. Existing Navigation Configuration and Dimensions

A visualization of the overall Mobile Harbor Federal Navigation Project, including the existing and authorized dimensions, is shown in Figure 1-1. Further descriptions of the various Mobile Harbor Federal Navigation Channel segments evaluated as part of this study are provided in the following paragraphs. The study did not evaluate modifications to the upper approximately 4.3 miles of the River Channel (i.e., north of station 226+16) because that portion of the channel is already constructed to its fully authorized dimensions.

2.4.2.1. Bar Channel

The Bar Channel is currently 47 ft deep by 600 ft wide for a length of approximately 8.1 miles across the Mobile Outer Bar, from the Gulf of Mexico through Mobile Pass to the southern extents of the Bay Channel. Construction to the current depth was completed in 1990. The channel stationing for the Bar Channel is 1760+10 to 2189+59. This channel segment includes three bends and a sediment trap feature. The bends (and associated wideners) are located at stations 1775+43, 1854+69, and 2089+54 and the sediment trap (47 ft deep by 100 ft wide resulting in a channel width of 700 ft) is located from station 2029+60 to 2149+60. The Bar Channel alignment and stationing are shown in Figure 2-18 along with the locations of the Sand Island Beneficial Use Area (SIBUA) and the ODMDS. The SIBUA is currently used for placement of material dredged as part of routine maintenance of the Bar Channel (predominately sandy material). The ODMDS has been used historically for the placement of material dredged from the Bay Channel (predominately fine grained silts and clays).

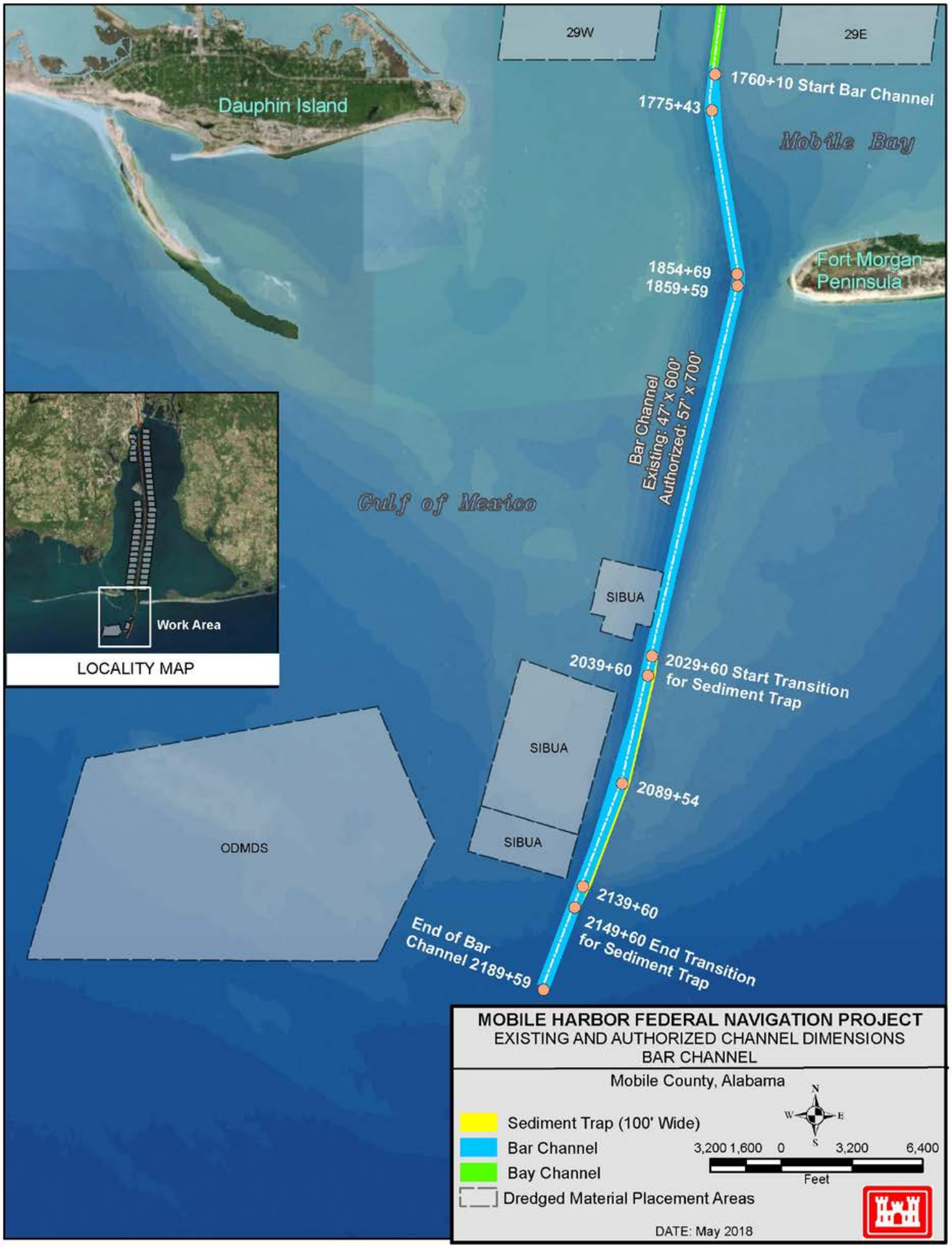


Figure 2-18. Bar Channel Alignment and Stationing

2.4.2.2. Bay Channel

The Bay Channel is currently 45 ft deep by 400 ft wide for a length of approximately 28.7 miles from the northern end of the Bar Channel through Mobile Bay to the mouth of Mobile River. Construction to the current depth was completed in 1990. The channel stationing for the Bay Channel is 244+66 to 1760+10. This channel segment includes a turning basin feature (i.e., the Choctaw Pass Turning Basin as described in the following paragraph) and three bends (and associated wideners). The turning basin is located between stations 244+66 and 273+21 and the bends (and associated wideners) are located at stations 423+47, 1055+43, and 1115+68. The Bay Channel alignment and stationing are shown in Figure 2-19 along with the locations of the open water dredged material placement areas in Mobile Bay. These areas (1E – 29E, 2W – 6W, and 14W – 29W) are used for placement of material dredged as part of routine maintenance of the Bay Channel (predominately fine grained silts and clays).

2.4.2.3. Choctaw Pass Turning Basin

The Choctaw Pass Turning Basin is currently 45 ft deep by approximately 1,570 ft long (including the 400-foot width of the existing Bay Channel) by 715 ft wide. Additionally, it contains a 100-foot widener/transition section about 3,500 ft in length along the eastern edge of the existing Bay Channel immediately south of the basin to improve basin access, reduce the basin size needed for turning, and increased vessel maneuverability. The authorized dimensions of the turning basin, per Section 201 of the WRDA of 1986, PL 99-662, were 55 ft deep by 1,500 ft square, located opposite to the McDuffie Coal Terminal; however, it was not constructed with the other project improvements during the late 1980s/early 1990s at the request of the NFS. A GRR was later prepared (in May 2007), per the NFS request, to re-evaluate the turning basin. The 2007 GRR recommended the turning basin be moved north to Choctaw Pass and deepened to 45 ft to match the adjacent channel dimensions. Construction to the recommended dimensions was completed in 2011. The turning basin is located between stations 244+66 and 273+21 and the widener/transition along the eastern edge of the existing Bay Channel is located between stations 273+21 and 317+73. The turning basin alignment and stationing are shown in Figure 2-20.

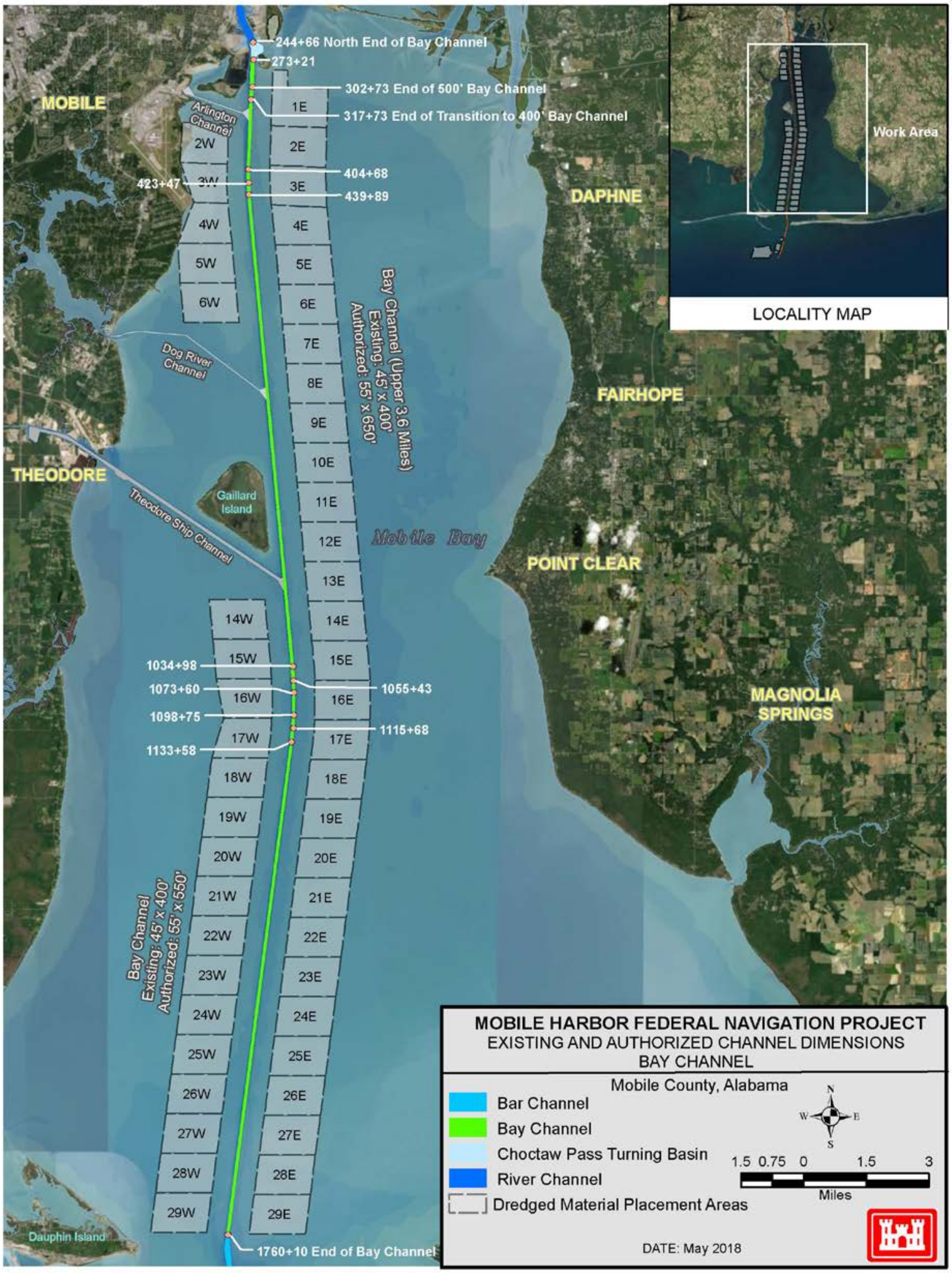


Figure 2-19. Bay Channel Alignment and Stationing

Figure 2-20. Choctaw Pass Turning Basin Alignment and Stationing

2.4.2.4. River Channel

The River Channel is currently 40 ft deep by 600 ft wide for a length of approximately 4.3 miles from the Cochrane-Africatown Bridge at the northern end of the harbor, over the Bankhead and Wallace Tunnels, to an area just upstream of the APM Terminals near the southern extents of the harbor. The channel then transitions to 45 ft deep by 600 ft wide for a length of approximately 1,850 ft, terminating at the northern end of the Bay Channel and Choctaw Pass Turning Basin. The upper (i.e., northern) approximately 4.3 miles of the channel, including the turning basins contained within this section, are currently constructed to the authorized dimensions due to depth and width limitations from the two tunnels that run underneath and the surrounding harbor infrastructure; therefore, modifications to this portion of the channel were not evaluated as part of this study. Construction of the lower 1,850 ft to the 45-foot depth was completed in 2008. The channel stationing for the upper (i.e., 40-foot deep) portion of the River Channel is 0+00 (at the Cochrane-Africatown Bridge) to 226+16 and the stationing for the lower (45-foot deep) portion is 226+16 to 244+66. The River Channel alignment and stationing are shown in Figure 2-21 along with the upland dredged material placement sites at Blakeley and Pinto Islands. These sites are used for the dredged material placement of fine-grained material dredged as part of the routine maintenance of the River Channel.

2.4.3. Maintenance Dredging

2.4.3.1. Maintenance Dredge Material Quantities

Based on historic rates, approximately 5.9 million cubic yards (mcy) of sediment are dredged annually as part of the routine maintenance of the Mobile Harbor Federal Navigation Project. Descriptions of the historic maintenance dredging rates and volumes by channel segment are provided in the following paragraphs.

2.4.3.1.1. River Channel

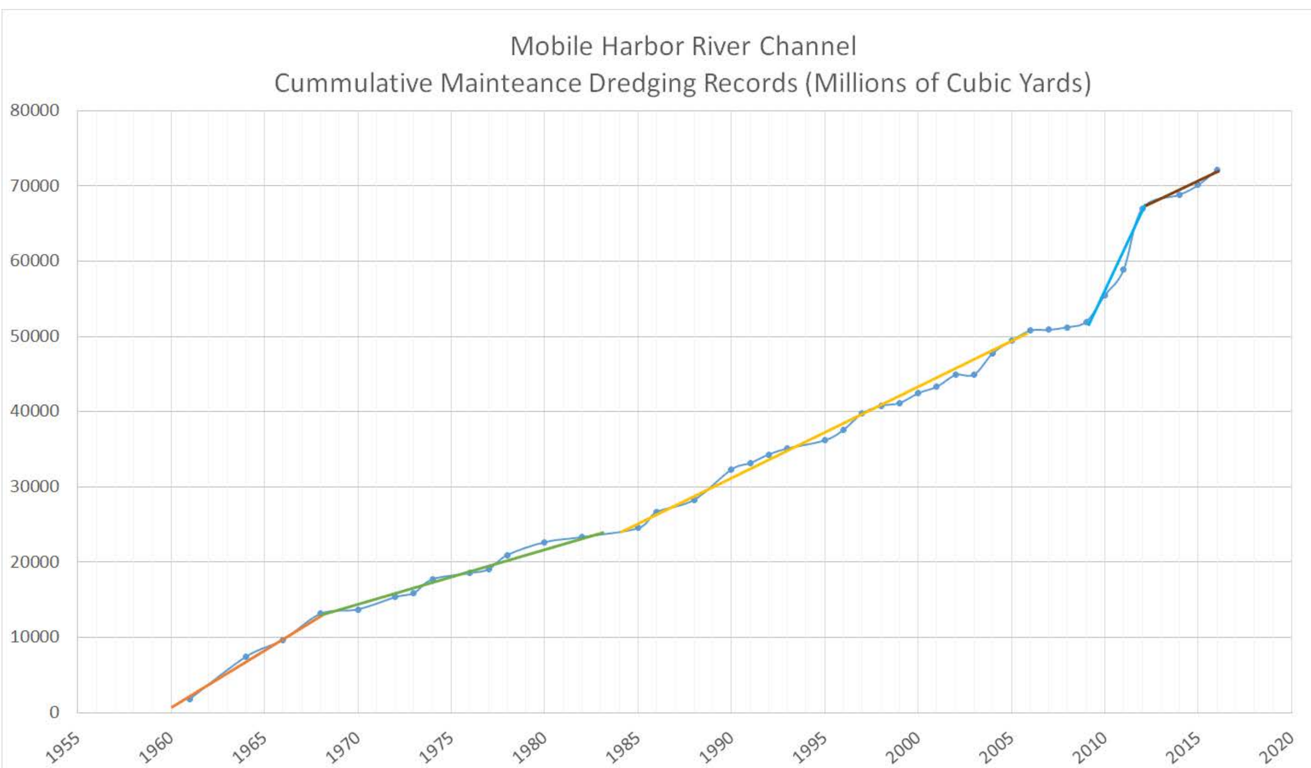
A summary of dredge history for the River Channel is provided in Table 2-17. River Channel Dredged Volumes 1961-2016 and the cumulative maintenance dredge volumes are shown in Figure 2-22. The historic rates are projected to continue for the future Without-Project condition. The figure of cumulative maintenance dredge volumes shows fairly consistent rates through time with rates averaging approximately 1.3 mcy per year since the 1960s, with the exception being a short period between 2009 and 2012. The reason for the increase in dredge rate in this time period is unclear but may be associated with the incorporation of some new work dredge volumes into maintenance dredge volume estimates, temporarily altered sediment transport patterns in the channel after completion of channel extensions and/or high river flows events, which occurred during this time period.

Figure 2-21. River Channel Alignment and Stationing

Table 2-16. River Channel Dredged Volumes 1961-2016

Dates	Maintenance Dredging (cubic yards (cy))	Maintenance Dredging (cubic yards per year (cy/yr))
1961-1970	15,809,904	1,057,754
1971-1980	9,519,787	1,231,870
1981-1990	11,086,834	1,167,886
1991-2000	10,510,970	1,081,540
2001-2010	9,733,857	1,481,238
2011-2016	13,331,146	2,666,229
1961-2016	72,179,400	1,312,353

Source Modified from Resource Management Group, Inc., 2010 with records to 2016



Source: Modified from Resource Management Group, Inc., 2010 with records to 2016

Figure 2-22. River Channel Cumulative Maintenance Dredged Volumes (1961– 2016)

2.4.3.1.2. Bay Channel

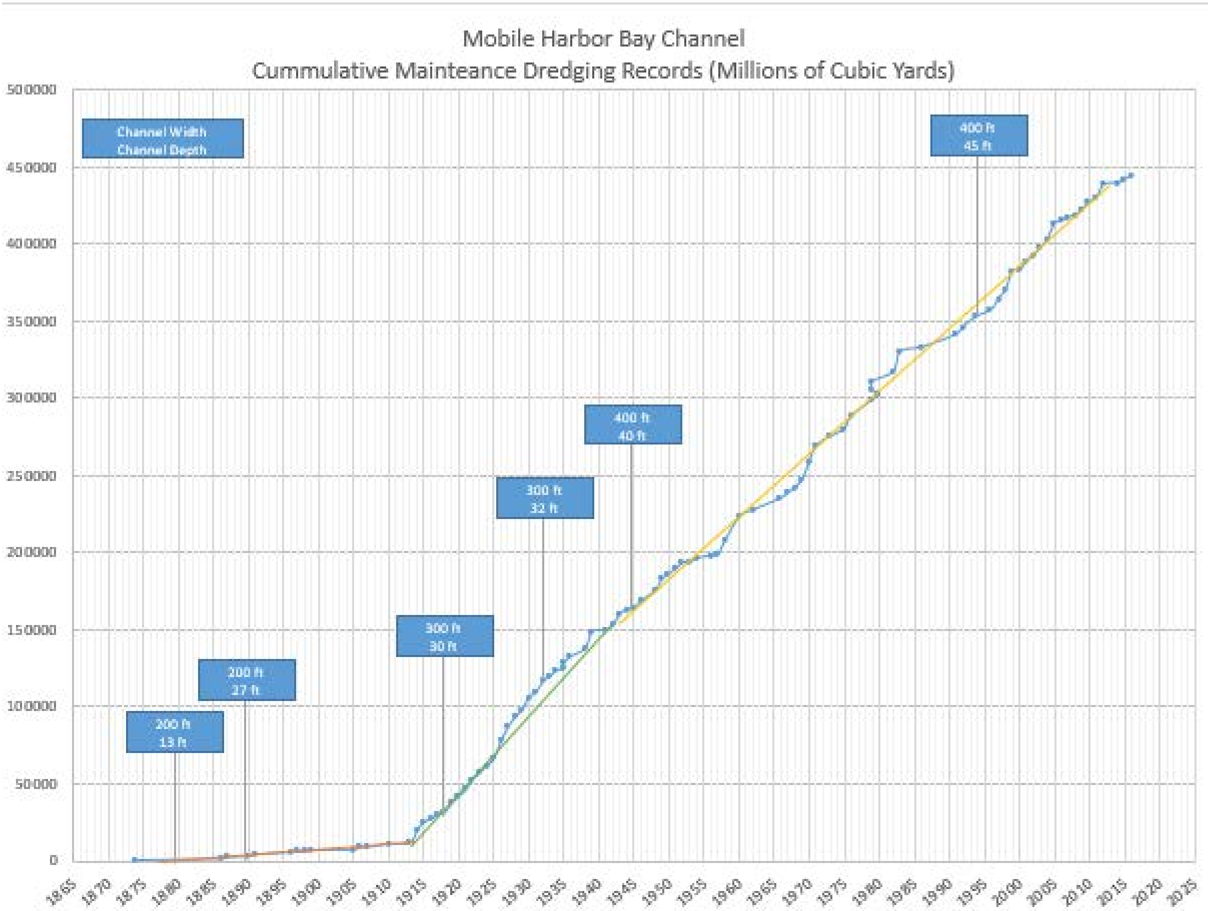
A summary of the dredge history for the Bay Channel is provided in Table 2-18 and the cumulative maintenance dredge volumes are displayed in Figure 2-23. The historic rates are expected to continue for the future Without-Project condition.

The figure of cumulative maintenance dredge volumes shows varying dredge rates through time, with rates averaging approximately 4 mcy per year since the Bay Channel was deepened to a depth of 45 ft MLLW in 1988 to 1990. Of relevance is the fairly consistent dredge rate since 1964 despite increases in channel dimensions during the time period and changes in dredge material placement practices inside the bay.

Table 2-17. Summary of Dredging History for the Mobile Bay Channel (1870-2016)

Channel Dimensions (ft)	New Work Dredging Dates	New Work (cy)	Maintenance Dredging Dates	Maintenance (cy)
13 x 200	Sept 20,1870 to Sept 1876	1,217,869	Sept 1876 to June 30, 1885	0
17 x 200	Feb 19, 1881to June 30, 1885	4,724,704	June 30, 1885 to Oct 3, 1895	3,236,420 (315,441 (cy/yr)
23 x 280	Oct 1888 to Oct 3, 1895	20,428,577	Oct 3, 1895 to 12-Jul-09	5,717,644 (415,225 cy/yr)
23 x 100	June 26, 1899 to 12-Jul-09	17,673,578	July 12, 1909 to 15-Aug-13	2,264,298 (557,709 cy/yr)
27 x 200	Jan 6, 1911 to 15-Aug-13	14,231,311	Aug 15, 1913 to 25-Jul-26	66,700,043 (5,150,582 cy/yr)
30 x 300	Sept 10,1918 to July 25,1926	14,712,024	July 25, 1926 to 19-July-33	38,607,404 (5,531,147 cy/yr)
32 x 300	1932 to July 19, 1933	7,291,046	July 19, 1933 to 10-Nov-64	106,628,266 (3,405,566 cy/yr)
40 x 400	27-Jan-56 to Nov 10,1964	54,106,804	10-Nov-64 to July 3, 1989	108,945,745 4,419,706
45 x 400	24-Oct-87 to July 3, 1989		July 3, 1989 to 3-Oct-16	109,911,136 (4,070,783 cy/yr)

Source: Modified from Byrnes, et. al., 2012 with dredge records to 2016



Source: Modified from Byrnes, et. al., 2012 with dredge records to 2016

Figure 2-23. Bay Channel Cumulative Maintenance Dredged Volumes (1904 – 2015)

2.4.3.1.3. Bar Channel

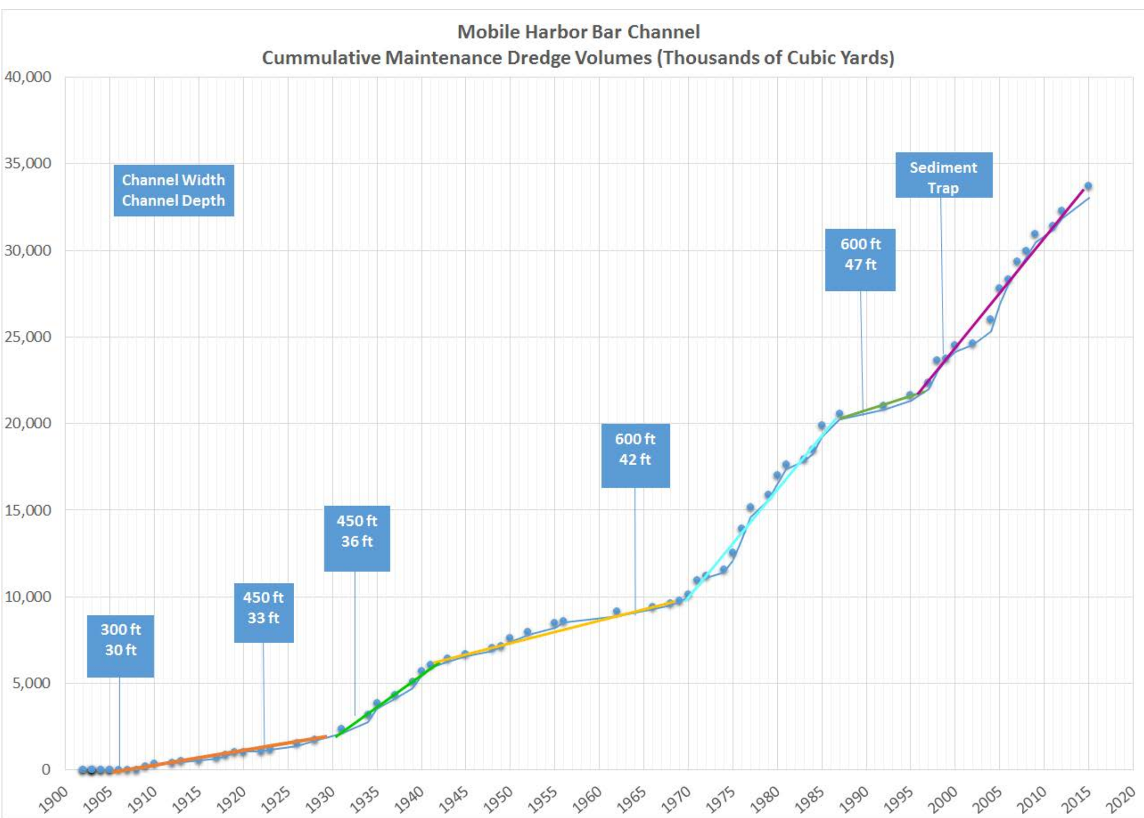
A summary of dredging history is provided in Table 2-19 and the cumulative maintenance dredge volumes are shown in Figure 2-24. The historic rates are expected to continue for the future Without-Project condition.

The figure of cumulative maintenance dredge volumes (Source: Modified from Byrnes, et. al., 2008) Figure 2-24 shows varying dredge rates through time, with rates averaging approximately 525,000 cubic yards/year since the Bar Channel was deepened to a depth of 47 ft MLLW in 1990. Since 1995, an increase in dredging rate to roughly 624,000 cy/yr is observed in the data. Of relevance to this later time period are the number of tropical storm events with significant water level response that impacted the area. This time period includes 7 of the top 10 hurricanes that produced the highest water levels recorded at the National Oceanic Atmospheric Administration (NOAA)'s long-term Dauphin Island Station 8735180.

Table 2-18. Summary of Dredging History for the Bar Channel (1904 – 2015)

Date (Authorized Dimensions)	New Work (cy)	Maintenance Dredging (cy)
May 1904 to October 1913 (30 ft deep, 300 ft wide)	787,304	529,727 (58,900 cy/yr)
October 1913 to June 1924 (33 ft deep, 450 ft wide)	1,078,426	651,236 (59,200 cy/yr)
June 1924 to August 1934 (36 ft deep, 450 ft wide)	685,171	2,012,611 (201,300 cy/yr)
August 1934 to July 1965 (42 ft deep, 600 ft wide)	3,510,878	5,944,787 (191,800 cy/yr)
July 1965 to April 1990 (47 ft deep, 600 ft wide)	6,755,352	11,422,278 (456,900 cy/yr)
April 1990 to September 1999 (47 ft deep, 600 ft wide)	3,061,598	4,562,767 (356,00 cy/yr)
September 1999 to 2015 (47 ft deep, 600 ft wide, sediment trap)	0	9,951,641 (664,000 cy/yr)

Source: Modified from Byrnes, et. al., 2008 with dredge records to 2015



Source: Modified from Byrnes, et. al., 2008

Figure 2-24. Bar Channel Cumulative Maintenance Dredge Volumes (1904 – 2015)

2.4.4. Maintenance Dredged Material Placement

Dredged material placement as part of maintenance operations for the future Without-Project conditions will continue to be placed in a combination of upland sites adjacent to the River Channel; open water placement sites within the bay; the SIBUA on the ebb tidal shoal, including a proposed northwestward expansion of the site; and the ODMDS in both the current limits and a future expansion area. The locations of the current placement areas as described above are shown in Figure 2-18, Figure 2-19, and Figure 2-21. Estimates of available capacity at each of these sites are contained in Table 2-20 through Table 2-23.

2.4.4.1. Upland Dredged Material Placement Sites, River Channel

Material dredged as part of the routine maintenance of the River Channel (primarily fine-grained sediments) is and will continue in the future Without-Project condition to be placed in the upland dredged material placement sites located east of the River Channel, as shown in Figure 2-21. Existing capacity estimates for these sites are shown within Table 2-20.

Table 2-19. Upland Dredged Material Placement Site Capacities

Location	Area (Acres)[1]	Projected Maximum Dike Elevation (ft)[1]	Total Idealized Volumetric Capacity (CY)[1,2]
North Blakeley	69	50	3,172,000
Mud Lake 6	70	46	3,388,000
Mud Lake 7	129	46	8,562,000
South Blakeley	196	65	12,087,000
North Pinto	48	47	3,434,000
Totals	**512**		**30,644,000**

1Taken from Table 7 of Resource Management Group, Inc., 2010 updated with USACE dredge material placement records through 2016.
2Idealized volumetric Capacity includes interior capacity plus the volume to build projected

Source: Modified from Resource Management Group, Inc.,2010.

2.4.4.2. Open Water Dredged Material Placement Sites, Bay Channel

Material dredged as part of the routine maintenance of the Bay Channel (primarily fine-grained sediments) is and will continue in the future Without-Project condition to be placed in the open water placement areas adjacent to the channel, as shown in Figure 2-18 and Figure 2-19. Existing capacity estimates for these sites are shown within Table 2-21.

Table 2-20. Open Water Dredged Material Placement Site Capacity

Open Water Placement Sites	Area (Acres)	Volume Capacity (CY)[1]
Placement Sites 1 - 29	21,560	140,974,000
Note: 1) No estimate of sediment transport from the sites were incorporated into the capacity estimates.		

2.4.4.3. SIBUA for the Bar Channel

Material dredged as part of the routine maintenance of the Bar Channel (primarily sandy sediments) is and will continue in the future Without-Project condition to be placed in the SIBUA. Existing capacity estimates for these sites are shown within Table 2-22.

In an effort to ensure adequate placement capacity for future maintenance dredging of the Bar Channel, the USACE, Mobile District is currently pursuing modifications to extend the SIBUA beyond its existing boundaries.[7] The site will be expanded to the northwest, following the shoal and pathway of sediment transport towards Dauphin Island. Further discussion regarding expansion of SIBUA can be found in Section 4.2.

[7] In 2000, the Dauphin Island Property Owners' Association filed a lawsuit in the United States Court of Federal Claims styled *Dauphin Island Property Owners' Association, et al. vs. United States*, No. 00-115-L (Fed. Cl.). The suit alleged, among other things, that the United States dredging practices had caused significant shoreline erosion of Plaintiffs' property on Dauphin Island, Alabama. A settlement was reached between the parties, and confirmed by the court, that required the Corps to continue to conduct its maintenance dredging practices to deposit material dredged from the Bar Channel in the SIBUA and/or the Feeder Berm Disposal Area, with exceptions in only certain specified circumstances.

Table 2-21. Sand Island Beneficial Use Site Capacity

	2018 Volume (CY) Below -15' MLLW	2018 Volume (CY) Below -20' MLLW	2018 Volume (CY) Below -25' MLLW
SIBUA	7,487,906	2,202,690	644,437
SIBUA South Extension	4,679,635	2,891,301	1,415,534
SIBUA Lighthouse(3)	1,320,708	682,208	309,517
SIBUA Northwest Extension	9,294,614	6,241,179	1,014,424
Total 2018 Capacity	**22,783,000**	**12,017,000**	**3,383,912**

NOTES:
(1) Capacity estimates displayed in this table do not account for uncertainty in volumetric change.
(2) Capacity estimates are rough order of magnitude assuming vertical side slopes. Final volume estimates will account for side slopes of the fill, which would likely result in reduced capacity.
(3) 2018 survey data did not cover the eastern section of the SIBUA Lighthouse Site therefore volume estimates for this area are based on NOAA 2014 Survey Data

2.4.4.4. Ocean Dredged Material Disposal Site (ODMDS)

Sediments dredged from the Bar, Bay, and River Channels have been placed historically in the ODMDS. Although material from the Bar Channel is now placed in the SIBUA (since 1999) and some material from the Bay Channel is disposed in the open water sites adjacent to the channel, the ODMDS is still primarily utilized for fine-grained material dredged from the Bay Channel. This practice will continue in the future Without-Project condition. Table 2-23 below contains the capacity for both the existing and proposed ODMDS expansion. The boundaries of the current and proposed ODMDS expansion and the bound are shown in Figure 4-7.

Table 2-22. ODMDS Capacity

Ocean Dredged Material Disposal Sites	Area (Acres)	Volume Capacity (CY)[1]
Current ODMDS	4,017	20,000,000
Expanded ODMDS	20,341	260,000,000
Total	**24,358**	**280,000,000**

Note: Volume estimates including capacity needs were taken from ongoing environmental coordination documents with the Environmental Protection Agency (EPA).

2.5. Environmental Setting

This section characterizes the affected environment and provides descriptions of existing conditions for environmental and socioeconomic resources in the overall project area which includes Mobile and Baldwin Counties. The information presented here will be used to compare conditions resulting from the implementation of the TSP as described in Section 3.6 to assess potential impacts. A summary of the comparative assessment of the alternatives and their potential environmental impacts is provided in Section 3.7. More detailed information regarding the potential impact assessments is presented in Section 3.0, Appendix C.

2.5.1. Geographic Setting

Along the Gulf of Mexico, the State of Alabama extends about 56 miles between Perdido Pass and Petit Bois Pass. This shoreline includes about 47 miles of sandy shoreline (Byrnes et al. 2010) in the southern portions of Mobile and Baldwin Counties. The Mobile Bay estuary is a bell-shaped, submerged river valley system approximately 31 miles long between the estuary mouth and the Mobile River and Tensaw River (Mobile-Tensaw River) Delta, and 23 miles wide between Mississippi Sound and Bon Secour Bay (Hummell, 1996). It receives water and sediment from the Mobile-Tensaw River System, the Nation's sixth largest in terms of total drainage area (Isphording and Flowers, 1987). The bay encompasses about 413 square miles of open water (Isphording et al. 1996) and has an average depth of about 9.7 ft at mean high water (Chermock et al. 1974).

The entrance to Mobile Bay, between Mobile Point on the western end of the Morgan Peninsula and Pelican Point on the eastern end of Dauphin Island, is an extensive natural inlet that has been improved by channel dredging activities since 1904, primarily through the outer bar at the seaward extent of the ebb-tidal delta. The entrance is commonly referred to as Mobile Pass or Main Pass and is the primary point of access between Mobile Bay (via the north-south Mobile Harbor Federal Navigation Channel) and the Gulf of Mexico. The entrance is about 3 miles wide. The GIWW intersects the Mobile Harbor Federal Navigation Channel just inside the entrance to the bay. The GIWW connects Mississippi Sound with Mobile Bay via Pass aux Herons on the west, and eventually heads to Perdido Bay via Bon Secour Bay.

Mobile Bay has been recognized as a nationally significant estuary of the U.S. since 1995, with the designation as one of 28 National Estuary Programs established by the Environmental Protection Agency (EPA). The Mobile Bay and the Mobile Tensaw River Delta support a diverse set of fish and wildlife habitats including: bogs, bottomland hardwoods, freshwater and hardwood swamps, freshwater wetlands, maritime forests, pine savanna, SAV, tidal and brackish water marshes and oyster reefs.

The study area encompasses Mobile Bay, Alabama which is bounded by the Morgan Peninsula to the east and Dauphin Island, a barrier island on the west. The deepest (75 ft) areas of the bay are located within the Federal navigation channel. The Mobile Bay Watershed drains water from three-fourths of Alabama as well as portions of Georgia, Tennessee and Mississippi into Mobile Bay. The Mobile-Tensaw River System empties into the northern end of the bay. Several smaller rivers and creeks in Mobile County, on the western side of the bay, and in Baldwin County, on the eastern side, also empty into the bay, making it an estuary. A feature of all estuaries is a transition zone, where the freshwater from the rivers mixes with the tidally-influenced salt water of the Gulf of Mexico.

Characterizations of baseline aquatic resources in estuarine, transitional, and freshwater environments are important to establish prior to channel modification and potential impacts from saltwater intrusion and other water quality parameters. A key component of the current study is to document potential changes to aquatic resources along the salinity continuum moving upriver and estimates of how far upriver changes may occur after the navigation channel is modified to its new dimensions. Elevated salinities upriver and in adjacent marshes have raised concerns among resource managers because of potential impacts to the marshes and their biological resources. Aquatic resources are a critical part of both estuarine and riverine food webs, providing habitat and forage for economically and ecologically important finfish and shellfish species, which are identified as an important indicator of potential effects, and are routinely monitored as part of environmental assessments.

Studies have been executed through a combination of 1) direct measurements of aquatic resources and 2) modeling approaches to characterize the existing conditions within the project area which contains a variety of natural resources that are comprised of wetlands, SAV, oysters, benthic invertebrates and fish. A discussion of the environmental conditions and existing resources are included below.

Watershed. The watershed that supplies Mobile Bay with water and sediment encompasses about 43,200 square miles and has an average discharge through the Mobile-Tensaw River system of about 62,000 cubic ft per second (cfs) (Isphording et al. 1996) as illustrated in Figure 2-25. Two outlets from Mobile Bay provide discharge points for water and sediment: 1) Mobile Pass discharges approximately 85% of the outflow, and 2) Pass aux Herons discharges about 15% of flow into Mississippi Sound (Isphording et al., 1996; Byrnes et al., 2010).

Mobile-Tensaw River Delta. The Mobile-Tensaw River system drains several physiographic provinces including parts of the Blue Ridge, Piedmont, Valley and Ridge, Appalachian Plateau, and the Coastal Plain Province (Johnson et al., 2002). Sediment deposited in the Mobile-Tensaw River Delta and transported into Mobile Bay reflects varying lithologies throughout the Mobile Bay Watershed. The Mobile-Tensaw River Delta is the second largest river delta in the U.S., ranging from approximately 6 to 16 miles wide by 45 miles long, and includes an area of approximately 192,000 acres. Ecosystems include approximately 20,000 acres of open water, 10,000 acres of marsh, more than 73,000 acres of swamp, and more than 89,000 acres of bottomland forest (Johnson et al., 2002).

Figure 2-25. Mobile Bay Watershed Area

The Mobile Bay Watershed drains through the Alabama and Tombigbee Rivers to the head of the Mobile-Tensaw River Delta where they form the Mobile River as shown in Figure 2-26. Uplands flanking the delta drain approximately 220,000 acres and 280,000 acres on east and west sides, respectively (Isphording et al., 1996). The Mobile River flows about 6 miles south into the delta before separating into the Mobile and Tensaw Rivers. As indicated by the distribution of ecosystems, a majority of the delta swamp contains an extensive growth of trees; however, the southern 25% of the delta is primarily covered with marsh grass. Throughout the delta there are many stream channel diversions and crossings where flat channel slopes result in low flow velocities (Isphording et al., 1996). As such, water travel time from the head of the delta to the head of Mobile Bay is on the order of two days. River and sediment discharge to northern Mobile Bay enters through the Mobile, Tensaw, Apalachee, and Blakeley Rivers as shown in Figure 2-26.

Figure 2-26. Mobile-Tensaw River Delta between the confluence of the Alabama and Tombigbee Rivers and the northern margin of Mobile Bay (Byrnes et al. 2013)

Gulf Beaches. Dauphin Island is the westernmost beach environment in coastal Alabama. The island is approximately 15 miles long and extends from Mobile Pass, at the Mobile Bay entrance, to Petit Bois Pass, a 4 mile wide tidal inlet separating western Dauphin Island, Alabama and eastern Petit Bois Island, Mississippi. The western two-thirds of Dauphin Island is a low-relief, washover barrier that is subject to overwash by Gulf of Mexico waters during tropical storms and hurricanes (Nummedal et al. 1980;

Byrnes et al. 1991; Hummell, 1996; Morton, 2007). Maximum relief along this portion of the island is about 7 ft relative to mean water level (MWL), except for dune features that may reach 10 ft MWL in elevation. Island width varies between about 800 and 2,600 ft. The eastern end of Dauphin Island has an average elevation near the beach of about 10 ft MWL; however, an extensive interior dune system that reaches an elevation of approximately 45 ft MWL exists north of beach deposits on top of existing Pleistocene coastal deposits (Otvos, 1979; Otvos and Giardino, 2004).

Seaward of the beach along eastern Dauphin Island, an ephemeral, subaerial sand deposit called Pelican Island is associated with the Mobile Pass ebb-tidal delta. This feature is prominent in its impact on shoreline response along eastern Dauphin Island (Byrnes et al. 1999; Parker et al. 1997). The island has continuously changed its shape, size, and location throughout the historical record in response to storms and normal wave and current processes (Hummell, 1996).

Along the eastern Alabama Coast in Baldwin County, the shoreline extends from the eastern margin of Mobile Pass, along the Morgan Peninsula east to Perdido Pass. The Morgan Peninsula forms the southeastern terminus of Mobile Bay and consists of an extensive beach backed by parallel dunes and numerous sub-parallel beach ridges, formed as a result of net longshore sediment transport processes (Bearden and Hummell, 1990; Stone et al. 1992).

2.5.2. Climate

The climate in the project area is subtropical, characterized by warm summers and short, mild winters. The average daily temperature ranges in the summer and winter are 81–91 and 42–63 degrees Fahrenheit (ºF) respectively. The average annual rainfall is about 66 inches, and is well distributed throughout the year. Precipitation records indicate July as the wettest month, while October is the driest. The National Climatic Data Center climactic summary for Mobile is shown on Table 2-24.

Table 2-23. Climactic Summary, Mobile Regional Airport, Alabama
(Station No. 015478)

Period of Record: 01/01/1948 to 6/10/2016													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (ºF)	60.9	64.2	70.6	77.9	84.7	90.0	91.0	90.7	86.8	79.3	69.8	63.0	77.4
Average Min. Temperature (ºF)	40.8	43.5	49.6	56.7	64.4	70.7	73.0	72.6	68.5	57.4	48.1	42.9	57.3
Average Total Precipitation (in.)	4.99	5.21	6.50	5.03	5.54	5.30	7.51	6.96	5.99	2.93	4.15	5.43	65.56
Average Total Snow Fall (in.)	0.1	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.4
Average Snow Depth (in.)	0	0	0	0	0	0	0	0	0	0	0	0	0

Source: Southeast Regional Climate Center.

2.5.2.1. Winds

Prevailing winds for the Alabama Coast are produced by two pressure ridges which dominate weather conditions: the Bermuda High, centered over the Bermuda-Azores area of the Atlantic and the Mexican Heat Low centered over Texas during warm months. Prevailing winds are predominately from the east and southeast during spring and summer months, and from the north and north east during fall and winter months. The strongest winds are recorded in February and March with the exception of frontal storms and tropical systems.

Wind data is readily available from the U.S. Air Force's 14th Weather Squadron. The nearest location for which the 14th publishes data is Brookley Field (a.k.a. "Downtown") Alabama. In many instances, for lack of local long-term records elsewhere, wind data obtained at Brookley Field at Mobile, Alabama has been adapted by the USACE, Mobile District for some coastal and navigation channel investigation design tasks. Wind data here is presented as a graphical representation of the wind regime in the area (Figure 2-27**)**. Wind rose data at this site show that wind speeds rarely exceed 25 knots.

2.5.2.2. Tides

The tidal variation in the Mobile Bay and adjacent waters is diurnal with an average tide cycle of 24.8 hours. The mean tidal range within the bay varies from 1.6 ft at the head of the bay to 1.2 ft at the entrance, which is classified as microtidal. The daily mean water elevation averaged by month increases for half the year and then decreases over a range that is about the same amplitude as the diurnal range. During the fall, winter, and spring months, water levels frequently fall within a range between 0.5 and 1.0-foot below MLLW. This annual cycle level is more regular at Mobile than at most U.S. tidal stations (Hands, et. al 1990). Although the tidal range caused by astronomical forces is relatively small winds, pressure gradients and river discharge can induce larger variations. Strong winds blowing from the north can force water out of the bay and result in current velocities of several knots in the passes. The reverse occurs with winds blowing from the southeast, which forces water shoreward toward the Mobile Tensaw River Delta. A more detailed discussion of the area tides is located in Section 2.4, Appendix A.

2.5.2.3. Waves

In general, wave intensity along coastal Alabama is low to moderate. The common wave direction is out of the southeast. The most common peak wave periods fall between a range of 4 to 5 seconds, with an overall mean wave period of 4.9 seconds. Significant wave heights range from 0 to 16 ft, with the most common wave heights being less than 3 ft. Overall mean significant wave height is 2 ft. A more detailed discussion of area waves is located in Section 2.5, Appendix A.

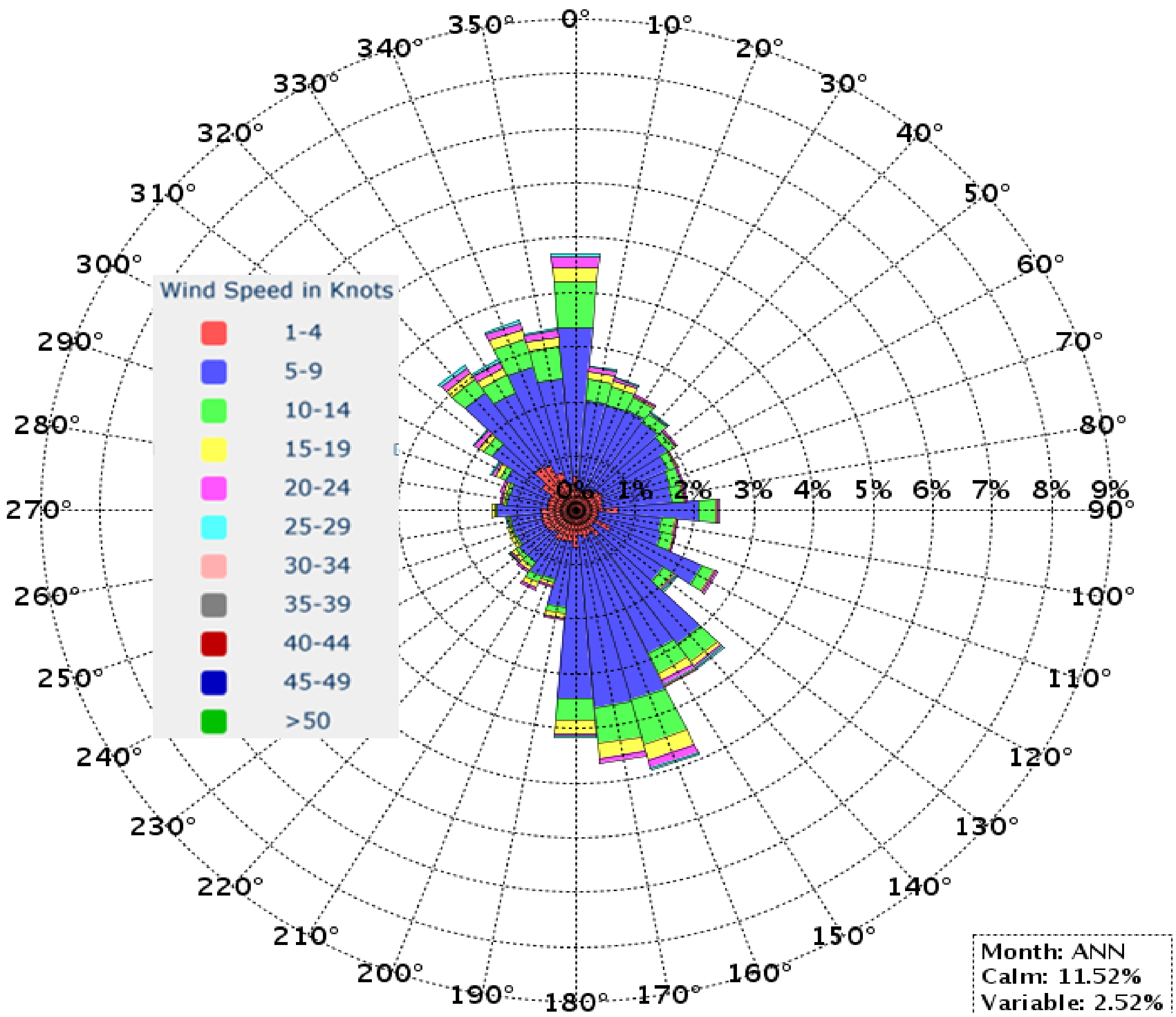


Figure 2-27. Wind Rose, Brookley Field, Mobile, Alabama.

Wind induced waves within the bay are fetch and depth limited. Limited wave data collected at the Middle Bay Lighthouse as part of the Mobile Bay Real-time Continuous Environmental Monitoring in 2013, 2014, and 2016, as well as 2016 aquadopp data collected in the upper bay, indicate average significant wave heights generally less than 1.5 ft with overall mean peak periods less than 4 seconds; however, hurricane and storm conditions, and strong winter cold fronts can produce significant surges and much larger wave conditions within the bay and along the coastline. Zhao and Chen, 2008 report 100-year return period maximum significant wave heights between approximately 8 and 10 ft, with maximum wave heights near the shoreline of approximately 5 ft. The maximum wave heights with the longest period occur near the bay entrance where they are influenced by Gulf of Mexico swell.

A vessel generated wave energy (VGWE) assessment was conducted to quantify the relative changes in wave energy due to future vessels calling at Mobile Harbor. The investigation included field data collection using a suite of five pressure sensors located north of Gaillard Island. Overall, the field data collected for this study provides the general trends for these types of waves generated from the existing vessel traffic. The Average VGWE represented as the statistically significant wave height, H_{mo}, for all sites ranged between 0.02 ft to 0.15 ft with the highest values being closer to the Mobile Harbor Federal Navigation Channel, decreasing in height moving further from the channel. More specific information pertaining to vessel draft, speed, and direction of transit is presented in detail in a report prepared by Allen (2018) which is included as Attachment A-4, Appendix A.

2.5.2.4. Currents

Tidal circulation and freshwater discharge from the Mobile-Tensaw River system are the two primary factors influencing currents in Mobile Bay under normal meteorological conditions. Strong winds associated with tropical cyclones and winter cold fronts impart significant energy on this shallow-water estuarine system, resulting in substantial changes in flow magnitude and sediment resuspension (Isphording, 1994; Schroeder et al., 1998; Zhao and Chen, 2008; Zhao et al., 2011). Although ebb and flood flow duration are approximately equal throughout the diurnal tidal cycle at Mobile Pass, during flood tide, water entering Mobile Bay is generally deflected east and north with maximum predicted flow velocities in the Bar Channel of about 5 ft/s (Byrnes et al., 2010). Hummell (1990) provides a compilation of average annual surface current distribution for flood and ebb tides based on data from Schroeder (1976) and Smith (1981). He illustrates a greater abundance of flood current arrows east of the ship channel, suggesting that most water entering the bay during flood tide flows along the eastern half of Mobile Pass. According to Chermock et al. (1974), water flowing eastward toward Bon Secour Bay encounters freshwater discharge from the Fish and Bon Secour Rivers creating a flow eddy that is deflected northwestward to rejoin a general northward flow in the central bay during flood tide. In the northern portion of Mobile Bay, flood currents are deflected eastward by fluvial discharge from the Mobile-Tensaw River system, resulting in a south-directed surficial freshwater flow along the western side of the bay (Austin, 1954; Hummell, 1990). During ebb tide, flow to the south generally is uniform. Based on flow measurements, approximately 85% of the water and sediment exiting Mobile Bay leaves through Mobile Pass and the remaining 15% exits through Pass aux Herons (Isphording et al., 1996; Schroeder and Wiseman, 1999; Byrnes et al., 2010).

This shallow estuary tends to be highly stratified due to weak tidal forcing compared with strong freshwater inflow. Except for episodic winds associated with cold fronts and tropical cyclones, circulation generated by average winds generally does not have enough energy to mix the estuary. However, meteorological conditions often have a significant impact on water level and circulation in the bay. Furthermore, water flow associated with wind wave energy under ambient conditions generally has minimal impact on sediment resuspension/transport within Mobile Bay.

Zhao and Chen (2008) noted that unlike winds and tides, no long-term observations of wind waves exist for Mobile Bay. As such, they used the short-term data of Pendygraft and Gelfenbaum (1994) to develop a wave atlas using the curvilinear, stationary version of the third-generation Simulating WAves Nearshore (SWAN) wave model (Chen et al., 2007). For a storm with a 100-yr return period, Zhao and Chen (2008) predicted wave heights of between 8.2 and 9.8 ft throughout most of the central portion of Mobile Bay and 4.9 ft or less near the shoreline (wave periods were on the order of 3.5 to 4.5 seconds). Overall, the spatial distribution of significant wave heights is primarily controlled by local water depth. Under non-storm conditions, wave heights within the bay generally are less than 1.6 ft.

2.5.2.5. Temperature

The coastal area of the Gulf of Mexico has a humid, warm-temperature to sub-tropical climate, with occasional subfreezing temperatures. The water temperature of the Gulf influences winter air temperatures in the Mobile area. Air temperatures usually reach 90 ^{o}F or higher about 70 days per year; temperatures in excess of 100 °F occur occasionally (U.S. Navy, 1986).

According to ClimaTemps.com (http://www.mobile.climatemps.com/temperatures.php) (2015), the mean annual temperature in Mobile 67.5°F. The warmest month is July with an average temperature of 82.2 °F and the coolest month is January with an average temperature of 49.82°F. The average monthly temperatures for the Mobile, Alabama area is reported by ClimaTemps.com in Table 2-2 in Appendix C.

During the summer months, the Bermuda High generates moisture-laden southerly winds which keep the coast cooler than inland areas. Air temperature on a typical summer day begins in the low 70s and rises rapidly before noon to the high 80s or low 90s until a sea breeze forms and checks further increases. Occasionally, a northerly breeze predominates throughout the day and temperatures rise to the high 90s or exceed 100 °F. In the winter, northerly winds bring cold, continental air masses, yet temperatures typically remain relatively mild with lows in the 40s and highs in the 60s.

2.5.2.6. Rain

The Mobile area receives an average annual rainfall of 65 inches, among the highest for metropolitan areas in the continental U.S. This rainfall can be accentuated by hurricanes, tropical storms, and El Nińo events. The driest period of the year is typically from August through November (TAI, 1998). Rainfall is somewhat evenly distributed throughout the year with the exception of a slight maximum at the height of the summer thunderstorm season and a slight minimum during the late fall. Average maximum monthly rainfall occurs in July with 7.7 inches and average minimum monthly rainfall in October, with 2.6 inches (U.S. Navy, 1986). Most precipitation originates from convectional frontal or cyclonic air masses. From May through October, thunderstorms occur primarily during the daylight hours. Frontal rainfall and thunderstorms are associated with synoptic processes (cold front intrusions) (U.S. Navy, 1986).

2.5.2.7. Sediment Transport

Riverine.

Seven major rivers supply water and sediment to the Mobile-Tensaw River system that ultimately empties into the Mobile-Tensaw River Delta and Mobile Bay. Based on the U.S. Geological Survey (USGS) fluvial sediment sampling on the lower Alabama and Tombigbee Rivers, Isphording et al. (1996) estimated an average fluvial sediment load to the delta of about 4.78 mt/yr. About 25% of this sediment deposits as delta fill (1.2 mt/yr), resulting in an average discharge of about 3.58 mt of suspended sediment to the bay each year (Byrnes et al., 2012). Based on long-term deposition trends, Byrnes et al. (2012) estimated that approximately 100,000 cubic yards per year entered the bay from the Tensaw River; 200,000 cubic yards per year was derived from Appalachee River/Chacaloochee Bay area; and 350,000 cubic yards per year associated with transport from the Blakeley River on the east side of the bay. According to historic dredge records detailed in Section 2.4.3.1 of this report, roughly 1.3 mcy/yr is deposited and dredged from the lower Mobile River Channel annually.

Mobile Bay.

Long-term regional sediment transport patterns within the bay for the period 1917/18 to 1984/2011 are documented in Byrnes et al. (2012) “Sediment Dynamics in Mobile Bay, Alabama: Development of an Operational Sediment Budget.” Byrnes et al. (2012) found that the most significant changes occurring during the 42-year interval evaluated were associated with deposition in the northern portion of the bay at the mouth of the Mobile-Tensaw River Delta; deposition in the southern part of the bay resulting from current flow and sediment movement at Mobile Pass, including sand transport into Mobile Bay along the north side of Mobile Point (Morgan Peninsula); and erosion and deposition associated with navigation channel dredging and placement. Elsewhere in the bay, only minor deposition and erosion patterns were identified within a large estuarine system that is net depositional (Byrnes et. al, 2012). In all, the study found that deposition in the bay accounts for approximately 72% of sediment input with 28% transported out of the bay through natural transport processes and offshore placement of dredged sediment.

While the rivers dominate sediment input, wind-induced waves and hurricanes have a significant impact on resuspension and redistribution of sediments and shoreline changes in Mobile Bay (e.g. Sapp et al. 1976, van Rijn 1984; Isphording and Imsand 1991; Isphording 1994; Schroeder et al. 1998, Chen et al. 2003, Jung et al. 2004; Zhao et al. 2011, Byrnes et al. 2012). Strong winds associated with tropical cyclones and winter cold fronts impart significant energy on this shallow-water estuarine system, resulting in substantial changes in flow magnitude and sediment resuspension (Isphording, 1994; Schroeder et al., 1998; Zhao and Chen, 2008; Zhao et al., 2011). Chen et al. (2012) found during hurricanes maximum shear stresses are primarily along the nearshore regions of the bay and near the navigation channel, expecting that these events can have a significant impact of sediment re-suspension in those areas. In estimating suspended sediment concentration and sediment dynamics in the Mobile Bay, Zhao et al. (2011) found that wind-induced resuspension lead to high inorganic suspended sediments (ISS) throughout the year and that a rapid fall was primarily from resettling rather than flushing from the bay within eastern side of the bay.

High sediment loads from the river and sediment resuspension both contribute to the 4 mcy of material dredged annually from the Bay Channel per year. Both Byrnes et al. 2012 and Gailani et al. (2014) suggest the contributions from re-suspended sediments to dredging are upwards of 30%. Through field data collection and sediment transport modeling conducted and part of a multi-agency regional sediment management effort evaluating thin layer placement of dredged sediments within Mobile Bay; Gailani et al. (2014) found that this contribution occurred with or without placement of dredge material within the bay and that the majority of the contribution was from the simulated hurricane events.

Coastal/Ebb Tidal Delta. The analysis of multi-decadal seafloor change of the western ebb tidal shoal and the nearshore area around Dauphin Island, Alabama during periods of intense and non-intense tropical storms are documented in Flocks, J.G. et. al (2017) “Analysis of Seafloor Change around Dauphin Island, Alabama, 1987–2015.” In addition long-term regional sediment transport patterns evaluated during two distinct time periods; one representing conditions prior to significant construction and maintenance dredging activities to determine natural changes (1847-1848 to 1917-1920) and another representing conditions after significant changes to the outer Bar Channel were made (1917-2002) are documented in Byrnes et al. (2008) “Evaluation of Channel Dredging on Shoreline Response at and Adjacent to Mobile Pass, Alabama.” These studies found that sediment erosion, transport and deposition is controlled by storm wave and current process that produce net littoral transport to the west. Despite differences in time periods and methods of analysis both studies find consistent patterns of erosion and deposition of major features as described in Section 2.9, Appendix A. Flocks et al. (2017) found that geomorphologic features identified in the study respond differently over the stormy and non-stormy time periods, and that these can be quantified through variations in erosion and accretion rates. Byrnes et al. (2008) had similar findings revealing a common link associated with geomorphic evolution including island breaching and island roll over associated with storms. Both these studies found that despite large volumes of sediment being dredged from the ship channel the ebb-tidal delta retains equilibrium, with areas of the ebb tidal shoal recovering through time from hurricanes.

2.5.2.8. Sea Level Change

Systematic long-term tide elevation observations suggest that the elevation of oceanic water bodies are gradually rising and this phenomenon is termed “sea level rise” (SLR). 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 Gulf of Mexico Coast, 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 Alabama Coast is affected by both subsidence and global SLR (adjusted for local conditions), these factors combine in a single element of “relative” SLR. Relative SLR 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 SLR of approximately 9 inches along the Alabama/Mississippi Coast during the 20th century.

Bays and 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 Alabama 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.

Under low to moderate rates of relative SLR, 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, while Petit Bois, Horn, and Ship Island in Mississippi are dominated by alongshore sediment transport. The predominance of westward alongshore sand transport both at geological and historical time scales indicates that this motion would 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 SLR, potential shoreline recession due to SLR accounted for 4–5% of the total island change signal. The remaining signal was driven primarily by the prevailing winds, storm waves, associated currents, and sediment supply.

USACE guidance (ER 1100-2-8162) requires consideration of projected future sea-level changes and impacts in project planning, design, operations, and maintenance. Because future SLR rates are uncertain, planning and design should consider project performance for a range of sea level change rates. Historic rates are used as the lower bound sea level change rate. Predictions of future sea level due to intermediate and high rates of sea level change are to be developed in accordance with USACE guidance by extension of rate Curve 1 and Curve 3 respectively from the National Research Council's 1987 report *Responding to Changes in Sea Level: Engineering Implications.*

Historic rates of sea level change are determined from tide gage records. Long-term tide gage records on the order of 40 years are preferred over shorter term records because the sea level change rate estimate error decreases as the period of record increases. There is one long-term tide gage in the vicinity of Mobile Harbor at Dauphin Island, Alabama; gage number 8735180. SLR rate for this location is shown in Table 2-25.

Table 2-24. Historic SLR Rates

Location	Rise in ft/yr	Std. Error of Rise
Dauphin Island, AL	0.0184	0.59
Period of Record	1966-2017	

Predicted rise scenarios for Dauphin Island sites were computed in accordance with current USACE guidance. Projected rise between 2018 and 2100 varies from roughly 1-foot (0.3 meters) for the low current rate curve to 5 ft (1.5 meters) for the high rate curve. Section 2.10.4.2, Appendix A discusses the considerations that led to using a 0.5 meter (m) SLR projection for quantitative assessments. The decision to use the intermediate relative SLR scenario (0.5 m) over the 50 year project horizon for quantitative assessments was twofold: (1) the running average in mean sea level falls between the intermediate and the high level projections in recent years at the Dauphin Island gage; and, (2) concern that any potential relative differences in the future With- and future Without-Project conditions combined with SLR may not be discernable in the models at the highest projected rate.

2.5.2.9. Gulf of Mexico and Mobile Bay Circulation

Gulf of Mexico. The circulation patterns within the eastern Gulf are dominated by the Loop Current. This current enters the Gulf through the Yucatan Straits and moves along the eastern edge of the Yucatan shelf into the eastern Gulf. The distance the current penetrates into the Gulf is dependent upon the season, with the maximum typically occurring during late summer. The current then deflects eastward and southeastward, exiting the Gulf between Cuba and the Florida Keys through the Florida Straits to become the Gulf Stream (U.S. Navy, 1986). Large penetrations of the Loop Current into the Gulf generally lead to the formation of a ring or residual eddy (U.S. Navy, 1986).

Water circulation within the offshore region consists of two interrelated systems, including the open and in-shore areas. The large-scale circulation in the Gulf is influenced by the Loop Current and associated eddies, winds, waves, freshwater inflows, and the density structure of the water column. The general circulation pattern within the in-shore region is more strongly influenced by the celestial tides, local winds, and freshwater inflows, as well as the open Gulf circulation features that act as a forcing mechanism. The coupling of local winds and tides is the major contributor to near-shore shelf circulation. Typically, sustained winds are the primary force controlling water movements within the near-shore area (USACE, 1985, as referenced in U.S. Navy, 1996).

Mobile Bay. Circulation patterns within Mobile Bay are controlled by astronomical tides, winds, and freshwater inflows. During periods of relatively low freshwater inflow, i.e., when inflow is about 12,200 cfs, the “flushing time” of the bay is estimated at between 45 and 54 days (U.S. Navy, 1986). During periods of higher flow, flushing times are substantially less.

The tidal circulation of Mobile Bay was investigated during a period of low river discharge. According to Austin, on flood tide: “The incoming current from the Gulf enters through the main pass. A portion of this water flows up the west side of the bay and part enters the Mississippi Sound through Pas aux Herons. Within about 4 hours, the flow through Pas aux Herons reverses and water enters Mobile Bay from the Sound. Another part of the flooding water mass flows to the east into Bon Secour Bay before turning west to rejoin the generally northward trending flood tide entering the central part of the bay.”

In the northern, upper portion of the bay, the tidal inflow from the south is forced to the east of the bay by the inflow from the Mobile-Tensaw River Delta. The freshwater inflow generally continues on the surface in a southerly direction along the western side of the bay. This flow pattern sets up a generally counter-clockwise circulation within the upper bay (U.S. Navy, 1986).

The project area encompasses 234 acres or approximately 0.1 % of all of Mobile Bay surface area. Within the project area, circulation is controlled by tidal fluctuations and wind-generated currents. The project area is isolated from river flows that contribute to the current patterns in Mobile Bay. Small currents could be established on a local level from flushing resulting from severe storm events that discharge from the Southern Drain and other associated stormwater drainage.

2.5.3. Geology, Soils, and Sediments

2.5.3.1. Geologic Setting.

The physiographic province for the Mobile Bay area represents the southernmost extent of the Alabama Coastal Plain consisting typically of Miocene, Pliocene, Pleistocene, or younger sediments. The geologic formations of the Alabama Coastal Plain form a wedge of seaward thickening sedimentary deposits.

The oldest geologic unit exposed is the undifferentiated Lower Miocene, which is characteristically composed of clay, sand, and sandy clay that are light-gray, yellowish-gray, yellow, and white in color. This unit is also known as the Mobile Clay in the Mobile-Baldwin County area and is equivalent to the Hattiesburg Clay in neighboring Mississippi and the Pensacola Clay to the east in the Florida Panhandle. Stratigraphically, this unit overlies the Tampa Limestone, which is not exposed in Alabama or western Florida. The Mobile Clay is an obvious marker bed throughout both Mobile and Baldwin Counties. This unit thickens southwestward and is fossiliferous, gray to green in color, glauconitic, and may contain beds of sand lenses. The Upper Miocene Ecor Rouge is composed of sands, clayey sands, and silts.

The next younger unit is the Pliocene Citronelle Formation, composed of characteristically dark-reddish-brown to orange sand and quartz gravel with local clay balls and clay partings. Yellowish-brown iron oxide-cemented sandstone can be used to differentiate the base of the formation from the older Ecor Rouge Formation. The Pleistocene units are alluvial and terrace deposits. These materials are typically composed of white, gray, brownish-red, and orange, fine- to coarse-grained sand that is gravelly in many exposures. Lenticular beds of light-gray, orange, and yellow sandy clay occur locally. Alluvial deposits consist of alluvium, beach, estuarine, swamp, stream, and deltaic deposits and include white, gray, black, orange, and brown, very fine- to coarse-grained sand, clayey sand, sandy clay, and peat. They may include variable amounts of organic material. Gravel may occur locally and is Holocene in age (TAI, 1998).

Mobile Bay is a geologically young estuary, defined as a drowned river valley. The bay has probably held its present outline and shape from the time of its formation several thousand years ago. Tectonic forces are believed responsible for the north-south configuration of the eastern shore with high scarps of late Miocene and Pliocene deposits, and also of the western shore with much lower scarps cut in the late Pleistocene (U.S. Navy, 1986).

Mobile County and Baldwin County are in two major land resource areas, the Southern Coastal Plan Resource area which includes the northern, western and central parts of the counties, and the Gulf Coast Flatwoods Resource area which includes a narrow strip along the eastern and southern boundaries.

The Southern Coastal Plan area has two general landscapes. The northern part of the area is mainly low hills with narrow to broad, gently sloping ridgetops, moderately-steep side slopes, and many narrow, well-defined drainage-ways. The southern part is mostly a series of level to gently sloping, low lying ridges that have steeper slopes along drainage-ways. The Gulf Coast Flatwoods area is mainly nearly level, low stream terraces and swamps along the rivers on the east side of Mobile County and broad flats with a few fairly large depressions and a few drainage-ways on the south side of the county. Petis Bois, Dauphin, and other small islands, 5 to 12 miles from the mainland, are included in Mobile County. These islands are part of the barrier islands that encloses Mississippi Sound. Elevation in Mobile County ranges from sea level along the coast to about 340 ft above sea level near Citronelle in the northern part of the county. Drainage in Mobile County in the western third is by the Escatawpa River and Big Creek, which flow in a south-westernly direction into the State of Mississippi. The eastern part of Mobile County is drained mostly by small streams that are part of the Mobile, Tensaw and Middle Rivers drainage system, which flows into Mobile Bay. Drainage in the southern part of Mobile County is by the Dog River, the Fowl River, and small streams that flow into Mobile Bay and into Mississippi Sound.

2.5.3.2. General Soil Setting.

The sediment of Mobile Bay consists of sand to clays with various mixtures of sand, silt, and clay covering most of the bay bottom. The Mobile Bay sediments are approximately 50% sand and 50% clay as described by the Navy (1986). The northern portion of the bay is comprised of deltaic sands, silty sand, silts and clayey silts carried in by the Mobile River. Sediments of the lower bay are primarily estuarine silty clay and clay. The western shoreline exhibits sands which grade to clayey sand, sandy clays, and clays towards the deeper parts of the bay. Oyster reefs and shell occur in isolated locations in the southern part of Mobile and Bon Secour Bays (USACE 1985). The upper portion of Mobile Harbor is predominantly silt and clay with higher concentrations of sand in the mouth of the Mobile River. The northernmost part of the harbor and Mobile River mouth, which reflects the conditions within the turning basin area is sandier due to the larger grain sizes initially deposited into the estuary by the mouth of the river while the finer silts and clays were deposited in the deeper portions of the harbor area.

Upland. The soils in upland areas surrounding the project area are classified as Urban Land soils with LaFitte Muck soils. Urban Land soils consist of extensively built-up areas, with 85 to 100% of a typical area being either covered by structures or disturbed by excavation and filling. Most of these areas are nearly level to sloping. Storm drain systems usually control runoff on paved areas. Small areas of moderately built-up land are also present where structures cover 50 to 85% of the surface, remnants of undisturbed natural soils are present on vacant lots, and the natural soil is covered by fill material (Hickman and Owens, 1980).

LaFitte Muck soils are very poorly drained, nearly level organic soils that occur along the mouths of streams and rivers in tidal marsh areas. The surface of these soils is usually a very dark grayish brown muck about 7 inches thick. The next layer is a very dark brown muck 15 inches to a depth of approximately 64 inches. The underlying material is a very dark gray silty clay to a depth of approximately 73 inches. Soil permeability is moderately rapid and the available water capacity is high.

Sediment. The total annual sediment load entering the Mobile River from the Alabama and Tombigbee Rivers is estimated at 4.76 million metric tons. Including contributions from adjacent water sheds downstream of the confluence of these rivers, a total of 4.85 million metric tons per year is estimated to enter the Mobile-Tensaw River Delta and Mobile Bay system. Approximately 33% of these materials remain in the delta, while 3.26 million metric tons enter the bay. Most of the sediment load is trapped within the bay (on the order of 2.5 million metric tons per year), whereas the remainder (about 16% of the total load entering the delta) is discharged to the Gulf and Mississippi Sound (TAI, 1998).

The sediment that formed the present Mobile-Tensaw River Delta accompanied the late Quaternary rise in sea levels. This sedimentation has resulted in the infilling of a much longer bay that extended initially from the present location of Mobile Bay to Mt. Vernon, Alabama. This infilling is continuing, although at a slower rate. Upland activities that have impacted the sedimentation rate within the estuary include the introduction of large-scale agriculture and the construction of dams along the major streams of the Mobile River system. Other activities, such as filling and dredging operations, tend to redistribute sediments. Resuspension of deposited sediments is a normal occurrence and winds in excess of 12 to 17 mph generate forces that dislodge considerable quantities of deposited sediments within Mobile Bay. Approximately 1.4 million metric tons per year of suspended sediment pass through the bay. These are deposited to the south and west of the tidal inlet (U.S. Navy, 1986).

The Mobile-Tensaw River Delta shoreline has exhibited a net tendency to release accumulated sediments. Erosion occurs primarily along the banks of the major River Channels, whereas accumulation occurs in areas of reduced velocity. The most substantial shoreline alteration within the Mobile Harbor area has resulted from the reclamation of bay bottom during the development of the harbor and adjacent industrial complex and during construction of the U.S. Highways 90/98 causeway (U.S. Navy, 1986).

Sediments near Mobile Bay and adjacent areas were noted as consisting mostly of fine-grained materials. At the mouth of the Mobile River, and in tidally influenced areas, sediments are more coarse-grained with less clay and more sand. Sediments located in the project area are typical of a depositional tidal basin (USACE, 2001).

2.5.3.3. Subsurface Geotechnical Conditions

As previously mentioned, the material within the depths and horizontal extents of the tentatively selected plan are made up of two types of material: maintenance material and new work material. Maintenance material is composed of material that is deposited in the channel from rivers upstream, the near shore current, and resuspended sediment from other parts of the bay. New work material is the in-situ soil that is located at depths or horizontal extents (widening) that have not previously been excavated. The nature of the new work soils varies throughout the proposed areas of deepening and widening. Characterization of substrata encountered within the soil test boring investigative depths was based upon visual examination of soil samples, laboratory analysis of select samples representative of existing substrata, and previously established correlations between standard penetration resistance values.

The new work soil in the turning basin is predominantly clean sand (SP) with some pockets of silty sand (SM). Clean and silty sands are present from elevation -39 ft down to the extent of the proposed deepening at elevation -54 ft. Fat clays (CH) and silts (ML) were also sampled in historical borings, intermixed with sand above elevation -39 ft. Borings indicate that most of the clays and silts would have been removed during the construction of the turning basin. The areas that will be expanded horizontally on the north and south side of the turning basin have intermittent layers of silt and clay, though predominantly sand.

Soils in the Bay Channel vary depending on location within the channel. A collection of soil types are present within the Bay Channel from stations 273+21 to approximately 740+00, or just north of Gaillard Island. Historical borings indicate four soil phases in this stretch, which include: 1) very soft and soft clays, silts, and clayey sands; 2) medium to very stiff clays, silts, and clayey sands; 3) medium to very dense coarse grained clean sands and clayey sands; and 4) organic deposits of silt and peat. These soils types occur in irregular layers or lenses. Generally, the soft, plastic clays and silts (CH, MH, and ML) tend to overlay the sands (SM and SP) and stiffer clays (CL). The top of the sand and stiffer clays generally starts between elevation -45 to -53. Vibracore borings taken in 1984 indicate that soils become sandier with depth, and a consistent layer of clean sand (SP) was noticed from elevation -53 to the termination of most borings. The organic silts (ML) and organic peat layers (OH) occur in isolated pockets, mostly sampled on the east side of the channel and within the top 10 ft of the borings.

Soils within the channel from approximately 740+00 to 1760+10 are almost entirely soft, plastic marine clays (CH) and silts (MH and ML). The majority of clays and silts in this stretch have an N value of zero. There is an isolated area of sand in the southern part of this stretch, stretching from approximately 1 mile north of the GIWW down to the Morgan Peninsula. Borings in this area show lenses of clayey and silty sands (SC and SM) between elevations -45 to -51 ft. These sands can be found in small quantities, and are flanked by the marine clays and silts.

Soils in the Bar Channel are intermixed and interbedded. These soils consist of silty sands (SM), poorly graded clean sands (SP), silts (ML), lean sandy clays (CL), clayey sands (SC), and inorganic plastic clays (CH). The coarse grained sandy soils are fairly dense, and the clays are generally stiffer than those that can be found within the Bay. Most of the soils are greenish in color and contain small clam and oyster shells, shell fragments, and decomposed wood fragments.

Soils boring have not been taken in the footprint of the passing lane widener. Adjacent borings at these stations, within in the channel, indicate the area is predominantly soft fat clay. Additional borings are scheduled to be sampled in this area later in 2018 to determine material properties.

2.5.3.4. Sediment Quality

Sediment sampling efforts were conducted for various portions of the Mobile Harbor Federal Navigation Project that included sampling of the Choctaw Pass Turning Basin in 2008, operation and maintenance (O&M) of Mobile Harbor Bay Channel in 2010, and channel widening associated with the Limited Reevaluation Report (LRR) of Lower Bay and Bar Channel dredged materials in 2014. These sampling events form the basis for physical and chemical sediment characterization and material suitability for placement in the Mobile ODMDS (as shown in Figure 2-28) under the Marine Protection, Research, and Sanctuaries Act (MPRSA) of 1972. In accordance with the MPRSA and the EPA ocean dumping criteria (40 Code of Federal Regulation (CFR) §227), full Tier III testing was performed on bulk sediments, standard and effluent elutriate samples, water column and whole sediment bioassays, and tissue bioaccumulation tests. These tests followed guidance in the: Inland Testing Manual (EPA 1998); Ocean Testing Manual (USACE/EPA 1991); and the Regional Implementation Manual, Requirements and Procedures for Evaluation of the Ocean Disposal of Dredged Material in Southeastern Atlantic and Gulf Coastal Waters (SERIM) (USACE/EPA 2008). A full description of the sediment testing activities referred to above are included in Section 2.3.4, Appendix C.

2.5.4. Water Quality

A water quality modeling effort was conducted for this study to understand the existing water quality within the waters of Mobile Bay and to quantify the relative changes in the water quality resulting from proposed Mobile Harbor Federal Navigation channel modifications. A 3-D water quality model was applied in concert with the combined wave and current numerical models (CSTORM and CH3D-WES MB). A 3-D model was determined necessary due to the existing deep-draft channels and vertical structure of salinity and temperature within the Bay and adjoining waters.

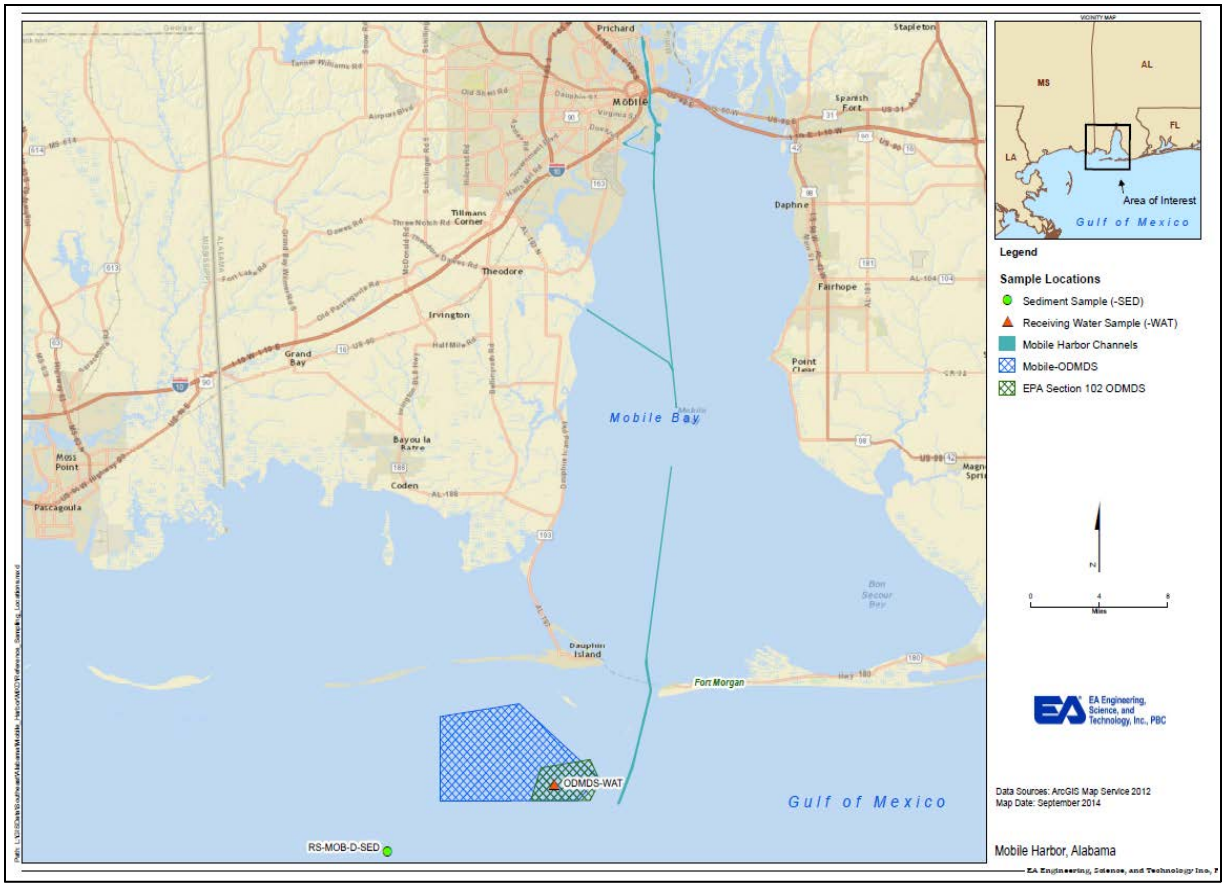


Figure 2-28. Mobile ODMDS Location Map

Using the tidal and river flow boundary condition time series developed by the CH3D-MB model, CEQUAL-ICM was run for the chosen scenarios described in 6.1 GSMB Multi-Block Hydrodynamic Modeling for the period January 1 – December 30, 2010. The output from these scenario runs were analyzed to assess relative differences in DO, salinity, temperature, total suspended solids, nutrients and chlorophyll-*a* ("Chl *a*"). A more detailed discussion on the modeling effort in included in Appendix A.

Six continuous environmental monitoring sites operated by the Dauphin Island Sea Lab and the Mobile National Estuary Program are located within the lower, middle and upper part of Mobile Bay. These sites have been operational over differing time periods with the longest operating monitoring sites being Dauphin Island (2003-2017), Middle Bay (2005-2017) and Meaher Park (2003-2017) stations. In addition, since July 2015, the Alabama Department of Conservation and Natural Resources (ADCNR), Marine Resources Division (MRD), have operated five continuous water quality monitoring stations at oyster reef locations within the bay. Data from these sites provide spatial and temporal patterns of change in temperature, salinity and dissolved oxygen within Mobile Bay.

2.5.4.1. Dissolved Oxygen

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 (Dissolved Oxygen (DO) < 2 milligrams per liter [mg/L]) is a common occurrence during the late spring and summer months. The EPA estimates that 4% of the bottom waters in the Gulf estuaries have hypoxic conditions or low DO on a continuing basis (EPA, 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.

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 mg/L to 8.99 mg/L, with the lowest summer level being 4.63 mg/L (MMS, 1991).

Hydrographic and water quality modeling performed by the Engineering Research and Development Center (ERDC) is documented in Appendix A. Evaluation of dissolved oxygen data from the continuous monitoring sites indicate temporal trends correlated to temperature, with the lowest levels occurring during the late summer months when temperatures are highest. The mean monthly dissolved oxygen at the monitoring sites generally fall with the range of 3 to 12 mg/l. Monthly distribution from the 2010 existing condition hydrodynamic and water quality model simulations conducted as part of this study provides the response of dissolved oxygen to hydrological and temperature conditions. Section 2.4.1 of Appendix C shows the distributions for dissolved oxygen at the bottom of the water column for February (high flow/cold) conditions and October (low flow/hot) conditions. As exhibited under existing conditions, the October (low flow/hot) conditions show decreased dissolved oxygen relative to the February (high flow/cold) conditions throughout the bay. The simulated DO concentrations are illustrated in further detail in Section 2.4.1, Appendix C.

2.5.4.2. Nutrients

Nutrients are a primary concern in both freshwater and marine ecosystems, providing the building blocks of biological production. Mobile Bay and its watershed is a productive estuarine system. Estuaries such as Mobile Bay are naturally nutrient-rich habitats (NEP 2001). In fact, the naturally high nutrient levels in estuaries are one of the reasons these special bodies of water are so productive; however, it is possible to get excessive nutrients, particularly regarding nutrient loads in estuaries. The natural balance of life-giving nutrients can be dramatically upset by man-made contributions from fertilizer runoff (from farms and suburban lawns), urban stormwater runoff, municipal sewage treatment overflows, industrial discharges, and failing septic tanks, among other sources.

The Mobile Bay National Estuary Program (NEP) has reported that with the high rainfall amounts received in coastal Alabama, the Mobile Bay and surrounding communities are particularly susceptible to increased stormwater runoff and decreased water quality in nearby surface waters. This runoff picks up sediments, nutrients, toxins, pathogens, refuse, and other substances usually characterized as *nonpoint source pollutants* and deposits them into local waterways. Nonpoint source pollutants come from scattered or diffuse sources including fertilizers, herbicides, and insecticides from residential areas, agricultural lands, and golf courses; oil, grease, and toxic chemicals from roadways and parking lots; pathogens and nutrients from pet waste, livestock, and faulty septic systems; and organic matter from yard clippings and leaves.

Excess nutrients such as nitrogen and phosphorus loading from coastal watersheds are primarily responsible for eutrophication. Because these nutrients are the primary nutrient forms used by algae, the loading of these forms are the most worrisome. A study in Mobile and Baldwin counties indicated that agricultural and urbanized watersheds were the primary sources of these nutrients (Lehrter, 2006). Ultimately, runoff from these coastal watersheds is delivered to the Bay and water column.

2.5.4.3. Salinity

Salinity distribution in Mobile Bay and the study area is a result of the interaction of freshwater discharge, tides, currents, winds, circulation, evaporation, and bathmetery (Hummell, 1990); however, the most important factor affecting salinity is the fresh-water discharge from the Mobile-Tensaw River system (USACE, 1946 and Chermock and others, 1974). Investigations to determine the salinity line in the Mobile River and its tributaries (1944 through 1946) found that north of Government Street, salinity was affected only slightly by daily tidal variations. Further investigations found that abnormal tides had little effect on saltwater intrusion in the Mobile River. During the investigations, it was found that saltwater intrusion extended upriver to Mile 21 but only lasted a short period of time. In the USACE 1946 study, salinity concentrations were found to be dependent on river discharge, with displacement of salt in the upper areas of the river being noticeable when river discharge was less than 10,000 cfs at the head of the Mobile River. In addition, when discharge exceeded 50,000 cfs, the system could be considered fresh from the head to the mouth of the river.

Monthly distribution, as shown in Section 2.4.3, Appendix C, provides the response to hydrological conditions with the distributions for the mean of depth-averaged salinity for February (wet conditions) and October (dry conditions). Channel has higher salinity than shoals. Dry condition, typically occurring in the fall, allows for more salt intrusion through the navigation channel to Mobile River than the wet conditions during winter conditions.

In the north end of the bay, flood-tidal waters continue to influence salinity as they are forced eastward by incoming freshwater from the Mobile-Tensaw River system (U.S. Department of the Navy, 1986; and Hummell, 1990). Lowest salinities average 15 parts per thousand (ppt) in the southern part of Mobile Bay and are typically present sometime between January and May, when river discharge and flooding ordinarily occur (Boone, 1973; Schoroeder and Lysinger, 1979). During floods, surface salinities can be reduced from 20 ppt to nearly 0 ppt in the southernmost part of the bay (USACE, 1979; Department of the Navy, 1986). The highest salinities average 30 ppt in the southern part of Mobile Bay and are typically found sometime between June and November, when low river discharges normally occur (Bonne, 1973; Schoroeder and Lysinger, 1979). Tidal action normally results in a daily north-south shifting of salinity fields, which can range from little or no movement up to 3.7 to 6.2 miles (Schroeder and Lysinger, 1979).

In general average annual bottom salinities are higher than those at the surface (Chermock and others, 1974). During low river discharges, the highly saline lower part and mouth of Mobile Bay approaches vertical homogeneity, whereas during high discharges these areas become stratified (Vittor and Associates, Inc., 1985). Vertical salinity stratification is variable seasonally, becoming more pronounced in late summer and fall (Vittor and Associates, Inc, 1985).

Evaluation of salinity data from the continuous monitoring sites within the bay indicate general spatial patterns of higher salinities within the lower bay with ranges in mean monthly salinities at Dauphin Island of 4 to 30 ppt and lower salinities in the upper bay with ranges in mean monthly salinities at Maher Park of 0 to 14 parts per thousand. All gages show similar temporal trends of highest salinities between July and November, when low river discharges normally occur and lowest salinities January and May, when higher river discharges typically occur.

2.5.4.4. Turbidity and Suspended Solids

Turbidity, defined as “muddiness created by stirring up sediment or having foreign particles suspended” in the water column (Mobile Bay National Estuary Program (MBNEP), 2008) 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. The MBNEP (2008) has described the brown water commonly seen in Mobile Bay as being due to its shallow depth and high suspended sediment load (4.85 million metric tons per year) that represents turbidity caused by both natural and anthropogenic factors.

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 bay from freshwater sources, but are hydraulically restricted due to the barrier islands and morphologic characteristics of the bay. These restrictions, combined with the bay's shallow depth and mixing from wind, tides, and currents, promote re-suspension of sediments. Stormwater runoff contributes to high turbidity levels by delivering sediments into the water column and providing nutrients which stimulate algae growth. Over-enrichment of nutrients (particularly nitrogen) comes from the use of agricultural and household fertilizers on our fields and lawns as well as waste from animals

The Alabama Department of Environmental Management (ADEM) has a standard for turbidity that is based on the background condition plus 50 nephelometric turbidity units (NTUs) outside a 750-foot mixing zone. Turbidity generated by dredging or placement must not cause substantial visible contrast nor result in an increase of more than 50 NTU above background turbidity levels in state waters.

2.5.4.5. Water Temperature

The measurements for the water temperature in Point Clear, Alabama are provided by the daily satellite readings provided by the NOAA and can be found at https://www.seatemperature.org/north-america/united-states/point-clear.htm. This provides a reasonable representation of the typical water temperatures throughout the Mobile Bay. The NOAA website above gives the range of monthly Mobile Bay water temperatures collected over many years of historical data. The temperatures given are the sea surface temperature (SST) which is most relevant to most users in Mobile Bay. More information can be found in Section 2.4.5, Appendix C.

Evaluation of temperature data from the continuous monitoring sites within the bay indicate temporal trends of highest temperatures between July and October, when river discharges are normally low and air temperatures high. As well as lowest temperatures generally occurring in December through February, when winter temperatures are low and river discharges are typically higher. Review of the data indicate that the mean monthly temperature within the bay generally falls with the range of 50º to 86º F.

Monthly distribution from the 2010 existing condition hydrodynamic and water quality model simulations conducted as part of this study, as discussed in Section 2.4.5 in Appendix C, provides the response to hydrological conditions and shows the distributions for mean depth-averaged temperature for February (high flow/cold) conditions and October (low flow/hot) conditions. As seen for existing conditions, the channel has slightly higher temperatures than the shoals. In addition, in the existing October (low flow/hot condition) increases in temperatures are seen throughout the bay with higher values in the central parts of the bay.

2.5.5. Groundwater.

Groundwater provides an important source of drinking water (public and private) in the Mobile Bay area. Surface water is the main public supply for the metropolitan areas of Mobile. Public water supply systems utilize groundwater, except the Prichard Water Works Board and the Mobile Area Water and Sewer System, which serves the metropolitan area of Mobile and uses surface water sources outside the Mobile Bay area. Groundwater hydrology in the Mobile Bay area can be generally described according to three locations: Baldwin County, Mobile County, and areas with special exceptions. These exceptions include Dauphin Island and Gulf Shores (TAI, 1998).

Groundwater in the Mobile Bay area is obtained in two ways: (1) shallow well unconfined aquifer withdrawal and (2) deep well confined aquifer withdrawal. Shallow wells typically tap Pliocene/Pleistocene alluvial and coastal deposits and are generally recharged by area rainfall. The Pliocene Citronelle Formation, which can crop at the surface (Springhill area of Mobile) and is up to 200 ft thick, is often tapped. Stratigraphically different yet hydraulically connected are the Upper Miocene and Pliocene aquifers, and most wells tap these units. The Mobile Clay, a mostly impervious unit, separates shallow groundwaters from deeper confined aquifers. Major confined aquifers in the area are within the Lower Miocene. Groundwater levels reported by the USGS have remained stable in recent years. Seasonal patterns in unconfined aquifers reveal highest levels in April and lowest levels in September. Given the shallow southerly dip of the beds, recharge of the units for Mobile County is north and west of many City wells (TAI, 1998).

However, wells are used for supplies in the southern and northern portions of the Mobile Bay area. Most wells typically tap the Miocene, with a moderate number withdrawing from the Pliocene Citronelle Formation (TAI, 1998).

Natural groundwater quality problems could include high levels of iron, manganese, sulfur compounds, dissolved solids, and other water quality parameters. Pollution concerns include septic tanks, waste sources, agriculture, and storage tanks. The entire Mobile Bay area is considered to be susceptible to contamination from the surface due to the permeability of the underlying sediments (TAI, 1998).

There are two major aquifers in Mobile and Baldwin Counties that act as recharge areas (Gillet et al., 2000). These aquifers are referred to the Miocene-Pliocene Aquifer and the Watercourse Aquifer (Chandler et al). The Watercourse Aquifer is located in the Pleistocene and Holocene alluvial deposits, and the Miocene-Pliocene Aquifer lies within the underlying series of the same name. Clay deposits are present in both of these series, especially in the Miocene and Pliocene. These clay layers act as aquitards within the Miocene and Pliocene, allowing for multiple aquifers which are hydraulically connected. The recharge areas for the Watercourse Aquifer are in close proximity to the bay, rivers, and other low-lying tributaries and waterways that are hydraulically connected to the bay. This aquifer is unconfined and also hydraulically connected to the Miocene-Pliocene Aquifer, making the two aquifers relatively subject to natural and manmade contaminants. Chandler et al. (1985) states that even though the Miocene-Pliocene Aquifer has a high yield, only a fraction of this groundwater can be used as there are many concerns with saltwater intrusion. Additionally, the Watercourse Aquifer is susceptible to contaminants via land source (Gillet et al. 2000), resulting in very few water supply wells that rely on the Watercourse Aquifer for potable water. A detailed discussion on these aquifers can be found in Section 5.4.2, Appendix A.

2.5.6. Biological Resources

Characterizations of baseline aquatic resources in estuarine, transitional, and freshwater environments are important to establish prior to channel deepening and potential impacts from saltwater intrusion and other water quality parameters. A key component of the current study is to document potential changes to aquatic resources along the salinity continuum moving upriver and estimate how far upriver changes may occur after the navigation channel is modified to its new dimensions. Elevated salinities upriver and in adjacent marshes have raised concerns among resource managers because of potential impacts to the marshes and their biological resources. Aquatic resources are a critical part of both estuarine and riverine food webs, providing habitat and forage for economically and ecologically important finfish and shellfish species, which are identified as an important indicator of potential effects.

Studies have been executed through a combination of 1) direct measurements of aquatic resources and 2) modeling approaches to characterize the existing conditions within the project area which contains a variety of natural resources that are comprised of wetlands, SAV, oysters, benthic invertebrates and fish. A discussion of the environmental conditions and existing resources are included below.

Coastal Alabama consists of several habitats including beaches, sand dunes, coastal maritime forests, emergent wetlands, SAV, rivers, tidal creeks, tidal flats, scrub/shrub wetlands, forested wetlands, and open-water benthic habitats. These areas are home to an immensely diverse, resilient, and environmentally significant group of species, including some threatened and endangered fauna. Ecological habitats within the project site include estuarine subtidal and intertidal water bottoms populated with diverse benthic communities. Benthic communities vary depending on the substrate bottom types present in the area. Intertidal and subtidal water bottoms vary from sand to muddy sand to mud. Subtidal bottoms consist primarily of soft mud sediments (Christmas, 1973). There are no SAV beds in the vicinity of the project area. Generally, the SAV are restricted to the northern shores of the barrier islands south of the mainland shoreline.

2.5.6.1. Terrestrial Plant Communities

Terrestrial uplands are areas of higher ground which are not subjected to riverine flooding or tidal inundation. Upland plant communities in south Alabama include pine woodland, pine-oak forest, and coastal pine-oak associations (U.S. Navy, 1986).

Across north Florida and south Alabama, pine woodlands are a dominant feature. Tree species include slash pine (*Pinus elliottii*) and longleaf pine (*Pinus palustris*). The understories of these habitats include gallberry (*Ilex glabra*), wax myrtle (*Myrica cerifera*), saw palmetto (*Serenoa repens*), and St. John's wort (*Hypericum* spp.) (U.S. Navy, 1986).

The pine woodland found in Mobile and Baldwin Counties integrates to pine-oak forest. The pine-oak forest is usually formed above the 10-foot contour line. Longleaf pine dominates the plant community along with southern red oak (*Quercus falcata*), sandpost oak (*Quercus margaretta*), flowering dogwood (*Cornus florida*), and persimmon (*Diospyros virginiana*) (U.S. Navy, 1986).

Along the coastal areas, the upland pine-oak association consists of species adapted to sandy substrate and salt spray from Gulf waters. In these areas, slash pine and sand pine (*Pinus clausa*) replace longleaf pine. Live oaks (*Quercus virginiana var. maritima*) and myrtle oaks (*Quercus myrtifolia*) are common (U.S. Navy, 1986).

The onshore portions of the project area contain no mature forests and have been disturbed frequently by past human activity. There are extensive areas of fill material.

2.5.6.2. Wetlands

Wetlands occur in areas exposed to surface inundation or groundwater saturation at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation adapted for life in saturated soil conditions (ERDC - Environmental Laboratory 1987). As a result of these characteristics, wetlands represent one of the most productive ecological components within the project area (Reddy and DeLaune 2008). Wetlands provide a number of valuable ecological functions (e.g., flood water retention, storm surge reduction, and wildlife habitat) which benefit society (e.g., recreation, flood risk reduction; Novitski 1996). The distribution of wetlands and various wetland community types on the landscape is dictated by elevation, substrate, hydroperiod, hydropattern, and water composition (Cowardin et al., 1979). In particular the salinity of water supporting wetlands maintains a controlling factor in wetland zonation in many areas (Huckle et al., 2000), with salinity displaying the capacity to alter patterns of wetland community distribution and productivity in coastal and estuarine environments (Crain et al., 2004).

Mobile Bay supports one of the largest intact wetland ecosystems in the U.S., including over 250,000 acres within the Mobile-Tensaw River Delta (AWF 2018). Wetlands within the bay provide essential habitat for a wide variety of recreational and commercially valuable species, including rearing and cover areas for fishes and waterfowl (Chabreck 1989). Additionally, Mobile Bay Watershed contains diverse plant communities including many rare, listed, and endemic species (Stout et al., 1998). The natural patterns of spatial and temporal salinity fluctuations resulted in the development of diverse and resilient wetland community types within Mobile Bay.

A characterization of baseline wetland community assemblages and distribution in estuarine, transitional, and freshwater habitats throughout Mobile Bay and the associated delta region was conducted (Berkowitz et al., 2018) and presented in detail in Section 2.6.2, Appendix C. The study area focused on the central and southern portions of the of Mobile Bay and the Mobile-Tensaw River Delta region. The areas identified as having the highest likelihood of potential impacts associated with the proposed channel modifications are shown in Figure 2-29. The study area included the portions of the delta south of the Interstate 65 (I-65) Bridge, above which freshwater communities are dominant. The southern extent of the sampling included wetlands dominated by wetland communities adapted to saline conditions. As a result, the study area encompasses the entire salinity gradient occurring with the Mobile Bay region, ranging from salt-intolerant bottomland hardwood forest species assemblages in the north to the halophytic plant communities common throughout coastal wetlands of the northern Gulf of Mexico.

Salinity tolerance classes were established for each wetland community using existing literature sources; including thresholds for decreased productivity and mortality. Freshwater river discharges, and thus salinity, vary seasonal with high flows typically occurring in the late winter and early spring and low flows dominating during in the summer. The lower and mid-portions of the bay (e.g., estuarine habitats) receive seawater during normal tidal exchanges.

Berkowitz et al. (2018) describes the wetlands within Mobile Bay as developed on prograding alluvial deposits as the river sediments are discharged into the drowned Pleistocene river valley (Gastaldo 1989). As a result of the observed salinity gradient increasing from north to south, wetlands in the northern portion of the bay are characterized by bottomland hardwood forests containing *Taxodium distichum*, *Nyssa aquatica, N. biflora, Acer sp., Carya sp., Fraxinus sp., Quercus sp.,* and *Ulmus sp*. Herbaceous species within this zone include *Typha domingensis, T. latifolia, Sagittaria lancifolia, Schoenoplectus americanus,* and *Alternanthera philoxeroides*. Additionally a number of aquatic bed species (e.g., *Nuphar sp., Nelumbo lutea*) can be found adjacent to open water reaches in many wetland areas. Wetlands within the southern portion of the delta form a transition zone of estuarine adapted, moderate salinity tolerant species dominated by a mixture of shrubs including *Baccharis glomeruliflora, B. halimifolia, Ilex sp., Morella cerifera, Persesa palustris,* and *Sabal minor*. The lower portions of the bay include an array of moderate to high salt tolerant herbaceous species including *Spartina cynosuroides, Panicum virgatum, Cladium jamaicense,* and *Juncus roemerianus*. Dense nearly monotypic stands of *Phragmites karka* also occur within the study area, occupying both disturbed (i.e., near the U.S. Highways 90/98 causeway) and natural portions of the bay.

Note: Dots represent field verification sampling sites

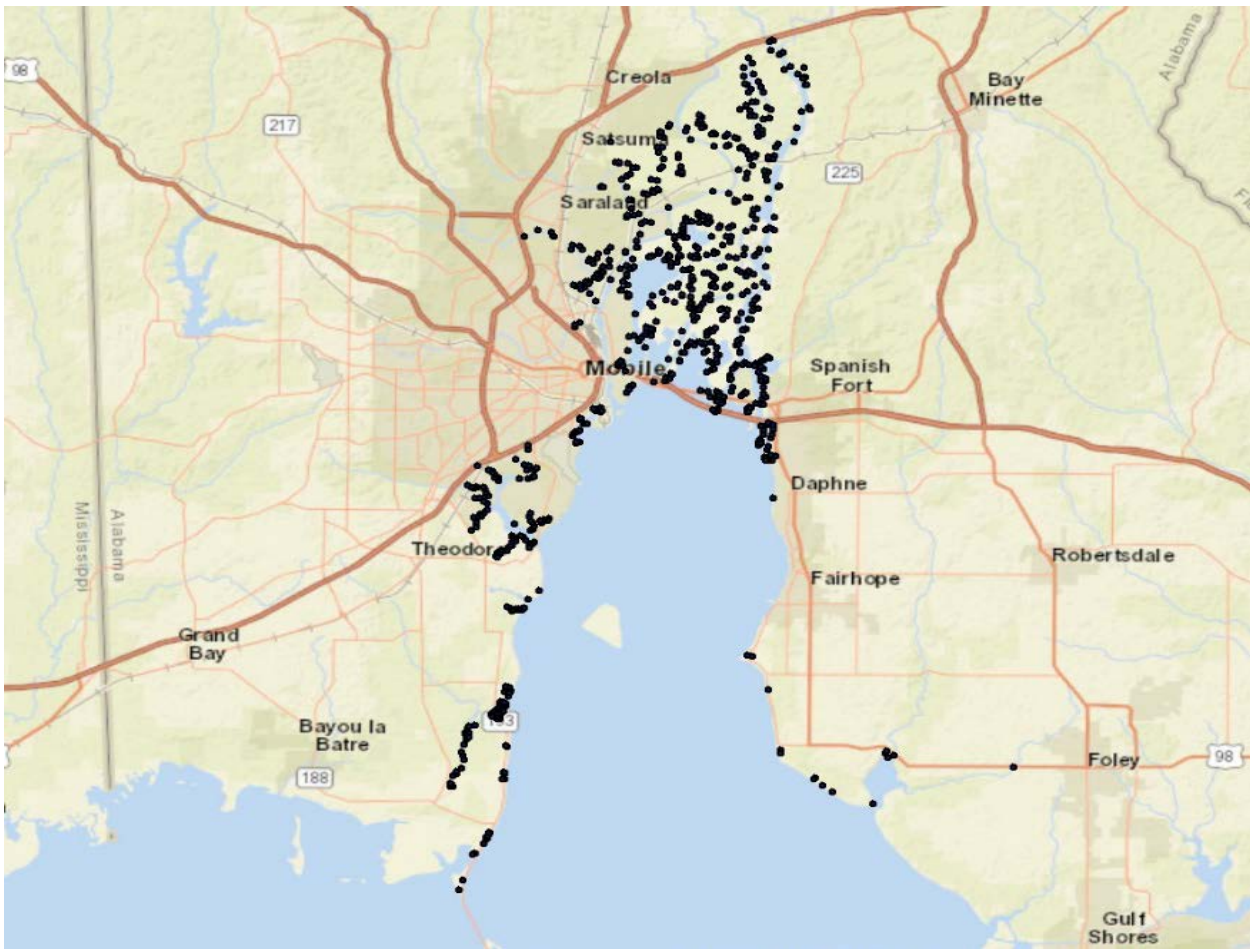


Figure 2-29. The study area focusing on portions of the Mobile Bay and Mobile-Tensaw River Delta region south of the I-65 Bridge.

Mapping of the existing wetlands (Berkowitz et al., 2018) illustrates 39 wetland communities occurring over an area of >73,000 acres as illustrated in Figure 2-30. Table 2-26 provides a list of the wetland classes, associated species, and area of their extent. The most abundant wetland community observed in the study area was the Bald cypress – tupelo – bottomland mix which accounted for 30% of the total wetland area, mostly located in upper portions of the study area and along the north eastern shore of the Bay. Additionally, the Baldcypress – tupelo – swamp bay – palmetto – shrub mix and the Tidal shrub mix each comprised nearly 15% of the total wetland area, occurring the upper to middle of the transition zone between freshwater and estuarine habitats.

2.5.6.3. Submerged Aquatic Vegetation (SAV).

Coastal seagrass beds represent one of the most productive ecosystems on the planet (Berkowitz et al., 2018). SAV communities in Mobile Bay serve as thriving habitats that provide shelter for fish and invertebrates, nursery habitat for commercially and recreationally important finfish and shellfish species, a food source for over-wintering waterfowl, and prevention against erosion through sediment stabilization (MBNEP, 2008). SAV in the project area includes various types of seagrass. Historical studies have identified varying areas of SAV in Mobile Bay. Within the project area, SAV is found primarily along the northern shorelines of the bay and 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). By buffering wave energy, modifying wave currents, preventing erosion, consolidating sediment and influencing deposition, SAV can help to maintain and shape coastal landscapes (Biber and Cho 2017). It is estimated that 50–90% of all marine species utilize SAV at some point in their life cycle (Moncreiff et al., 1998).

SAV diversity and distribution are limited by a number of water quality parameters. Light attenuation and water clarity are critical as these are vascular plants that require light. In addition to light, predominant limiting factors to SAV distribution and diversity are salinity and temperature. In this study, the parameters that were considered for evaluation were salinity and DO.

The health, continued survival, and future growth of many SAV have been threatened around the bay and is likely due to consequences of land-use change such as increased turbidity, nutrient over-enrichment, and shoreline armoring along with some natural processes such as drought, salinity change, and tropical weather events (MBNEP, 2008). There are also significant seasonal and annual variations in SAV abundance and species composition (Cho and May, 2006). Other human activities detrimental to SAV survival include recreational and commercial boating which causes a re-suspension of sediments

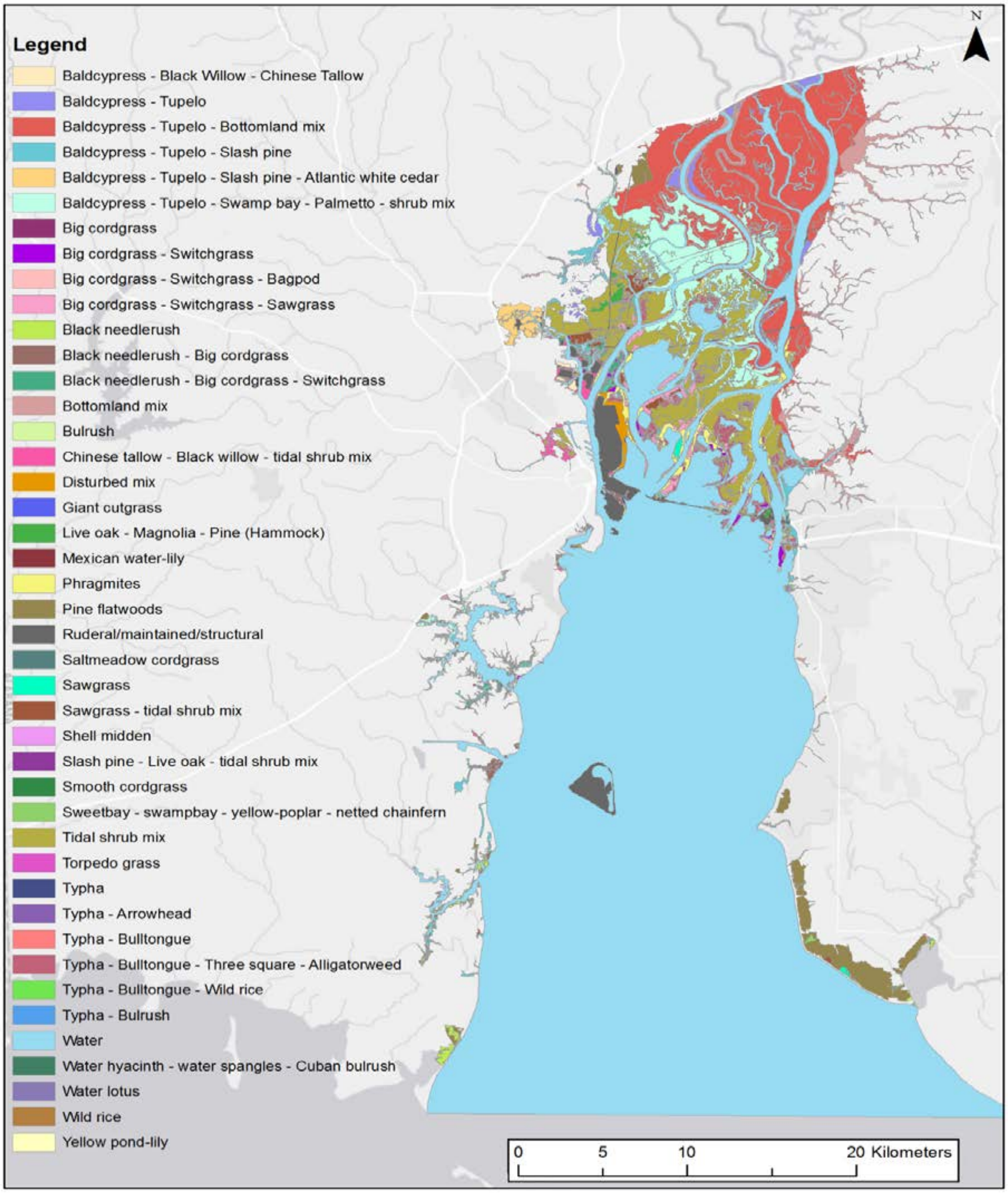


Figure 2-30. Distribution of wetland communities within the study area (Berkowitz et al., 2018)

Table 2-25. Wetland classes, species names, and area of extent within the study area

Class Name	Representative Species	Area (acres)
Baldcypress – black willow – Chinese tallow	*Taxodium distichum – Salix nigra – Triadica sebifera*	155
Baldcypress – tupelo	*Taxodium distichum – Nyssa aquatica/N. biflora*	2900
Baldcypress – tupelo – bottomland mix	*Taxodium distichum – Nyssa aquatica/N. biflora –* (*Acer sp. – – Carya sp. –– Fraxinus sp. –– Quercus sp. –– Ulmus sp*)	22687
Baldcypress – tupelo – slash pine	*Taxodium distichum – Nyssa aquatica/N. biflora – Pinus elliottii*	1114
Baldcypress – tupelo – slash pine – Atlantic white cedar	*Taxodium distichum – Nyssa biflora – Pinus elliottii – Chamaecyparis thyoides*	1018
Baldcypress – tupelo – swamp bay – palmetto – shrub mix	*Taxodium distichum – Nyssa biflora – Persea palustris -* (*Baccharis sp., Morella cerifera, Ilex sp.*)	10566
Big cordgrass	*Spartina cynosuroides*	31
Big cordgrass – switchgrass	*Spartina cynosuroides – Panicum virgatum*	442
Big cordgrass – switchgrass – bagpod	*Spartina cynosuroides – Panicum virgatum – Sesbania vesicaria*	83
Big cordgrass – switchgrass – sawgrass	*Spartina cynosuroides – Panicum virgatum – Cladium jamaicense*	1342
Black needlerush	*Juncus roemerianus*	569
Black needlerush – Big cordgrass	*Juncus roemerianus – Spartina cynosuroides*	763
Black needlerush – Big cordgrass – switchgrass	*Juncus roemerianus – Spartina cynosuroides – Panicum virgatum*	553
Bottomland mix	*Acer sp. –– Carya sp. –– Fraxinus sp. –– Quercus sp. –– Ulmus sp.*	5500
Bulrush	*Schoenoplectus californicus/S. tabernaemontani*	3
Chinese tallow – Black willow – tidal shrub mix	*Triadica sebifera – Salix nigra – Baccharis sp. – Morella cerifera*	971
Giant cutgrass	*Zizaniopsis miliacea*	263
Live oak – Magnolia – Pine (Hammock)	*Quercus virginiana – Magnolia grandiflora – Pinus elliottii/Pinus taeda*	440
Mexican water-lily	*Nymphaea mexicana*	1
Phragmites	*Phragmites karka*	2913
Pine flatwoods	*Pinus elliottii/P. palustris/P. taeda*	3862
Saltmeadow cordgrass	*Spartina patens*	5
Sawgrass	*Cladium jamaicense*	638
Sawgrass – tidal shrub mix	*Cladium jamaicense – Baccharis sp., Ilex sp., Morella cerifera, Persesa palustris, Sabal minor*	751
Slash pine – live oak – tidal shrub mix	*Pinus elliottii – Quercus virginiana –* (*Baccharis sp., Ilex sp., Morella cerifera, Persesa palustris, Sabal minor*)	109
Smooth cordgrass	*Spartina alterniflora*	3
Sweetbay – swampbay – yellow-poplar – netted chainfern	*Magnolia virginiana – Persea palustris – Liriodendron tulipifera – Woodwardia areolata*	61
Tidal shrub mix	*Baccharis glomeruliflora, B. halimifolia, Ilex sp., Morella cerifera, Persesa palustris, Sabal minor*	12511

Table 2 26. Wetland classes, species names, and area of extent within the study area

Torpedograss	*Panicum repens*	54
Typha	*Typha domingensis*	164
Typha – arrowhead – alligatorweed	*Typha domingensis/T. latifolia – Sagittaria latifolia – Alternanthera philoxeroides*	24
Typha – bulltongue	*Typha domingensis – Sagittaria lancifolia*	321
Typha – bulltongue – three-square – alligatorweed	*Typha domingensis/T. latifolia – Sagittaria lancifolia – Schoenoplectus americanus – Alternanthera philoxeroides*	2525
Typha – bulltongue – wild-rice	*Typha domingensis – Sagittaria lancifolia – Zizania aquatica*	108
Typha – bulrush	*Typha domingensis – Schoenoplectus californicus/S. tabernaemontani*	5
Water hyacinth – water spangles – Cuban bulrush	*Eichhornia crassipes – Salvinia minima – Oxycaryum cubense*	24
Water lotus	*Nelumbo lutea*	78
Wild-rice	*Zizania aquatica*	153
Yellow pond-lily	*Nuphar advena/N. ulvaceae*	28
Total		73741

Source: (ERDC 2018)

from propellers and boat wakes along bay edges. These activities increase turbidity, and grounding of outboard motor props rips seagrass leaves and rhizomes out of the sediments, leaving behind “prop scars” that can take three to five years to recover. Some other human activities impacting SAV growth include commercial and recreational trawling, which disturbs the substrate in which the plants grow and increases turbidity by stirring up sediments, and deposition of dredge material.

Berkowitz et al. (2018) established baseline conditions that were assessed by groundtruthing and utilizing baseline maps of SAV habitat within the system, identifying variation in SAV distribution across several years and seasons. The detailed study is included in Section 2.6.3, Appendix C. Baseline data from existing maps of SAV distribution were field verified to check accuracy and temporal variation in order to establish baseline distribution, within Mobile Bay, utilizing recent and historic SAV survey maps developed by Barry A. Vittor and Associates, Inc (2004). Their surveys focused on near-shore estuarine and marine aquatic ecosystems in coastal Alabama including the entire coastline (Vittor, 2004). The SAV surveys were conducted over several years to support the NEP and the ADCNR.

Ground truthing surveys conducted by Berkowitz et al. (2018) as described in their report, covered a distance of 40 miles throughout the Mobile Bay, with the goal of mapping the edges of various SAV beds to compare to beds recently mapped by Vittor (as shown in Figure 2-31), which represents the baseline SAV conditions for this study. A legend identifying the species represented in Figure 2-31 is listed in Table 2-28. A total of 31,684 points were mapped and 1,788 of these points (~0.06%) detected the presence of SAV.

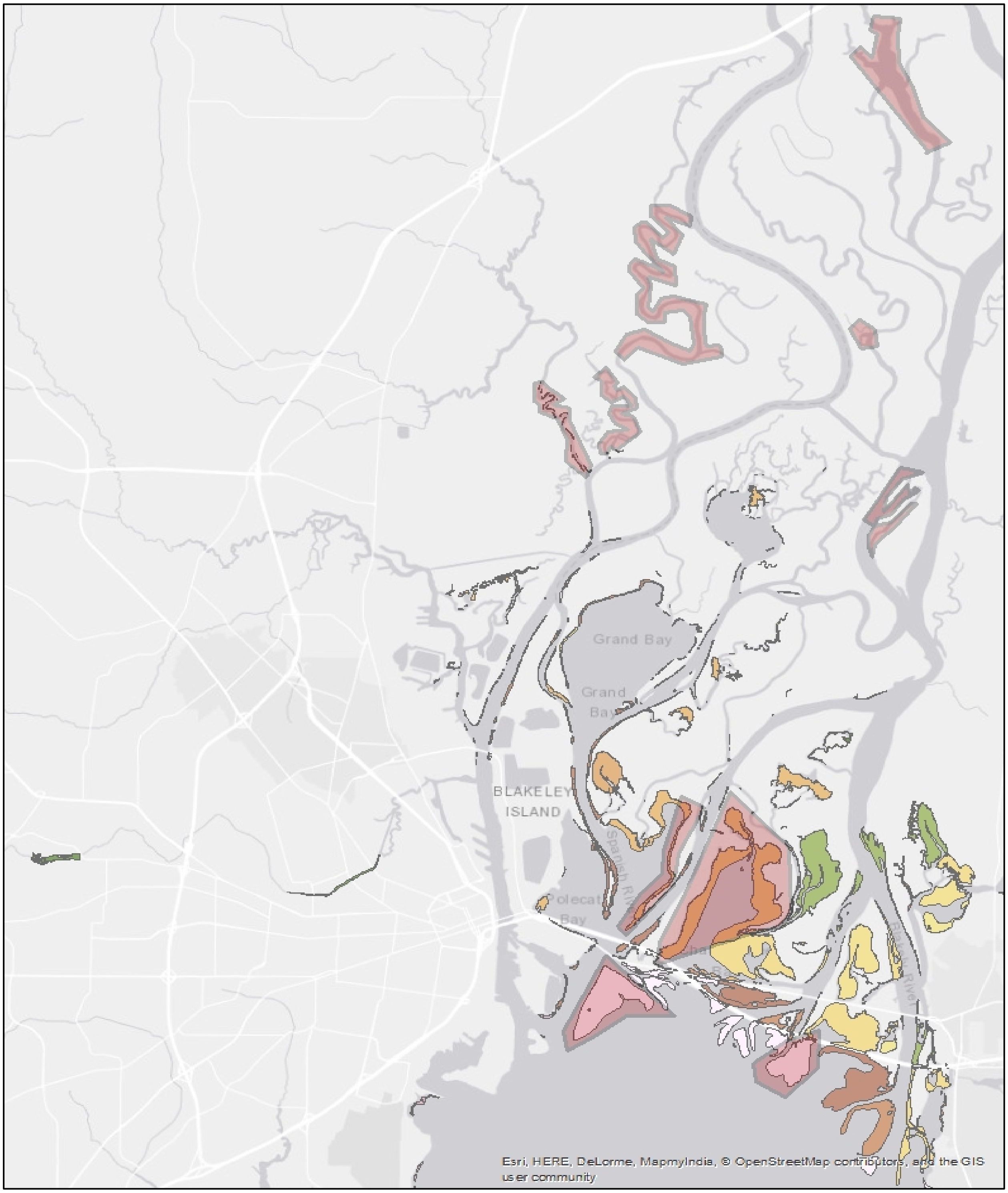


Figure 2-31. Fall 2016 Field verification sites (highlighted red polygons) and Fall 2015 SAV distribution within Mobile Bay as mapped by Vittor & Associates.

Table 2-26. Species legend for Figure 2-31

Species	
CC CD MS	*Cabomba caroliniana,Ceratophyllum demersum, Myriophyllum spicatum*
CC MH	*C. demersum, Myriophyllum heterophyllum*
CC NG	*C. demersum, Najas guadalupensis*
CD HD MS NG VN	*C. demersum, Heteranthera dubia,M. spicatum, N. guadalupensis, Valissneria neotropicalis*
CD MS NG	*C. demersum, M. spicatum, N. guadalupensis*
CD RM	*C. demersum, Ruppia maritima*
EB LF MH NU	*Eleocharis baldwinii, Luziola fluitans, M. heterophyllum, Nuphar ulvacea*
HD	*Heteranthera dubia*
HD MS	*H. dubia, M. spicatum*
HD MS NG	*H. dubia, M. spicatum, N. guadalupensis*
HD MS NG VN	*H. dubia, M. spicatum, N. guadalupensis, V. neotropicalis*
HW	*Halodule wrightii*
HW RM	*H. wrightii, R. maritima*
MH	*M. heterophyllum*
MS	*M. spicatum*
MS NG	*M. spicatum, N. guadalupensis.*
MS NG PP VN	*M. spicatum, N. guadalupensis, Potamogeton pusillis, V. neotropicalis*
MS NG RM VN	*M. spicatum, N. guadalupensis R. maritima, V. neotropicalis*
MS RM VN	*M. spicatum, R. maritima, V. neotropicalis*
MS VN	*M. spicatum, V. neotropicalis*
NG PP	*N. guadalupensis, P. pusillis*
NG PP RM VN	*N. guadalupensis, P. pusillis, R. maritima, V. neotropicalis*
NG PP UT	*N. guadalupensis, P. pusillis, Utricholaria inflata*
RM	*R. maritima*
RM VN	*R. maritima, V. neotropicalis*
TT	*Thalassia testinudum*
VN	*V. neotropicalis*

Year to year and seasonal variation in SAV coverage by year is both common and extensive (Table 2-28). The species with both the most coverage and the most temporal variation in coverage were Eurasian Watermilfoil (*Myriophyllum spicatum*), Water Celery (*Vallisneria neotropicalis*), Southern Naiad (*Najas guadalupensis*), Water stargrass (*Heteranthera dubia*), and Coons Tail (*Ceratophyllum demersum*). These species ranged in mean acreages of ~1,600 to 4,000 with high variance (standard deviation ranged from ~1,300-2,000 acres). In comparison, on average, the rest of the common species covered less than 1,000 acres each and all but Widgeon Grass (*Ruppia maritima*) covered less than 400 acres each.

Table 2-27. Variation in acreage over time. Values are obtained from Vittor SAV survey maps. Highlighted species are those predicted to have potential impacts from project implementation.

Species	Acres					
	2003	2009	Summer 2015	Fall 2015	Mean	Standard Deviation
Myriophyllum spicatum	2318.5	2955.2	6734.8	4647.3	4163.9	1975.7
Vallisneria neotropicalis	2610.4	2499.7	5304.3	2851.1	3316.4	1333.4
Najas guadalupensis	762.2	1773.6	4832.9	2041.2	2352.5	1742.9
Heteranthera dubia	427.8	312.0	3540.0	3075.9	1838.9	1707.5
Ceratophyllum demersum	954.6	188.8	2002.1	3329.4	1618.7	1361.3
Ruppia maritima	475.2	293.1	1767.6	632.1	792.0	665.0
Stuckenia pectinata	0	238.9	1280.2	5.7	381.2	609.6
Potamogeton pusillus	0	17.1	1115.1	131.2	315.8	536.0
Cabomba caroliniana	0	1.9	28.1	768.8	199.7	379.6
Potamogeton crispus	0	27.9	375.3	9.8	103.2	181.7
Utricularia foliosa	0	5.7	213.4	114.1	83.3	101.4
Zannichellia palustris	0	0	198.8	0.2	49.8	99.4
Hydrilla verticillata	0	76.1	16.7	91.2	46.0	44.4
Nuphar ulvacea	0	46.0	5.7	29.9	20.4	21.4
Myriophyllum heterophyllum	0	0	5.7	29.9	8.9	14.3
Myriophyllum aquaticum	0	0	0	0.1	0	0.1

2.5.6.4. Hard Bottom Habitat.

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).

Other than existing oyster reefs which are covered in Section 2.5.6.9, no natural hard bottom habitats are located within the Mobile Bay and surrounding waters. Most natural hard bottom habitats lie east of the Alabama Coast. Small, isolated patches of lag deposits composed of shell and rock gravel are found off the south sides of the barrier islands (MDWFP, 2005). Numerous artificial reefs consisting of concrete rubble, concrete culverts, steel hull vessels, and artificial reef pyramids have been placed within or near the project area as discussed below. Additionally, there are numerous gas and oil platforms in the bay and nearshore waters of the Gulf that provide artificial structural habitats.

2.5.6.4.1. Artificial Reefs and Structures.

Offshore. Alabama has one of the largest artificial reef programs in the world (ADCNR, Alabama Marine Resources Division, 2009). Alabama's natural bottoms are predominately flat sand/mud type bottom that are not conducive to attract commercially or recreationally valuable fish. The creation of vertical relief is known to attract many reef fish such as snappers and groupers and numerous other valuable species. Over time, artificial reefs will appear and function as natural reefs with similar communities of encrusting organisms and bait fish. The artificial reefs created under Alabama's program have been shown to recruit juvenile fish species and other associated reef dwelling communities that allow the artificial reef to function as natural reefs (ADCNR, Alabama Marine Resources Division, 2009).

Since 1953, Alabama's artificial reef building program started with the placement of 250 car bodies and has continued with offshore placement of many different types of materials including culverts, bridge rubble, barges, boats, planes, tanks and ships. By 1987 the areas encompassed almost 800 square miles and continues to increase in size. The USACE authorized an expansion of Alabama's artificial reef construction areas in 1997 to allow for greater freedom in reef placement and greater variety in depth. The combined area for all reef permit zones now encompasses approximately 1,260 square miles.

Inshore. In addition to Alabama's offshore artificial reef program, the State has created numerous inshore artificial fishing reefs throughout Mobile Bay and local waters. The reef structures are meant to mimic the function of relic oyster reefs that attracted schools of fish by providing habitat for barnacles, mussels, worms and bryozoans, along with a variety of crabs and shrimp. The reefs are developed to ring marginally productive oyster reefs in the bay with some form of hard, durable material, and filled with oyster cultch such as shell or crushed limestone for vertical relief (ADCNR, Alabama Marine Resources Division, 2009). By creating such structures, it was anticipated that improved sportfishing at the sites would result due to increased vertical relief and biological diversity. Subsequent reefs were constructed using concrete rubble that became available from the demolition of old bridges of the U.S. Highways 90/98 causeway bridges (Tensaw, Blakeley, and Apalachee rivers). The locations of the inshore reefs are illustrated in Figure 2-32.

A total of 30 inshore fishing reefs are located within Mobile and Bon Secour Bays, Mississippi Sound, and the Perdido System. Concrete bridge materials, culvert pipes, concrete roof panels, oyster shells and crushed limestone were utilized as reef materials. Five reefs are experimental dual-purpose sites, providing excellent inshore fishing while improving oyster production on nonproductive relic oyster reefs. In addition, seven gas production platforms in lower Mobile Bay have been enhanced with limestone rock fish attracting pads.

Gas Platforms. The natural gas platforms in and around Mobile Bay provide hard substrate that attract fish and other marine communities. Locations of the platforms are shown in Figure 2-32. Stabilization materials originally placed around gas platforms in the lower bay once provided excellent benthic invertebrate habitat, supporting large populations of predatory fishes. Crushed limestone aggregate provides an ideal substrate for the settlement and growth of oysters and other benthic invertebrates. Local recreational fisheries associated with these gas platforms have benefited as a result these structures.

Figure 2-32. Locations of the artificial inshore reef and gas platforms within and adjacent to the project area (ADCNR, Alabama Marine Resources Division, 2009).

2.5.6.5. Essential Fish Habitat.

The Magnuson Stevens Fishery Conservation and Management Act (16 U.S.C. 1801-1882) (MSFCMA) established regional Fishery Management Councils (FMC) and mandated that Fishery Management Plans (FMP)s be developed to responsibly manage exploited fish and invertebrate species in waters of the U.S. When Congress reauthorized this Act in 1996 as the Sustainable Fisheries Act, several reforms and changes were made. One change was to charge the National Marine Fisheries Service (NMFS) with designating and conserving EFH for species managed under existing FMPs. This is intended to minimize, to the extent practicable, adverse effects on habitat caused by fishing or non-fishing activities, and to identify other actions to encourage the conservation and enhancement of such habitat.

EFH is defined as “those waters and substrates necessary to fish for spawning, breeding, feeding, or growth to maturity” [16 U.S.C. § 1801(10)]. “Waters” include "aquatic areas and their associated physical, chemical, and biological properties that are used by fish, and may include aquatic areas historically used by fish where appropriate." “Substrate” includes “sediment, hardbottom, structures underlying the waters, and associated biological communities.” “Necessary” refers to "the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem." “Fish” includes "finfish, mollusks, crustaceans, and all other forms of marine animal and plant life other than marine mammals and birds," and "spawning, breeding, feeding or growth to maturity" covers the complete life cycle of those species of interest.

The Gulf of Mexico FMC (GMFMC) currently maintains FMPs for a total of 21 selected species. These species or species complexes are shrimp (brown, pink, and white), red drum, reef fish (red, gag, and scamp grouper; red, gray, yellowtail, and lane snapper; greater and lesser amberjack; and tilefish); coastal migratory pelagic species (king and Spanish mackerel, cobia, and dolphin); stone crab, spiny lobster, and coral. For the Gulf of Mexico, EFH includes all estuarine and marine waters and substrates from the shoreline to the seaward limit of the Exclusive Economic Zone. In estuarine waters such as Mobile Bay, these habitats include areas such as estuarine emergent wetlands, seagrass beds, algae flats, mud, sand, and shell substrates, and the estuarine water column.

Table 2-29 provides a list of the species that NMFS manages under the federally implemented FMP in the vicinity of the project area (NOAA, 1999). None of the stocks managed by the FMC are endangered or threatened.

In the project area, EFH is likely to exist for red drum, brown shrimp, pink shrimp, and white shrimp. Blue crab, mullet, and redfish are known to use the wetland areas along the western shoreline. Shrimping and crabbing occur in the project area.

Table 2-28. FMPs and Managed Species for Gulf of Mexico and Those Likely to Occur in Mobile Bay.

Shrimp FMP	Coastal Migratory Pelagic FMP
Brown Shrimp	Spanish mackerel *(S. maculatus)*
Pink Shrimp	
White Shrimp	**Gulf Stone Crab FMP**
Red Drum FMP	**Reef Fish FMP**
Red Drum	
Stone Crab *(Menippe sp.)*	**Gray Snapper** *(Lutjanus griseus)*

NMFS, 1999
FMP Fishery Management Plan

2.5.6.6. Plankton and Algae

Phytoplankton. A total of 13 species of blue-green algae and 23 species of green algae were collected during a study of the effects of dredging (U.S. Navy, 1986) (Table 2-30). The lowest numbers of phytoplankton occurred in Mobile Bay from October through December, whereas peak abundance occurred in April and September. Generally, the number of taxa (species richness) varied inversely with organism abundance. Species richness was greatest during late fall and early winter (U.S. Navy, 1986). Common species include diatoms (*Asterionella* sp., *Melosira* sp., and *Skeletonema* sp., among others), prasinophytes (*Pyramimonas* sp.), and chlorophytes (*Ankistrodesmus* sp., *Scenedesmus* sp.) (U.S. Navy, 1986) (Table 2-31). Generally, in estuaries along the Gulf, phytoplankton populations exhibit seasonal variations.

Table 2-29. Phytoplankton Collected from Mobile Bay

Blue-Green Algae		Green Algae
Anabaena sp.	*Actinastrum hantschii*	*Oocystis spp.*
Aphanizomenon sp.	*Ankistrodesmus concolutes*	*Scenedesmus spp.*
Borizia trilocularis	*Ankistrodesmus falcatus*	*Schroederia setigera*
Chroococcus planetonia	*Closterium acicularis*	*Tetraedron muticum*
Coccochloris sp.	*Closteriopsis longissimi*	*Tetraedon trigonum*
Gloeocapsa sp.	*Coelastrum cambricum*	*Tetrallantos lagerhermii*
Lyngbya aestuarii	*Coelastrum microporum*	*Tetrastrum heteracanthum*
Lyngbya contorta	*Crucigenia apiculate*	*Treubaria triappendiculata*
Lyngbys sp.	*Dictyosphaerium ehrenbergi*	*Trochischia sp.*
Merismopedia punctate	*Dictyosphaerium naegelianum*	*Westella botryoides*
Microcystis incerta	*Docidium sp.*	Unidentified
Oscillatoria tenuis	*Kirchneriella obesa*	
Schizothrix calcicola		

Source: U.S. Navy, 1986

Table 2-30. Phytoplankton Survey Data Collected in Vicinity of Pinto Island, February 1986a

Diatoms	**Dinoflagellates**
Asterionella formosa	*Prorocentrum minimum*
Asterionella glacialis	
Coscinodiscus lineatus	**Chlorophytes**
Cyclotella sp.	*Ankistrodesmus falcatus*
Cylindrotheca closterium	*Scenedesmus acuminatus*
Fragilaria sp.	*Scenedesmus denticulata*
Leptocylindrus minimus	*Scenedesmus quadracaudata*
Skeletonema costatum	
Melosira moniliformis	**Chrysophytes**
Melosira granulate	*Dinobryon sp.*
Nitzschia delicatissima	
Synedra sp.	**Cyanobacteria**
Thalassiosira decipiens	*Oscillatoria sp.*
Thalassiosira pseudonana	
	Other
Prasinophytes	Small Forms*
Pyramimonas sp.	

* Small forms consist primarily of unidentifiable blue-green and green algae that are less than 2 microns in diameter.
Source: U.S. Navy, 1986.

Zooplankton. From data collected in lower Mobile Bay, copepods were by far the most abundant taxonomic group, with peaks occurring in winter and spring. Other species found include *Amphipoda, Cladocera, Porcellanidae,* and *Sagetta spp*., all varying from season to season.

Factors influencing zooplankton include flushing rate, patterns of circulation, salinity, turbidity, nutrient concentration, phytoplankton composition and quantity, predator abundance, and levels of various pollutants. Estuarine zooplankton exhibit volumetric and numerical abundance, but limited diversity even under favorable conditions. Most species tolerate a wide range of temperatures. Summer populations are usually high because of increased primary productivity and the seasonal effect of meroplankton. In Mobile Bay, relatively shallow depths and rapid tidal mixing could combine to enhance nutrient cycling. This results in increased primary production and increased food supply for zooplankton. Ctenophores are recognized as major predators of suspended crustaceans and constitute an important regulatory component in zooplankton populations (Navy. 1986).

2.5.6.7. Benthic Communities.

The balance between freshwater inflow and saltwater tidal exchanges is an important driver establishing salinity-zone habitats in estuaries (Van Diggelen and Montagna 2016) and salinity strongly influences benthic macroinvertebrate distributions (Telesh and Khlebovich 2010). Changes to this freshwater/saltwater relationship are associated with wetland loss on the northern Gulf of Mexico via altered riverine input of freshwater and sediment (Day et al. 2000) and saltwater intrusion via canal and channel dredging (Turner 1997). Other factors affect habitat quality and the salinity balance within an estuary, including severe storms, sediment changes, and development. Alterations to inputs of freshwater (e.g., droughts, floods, flood control levees) or saltwater (e.g., channel deepening), can affect biotic communities that are adapted to particular salinity zones by changing their taxonomic composition and distributions. Important estuarine biota includes benthic invertebrates, which are relatively stationary, living within bottom sediments. Their abundances and distributions, therefore, can serve as an indicator of environmental conditions in an area. Salinity, however, is not the only factor affecting the distributions of benthic invertebrates, which also respond to sediment composition, competition, and predator-prey relationships (Little et al. 2017). Commercially and recreationally important estuarine fish feed on benthic invertebrates in estuarine and contributing freshwater habitats.

A recent evaluation conducted by Berkowitz et al. (2018) characterizes baseline benthic infaunal communities in estuarine, transitional, and freshwater habitats in the Mobile Bay Watershed. Details of this study is included in Section 2.6.7, Appendix C. Sampling was conducted in October 2016 and May of 2017 with a total 240 benthic samples collected over 40 stations within habitat zones of freshwater, brackish, and estuarine as illustrated in Figure 2-33**.** Changes in benthic community composition among these habitat types are documented along the salinity gradient. The empirical data were collected to document the distribution and abundance of benthic macroinvertebrates within the potential zone of influence of harbor modifications. Multivariate statistical techniques were used to determine the location(s) where the taxonomic composition of these benthic assemblages changed relative to bottom salinity concentrations.

Potential impacts of harbor modifications on benthic resources in Mobile Bay are a concern because the navigation channel has an influence on water circulation, estuarine mixing, and sedimentation patterns in the bay (Osterman and Smith 2012). Benthic macrofauna in Mobile Bay are dominated by polychaetes and macrofaunal abundances are relatively low in this area compared to other Gulf of Mexico estuaries (HX5, 2016). This benthic evaluation conducted by Berkowitz et al. (2018) examined the benthic macroinvertebrates and established how benthic communities transition from estuarine to freshwater habitat, which largely reflected a change from relatively high abundances of polychaetes to insects, respectively. A similar transition in benthic community composition was reported for Lavaca Bay and Matagorda Bay, Texas, in which polychaetes and crustaceans were indicator taxa for brackish and marine habitats and insect larvae occurred in freshwater areas (Pollack et al. 2009). A detailed summary of the average abundances of benthic macroinvertebrates associated with the estuarine, transitional, and freshwater zones for each sampling period can be found in Section 2.6.7, Appendix C.

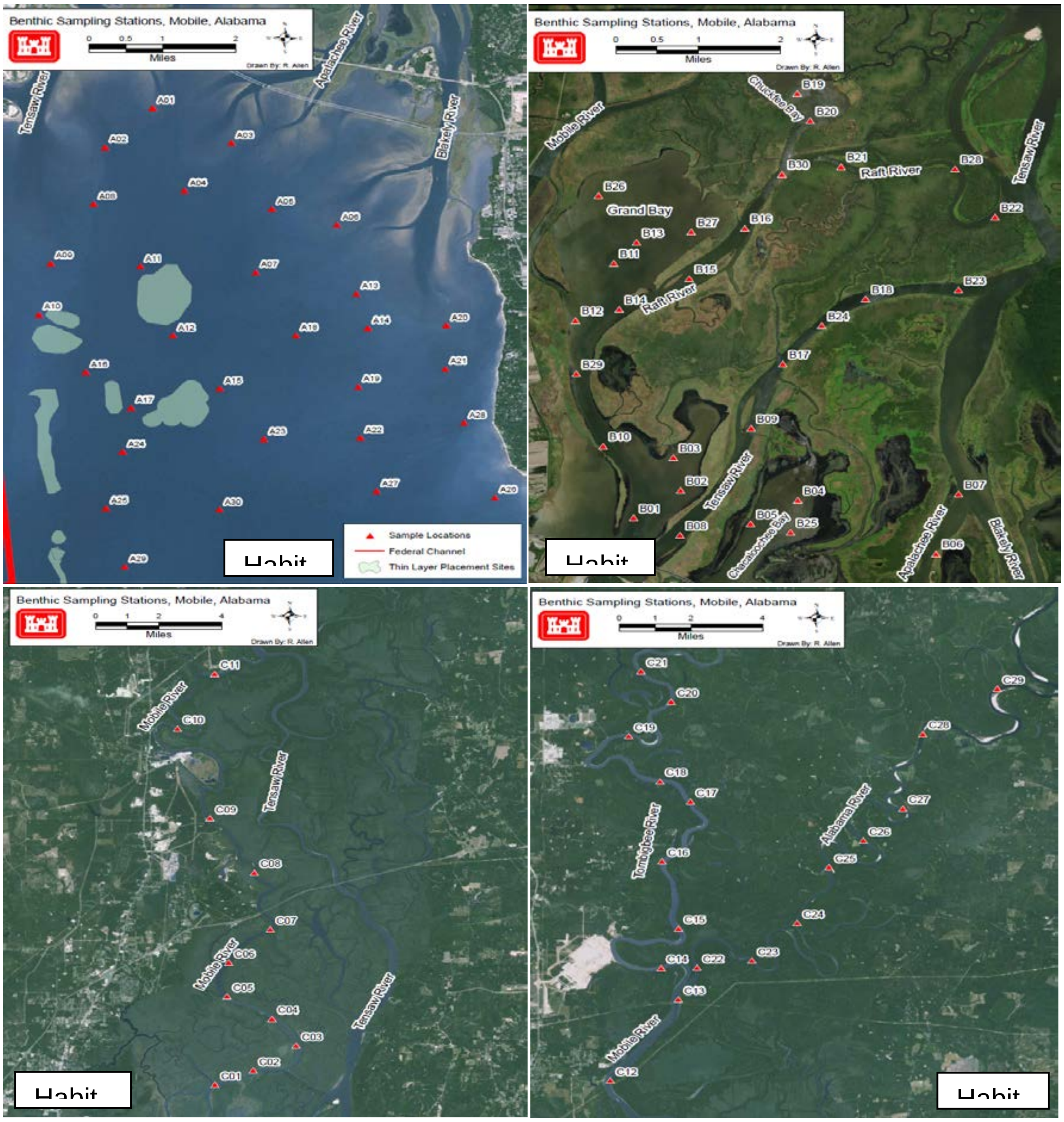


Figure 2-33. Benthic station locations for A-estuarine, B-transition, and C-freshwater zones.

2.5.6.8. Fish

Mobile Bay ranks first in the number of freshwater species in the Southeastern Atlantic and Gulf of Mexico drainages, with a total of 157 species recorded, 40 of which are endemic (Swift et al 1986). Long-term collections in Mobile Bay estuary by the Alabama Marine Resource Division, catalogued in the Fisheries Assessment and Monitoring Program (FAMP) database, list 140 species of estuarine fishes. High biodiversity reflects the ecological importance of this drainage network, including inflows from the Black-Warrior, Tombigbee, and Alabama Rivers. A recent study was conducted by Berkowitz et al. (2018) during September 2016 to evaluate recruitment and growth and May 2017 to evaluate the spawning period and young-of-year survival. Details of this study is included in Section 2.6.1, Appendix C.

Sampling was conducted in the freshwater, transition and upper bay zones for a total of 11 sites utilizing the same gear and protocol as with the FAMP database (seine and trawl) used by the ADCNR, MRD. The sampling efforts in the upper bay zone were conducted to provide complementary data in that zone and to also aide in calibrating efforts in the transition and freshwater zones with comparable efforts in the remaining zones. Data used for the fishery analysis encompassed information from 2000-2015, and the ERDC data collected in 2016 and 2017. A map, Figure 2-34, depicting the sampling station distribution (overall map with two insets) was created that illustrates the FAMP stations historically and currently sampled by the ADCNR, MRD (1981-present) as well as the location of the ERDC samples. The inclusion of all FAMP data provides a visual aide supporting the breadth of geographic coverage represented by the data.

Outputs from the study provided for the fisheries assessment included baseline conditions, With-Project conditions and the numerical difference (change) between baseline and project values. Basic summary statistics were generated (i.e., mean, minimum, maximum, standard deviation, percentile) for each modeled cell within the grid and for each respective condition. Physical and water quality habitat measurements were taken in conjunction with fishery collections at each site. Salinity tolerances for each fish guild community in Mobile Bay study areas were identified according to the Gulf Coastal Research Laboratory publication by Christmas (1973) following the recommendations by Elliott et al (2007). Guilds included: freshwater only, freshwater entering estuary, resident estuary, marine entering estuary, and marine only. A total of 2,097,836 individuals representing 162 species were recorded and used in the analysis. Species were classified according to the salinity tolerance guilds. A detailed list of species abundance in the Mobile Bay project area by salinity classification can be seen in Section 2.6.1, Appendix C.

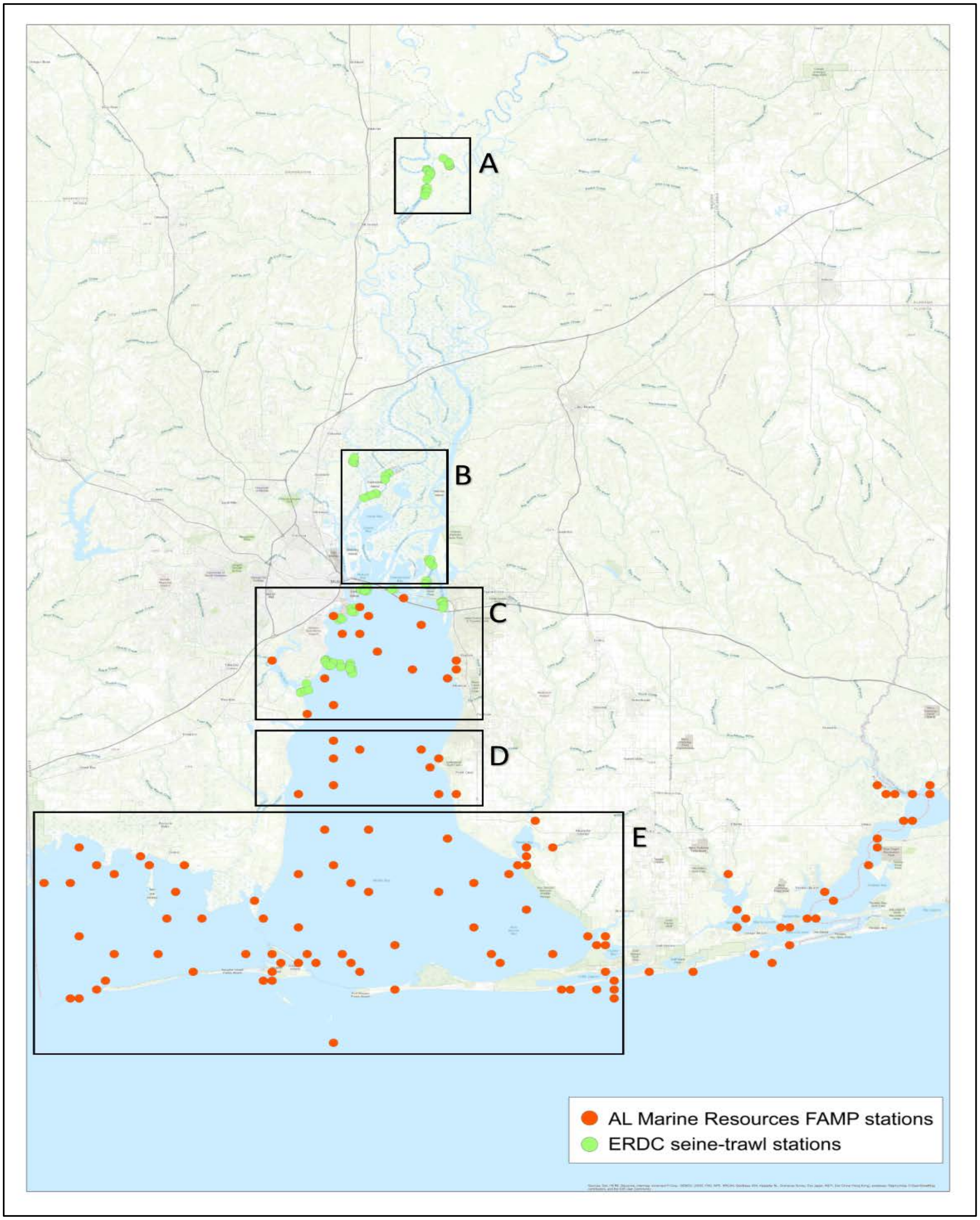


Figure 2-34. Distribution of the ERDC sample stations (green) and ADNCR, MRD FAMP stations (red) utilized for fisheries assessment (A).

2.5.6.9. 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 the northern Gulf and barrier islands (Cake, 1983).

The hard clam is an estuarine and marine species most often found in coastal bays from intertidal zones to water depths of 50 ft. These clams may be found in open ocean, but prefer shallow waters (<33 ft). 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). Other abundant mollusks found in the Mississippi Sound include various gastropods.

The commercially valuable oysters inhabit shallow estuarine waters during all lifestages. Oyster recruitment is the key driver for maintaining oyster population over time. However, this process is poorly understood due to the difficulty in tracking oyster larvae over time. Recruitment occurs through the settlement of larvae from their natal reef (intra-reef recruitment), or from other reefs within the system (inter-reef recruitment). Intra-reef recruitment has been shown to be relatively low, indicating that inter-reef recruitment is crucial for sustaining oyster populations in hydrodynamically-driven systems (Berkowitz et al., 2018).

Berkowitz et al., (2018) using information provided by the ADCNR, MRD, assessed 13 adult oyster reefs (>3,600 acres) for salinity and DO potential impacts based on juvenile and adult oyster tolerance thresholds. Details of this study are included in Section 2.6.2.1, Appendix C. Understanding the oyster larvae movement and reef recruitment dynamic is critical towards understanding how potential project actions will impact oyster populations within the project area of influence. Specifically, if oyster recruitment within the Mobile Bay area is altered so that a higher percentage of oyster larvae are flushed out of the bay due to hydrodynamic changes caused by alterations to the navigation channel, this could affect the local oyster recruitment (Berkowitz et al., 2018).

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).

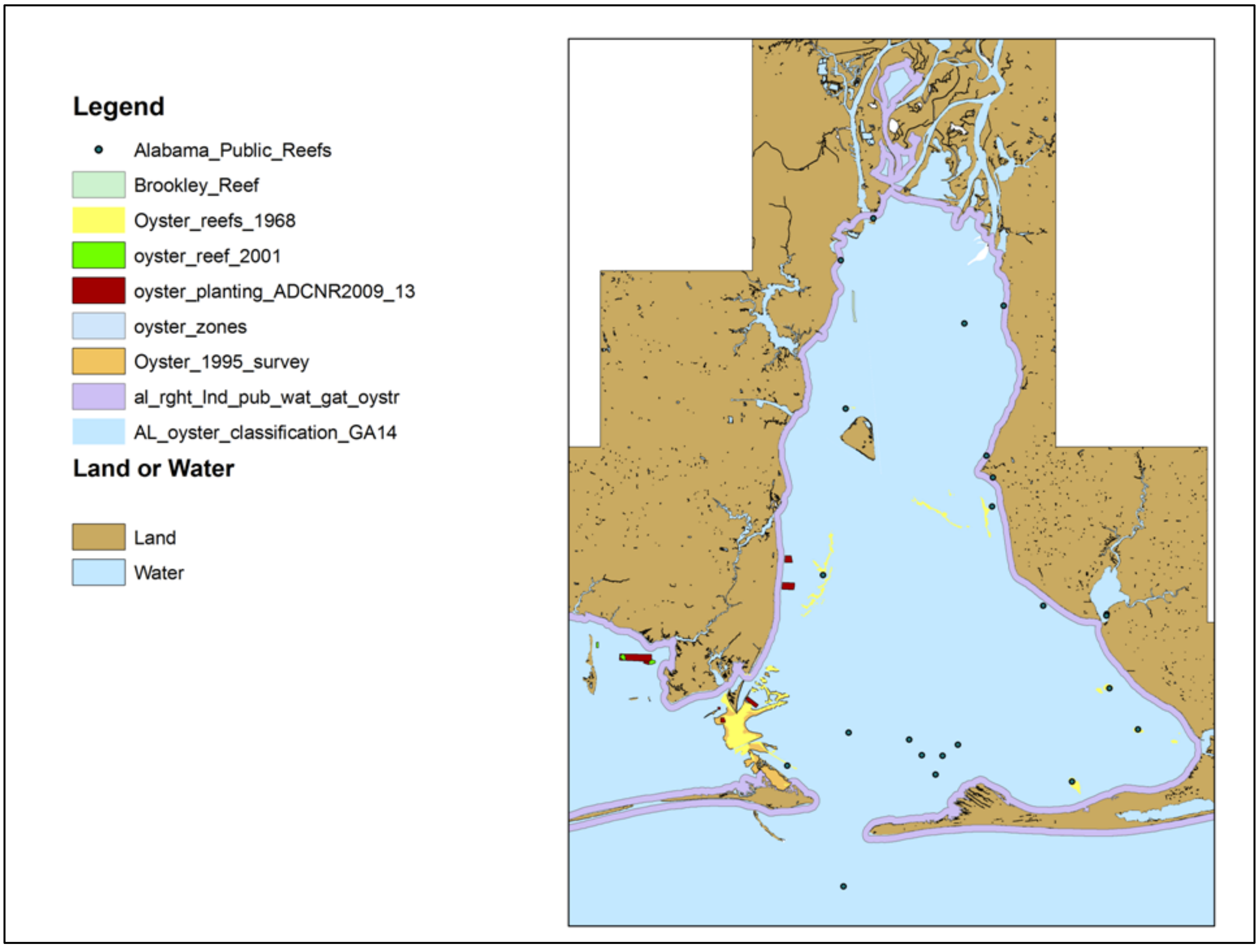


Figure 2-35. Oyster reefs in Mobile Bay

2.5.6.10. Crustaceans

Crustaceans of abundance in the Mobile and vicinity 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 Alabama 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 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*).*

Mature pink shrimp inhabit deep offshore waters, and the highest concentrations occur in depths of 33 to145 ft (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 ft in depth and generally become most abundant at about 15-45 ft 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.

Brown shrimp are most abundant from June to October and can be found in inshore and offshore waters. 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.

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 Alabama and egg-bearing crabs may be found in all but the coldest months. Females with eggs are found around barrier islands in large numbers during the summer. Eggs hatch near those areas and planktonic zoeal larvae are carried offshore for up to one month to spend their larval stage in the offshore plankton (Pattillo et al., 1997). 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% 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).

2.5.7. Threatened and/or Endangered Species.

Several species of threatened and endangered marine mammals, turtles, plants, snails, fish and birds occur in the Gulf of Mexico off the coast and in upland areas of Alabama including Mobile and Baldwin Counties and waters offshore of Alabama and Mississippi. Table 2-32 includes 12 species that NOAA Fisheries, Protected Resource Division (PRD), 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 2-31. Federally Listed Threatened and Endangered Species in the Project Area

Common Name	Scientific Name	Status[a]	Area of Potential Occurrence	Habitat
Dusky gopher frog	*Rana sevosa*	LE (USFWS)	Mobile County	Habitat includes both upland sandy habitats historically forested with longleaf pine and isolated temporary wetland breeding sites imbedded within this forested landscape. This frog spends the majority of its life in or near underground refugia and historically used gopher tortoise burrows for this purpose (Allen 1932).
Red Knot [b]	*Calidris canutus ssp. rufa*	LT (USFWS)	Mobile and Baldwin Counties	Sandy beaches, tidal mudflats, salt marshes, and peat banks (USFWS, 2010i).
Wood stork	*Mycteria americana*)	LT (USFWS)	Mobile and Baldwin Counties	Optimal water regimes for the wood stork involve periods of flooding, during which prey (fish) populations increase, alternating with dryer periods, during which receding water levels concentrate fish at higher densities coinciding with the stork's nesting season.
Tan riffleshell	*Epioblasma florentina walkeri*	LE (USFWS)	Mobile and Baldwin Counties	Relatively silt-free substrates of sand, gravel, and cobble in good flows of smaller streams.
Alabama Red-bellied Turtle	*Pseudemys alabamensis*	LE (USFWS)	Mobile and 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*	LT (USFWS)	Mobile County	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)	Mobile and Baldwin Counties	Dry, mature pinelands dominated by longleaf pine, with a fire-maintained subclimax understory community (USFWS, 1982).
Gopher Tortoise	*Gopherus polyphemus*	C (USFWS)	Mobile and Baldwin 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).
Saltmarsh topminnow	*Fundulus jenkinsi*	Under Reveiw (USFWS)	Mobile and Baldwin Counties	This species prefers cord grass (*Spartina*) marsh with a salinity below 20 parts per thousand and is most abundant at 1-4 parts per thousand (Lee et al. 1980, Robins et al 1986). It is characterized as a small, schooling fish that can occur in large numbers in quiet fresh waters, bays, saltwater marshes, tidal creeks, estuaries, and lagoons. It is not found on reefs or far away from shore (Robins et al. 1986).
Mississippi Sandhill Crane	*Grus canadensis pulla*	LE (USFWS)	Mobile 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)	Mobile and Baldwin 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).
Southern clubshell	*Pleurobema decisum*	LE(USFWS)	Mobile and Baldwin Counties	All populations are experiencing sediment and water quality problems, and are susceptible to stochastic and chronic events (e.g., spills, drought and/or landuse runoff).
West Indian Manatee	*Trichechus manatus*	LT (USFWS)	Mississippi Sound and Mobile Bay	In marine, estuarine, and freshwater environments (USACE, 2009a).
Alabama sturgeon	*Scaphirhynchus suttkusi*	LE (USFWS)	Mobile and Baldwin Counties	Based on capture data, it inhabits the main channel of large coastal plain rivers of the Mobile River Basin. Most specimens have been taken in moderate to swift current at depths of 6 to 14 m, over sand, gravel or mud bottom (Williams and Clemmer 1991).
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)	Mobile and Baldwin Counties 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)	Mobile and Baldwin Counties 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)	Mobile and Baldwin Counties and oceanward waters near the barrier islands	High energy beaches with deep, unobstructed access along continental shorelines. Oceans worldwide.

Hawksbill Sea Turtle [b]	*Eretmochelys imbricate*	LE (USFWS)	Mobile and Baldwin Counties and oceanward waters near the barrier islands	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)	Mobile and Baldwin Counties, and offshore waters	Rivers, estuaries, and Gulf of Mexico waters (USFWS and NOAA Fisheries, 2009).
Alabama (=inflated) heelsplitter	*Potamilus inflatus*	LT (USFWS)	Mobile and Baldwin Counties	Soft, stable substrate in slow to moderate currents (Stern 1976). It has been found in sand, mud, silt and sandy gravel, but not in large gravel or armored gravel (Hartfield 1988).
Oceanic whitetip shark	*Carcharhinus longimanus*	LT (NOAA)	Offshore waters	Offshore waters.
Maui remya	*Remya mauiensis*	LE (USFWS)	Baldwin County	
American chaffseed	*Schwalbea americana*	LE (USFWS)	Baldwin County	
Perdido Key beach mouse	*Peromyscus polionotus trissyllepsis*	LE (USFWS)	Baldwin County	Sandy coastal and beach dune areas
Alabama beach mouse	*Peromyscus polionotus ammobates*	LE (USFWS)	Baldwin County	Sandy coastal and beach dune areas
Finback Whale	*Balaenoptera physalus*	LE (USFWS and NOAA)	Offshore waters	Offshore waters.
Giant manta ray	*Manta birostris*	LT (NOAA)	Offshore waters	Offshore waters.
Bryde's whale	*Balaenoptera edeni*	Proposed endangered (NOAA)	Offshore waters	Offshore waters.
Sei Whale	*Balaenoptera borealis*	LE (NOAA)	Offshore waters	Offshore waters.
Sperm Whale	*Physeter macrocephalus*	LE (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 nine Federally listed species, two critical habitat designations for piping plovers and nearshore productive and nesting habitat loggerhead sea turtles, and one candidate species (Bryde's whale) for Federal protection that may occur in the vicinity of the proposed project and could be affected by construction activities.

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 16 species would not occur in or around the proposed project area and are not further discussed:

- Inflated heelsplitter
- Dusky gopher frog
- Wood stork
- Black pine snake
- Eastern indigo snake
- Gopher tortoise
- American chaffseed
- Maui remya
- Tan riffleshell
- Mississippi sandhill crane
- Saltmarsh top minnow
- Southern clubshell
- Oceanic whitetip shark
- Humpback whale
- Perdido key beach mouse
- Giant manta ray

The USACE, Mobile District, does not anticipate sperm, Bryde's, fin, or sei whales would be adversely affected by the varying dredging methods (i.e. hydraulic, hopper, and/or mechanical) described by the proposed action along the entire proposed action area. Previous coordination with NOAA Fisheries, under the 2003 Gulf Regional Biological Opinion (GRBO) (amended 2005 and 2007) with a determination that dredging activities have a "not likely to adversely affect" (NLAA) determination for whale species potentially within the project area. The possibility of collision with the dredge is remote since these are deepwater species and the likelihood for collision would be reduced by the highly mobile nature of these species. Given their likely absence, feeding habits, and very low likelihood of interaction, the USACE, Mobile District, does not anticipate the proposed actions identified in this EIS will affect these species. As such, sperm, fin, and sei whales are not considered further in this assessment.

The life cycle descriptions of the protected species and critical habitats known to occur in the project area are included in more detail in Section 2.7, Appendix C.

2.5.8. Marine Mammals.

All marine mammals are protected under the Marine Mammal Protection Act (MMPA), regardless of their status under the ESA. It should be noted that the only two whale species that may occur in the project area are also covered under the ESA. There are a total of six threatened or endangered whale species (i.e., whale species protected under both the ESA and MMPA).

All marine mammals are protected by the MMPA of 1972, as amended, but the West Indian manatee and four whale species, which include the finback, sei, sperm, and Bryde's 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.

The marine mammal species listed in Section 2.8, Appendix C, 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 ft or more, and are uncommon in waters less than 984 ft deep.

Recently, the NMFS has identified the Bryde's whale as a potential concern in the Gulf of Mexico. The Bryde's whale (*B. edeni*) is a large baleen whale found in tropical and subtropical waters worldwide. The Bryde's whale is proposed for the federal listing as an endangered species under the ESA (50 CFR Part 224, Federal Register 2016-29412). However, it is currently protected under the MMPA. The northeastern Gulf of Mexico encompasses the current areal distribution of a small resident population. Sightings have been found in the Northeastern Gulf of Mexico along the continental shelf break in an area known as the DeSoto Canyon which is between 328 ft and 984 ft deep.

Vessel collisions are a significant source of mortality for a variety of coastal large whale species. The northern Gulf of Mexico is an area of considerably high amount of ship traffic, which may increase the risk of vessel-whale collisions. Several important commercial shipping lanes travel through the primary Gulf of Mexico Bryde's whale habitat in the northeastern Gulf of Mexico, particularly vessel traffic from ports in Mobile, Pensacola, Panama City, and Tampa.

Of the other more common species sighted along the upper continental shelf, three marine mammal species are commonly found along nearshore areas of Alabama. They include Atlantic bottlenose dolphin, Atlantic spotted dolphin (*Stenella frontalis*), and spinner dolphin (*Stenella longirostris*) (MMS, 2000; 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 Alabama coastal and estuarine waters are home to stable populations of Atlantic bottlenose dolphins, 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.

The West Indian manatee is one of four remaining marine mammals in the order *Sirenia*. Manatees were originally listed as endangered throughout their range in 1967. The Florida manatee, a geographically distinct population, is currently federally listed as endangered only in Florida, Georgia, Puerto Rico, Mexico, and the Caribbean but occurs as far west as Texas in the summer and early fall. Manatees undertake large seasonal migrations with distribution controlled by temperature. In the summer and fall, manatees seek shallow grass beds with ready access to deep channels as preferred feeding areas in coastal and riverine habitats including secluded canals, creeks, embayments, and lagoons, particularly near the mouths of coastal rivers and sloughs. Artificial sources of fresh water are also attractive to manatees. Manatees are herbivores and forage on SAV, especially undersea grasses. These grasses typically grow at 3-6 ft in depth. However, manatees have been noted in water as shallow as 1.5 ft and in deeper waters during coastal and other migrations to SAV areas. Areas with SAV are particularly important to manatee conservation.

In the winter, manatees from the Gulf Coast typically return to Florida, congregating en masse around on warm water springs and effluent discharges such as those below power plants. Increasing numbers of manatees are found in Alabama waters in the summer. They are known to utilize bay channels extensively as they migrate throughout Mobile Bay and into the adjacent rivers. A major threat to the manatee, accounting for over one third of all death of adults, is watercraft strikes. Water control structures and navigation aides also are significant causes of deaths, as are red tides and incidents of freezing. Some manatees are also believed to die as a result of poor nutritional status when the underwater vegetation they feed on is killed by salinity changes or pollution.

2.5.9. Wildlife Communities.

Birds. The Gulf Coast, including the Alabama and Mississippi Coasts and the Mobile Bay and associated watershed, 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 (18–24 hours) of greater than 600 miles, and the first possible landfall for birds returning north in spring (USACE, 2009a).

The coastal marshes, islands, and beaches of Alabama are utilized by large populations of waterfowl, passerines, wading birds, and shorebirds. Passerines common to the coast of Alabama include the gray kingbird (*Tyrannus dominicensis*), fish crow (*Corvus ossifragus*), boat-tailed grackle (*Quiscalus major*), marsh wren (*Cistothorus palustris*), and seaside sparrow (*Ammodramus maritimus*).

Common wading birds in the area include the great egret (*Casmeroduis albus*), snowy egret (*Egretta thula*), great blue heron (*Ardea herodia*), little blue heron (*Egretta caerulea*), and tricolored heron (*Egretta tricolor*) (U.S. Navy, 1986; Audubon, 2002).

In Alabama, most of the migratory waterfowl winter in the Tennessee Valley, on Upper Mobile Bay, and on Mississippi Sound (U.S. Navy, 1986). Considering the location of the project area in the upper portion of Mobile Bay, it is likely that some migratory waterfowl use the area for foraging and loafing. Coastal areas and river valleys provide abundant food and shelter for migrants. The more abundant species in the Mobile Bay area include the lesser scaup (*Aythya affinis*), ring necked duck (*Aythya collaris*), gadwall (*Anas strepera*), green-winged teal (*Anas carolinensis*), mallard (*Anas platyrhynchos*), and ruddy duck (*Oxyura jamaicensis*) (U.S. Navy, 1986).

Mammals. Diversity among the upland mammal species is limited in the project area because there is not a wide variety of vegetative communities to serve as habitat. Species likely to be found in the project area are common throughout Mobile County, and are somewhat opportunistic species such as the nine-banded armadillo (*Dasypus novemcinctus*), opossum (*Didelphis marsupialis*), and raccoon (*Procyon lotor varius*) (U.S. Navy, 1986). Fox (*Vulpes sp.*) have been spotted in the area. The swamp rabbit (*Sylvilagus aquaticus littoralis*) may also be found throughout the coastal marshes of Alabama.

Other mammals that could be found in the region include the hoary bat (*Lasiurus cinereus*), black rat (*Rattus rattus*), Norway rat (*Rattus norvegicus*), house mouse (*Mus musculus*), and rice rat (*Oryzomys palustris palustris*) (U.S. Navy, 1986).

Reptiles/Amphibians. The Mobile Bay and Mobile-Tensaw River Delta are rich in wildlife diversity with more than 126 species of reptiles and amphibians. Reptiles are cold-blooded, meaning their body temperature is not internally regulated and so it's similar to that of the external temperature. These vertebrates usually lay eggs and have an external covering of scales or horny plates. They breathe by means of lungs. The ADCNR reports that that Alabama is home to 93 native reptiles, including 12 lizards, 49 snakes, 31 turtles and the American alligator. In addition, four exotic lizard species have established populations in south Alabama. The only snake to habitually occupy the salt marsh habitat in Alabama is the Gulf salt marsh water snake (Natrix fasciata clarki) (Mount, 1975). Many of these species occur within the project area.

Table 2-32. 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.

Amphibians are cold-blooded (body temperature is not internally regulated and therefore is similar to the external temperature), smooth-skinned vertebrates that characteristically hatch as an aquatic larva with gills. The larva then transform into an adult having air-breathing lungs. According to the ADCNR, Alabama is home to 73 native amphibians, including 30 species of frogs and 43 species of salamanders. One established exotic species, the greenhouse frog, occurs in Baldwin and Mobile counties. Two native species, the Mississippi gopher frog and the flatwoods salamander have not been observed in many years and may be extirpated from Alabama.

The Alabama red-bellied turtle (*Pseudemys alabamensis*), a Federally listed endangered species, has been sighted in the brackish marshes in the area north of the Arlington and Garrows Bend Channels (U.S. Navy, 1986). However, Dr. David H. Nelson, Associate Professor at the University of South Alabama (2003), has indicated that the turtle is usually not found in brackish or saltwater, but prefers freshwater. Other turtle species that could occur in the area include the river cooter (*Chrysemys concinna concinna*) and Mississippi diamondback terrapin (*Malaclemys terrapin pileata*).

2.5.10. Fisheries Resources

Fish, Crustaceans, and Mollusks. Mobile Bay supports a varied mix of commercially and recreationally important species of finfish and shrimp. These species are present in Mobile Bay during part or all of their life cycle. In 1996, the American Sportfishing Association (ASA) reported that recreational fishing in Alabama is a major industry. Common recreational fishes that could be targeted in Mobile Bay, as well as in the project area, include red drum (redfish), spotted sea trout, mullet, and flounder. Bay anglers generally fish from private boats, beaches, piers, and jetties, whereas offshore anglers tend to focus on a few naturally occurring sites such as rock piles and topographic highs.

Land access to the shoreline of the project area is somewhat limited by expansive wetland complexes and upland land uses such as industry and private property. The large expanses of wetland do not allow shore anglers to reach open water to fish. Sediments along the shoreline are somewhat soft and do not allow for anglers to wade-fish.

Along the eastern shore, shoreline fishing is most likely limited by the industrial activities and the limited access due to private property. Considering the substantial amount of industrial activity in the project area, recreational anglers in boats would most likely have to stay near the shorelines to avoid boat traffic and the necessity to relocate often.

Red Drum. The red drum is common in the Mobile Bay area (Nelson, 1992). This species is overfished throughout the Gulf and is managed by the GMFMC. Stringent catch restrictions are in place to control the level of commercial and recreational red drum catch. Red drum are heavily exploited, beginning as late juveniles, by the recreational fishery in the Mobile Bay area. The work by Van Hoose (1987) indicates that in creel surveys, the smallest red drum (7.9 to 11.8 inches total length) occurred in June and were a result of the previous fall's spawn. By their second spring, most red drum disappeared from the inshore anglers' catches in Alabama (Van Hoose, 1987). At this age, the fish are moving to offshore waters.

Adult red drum are found in Gulf waters off the Mobile Bay area and likely spawn from mid-August to early October (Van Hoose, 1987). Comyns et al. (1991) observed spawning dates for red drum in Louisiana, Mississippi, and Alabama coastal waters that ranged from August 21 to November 2, with peak spawning in September. Reports of red drum eggs and larvae in the Mobile Bay area are scarce in the literature. Holt, Godbout, and Arnold (1981) determined that the best conditions for hatching and early larval survival were at 30 ppt salinity and 77^{o} F. Eggs were found to sink at salinities below 25 ppt.

Larvae were found in samples collected in Mobile Bay at 3 to 4 mm standard length (Van Hoose, 1987). The literature suggests that larval red drum appear in September around Dauphin Island (Eckmayer et al., 1982) and in October in the Bay Channel (Williams, 1983).

Habitat preferences for red drum postlarvae and early juveniles are unclear, in that two stations where they were collected had similar bottom types but dissimilar shorelines, and both were adjacent to strong tidal flows (Van Hoose, 1987). Greatest postlarval catch per unit effort occurred at the Dauphin Island area from mid-September to mid-October. Van Hoose reports that postlarvae were present at salinities ranging from 8 to 31 ppt, that temperatures ranged from 66^{o}F to 88^{o}F, and that early juveniles were captured primarily in March.

Shrimp Fishery, Life History, and Habitat in Mobile Bay. Shrimp have been the single most important commercial fishery species group in Alabama, in both quantity and value (Swingle, 1971), accounting for 85 to 95% of the total value of the fishery. Commercial shrimp catches in Alabama have been composed of 87% brown, 10% white, and 3% pink and royal red (Swingle, 1971). In 1999, the shrimp fishery in Alabama had a combined value of nearly $17 million. Brown shrimp dominate the shrimp fishery in early summer, white shrimp in the fall, and pink shrimp are taken in the early spring along with browns and whites from the previous year. Most shrimp trawling takes place in the lower bay and coastal waters (Chemock, 1974).

A general summary of the life history and environmental tolerances for these three species of shrimp is provided by Pattillo et al. (1997). All three shrimp species spawn offshore in the Gulf. Shrimp postlarvae migrate into the bay where they concentrate in shallow vegetated marsh habitat. As they grow, they move into the deeper portions of the bay before migrating out into the Gulf waters to spawn. The results of the fish stock assessment suggests key bay areas for postlarval abundance are marshes at the western mouth of Mobile Bay (eastern Mississippi Sound); Weeks Bay; the eastern mouth of the GIWW, and the marshes associated with tributaries on the western shore of the bay. A limiting factor for all three species in Mobile Bay is the availability of shallow marsh edge vegetated habitat.

Brown Shrimp. Adult brown shrimp are the most abundant and commercially valued shrimp fishery in Mobile Bay (Swingle, 1971). Landing statistics of brown shrimp from the Alabama Gulf of Mexico, Alabama reaches of Mississippi Sounds, and Bon Secour Bay during the period of 2013 through 2016 has been reported by the ADCNR, MRD (2018) as over 15.5 million pounds and valued at a gross dock-side value of over $38 million over that time period. They occur in Mobile Bay from April to November, peaking in May. They occur most frequently in shallow vegetated areas, in water <3 ft in depth. They have a high affinity for vegetated habitat (Howe et al., 1999). Brown shrimp have been taken from salinities of 0.2 to >30 ppt in Mobile Bay but are most abundant in the bay at 2 to 20 ppt (Swingle, 1971).

The peak spawning period for brown shrimp occurs in December and January. Postlarvae and juveniles first appear in Mobile Bay in late March and early April (Swingle, 1971). Immigration of postlarvae may occur from February to October, with a peak in April (Swingle, 1971). The greatest concentration of juvenile brown shrimp is found in the western portion of the bay, perhaps because it is shallower than the eastern portion. They inhabit shallow bay waters, and are most abundant at <10 ft of water. The preferred habitat is select shallow, vegetated areas.

White Shrimp. The adult white shrimp occur in Mobile Bay from June to late November, reaching a maximum abundance in July and August. These commercially valuable shrimp are harvested from the Alabama waters in the Gulf of Mexico, Mobile and Bon Secour Bays, and Mississippi Sound. The ADNCR, MRD indicates the white shrimp harvest in these areas from 2013 through 2016 consists of approximately 6.9 million pounds with a dock-side value of about $19.8 million.

White shrimp have been recorded in Mobile Bay waters with salinities ranging from 1.3 to >30 ppt, with the highest quantity occurring when salinities are 25 to 29 ppt (Swingle, 1971). Adults are much more abundant in the western than the eastern portion of the bay and also in the northern than the southern portion. The post-larvae and juveniles are most often found in <2 ft of water. They are most abundant in areas of high quantities of organic detritus and have a high affinity for vegetated habitat. Their abundance at the marsh edge was described by an observer as “thousands in a band no more than 6 ft wide along the edge.” This species is generally considered to be more tolerant of sudden salinity changes than the brown shrimp (Pattillo et al., 1997). From September through November, they move to the deeper parts of bay. Emigration of white shrimp into the Gulf begins in August and continues through October, with a peak in September. The

Swingle (1971) study found peak abundance of white shrimp in Alabama estuaries at salinities of 15 to 29.9 ppt.

Pink Shrimp. Adults occur in Mobile Bay in highest numbers from October to May. They occur most frequently in the lower portion of the bay. They typically occur in waters with salinities >10 ppt (Swingle, 1971). The postlarvae and juveniles have a high affinity for vegetated habitat.

Oyster. Oyster harvesting is an active industry in Mobile Bay. The oyster reefs have progressively migrated down-bay, with most occurring near the Gulf at the lower end of Mobile Bay. According to a 1995 survey of reefs south of the East Fowl River, the reef area at Cedar Point was nearly twice that found in 1968 (Mobile Bay National Estuary Program, 2002a). A study conducted in 2002 in the upper Mobile Bay surrounding the Garrows Bend area has indicated that most of that area is permanently closed to oyster harvesting (Mobile Bay National Estuary Program, 2002a). According the ADNCR, MRD, the oyster harvest in Mobile and Bon Secour Bays and the Alabama portion of Mississippi Sound for the period of 2013 through 2016 was reported at just over 274,000 pounds of shucked oysters which translates to an approximate dock-side value of over $2.1 million.

Blue Crab. Adults, juveniles, and larvae are highly abundant in Mobile Bay (Pattillo et al. 1997; Nelson, 1992). Blue crabs are euryhaline and have been found from freshwater to hypersaline lagoons (0 to 50 ppt). Typically, juveniles are found in lower-salinity waters (2 to 21 ppt). Adult males are usually found in waters with salinities less that 10 ppt, whereas egg-bearing females are found in 23- to 33 ppt salinity and 19 to 29° C waters. The interaction of salinity and temperature reveals the blue crab to be less tolerant of low salinities at high temperatures and high salinities at low temperatures. Mating of the blue crab occurs in the bay (Pattillo et al., 1997). Blue crab mate and ovulate in spring and summer in the bay estuary. Juvenile crabs can be found congregating in channels and marine and brackish marshes along the bay throughout the year. They prefer soft mud substrate sediment and low salinity. Marketable size is reached in about 1 year. Blue crab are widely distributed throughout Mobile Bay.

As a commercially valuable species, the ADNCR, MRD has indicated that between 2013 and 2016 approximately 4.9 million pounds of crabs have been harvested from the Alabama waters in the Gulf of Mexico, Mobile and Bon Secour Bays, and Mississippi Sound. The harvest during this time period represents a gross dock-side value of about $4.8 million.

Striped Mullet. Striped mullet live in a wide range of habitats and depths depending on life stage, season, and location. This species is one of the most abundant fishes in shallow Gulf waters and often has the highest biomass. It is most abundant in waters near-shore, occupying virtually all shallow marine and estuarine habitats including open beaches, flats, lagoons, bays, rivers, salt marshes, and grass beds.

In Mobile Bay, striped mullet adults, juveniles, and larvae are abundant (Pattillo et al., 1997). Spawning begins in October to mid-November and lasts until March. Ripe adults collect in large schools and migrate offshore. Spent adults usually return in about 10 days. Spawning takes place in the offshore marine waters of the Gulf over a broad area of the continental shelf. Pre-juveniles, juveniles, and adults are nektonic and form schools ranging from a few individuals up to several hundred. Pre-juveniles enter bays and estuaries to mature. This occurs from November to June after they have reached 15 to 32 mm in total length, with the highest occurrence from December to February. Juvenile and adult feeding preferences include organic detritus, diatoms, filamentous algae, organic matter, benthic organisms, plant tissue, foraminifera, and plankton of correct particle size, but they have also been observed with fish scales, sponge spicules, and minute gastropods in their stomach contents.

The mullet are a commercially valuable species harvested in the Alabama waters in the Gulf of Mexico, Mobile and Bon Secour Bays, and Mississippi Sound. Included with harvesting of other finfish species, statistics collected by the ADNCR, MRD indicates that for the years of 2013 through 2016 the total harvest of finfish from Alabama waters yields approximately 20.1 million pounds. This represents a gross dock-side value of about $18.5 million.

2.5.11. Invasive Species.

Invasive species in Mobile Bay include both plant and animal species. Currently, the Eurasian watermilfoil, water hyacinth (*Eichhornia crassipes*), nutria (*Myocastor coypus*), and cattle egrets (*Bubulcus ibis*) are known invasive species. The plant species (Eurasian watermilfoil and water hyacinth) in some instances have clogged some area waterways, altering hydrology and navigation, while also crowding out native submerged and emergent aquatic vegetation. The nutria, an exotic estuarine rodent, is responsible for the destruction of large areas of marsh vegetation in the Mobile Bay estuary. Cattle egrets directly compete with native wading birds for nesting habitat (Mobile Bay National Estuary Program, 2002b).

Eurasian watermilfoil, a submerged aquatic weed native to Europe, Asia, and northern Africa, has spread rapidly throughout the U.S. Watermilfoil invades lakes, ponds, and reservoirs and is especially troublesome in nutrient-rich waters with high motorboat use. Watermilfoil has been spread inadvertently throughout the country by anglers and aquarium dealers. The plant disperses primarily by vegetative propagation through stem fragmentation. Due to its unique growth habits, watermilfoil competes aggressively with native aquatic plants. Soon after becoming established at a new site, it quickly forms an extensive root system. In the early spring, the species begins to grow well before native species. Later in the season, watermilfoil forms a dense canopy that overtops and shades out existing vegetation. The plant's ability to grow in eutrophic conditions and over a broad temperature range also contributes to its competitive edge over native plants. In the Mobile-Tensaw River Delta of Alabama, watermilfoil has displaced populations of native eelgrass and southern naiad (Westbrooks, 1998).

The water hyacinth was probably introduced from South America into the U.S. at the World's Industrial and Cotton Centennial Exposition of 1884-1885 in New Orleans. Substantial environmental harm can result from large water hyacinth populations, e.g., degraded water quality and drastic changes in plant and animal communities. Light and oxygen diffusion are severely curtailed by this floating plant, and water movement can be reduced by 40 to 95%. In addition, spawning areas for fishes are reduced by water hyacinth mats. Once the plant dies, the large masses shade out benthic communities and can nearly block the diffusion of oxygen through the water-atmosphere interface. Low oxygen concentrations underneath water hyacinth mats have been implicated in fish kills (University of Florida, 2002a).

The nutria occurs generally in temperate South America and is now widely dispersed in the U.S. and Western Europe. The nutria is a large rodent, almost equal in size to a beaver. It measures up to 40 inches in total length. The first nutria are said to have been released in the Louisiana marshes in the early 1930s near New Orleans to destroy objectionable aquatic plants. As a biological agent in the control of aquatic plants, nutria have been vastly overrated. Typically, they eat vegetation that humans do not want controlled, passing up water hyacinths, alligator weed (*Alternanthera philoxeroides*), coontail (*Ceratophyllum demersum)*, bladderwort *(Utricularia* sp*.)*, and other plants that they were introduced to destroy (Lowery, 1974).

Overall invasive species management priorities in Alabama include water hyacinth, as well as the plants hydrilla (*Hydrilla verticillata*) and giant salvinia (*Salvinia molesta*), and the animals bighead carp (*Hypophthalmichthys nobilis*) and spotted jellyfish (*Phyllorhiza punctata*) (EPA, 2000).

2.5.12. Air Quality.

Ambient air quality is determined by the type and amount (concentration) of pollutants emitted into the atmosphere, the size and topography of the air basin in question, and the prevailing meteorological conditions in that air basin. Through its passage of the Clean Air Act of 1970 (CAA) and its amendments, Congress has mandated the protection and enhancement of our Nation's air quality. The EPA has established the National Ambient Air Quality Standards (NAAQS) for the following criteria pollutants to protect the public health and welfare: sulfur dioxide (SO_2), ozone (O_3), nitrogen dioxide (NO_2), particulate matter (PM) whose particles are less than or equal to 10 micrometers (PM_{10}), particulate matter whose particles are less than or equal to 2.5 micrometers ($PM_{2.5}$), carbon monoxide (CO), and lead (Pb). The State of Alabama adopted the NAAQS as the state ambient air standards (ADEM 2017a).

The description of the criteria pollutants and their effects on public health and welfare and the NAAQS are detailed in Section 2.12, Appendix C. The primary NAAQS were promulgated to protect public health, and the secondary NAAQS were promulgated to protect public welfare (e.g., visibility, crops, forests, soils and materials) from any known or anticipated adverse effects of air pollutants.

Since the localized air quality condition can be correlated with the close proximity of major emission sources, sensitive receptors (e.g., individuals with respiratory conditions) that are close to major emission sources generally tend to have more air quality concerns than those located far from emission sources.

Mobile Harbor's operational activities are mostly associated with mobile source operations conducted around port terminals and River Channels within a relatively large geographic area. The air quality impact analysis selected for this SEIS purpose estimates emissions that occur from operational activities under both baseline 2011 conditions and the future 2035 No Action and Action Alternatives. The sources of criteria pollutant emissions evaluated include those identified within Mobile Harbor such as:

- Stationary sources
    - : terminal exhaust stacks and coal transport operations
- Mobile sources:
    - Drayage, cargo handling equipment, and on-terminal activities
    - Harbor craft
    - Ocean going vessels including
    - Ships at terminal
    - Ships underway along the channels
    - Roadway vehicles including trucks in and out of the port
    - Railroad and railyard

The areas around Mobile Harbor are considered in attainment for all criteria pollutants. When emissions associated with a Federal action would occur in areas that are in attainment, the CAA general conformity rule is not applicable, but NEPA and its implementing regulations require analysis of the significance of air quality impacts from these sources. However, neither NEPA nor its implementing regulations have established de minimis emission thresholds to determine potential significance of air quality impacts in attainment areas on a local level as compared to an area that is nonattainment.

2.5.13. Hazardous and Toxic Materials

Hazardous substances, including hazardous waste, are defined as any substance or material that has been determined to be capable of posing an unreasonable risk to health, safety, and property. Hazardous waste is listed under the Resource

Conservation and Recovery Act (RCRA), meeting certain characteristics relating ignitability, corrosivity, reactivity, or toxicity.

Hazardous materials and management of these materials are regulated under a variety of Federal laws including the Occupational Safety and Health Administration (OSHA) standards, the Emergency Planning and Community Right to Know Act (EPCRA), and the Toxic Substances Control Act along with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). The USACE adheres to these requirements. Under EPCRA regulations 40 CFR 355, facilities that have any extremely hazardous substances present in quantities above the threshold planning quantity, are required to provide reporting information to state and local emergency agencies, and local fire department. Inventory reporting to the indicated emergency response parties is required for facilities with greater than the threshold planning quantity of any extremely hazardous substances or greater than 10,000 pounds of any OSHA regulated hazardous material. EPCRA also requires inventory reporting for all releases and discharges of certain toxic chemicals. Dredged material is excluded from RCRA and regulated under the CWA and MPRSA.

The Mobile Harbor Federal Navigation Channel, itself, does not generate hazardous materials; however, approximately 10 terminals currently handle coal, petroleum products, and containerized hazardous materials. The petroleum products are considered hazardous with respect to human and ecological health. These operations are regulated such that the risk of spills or other releases are minimized. Additionally, large vessels have fuel and other lubricants on board while traveling in the channel. The two dredges used in the channel for routine maintenance dredging would also have these supplies on board. Unless there is an unavoidable accident or other unforeseeable conditions, the transportation of hazardous materials and petroleum products should not harm human health or the environment.

2.5.14. 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 also measured in dB and then compared to a fixed reference level. Noise levels continuously vary with location and time. In general, noise levels are high around major transportation corridors along highways, railways, airports, industrial facilities, and construction activities. Sound from a source spreads out as it travels from the source, and the sound pressure level diminishes with distance. In addition to distance attenuation, the air absorbs sound energy; atmospheric effects (wind, temperature, precipitation) and terrain/vegetation effects also influence sound propagation and attenuation over distance from the source. An individual's sound exposure is determined by measurement of the noise that the individual experiences over a specified time interval.

A detailed discussion of noise regulations, sound levels, and standards are included in Section 2.14, Appendix C.

Airborne Noise. The area surrounding the project site consists of conditions ranging from a highly populated urban area, to a heavily industrial area to unpopulated open water in Mobile Bay. The locations of potential noise sensitive receptors were assessed using a 0.5 mile buffer from the center of the proposed channel modifications. These sensitive receptors included National Register of Historic Properties, schools, churches and hospitals. The web-based search yielded 4 churches, 3 schools and 17 historic properties along the length of the channel. All but two of these are located in the vicinity of the I-10 tunnels under Mobile Bay (NEPAssist 2018).

Sound is measured in units of decibels (dB). Sound level measurements are typically weighted to correspond to the limits of human hearing. This adjusted unit of measure is known as the A-weighted decibel (dBA). A noise change of 3 dBA or less is not normally detectable by the average human ear. An increase of 5 dBA is generally not readily noticeable by anyone, and a 10 dBA increase is usually felt to be "twice as loud" as before. Existing noise levels in the project area where sensitive receptors are located are already relatively high ranging from 56 to 85 dBA (2. USACE 2003, 3. FHWA and ALDOT 2014). Airborne noise levels in the portions of the channel in open water would be very low and there are no sensitive receptors located in these stretches. Therefore, changes to airborne noise levels in the open water areas are not analyzed further in this SEIS.

Road traffic noise is not usually a serious problem for people who live more than 500 ft from heavily traveled freeways or more than 100 to 200 ft from lightly traveled roads (6. Federal Highway Administration 2011). Due to the nature of the decibel scale and the attenuating effects of noise with distance, a doubling of traffic would result in a 3 dBA increase in noise levels, which in and of itself would not normally be a perceivable noise increase.

The level of construction noise is dependent upon the nature and duration of the project, and the type of construction equipment used. Construction activities for most large-scale projects would be expected to result in increased noise levels as a result of the operation of construction equipment onsite and the movement of construction-related vehicles (i.e., worker trips, and material and equipment trips) on the surrounding roadways. Noise levels associated with construction activities will increase ambient noise levels adjacent to the construction site and along roadways used by construction-related vehicles. Construction noise is generally temporary and intermittent in nature as it generally only occurs on weekdays during daylight hours, which minimizes the impact to sensitive receptors (residences or other developed sites where frequent human use occurs such as churches and schools).

Underwater Noise. Underwater (waterborne) sound measurements are different from airborne sound measurements. When underwater objects vibrate, they create sound-pressure waves that alternately compress and decompress the water molecules as the sound wave travels through the water. Because of the differences in reference standards, noise levels for air do not equal underwater levels.

As noted above, sound levels are referenced to a standard pressure at a standard distance. The reference level used in air (20 µPa at 1m) was selected to match human hearing sensitivity. A different reference is used for underwater sound: 1µPa at 1m.

The mechanical properties of water differ from those of air and, as a result, sound moves at a faster speed in water than in air. Temperature also affects the speed of sound, which travels faster in warm water than in cold water.

Sound is the only form of energy that travels efficiently through water. For instance, radio and other electromagnetic waves are attenuated in water at a much greater degree than sound. The different medium also affects the rate at which sound energy is lost. In general, shallow water areas experience a higher transmission loss than deep water areas, especially when sound-absorbing, soft bottom material is present However, in areas with a highly reflective bottom such as hard rock, the transmission loss may be less than in deep water. Low-frequency sounds travel farther than high-frequency ones. There are many sources of underwater noise, including physical phenomena (e.g., waves and wind); biological activity (marine mammals); and human actions (e.g., vessel traffic, shoreline industrial activities).

2.5.15. Coastal Barrier Resources

The Coastal Barrier Resources Act of 1982 (CBRA) (PL 97-348) restricts Federal expenditures and financial assistance within designated CBRA zones in the Gulf and Atlantic Coasts. There are no designated CBRA zones within the project area and will not be considered further under this study.

2.5.16. Cultural and Historic Resources

Cultural resources is a broad term encompassing all aspects of human culture, both tangible and intangible. More specifically the National Historic Preservation Act (NHPA) has defined historic properties as prehistoric and historic archaeological sites, structures, buildings, districts, objects or any other physical evidence of human activity considered important to a culture, a subculture, or a community for scientific, traditional, religious, or any other reason. Several Federal laws and regulations protect these resources, including the NHPA of 1966, the Archaeological and Historic Preservation Act of 1974, the American Indian Religious Freedom Act of 1978, the Archaeological Resources

Protection Act of 1979, and the Native American Graves Protection and Repatriation Act of 1990.

Section 106 of the NHPA and its implementing regulations, 36 CFR Part 800, require an assessment of the potential impact of an undertaking on historic properties that are within the proposed project's Area of Potential Effect (APE), which is defined as the geographic area(s) "within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist." The APE for the project area includes the area where dredging activities and the placement of dredged material would occur.

Documentation of historic/cultural resources is important for this project because Mobile Harbor provides an environment that is rich in prehistoric and historic human activity, and its geological setting is characterized by sediment types that are known for preserving shipwrecks and their contents. In addition to submerged resources such as prehistoric landforms that were well suited for human occupation when sea levels were lower, as well as historic resources such as shipwrecks, there are a number of terrestrial archaeological sites and historic buildings and structures in Mobile Bay or along the shoreline. The shoreline structures include historic structures such as the National Register listed Forts Morgan and Gaines; structures in the bay include the National Register listed Middle Bay Lighthouse and historic Sand Island Lighthouse. An extensive discussion of the prehistory and history as well as known cultural resources within and near the proposed project's APE is included in detail in Section 2.16, Appendix C.

2.5.17. Protected Managed Lands and Resources

According to the ADCNR, Alabama is home to 11 national wildlife refuges that represent a cross-section of Alabama's diverse natural environment as well as state and private managed areas. Alabama's protected lands and resources encompass the beaches and estuaries of the Gulf Coast, the waters of the Tennessee River, and the swamps and wetlands along the Tombigbee River. The ADCNR is the state agency responsible for the conservation and management of Alabama's natural resources, including state parks, state lands, wildlife, and aquatic resources.

Gulf State Park. The Gulf State Park is a public recreation area on the Gulf of Mexico in the city of Gulf Shores in southern Baldwin County. The park's 6,500 acres mostly encompass the land just north of the Gulf Shores beach community, between State Highways 59 and 161 and extending south to a wide beach area. The park also includes marshland, boggy tea-colored streams, pine forests, and three spring-fed, fresh-water lakes: Lake Shelby (750 acres); Middle Lake; and, Little Lake (Ress, 2012). The park is managed by the ACDNR, with park enforcement rangers providing around-the-clock security and enforcing anti-littering regulations.

Weeks Bay National Estuarine Reserve. This Reserve is a field research facility along the Weeks Bay estuary, about 6,000 acres in size. The reserve area receives freshwater from the Magnolia and Fish Rivers, and drains a watershed of about 127,000 acres into the portion of Mobile Bay via a narrow opening. This sub-estuary of Mobile Bay averages just 4.8 ft deep and provides rich and diverse habitats for a variety of fish, crustaceans and shellfish, as well as many unique and rare plants fringed with marsh and swamp habitats. The reserve lands also include upland and bottomland hardwood forests, freshwater marsh, SAV, and unique bog habitats. Weeks Bay is a critical nursery for shrimp, bay anchovy, blue crab and multitudes of other fish, crustaceans and shellfish that support robust commercial fisheries providing $450 million/year for Alabama. The Weeks Bay Interpretive Center offers the public opportunities to learn about coastal habitats through its exhibit, live animals displays and collections of animals and regional plants. Self-guiding nature trails wind through wetlands, marshes, bogs and forests.

Grand Bay National Wildlife Refuge (NWR). This refuge falls within the borders of both Alabama and neighboring Mississippi along the Gulf Coast. The 10,188-acre reserve is part of the Federal Gulf Coast National Wildlife Refuge (NWR) Complex. The refuge was established in 1992 to protect one of the largest remaining expanses of wet pine savanna habitat consisting of a complex of wet pine savanna, maritime forest, tidal wetlands, salt marshes bays, and bayous. Protected species that inhabit the refuge include the threatened gopher tortoise, the endangered red-cockaded woodpecker, and the endangered brown pelican.

Bon Secour NWR. The Reserve is located on the Morgan peninsula about 10 miles west of the city of Gulf Shores in Baldwin County. Approximately 7,000 acres the refuge consists of beaches, dunes, saltwater marshes, freshwater swamps, and scrubland. Established in 1980, the goal of the refuge is for preserving coastal habitat for migratory song birds. The refuge lies directly on the migration path for many of these birds who use the refuge as a stopping point on their fall migration before they begin the long flight to the Caribbean and Central and South America. Bon Secour is considered one of the last remaining natural patches of coastal habitat among the coastal areas and thus vital for the survival of migratory birds. Coyotes, red foxes, American alligators, armadillos, and more than 370 species of birds have been sighted at the refuge. The refuge contains nesting habitat for the endangered Alabama beach mouse and loggerhead and Kemp's Ridley sea turtles. Other protected habitats within the refuge include beaches and sand dunes, scrub forest, fresh and saltwater marshes, fresh water swamps, and upland.

Meaher State Park. Meaher State Park is a publicly owned recreation area located on Big Island in the north end of Mobile Bay lying within the city limits of Spanish Fort. The state park occupies 1,327 acres along the bay shoreline at the junction of Mobile Bay and the Mobile-Tensaw River Delta (Ress, 2012) and is surrounded by wetlands of the Mobile Bay estuary. The park is accessed from the U.S. Highways 90/98 causeway and is managed by the ADCNR.

Historic Blakeley State Park. Located on the site of the former town of Blakeley, Historic Blakeley State Park is on the Tensaw River. The park encompasses an area once occupied by settlers in what was a thriving community on the river. Later, Confederate soldiers were garrisoned here and fought in the last major battle of the U.S. Civil War against superior Union forces. The park was founded by school teacher Mary Grice, of Mobile, Alabama. In 1976 the park was established as a private not-for-profit foundation. The goal was to preserve and redevelop the area. In 1981, the Alabama Legislature named Blakeley a state park and created a separate state authority to oversee operations. Although it is called a state park, it is not operated by the ADCNR. State funding was suspended during 2011, and the park is now fully funded by private contributions and gate receipts.

2.5.18. Aesthetics and Recreation

Coastal-based tourism and recreation account for a significant portion of Alabama's tourism and recreation industry. Opportunities for recreation include arts and entertainment, boating, golfing, sightseeing, picnicking, swimming, bird watching, and fishing. For land lovers, Mobile and Baldwin Counties also offer plenty to do away from the water, including cultural, historic, educational and family-friendly attractions. Visitors can enjoy outdoor activities such as fishing and swimming in waters of the Gulf of Mexico in the beach towns of Gulf Shores, Orange Beach, and Fort Morgan, and Dauphin Island as well as several historic places.

Alabama has a rich history and diversity of freshwater, inshore, and saltwater sport fishing opportunities within its extensive rivers systems, farm ponds and the inshore and offshore waters of the Gulf of Mexico. According the ADCNR, the State contains 47 reservoirs larger than 500 acres that cover an area of 551,220 acres, 23 Alabama State Public Fishing Lakes, and 77,000 miles of perennial rivers, streams and the Mobile-Tensaw River Delta as well as over 60 miles of shoreline along the Gulf Coast that provide fresh and saltwater fishing opportunity. Alabama supports 11 million angler fishing days with expenditures of three-quarters of a billion dollars. There is excellent access to the inshore waters of Mobile Bay and offshore waters of the Gulf of Mexico from Mobile and Perdido Bay. Inshore and estuarial fishing opportunities are extensive in both upper and lower Mobile Bay, but extend from Grand Bay in the Mississippi Sound on the West to the western shores of Perdido Bay near Orange Beach, Alabama. Numerous local, regional and national fishing tournaments take place throughout the State every year.

As described by Douglass (2009), the Alabama coastline stretches 60 miles and is home to beaches along the Gulf and provides quality of life for many Alabamians. It also plays a major role in the State's economy as well as being recognized as valuable environmental asset. The beaches of the coastal towns of Orange Beach, Gulf Shores, and Dauphin Island are popular instate vacation destinations for out-of-state visitors and are top tourist destinations. The beach tourism industry in south Baldwin County provides more than 50,000 jobs and generates more than $2 billion in revenue annually, and beaches are the linchpin of that industry (Douglass, 2009). The coastal bays, rivers, and bayous tidal shoreline that borders all of the Mobile and Baldwin counties extends another 600 miles, with the shoreline around Mobile Bay accounting for about 100 of those miles (Douglass, 2009). Today, Alabama's coastal beaches remain a major tourist attraction as well as a lifestyle staple for Alabama residents (ADEM, 2017). Alabama has approximately 50 miles of Gulf beach and an estimated 65 to 70 miles of bay beaches where the adjacent waters are classified for swimming under the State's Water Use Classification System (ADEM, 2017)

Ecotourism, one of the largest industries in Alabama, has been identified globally as one of the few industries that can actually have a positive impact on the area. The potential market for ecotourism is significant. Worldwide, ecotourism is experiencing a 5% annual growth rate and it represents 6% of the world gross domestic product (Alabama Communities in Transition (ACTION), 2006). In addition to Mobile Bay and adjacent inshore and nearshore waters including the Gulf beaches, approximately 77,000 miles of rivers and streams, 50,000 small impoundments and 42 large reservoirs are found within our state boundaries. These abundant water resources provide a wide range of environments that harbor the most diverse aquatic fauna of any state in North America featuring a range of activities such as hiking, road and mountain biking, canoeing, kayaking, horseback riding, camping, wildlife watching, sail and power boating, hunting, and fishing (ACTION, 2006). The "5 Rivers – Alabama's Delta Resource Center" is a facility of the ADCNR State Lands Division and home of the Coastal Section offices. It provides public access to over 250,000 acres that comprise part of the Mobile-Tensaw River Delta.

Alabama's Gulf Coast has several historic places worth visiting, including Civil War-era Fort Morgan, near Gulf Shores, and Fort Gaines on Dauphin Island. Fort Conde, in downtown Mobile, is a replica of an 18th century French Fort. Battleship Memorial Park in Mobile includes the USS Alabama, one of the most decorated World War II battleships in America; the USS Drum, which is America's oldest submarine on display; and numerous combat planes.

2.5.19. Socioeconomics

This section provides an overview of the existing socioeconomic conditions within the project area. Components of socioeconomic resources that are analyzed include population, employment, and income. The Region of Interest (ROI) encompasses Alabama's two southernmost coastal counties - Mobile and Baldwin Counties. It includes the developed urban area of the City of Mobile, the maritime facilities, and residential areas along the east and west banks of the Mobile River and Mobile Bay which are immediately adjacent to the navigation channel.

Mobile and Baldwin counties form the economic ROI, which is the geographic area in which the predominant social and economic impacts of the Proposed Action are likely to occur. Mobile County is geographically smaller than Baldwin County, but has almost double its population. Together, the counties cover a land area of 2,819 square miles (USCB 2017). Mobile County includes the City of Mobile, which is the largest city in the region. Other cities in the Region of Interest (ROI) with more than 10,000 residents are Prichard, Saraland, Foley, Daphne, and Fairhope (TWT 2017).

In 2014, the total economic value of the marine cargo and vessel activity at Mobile Harbor including the revenue and value added at each stage of moving an export to the port or an import from the marine terminals was estimated at nearly $24.8 billion. In the state of Alabama, 149,432 jobs were in some way related to the cargo and vessel activity at the public and private marine terminals at Mobile Harbor.

The 2016 estimated population of Mobile County was 414,291 (USCB 2016). Population in the county is stable. Between 1990 and 2016, the population increased by 9.4 percent, yielding an average annual growth rate of 0.6 percent. The 2016 estimated population of Baldwin County was 199,510 (USCB 2016). Population in the county exhibits strong growth. Between 1990 and 2016, the population increased by 103.0 percent, yielding an average annual growth rate of 6.4 percent. Total employment in Mobile County in 2016 was 236,901 (BEA 2017) and 107,334 in Baldwin County, Alabama.

Additional detailed information on Regional Economic Activity, Population, Employment and Income concerning the socioeconomics of the ROI is included in Section 2.19.2, Appendix C.

2.5.20. Transportation

An overview of existing transportation resources within the project area is included in detail in Section 2.20, Appendix C. Components of transportation resources that are analyzed include roads, traffic, railroads, and airports

I-10 is the most southern major highway connector in the U.S.; it travels in an east-west direction, linking Florida to California. In the southeastern U.S., I-10 stretches from Jacksonville, Florida, to Houston, Texas, covering a majority of the coastline of the Gulf of Mexico. Along the Gulf, major seaports, including Pensacola, Florida; Mobile, Alabama; Gulfport, Mississippi; New Orleans, Louisiana; and Houston, Texas, are linked. Mobile is located at approximately the halfway point between Houston, Texas, and Jacksonville, Florida. I-10 in the vicinity of Mobile Harbor is a multi-lane (6 to 8 lanes), divided interstate level highway with controlled access. The speed limit is signed for 65 to 70 miles per hour (mph) (USACE 2003).

To the west of the harbor, I-10 has numerous interchanges with the Mobile Central Business District (CBD) and then crosses under the Mobile River by means of the Wallace Tunnels, a four-lane facility. Hazardous truck cargoes must bypass the tunnels by exiting at Water Street and detouring to cross the Mobile River via the Cochrane-Africatown Bridge to the north. I-10 then crosses the Mobile Bay by the four-lane I-10 Bayway to the Eastern Shore (Daphne in Baldwin County) and continues east to Florida. Direct access for Mobile Harbor to I-10 and its connecting network can be made by Broad Street and Virginia Street to their interchanges with I-10. A variety of other surface streets provide access to the harbor including Old Water Street, Water Street and State Docks Road (Google Earth 2018a). Currently, Broad Street and Virginia Street are two-lane roadways between the harbor and I-10.

Rail transportation includes public terminals around Mobile Harbor that are connected to I-10 and I-65 and five Class I railroads- CSX, Canadian National, Burlington Northern Santa Fe (Alabama & Gulf Coast Railroad), Norfolk Southern, and Kansas City Southern. All-water, rail connections into Mexico's national railroad system is offered by C.G. Railway every four days between Mobile and Coatzacoalcos, Mexico (Alabama Department of Commerce 2016).

Air transportation consists of Mobile Downtown Airport, previously and locally known as Brookley Field, which is located approximately 2.75 miles southwest of the Choctaw Point Turning Basin. This facility is a former U.S. Air Force Base. The closing of Brookley Field was initiated in 1964, and the City of Mobile accepted ownership on July 3, 1969. Management of the facility was transferred to the Mobile Airport Authority in 1982. The facility is now managed by the Mobile Airport Authority as a public facility, with private aviation and non-aviation light industrial companies located on the property (USACE 2003). The airport currently also houses the Mobile Aeroplex at Brookley (Mobile Aeroplex at Brookley 2018). Mobile Regional Airport is the primary commercial passenger airport serving the Mobile area. It is located approximately 11 miles west of the Choctaw Point Turning Basin and does not have rail access. The primary highway routes between the harbor and the airport are I-10, I-65, and Airport Boulevard (Google Earth 2018b).

Public transportation includes services such as The Wave Transit System, which is funded by the City of Mobile, and is the largest fixed-route transit system in the region. It provides service within Mobile City limits, limited service into the City of Prichard to the north, and paratransit service, in accordance with the Federal Transit Authority mandated 0.75 mile radius to those who qualify, and neighborhood curb-to-curb service in predefined areas. Wave Transit operates a network of 14 fixed routes and one downtown circulator in Mobile. Some populations have a higher propensity to take public transit than the national average. These populations include the young, elderly, low income, those with no access to personal vehicles, and minorities. Downtown, northwest of downtown along I-165 into Prichard, and southwest along I-10 just north of the Brookley

Aeroplex are the areas with the highest propensity for transit. These areas currently have fixed route bus service from Routes 5, 9, 11, and 16 (SARCOR et al. 2014). These areas are also close to Mobile Harbor.

Less than one percent of the working population, ages 16 and older, use public transportation for their commute in Mobile and Mobile County. Of those without access to a vehicle, only 7.6% of individuals and 8.6% of individuals, respectively, use public transportation to commute.

2.5.21. Utilities and Infrastructure

The existing infrastructure and utilities within the vicinity of the project area include roads, rail lines, airports, ports, electrical power sources, gas lines, water and sewer lines, and communications lines. More detail can be found in Section 2.21, Appendix C.

Alabama Power provides electrical service to Mobile County and parts of Baldwin County. Baldwin County EMC, and Rivera Utilities, and other area providers supply electrical service to parts of Baldwin County. Near the Choctaw Terminal, several large transmission lines occur along the boundary of the project site. These pole-supported lines extend adjacent to Baker Street and Yeend Street. The lines adjacent to Yeend Street conduct three-phase current, and are mounted on tall concrete poles. Wooden poles support the lines adjacent to Baker Street. Other electrical distribution lines extend across the northern end of the Choctaw Terminal, in various directions (USACE 2003). In Baldwin County, Alabama Power Company has substations, and 22KV, 44 KV 110KV transmission lines (Alabama Power 2018)

Natural gas is supplied throughout the project area by Spire (formerly Mobile Gas Service Corporation) (Mobile Area Chamber of Commerce 2018).

Mobile Area Water & Sewer System (MAWSS) provides drinking water and sanitary sewer service for the Mobile metropolitan area. Water is supplied from a reservoir, which is continually fed by groundwater, streams and rainfall. MAWSS has an alternative source of water to provide raw water for industrial use. Many area industries draw and treat water directly from the Tombigbee or Mobile rivers for industrial use (Mobile Area Chamber of Commerce 2018). Utilities, and other local providers, provide water and wastewater services to Baldwin County.

The EPA and the ADEM designated Mobile County as an owner/operator of a Phase II municipal separate storm sewer system (MS4). This necessitates Mobile County to develop a stormwater management program designed to protect water quality and to prevent harmful pollutants in stormwater runoff from entering the MS4 area. Stormwater runoff is rainfall that does not seep into the ground but runs off over developed areas. The runoff then enters the storm sewer system which flows directly into creeks, rivers, bays and the Gulf of Mexico (Mobile County 2018). Within the City of Mobile, the Storm Drain and Heavy Equipment Section is responsible for all pipe laying and roadside ditches, cleaning catch basins and repairing erosion along the stormwater system. The Flood Control Section is responsible for maintaining storm water systems through chemical and mechanical mowing and for cleaning debris from the system to allow the free flow of storm water. The Dredging Section is responsible for removing sand and silt from the City's rivers, canals and creeks in the stormwater system (City of Mobile 2018).

BellSouth Telecommunications doing business as (dba) AT&T, Alabama and CenturyTel and Gulf Telephone, both dba CenturyLink are the Incumbent Local Exchange Carriers (ILECs) operating and providing services to customers located near Mobile Bay in Mobile and Baldwin counties. Other telecommunications providers in the Mobile area include Southern Light, Madison River Communications, Southern Telecom, Inc. dba Sotelco, MCI Communications Services, Inc. dba Verizon Business Services and ITC DeltaCom among others (Alabama Public Service Commission 2018). Cable television is provided by DIRECTV, Xfinity, AT&T U-verse TV, and Mediacom Cable among others (CableTV 2018).

Mobile Harbor provides significant oil and gas infrastructure. Oil and Natural Gas wells and platforms are located in Mobile Bay and in the Gulf of Mexico south of Dauphin Island. Petroleum refineries, natural gas processing plants, petroleum and natural gas pipelines, import/export terminals, electrical transmission lines and power plants are also prominently located in the Mobile area. More details are presented in Section 2.21, Appendix C.

2.5.22. Environmental Justice

A summary overview of environmental justice (EJ) considerations within the project area is included here. However, due to the extensive analysis that was conducted for this subject matter, the detailed analysis for EJ is presented in Section 2.22, Appendix C. The components of EJ that are analyzed include minority and low-income populations.

EO 12898 (59 Federal Register [FR] 7629) directs Federal agencies to identify and address, as appropriate, potential disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority and low-income populations. The Council on Environmental Quality (CEQ) has provided guidance for addressing environmental justice in *Environmental Justice: Guidance under the National Environmental Policy Act* (CEQ 1997).

In identifying minority and low-income populations, the following CEQ definitions of minority individuals and populations and low-income populations were used:

- *Minority individuals.* Individuals who identify themselves as members of the following population groups: American Indian or Alaskan Native, Asian, Native Hawaiian or Other Pacific Islander, Black, Hispanic, or two or more races.
- *Minority populations.* Minority populations are identified where (1) the minority population of an affected area exceeds 50% or (2) the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis. For the purposes of this analysis, “meaningfully greater” is defined as greater than 20% of the minority population percentage in the general population of the county.
- *Low-income populations.* Low-income populations in an affected area are identified with the annual statistical poverty thresholds from the Census Bureau’s Current Population Reports, Series P-60, on Income and Poverty. In this analysis, low-income populations are identified where (1) the population of an affected area exceeds 50% low-income based on the Census data or (2) the percentage of low-income population in the affected area is greater than 20% of the low-income population percentage in county.

According to CEQ guidance, U.S. Census data are typically used to determine minority and low-income population percentages in the affected area of a project in order to conduct a quantitative assessment of potential environmental justice impacts.

There are two components of consideration for potential environmental justice impacts: (1) whether the proposed action results in significant adverse health or environmental impacts; and, if so, (2) whether disproportionate adverse impacts would be experienced by minority or low-income populations, as compared to other parts of the population found within any of the communities in the Region of Interest (ROI). The ROI is the affected environment for the environmental justice analysis.

The project site is located in Mobile Harbor, at the junction of Mobile River with the head of Mobile Bay. The project area is located in Mobile County, but is adjacent to Baldwin County. Therefore, for this project, the ROI encompasses Mobile and Baldwin Counties. The geographic unit used in the analysis to identify any environmental justice communities of concern is the census block group.

For the purposes of this analysis, a census block group constitutes an environmental justice community if it contains 50% or more aggregate minority or low-income population (the “Fifty Percent” analysis), or 20% or more aggregate minority or low-income population than the county average in which the block group is located (the “meaningfully greater” analysis). The most conservative metric, yielding the greatest number of block groups, was used in the analysis. See Section 2.22, Appendix C for more information.

2.5.23. Public and Occupational Safety

This section describes an overview of existing public health and safety related issues and the potential impacts associated with the No Action Alternative and the TSP. Public health issues include emergency response and preparedness to ensure project construction and operations do not pose a threat to public health and safety. Safety issues include occupational (worker) safety in compliance with the OSHA standards.

Workplace health and safety regulations are designed to eliminate personal injuries and illnesses from occurring in the workplace. These laws may comprise both Federal and state statutes. OSHA is the main organization protecting the health and safety of workers in the workplaces. The USACE has internal safety programs and processes designed to identify actions required for the control of hazards in all activities, operations and programs. It also establishes responsibilities for implementing OSHA and state requirements. There are several Federal safety regulations and requirements which apply to all USACE projects. These include:

- Comprehensive Environmental Response Compensation and Liability Act (CERCLA) 42 USC, 9601 et seq.)
- Superfund Amendments and Reauthorization Act (SARA) PL 99-499 (100 Stats. 1613)
- Resource Conservation and Recovery Act (RCRA; 42 USC, 6901 et seq.)
- Clean Water Act (CWA) (33 USC, 1251 et seq.)
- Hazardous Material Transportation Act (HMTA)
- Toxic Substances Control Act (TSCA) (15 USC, 2601 et seq.)
- Federal Regulations on Hazardous Waste Management (40 CFR, 260-279)
- Chemical Accident Prevention Provisions
- Emergency Planning and Community Right-to-Know Act (EPCRA)
- Occupational Safety and Health Standards
- Spill Prevention Control and Countermeasures Plans (SPCC)
- Emergency Evacuation Plan

The USACE ensures that all regulations are followed and requirements are met during the course of a project.

The general project area considered in the evaluation of public and occupational safety includes 37 miles of channel and the area surrounding Mobile Harbor. Land use in the project area is urban, industrial, commercial and open water. Although residences are located in the area, no persons or businesses are currently located within the footprint of the TSP dredging sites. The proposed dredging areas also do not include infrastructure such as roads, powerlines, water lines, or other utilities.

Public emergency services in the region include hospitals, law enforcement services, and fire protection services. There are four hospitals in the area (Mobile Infirmary, USA Medical Center, Springhill Medical Center, and Providence Hospital). Mobile Infirmary (2.5 mi) is the closest to Mobile Harbor. There are numerous occupational health clinics, a women's and children's hospital, infirmaries and doctor's offices located throughout Mobile. Medical and health resources are not located along the channel, but multiple options are available along both shores of Mobile Bay to the Gulf. Law enforcement in Mobile is provided by the Mobile Police force. Mobile County and Baldwin County both have Sheriff's Departments; and a number of smaller municipalities along the shores of the bay have police forces as well. The City of Mobile has a Fire and Rescue Department which includes first-responders. In addition, multiple fire departments are in the smaller municipalities along the shores of Mobile Bay, including volunteer fire departments in the less populated areas. The nearest fire station to ASPA Main Dock Complex of Mobile Harbor is located approximately 2 miles west of the facility. The Alabama Emergency Management Agency has the responsibility and authority to coordinate with state and local agencies in the event of a release of hazardous materials in association With-Project activities.

It is the USACE's policy that contractors have in place a site-specific health and safety plan prior to conducting construction activities at USACE controlled areas. The contractor site-specific health and safety plans address the hazards and controls as well as contractor coordination for various construction tasks. A health and safety plan would also be required for workers involved in the dredging projects.

The potential offsite consequences and emergency response plan are discussed with local emergency management agencies. Health hazards may also be associated with emissions and discharges from dredging machinery throughout the project area.

Hazardous wastes are not handled by the ASPA; additionally, hazardous materials would not be used during dredging operations. Limited quantities of petroleum products would be associated with dredging operations.

The ASPA has a Port-Wide Mass Notification System to alert ASPA employees, tenants, visitors and interested stakeholders in the event of an emergency within the Authority's seaport facilities. The system is designed to provide registrants alerts in the event of security incidents, hazardous chemical leaks, tornados and other severe weather (ASPA 2018). The system includes loudspeakers on the ASPA's Main Docks Complex, McDuffie Terminal, Pinto Terminal, Marine Liquid Bulk Terminal and Mobile Middle Bay Port. In high noise areas, strobe lights are used to signify a safety message. There are also LED signs throughout the port, which transmit security messages, etc (ASPA 2018).

Stakeholders outside of the Port's network can take advantage of the system by registering to be notified on land-line telephones or electronic devices. Up to 10,000 people can opt-in to be notified via text and email messages on iPhones, Androids and BlackBerry devices. The notification system keeps a record of who was notified and who responded. In order to opt-in to the notification system, it is necessary to register on the WebMsg website (ASPA 2018).

SECTION 3.0 PLAN FORMULATION

3.1. Planning Strategy

The USACE planning process follows a process defined in the U.S. Water Resources Council Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies. This process, used for all planning studies conducted by the USACE, provides a structured approach to problem solving and provides a rational framework for sound decision making.

The USACE plan formulation process identifies existing and anticipated problems and opportunities to develop planning objectives. It then identifies and refines specific measures that could be combined to develop alternative plans that meet the planning objectives. These alternatives are then screened, analyzed, and compared with each other to identify the alternative that best addresses the objectives and avoids the constraints.

During repeated refinement, the alternatives are designed to be complete, effective, efficient, and acceptable in an effort to maximize overall benefits and minimize costs and adverse impacts. To select a plan, the alternatives are compared from the perspectives of National Economic Development (NED), Regional Economic Development (RED), Environmental Quality (EQ), and Other Social Effects (OSE) to identify and recommend the alternative that provides the best and most balanced solutions, considering all four accounts.

The USACE began implementing a modernization of its planning program in 2012. The initiative applies a risk-based approach to shorten schedules and reduce the cost to complete the study process by eliminating non-essential activities while still producing reports that make and adequately support prudent recommendations. The risk-based process concentrates on collecting and presenting information related to the factors that most influence the decisions being considered and minimizing the collection and reporting of information that does not meaningfully influence the decisions and recommendations. When appropriate, it also uses assumptions, professional judgment, and/or estimates instead of acquiring new data to support the decision-making process after considering the relative likelihood, nature, and magnitude of the impacts to the overall decision and the associated environmental, social, and economic consequences. With this in mind, the PDT determined that the study would identify the potential measures, develop an initial array, narrow that array into a focused array of alternatives, and narrowing that array into the final array of alternatives. As the focused array of alternatives was being analyzed, the PDT would also determine which of the considered alternatives would most likely bracket the maximum dimensions that would be implemented for the purpose of evaluating the environmental impact analysis. The results of analyses on the focused array would be screened to narrow the alternatives to a final array of alternatives. From that array, additional screening would narrow the plans to the likely alternative that could be considered as the TSP.

3.2. Summary of Management Measures

A management measure is a feature or activity that can be implemented at a specific geographic site to address one or more planning objectives. They are generally categorized as structural or nonstructural. Preliminary alternatives are formulated and refined by combining, adapting, and scaling management measures to best address four criteria described in the Principles and Guidelines:

Completeness. Extent to which the alternative provides and accounts for all necessary investments or actions to ensure realization of the planning objectives

Effectiveness. Extent to which the alternative contributes to achieving the planning objectives

Efficiency. Extent to which the plan is the most cost-effective means of addressing the specified problems and realizing the specified opportunities, consistent with protecting the N ation’s environment

Acceptability. The extent to which the alternative plans are acceptable in terms of applicable laws, regulations and public policies

In accordance with 40 CFR 1502.14, the USACE will “rigorously explore and objectively evaluate all reasonable alternatives, and for alternatives eliminated from detailed study, briefly discuss the reasons for their having been eliminated.” For this feasibility study, a reasonable alternative is defined as an alternative that meets the objectives of the study and is under USACE authority to implement. A measure that could be implemented by others can be considered as long as it meets the objectives on its own or it can be a component of an alternative that meets the objectives in a way that is complete, effective, efficient, and acceptable.

Structural measures identified to be considered for Mobile Harbor include deepening the channel, widening the channel, bend easing in the Bar Channel, and modifying the turning basin. Nonstructural measures that could be considered include relocation of navigation aids, use of tugs, lightering, topping-off offshore, and scheduling. Table 3-1 presents the measures that were considered for this study.

Table 3-1. Measures Considered

Structural Measures	Non-Structural Measures
• Deepening	• No Action
• Widening	• Relocation of buoys
• Bend Easing	• Additional tugs
• Passing Lanes	• Light-loading
• Meeting Areas	• Lightering offshore
• Turning Basin	• Topping-off offshore
	• Scheduling

3.3. Initial Array of Alternatives

The Mobile Harbor Draft GRR/SEIS included evaluation of a future Without-Project condition that would not include any changes to the current channel dimensions. The PDT screened the measures considered to develop an initial array of alternatives to be analyzed to develop a focused array of alternatives. In addition to the non-structural measures, an array of structural measures was identified to address the planning objectives and included modifications to the Bay and Bar Channels, bend easing, and the turning basin. Specifically, this included:

> Deepening – Based on the study objectives, the alternative depths to screen for analysis ranged from 46 to 55 ft with an additional 2 ft of depth in the Bar Channel.

> Widening - Based on the study objectives, the alternative depths screened for analysis were 500 and 550 ft to allow for two way traffic within the Bay Channel for up to 15 nautical mile length.

> Bend Easing – Based on study objectives, widening of the two sharpest bends in the Bar Channel would be considered to conform with engineering guidance would allow for 24-hour operations.

> Turning Basin - Based on study objectives, modifications to the turning basin would be considered to conform to proposed design depth alternatives and the proposed design vessel.

The initial array of alternatives is displayed in Table 3-2.

Table 3-2. Initial Alternatives

Initial Alternatives		
Structural Measures		**Non-Structural Measures**
Depth	Width	
• 46 ft to 55 ft in 1 ft increments (48 ft to 57 ft in Bar Channel) • Turning Basin Depth to match channel depth (also, modification as needed for design vessel)	▪ 500 ft and 550 ft in Bay Channel ▪ Widen full channel length ▪ 700 ft in Bar Channel ▪ Bend easing	Nonstructural alternatives will match nonstructural measures list in Table 3-1.

3.3.1. Evaluation and Comparison of Alternatives

Alternative plans are evaluated by applying rigorous criteria. Per the *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies*, as stated in Section 3.2, four general criteria are considered during alternative plan screening: completeness, effectiveness, efficiency, and acceptability.

There are also specific technical criteria related to engineering, economics, and the environment, which also need to be considered in evaluating alternatives. These are:

Engineering Criteria:

- The plan must represent a sound, acceptable, safe, efficient and reliable engineering solution.

Economic Criteria:

- The plan must contribute benefits to NED.
- Tangible benefits of a plan must exceed economic costs.
- Each separable unit of improvement must provide benefits at least equal to costs.

Environmental Criteria:

- The plan will fully comply with all relevant environmental laws, regulations, policies, and executive orders.

- The plan represents an appropriate balance between economic benefits and environmental sustainability.
- The plan has been developed in a manner that is consistent with the USACE Environmental Operating Principles.

3.3.1.1. Screening of Initial Alternatives

For the stated evaluation criteria, there would be a significant amount of analysis required to fully evaluate the entire range of deepening and widening alternatives. In 2012, the USACE adopted a Specific, Measureable, Attainable, Risk-Informed, and Timely (SMART) Planning process to accelerate feasibility study execution. Based on guidance from this initiative, the number of alternatives to be analyzed were reduced considering information developed in previous study efforts, a planning Charette held in January 2015, and vertical coordination. After discussions within the PDT, it was determined that nonstructural measures alone would not achieve the planning objectives. The PDT determined that the best approach to achieve the project objectives would be to examine an array of structural measures including the existing condition, channel deepening, two widths and three lengths of wideners. The results of this analysis would develop a focused array of alternatives. Widening measures would evaluate adding 100 or 150 ft of width in the Bay Channel. The length of the widener to be analyzed for economic justification would have length increments of 5, 10, and 15 nautical miles. It was determined through ship simulation that bend easing was not a separable element but those changes would be necessary from a safe operations standpoint for the deepening alternatives. The turning basin would also be deepened to match any deepening alternative but ship simulation also found that some modification of the turning basin was needed to assure safe operations.

Based on historical vessels calling at Mobile Harbor, few had design drafts greater than 52 ft. Data showed an increase in vessels calling at Mobile Harbor with design drafts of 52 ft or less. Therefore, alternatives with depths greater than 53 ft were eliminated from further analysis. The depth of 46 ft was also screened from further analysis because the protocol in deep draft navigation projects is typically a minimum of 2 ft greater than the existing channel depth. As a result, the deepening alternatives considered for evaluation would range from useable drafts from 47 to 52 ft in the Bay Channel and 49 to 54 ft in the Bar Channel (additional depth and width in the bar channel is authorized to account for increased wind, wave, and tidal action in that area).

The analysis to this point also demonstrated the potential construction cost of each initial alternative. The NFS used the cost data to determine the range of cost that could be suitable for their cost share. The NFS indicated that deepening to 50 ft appeared to be the maximum that they could support. It should be noted at this point that the NFS's desire to not deepen below 50 ft led the benefit analysis to utilize the categorical exemption to the NED Plan per paragraph 3-2b(10) of Engineer Regulation (ER) 1105-2-100.

Based on this information and in coordination with the NFS, for environmental impact analysis, the PDT determined that the maximum project dimensions that could reasonably be expected would be a 50 foot deep channel (with an additional 2 ft of depth in the Bar Channel) with an added 100 ft of width for a widener for 5 nautical miles with bend easing and turning basin modification. This information was provided to the engineering and modeling team for their development of the environmental impact analysis.

3.4. Focused Array of Alternatives

An analysis of the remaining initial deepening and widening alternatives was conducted using rough order of magnitude costs and benefits that the PDT considered an appropriate level of detail. As this analysis progressed, the results helped shape the focused array of alternatives that would utilize more refined cost and economic data. It was found that each of the deepening alternatives had positive net benefits. It was also found that widening 5 nautical miles of the channel with an additional width of 100 ft or 150 ft had negative net benefits. Based on this determination, widening lengths greater than 5 nautical miles with widths of 100 ft or 150 ft would likely not be economically feasible for the depths being considered and therefore were dropped from consideration. Review of the 5 nautical miles widening results and previously conducted ship simulation suggested that 100 ft of widening with a 3 nautical mile length might be acceptable and economically feasible. With the above considerations, the focused array of alternatives considered is shown in Table 3-3.

Table 3-3. Focused Array of Alternatives

Measure	Alternatives			
Deepening	47	48	49	50
Widening	Additional 100 ft of width for 3 nautical miles for each depth alternative			

Following determination of the focused array, the PDT further refined the cost and economic data to provide information needed to meet the technical criteria above to narrow alternatives to a final array to determine the plan that could be considered as the TSP. Cost and economic data for the focused array is presented in Table 3-4. Cost and Economic Data for Focused Array

Table 3-4. Cost and Economic Data for Focused Array

Preliminary Project Cost* ($M)				
Measure	Depth (Ft)			
	47	48	49	50
Deepening**	169.4	238.4	302.5	373.5
Deepening** and Widening 100 ft for 3 nautical mi	179.09	249.53	315.41	387.76
Preliminary Project Net Benefits ($M)				
Measure	**Depth (Ft)**			
	47	**48**	**49**	**50**
Deepening	$14.8	$19.6	$24.3	$34.4
Deepening and Widening 100 ft for 3 nautical mi	***	***	***	$34.5

Notes: *Price Level FY 18, Includes Associated Costs, Excludes O&M Costs
**Deepening of River, Bay, and Bar Channels, Bend Easing and Choctaw Pass Turning Basin
*** Net benefits were only calculated for the optimized depth.

3.5. Final Array of Alternatives

The project objectives defined previously are:

- Reduce vessel congestion.
- Improve the efficiency of operations for containerships, bulk, and other cargo vessels within Mobile Harbor.
- Accommodate current and anticipated growth in containerized and bulk cargo vessel traffic.
- Provide navigation improvements to improve vessel transit safety.

To achieve the objectives, modification to project depth and width are necessary. Combining the results of the refined cost and economic data for the depth and widening alternatives that would satisfy the project objectives defined the values to be considered as a TSP in the final array of alternatives. Those values are provided in Table 3-5. Final Array of Alternatives

Table 3-5. Final Array of Alternatives

Combined Measures Preliminary Project Cost and Net Benefits ($M) Deepening, 3 Nautical Mile Widener, Bend Easing, Turning Basin				
	Alternative (Depth in Ft)			
	47	48	49	50
Cost*	$179.09	$249.53	$315.41	$387.76
Net Benefit	**	**	**	$34.5

*FY18 Price Level, Includes Associated Costs, Excludes O&M Costs.
** Net benefits were only calculated for the optimized depth.

3.6. Plan Selection

Based on analysis of the final array, the PDT was able to narrow the array to an alternative that appeared likely to satisfy the project objectives and be considered for selection as the TSP; that plan is the 50-foot alternative. This alternative has greater net benefits than smaller scale plans (47, 48, and 49 ft), and, considering categorical exemption from the NED Plan per paragraphs 3-2b(10) of ER 1105-2-100, a sufficient number of alternatives were analyzed to insure that net benefits do not maximize at a scale smaller than the 50-foot plan.

SECTION 4.0 TENTATIVELY SELECTED PLAN (TSP)

4.1. Plan Components

The Bar, Bay, and River (lower 1,850 ft below station 226+16) Channels of the Mobile Harbor Federal Navigation Project are currently 47, 45, and 45 ft deep, respectively, (as shown in Figure 1-1) with an additional 2 ft for advanced maintenance plus 2 ft of allowable overdepth for dredging (total depths of 51, 49, and 49 ft, respectively). Those same channel segments are currently 600, 400, and 600 ft wide, respectively. In addition, the Choctaw Pass Turning Basin, located at the northern limit of the Bay Channel, is currently 45 ft deep by approximately 1,570 ft long (including the 400-foot width of the existing Bay Channel) by 715 ft wide at its easternmost extent. It also contains a 100-foot widener/transition section about 3,500 ft in length along the eastern edge of the existing Bay Channel immediately south of the basin to improve basin access, reduce the basin size needed for turning, and increase vessel maneuverability.

Modifications to these channel features, as recommended in the TSP, are as follows:

- Deepen the existing Bar, Bay (including the Choctaw Pass Turning Basin), and River Channels (south of station 226+16) by 5 ft to project depths of 52, 50, and 50 ft, respectively, with an additional 2 ft for advanced maintenance plus 2 ft of allowable overdepth for dredging (total depths of 56, 54, and 54 ft, respectively).
- Incorporate minor bend easings at the double bends (at stations 1857+00 and 1775+26) in the Bar Channel approach to the Bay Channel.
- Widen the Bay Channel from 400 ft to 500 ft from the mouth of Mobile Bay northward for 3 nautical miles to provide a two-way traffic area for passing.
- Expand the Choctaw Pass Turning Basin 250 ft to the south (at a depth of 50 ft) to better accommodate safe turning of the design vessel and other large vessels.

Details of the TSP components are shown in Figure 4-1 through Figure 4-5.

4.2. Dredging and Dredged Material Management for the TSP

Approximately 24.1 mcy of “new work” material will need to be dredged to construct the TSP for the Mobile Harbor Federal Navigation Project. In addition, increases of 5 to 15% in maintenance dredging volumes are anticipated post-implementation. For reference of scale, approximately 5.9 mcy of sediment are currently dredged annually as part of the routine maintenance of the project (see Section 2.4.3 of this report and/or Section 4.10, Appendix A for further information). The details of dredged material placement options for the new work construction and future maintenance operations are provided in the following paragraphs. A summary of the new work quantities by channel segment is shown in Table 4-1.

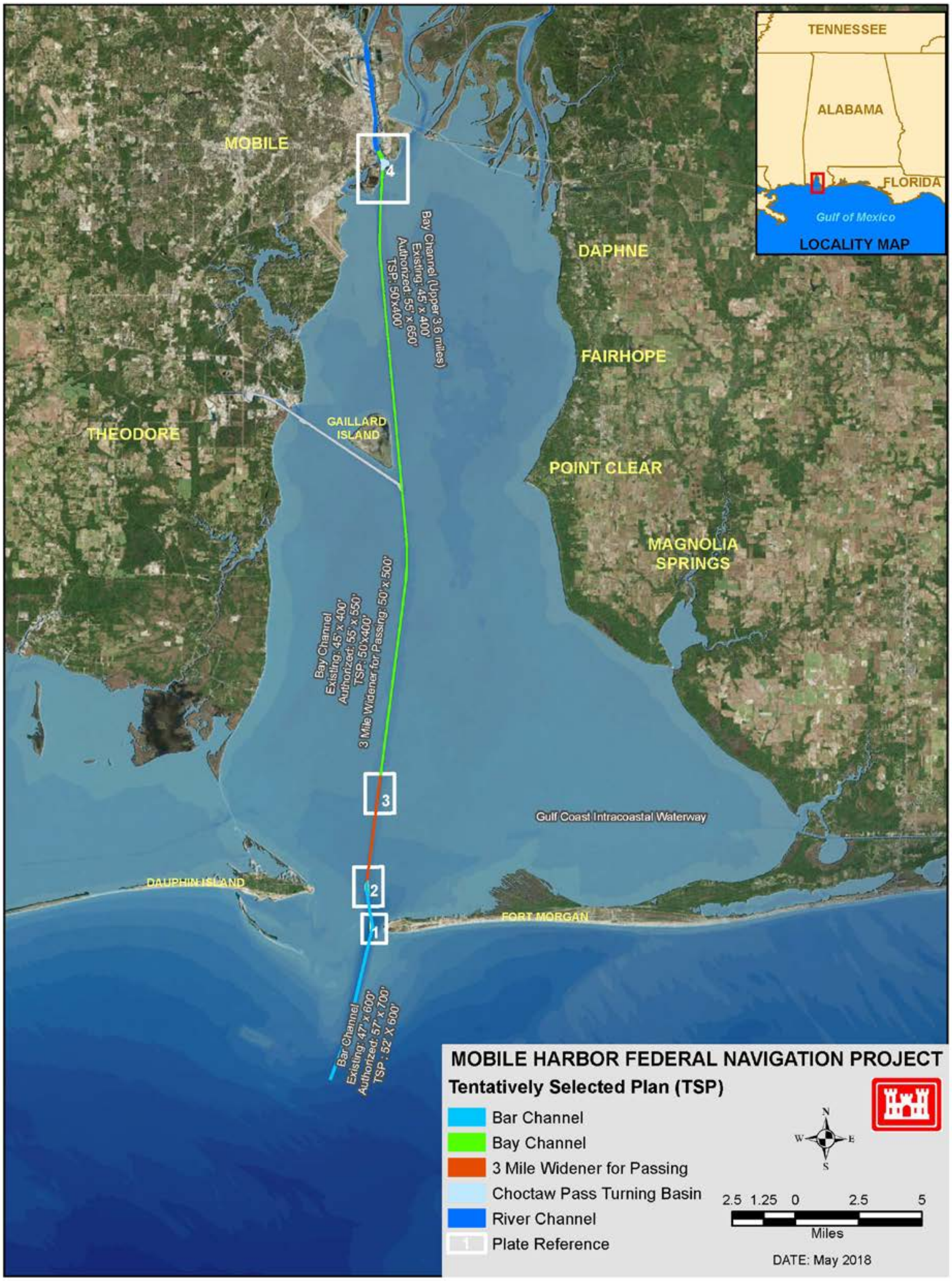


Figure 4-1. TSP for the Mobile Harbor Federal Navigation Project

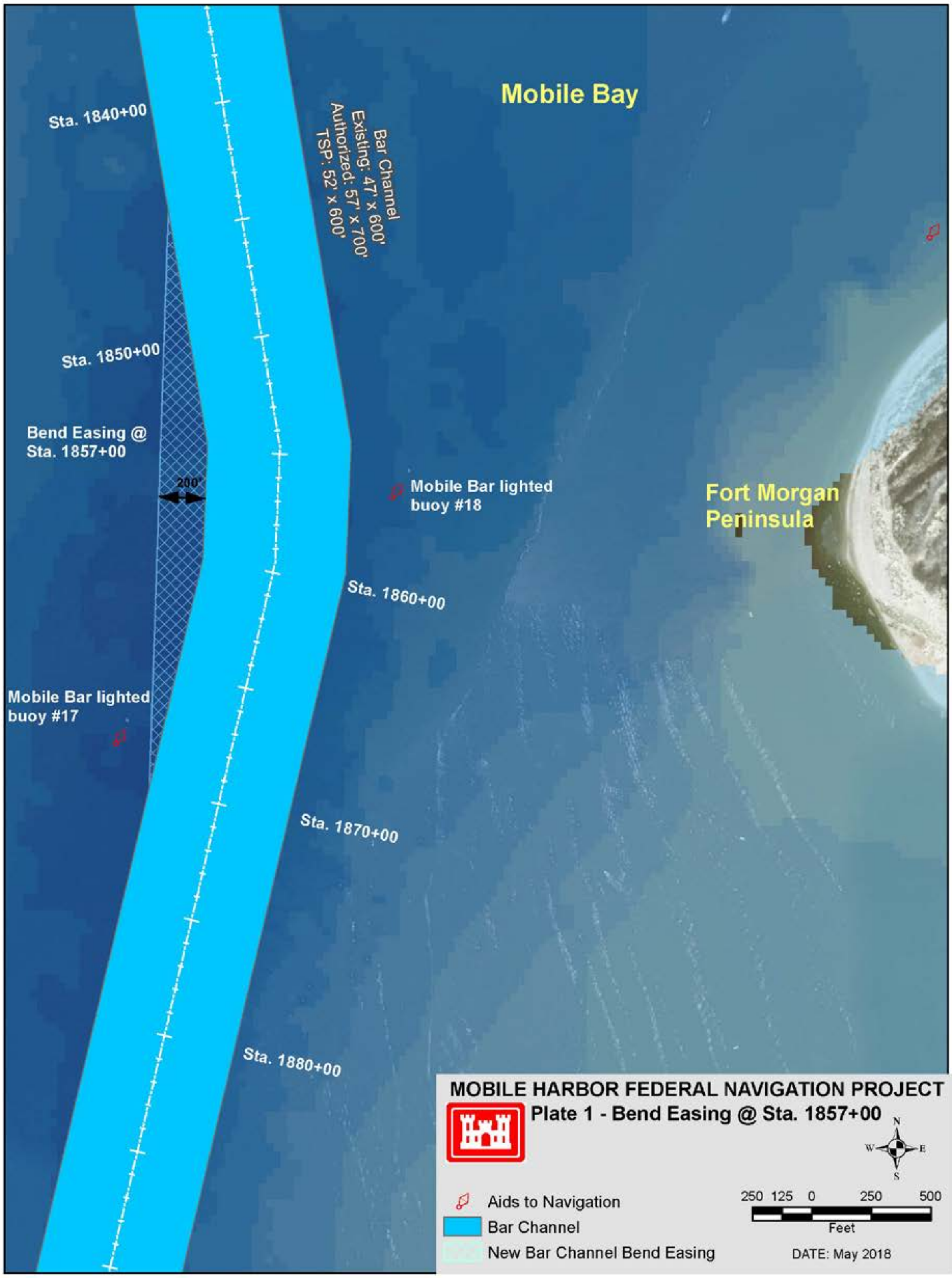


Figure 4-2. Bend Easing in Bar Channel at Station 1857+00

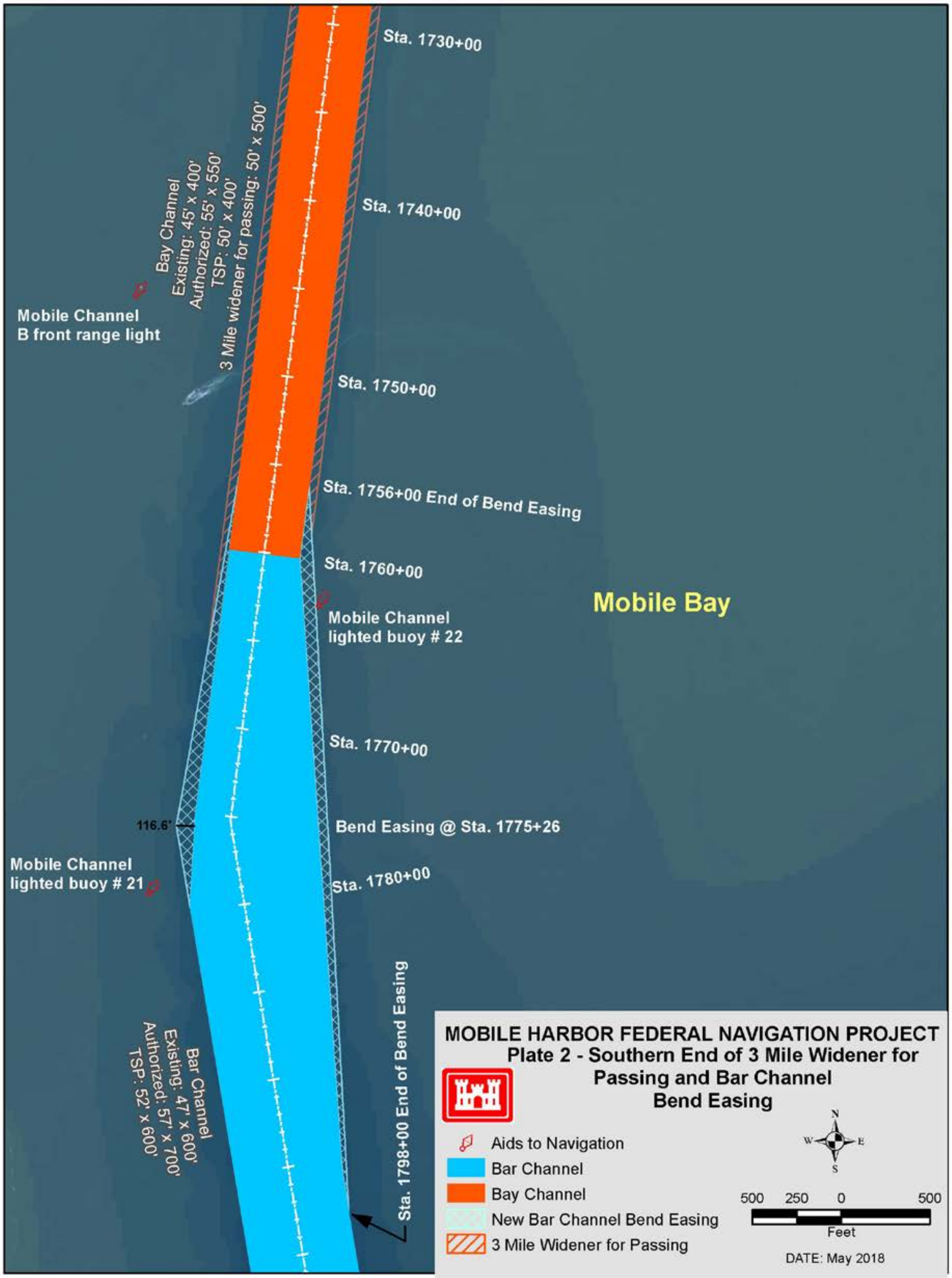


Figure 4-3. Bend Easing in Bar Channel at Station 1775+26 and Southern End of 3 Nautical Mile Channel Widener for Passing in Bay Channel

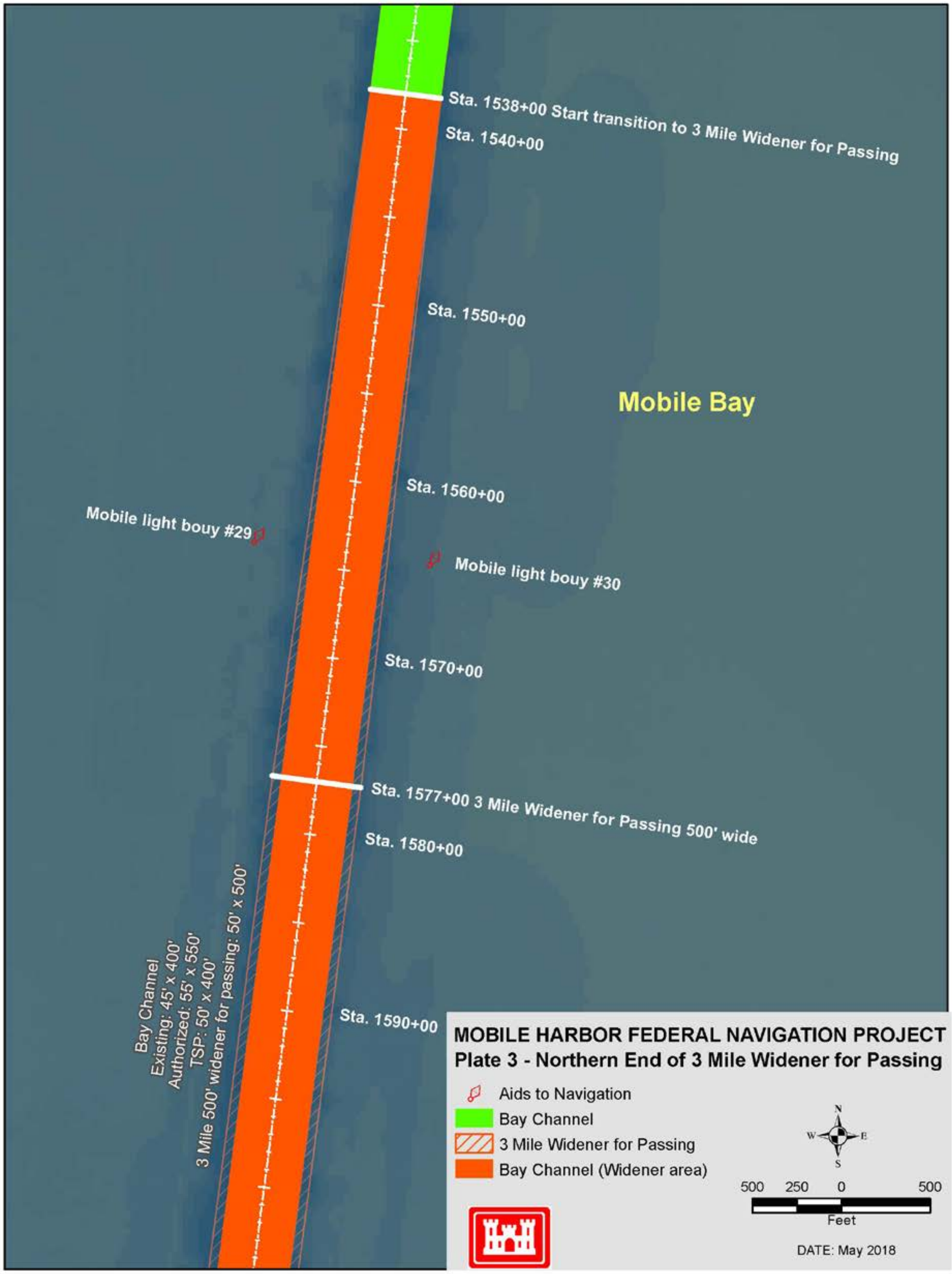


Figure 4-4. Northern End of 3 Nautical Mile Widener for Passing in Bay Channel

Figure 4-5. Choctaw Pass Turning Basin Expansion

Table 4-1. New Work Quantities by Channel Segment

Channel Segment	Quantity (cy)
River (stations 226+16 to 244+66)	260,444
Bay (stations 244+66 to 1760+09.28)	15,331,506
Bar (stations 1760+09.28 to 2189+59)	5,077,827
3 Nautical Mile Widening for Passing (stations 1577+82 to 1760+10)	1,368,685
Bend Winders (stations 1775+43 and 1854+69)	155,259
Turning Basin (250 foot Expansion to the South)	1,688,864
Total New Work Volume	**24,082,585**
Note: Quantities include the authorized depths plus advanced maintenance and allowable overdepth.	

4.2.1. New Work Material Placement Options

Several sites were evaluated for potential placement of new work material for the TSP. These included six relic shell mining areas, the ODMDS, and the SIBUA (if new work sand sources are found within the Bar Channel). Further discussion on these elements is provided in the following paragraphs. Details of the capacity estimates for the northwest extension of the SIBUA and the expansion of the ODMDS are discussed in this report in Section 2.4.4 and Section 4.11, Appendix A.

4.2.1.1. Relic Shell Mined Areas

The Relic Shell Mined Areas are located to the northeast of Gaillard Island on the eastern side of the ship channel as shown in Figure 4-6. The proposed placement within this site is the result of beneficial use discussions with the cooperating agencies where it was suggested that Mobile District conduct open bay placement of the dredged material in strategic areas of the bay in an effort to restore sediment to the system and improve bay bottom conditions

Approximately 5.5 mcy of new work material are anticipated to be placed in the Relic Shell Mined Areas. Site selection and volume estimates for these sites were based on the

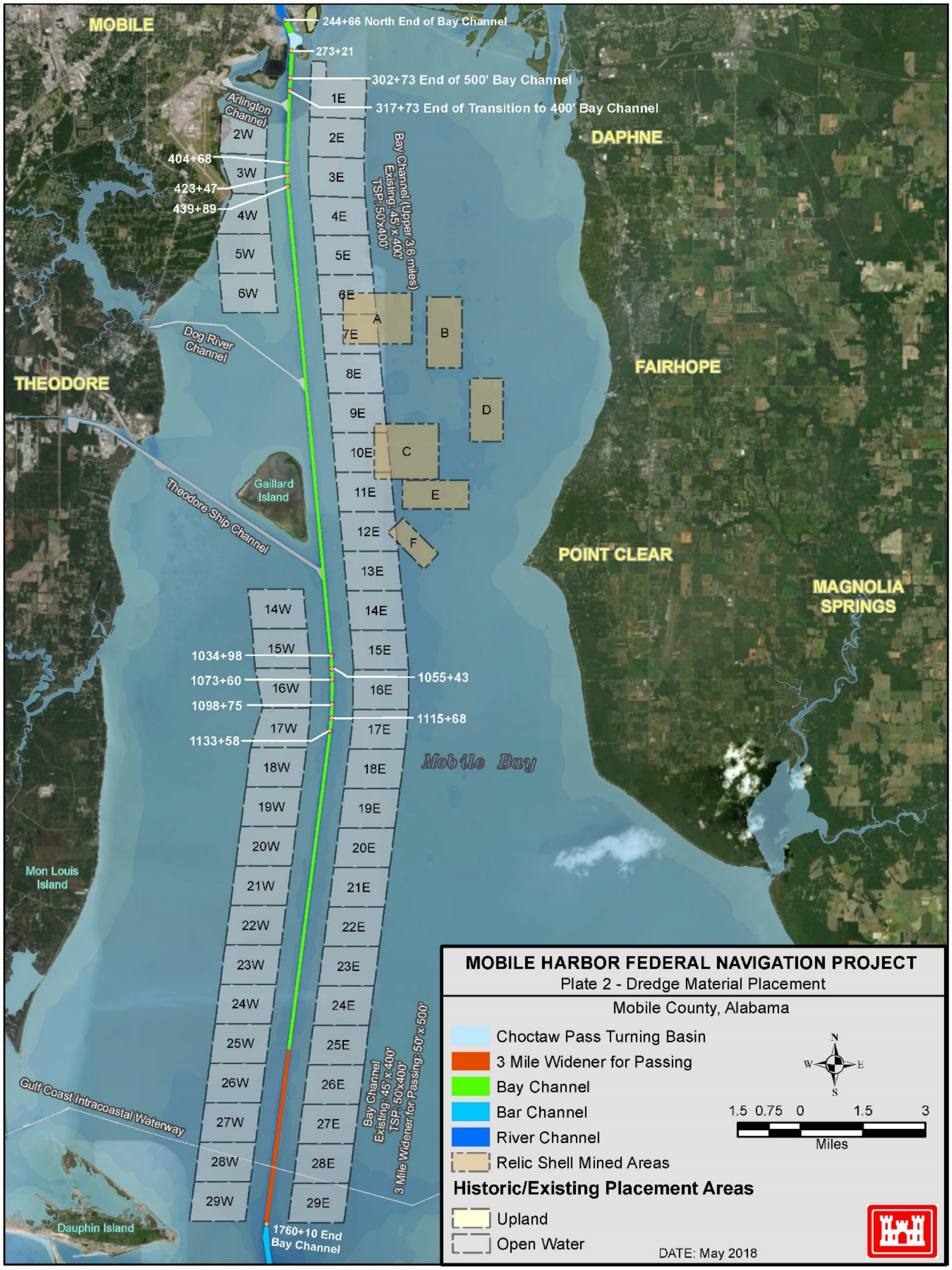


Figure 4-6. Relic Shell Mined Areas

NOAA compiled surveys within the area between 1960 and 1961 and 1984 and 1987. The potential placement areas were laid out in sections where there were disturbances with 15-foot depths or greater based on the combined surveys from 1960/61 and 1984/87. These areas encompass approximately 4,100 acres and existing depths within the sites generally range from 10 to 14 ft.

Placement is anticipated to be accomplished with a maximum thickness of approximately 3 ft due to the characteristics of the new work material; however, the volume of material planned to be placed in the sites is based on an average material thickness of 1.5 ft over the sites. The quantity of material planned for placement in each area is shown in Table 4-2 and a map detailing the locations of the sites is shown in Figure 4-6. Additional detailed hydrographic surveys of these sites will be collected during the Preconstruction, Engineering and Design (PED) Phase.

Table 4-2. Placement Capacities within the Relic Shell Mined Areas

	Area (acres)	Placement Volume (cy) Placement Thickness assumed 1.5-foot	Bulking Factor= 1.2 O&M, 1.8 New Work	Approximate Distance from Channel (ft) Center to Placement Center
A[1]			0	10,000
B	920	2,226,000	1,237,000	18,000
C	770	1,863,000	1,035,000	22,000
D	1306	3,161,000	1,756,000	12,000
E	702	1,699,000	944,000	16,000
F	403	975,000	542,000	12,000
Total	**4101**	**9,924,000**	**5,514,000**	

Note: 1) Area A is located within the bounds of existing open water placement sites used for operation and maintenance material and was therefore not considered here for new work.

4.2.1.2. Expanded ODMDS

The capacities of the existing ODMDS site and the proposed expansion were obtained from ongoing environmental coordination documents between the USACE, Mobile District, and EPA and are provided in Table 4-3. As shown, an available/remaining capacity of approximately 52 mcy is expected after 20 years of future placement of maintenance material in the site. This volume is more than adequate to handle the anticipated 18.6 mcy of new work material that will be placed in the site during construction of the TSP. The boundaries of the current and expanded area are shown in Figure 4-7. (Note: The approximately 1.7 million cubic yards of new work material to be dredged for the Choctaw Pass Turning Basin expansion are anticipated to be predominantly clean sands with some pockets of silty sands. For conservative cost and placement location planning purposes, this quantity is included in the 18.6 million cubic yards slated for the ODMDS; however, it could be considered for beneficial use at other locations, if deemed suitable. The suitability of this material will be further investigated prior to the completion of the Final Report or during the PED Phase of this project.)

Table 4-3. Placement Capacity within the Expanded ODMDS

ODMDS	Area (Acres)	Volume (CY)[1]
Current ODMDS (4.75 square nautical mi)	4,017	20,000,000
Expanded ODMDS (24 square nautical mi)	20,341	260,000,000
Total	**24,358**	**280,000,000**
20 year Capacity Need		228,000,000
Remaining Capacity after 20 Years		**52,000,000**
Note: Volume estimates including capacity needs were taken from ongoing environmental coordination documents with EPA.		

Table 4-4. Upland Dredged Material Placement Site Capacities

	Area (Acres)[1]	Projected Maximum Dike Elevation (ft)[1]	Total Idealized Volumetric Capacity (CY)[1,2]
North Blakeley	69	50	3,172,000
Mud Lake 6	70	46	3,388,000
Mud Lake 7	129	46	8,562,000
South Blakeley	196	65	12,087,000
North Pinto	48	47	3,434,000
Totals	**512**		**30,644,000**
20 year Project Capacity Needs of River Channel (1.3 mcy/year)			26,247,060
Remaining Capacity After 20 Years			4,396,000

Notes: 1) Taken from Table 7 of Resource Management Group, Inc., 2010 updated with USACE dredge material placement records through 2016.
2) Idealized volumetric Capacity includes interior capacity plus the volume to build projected

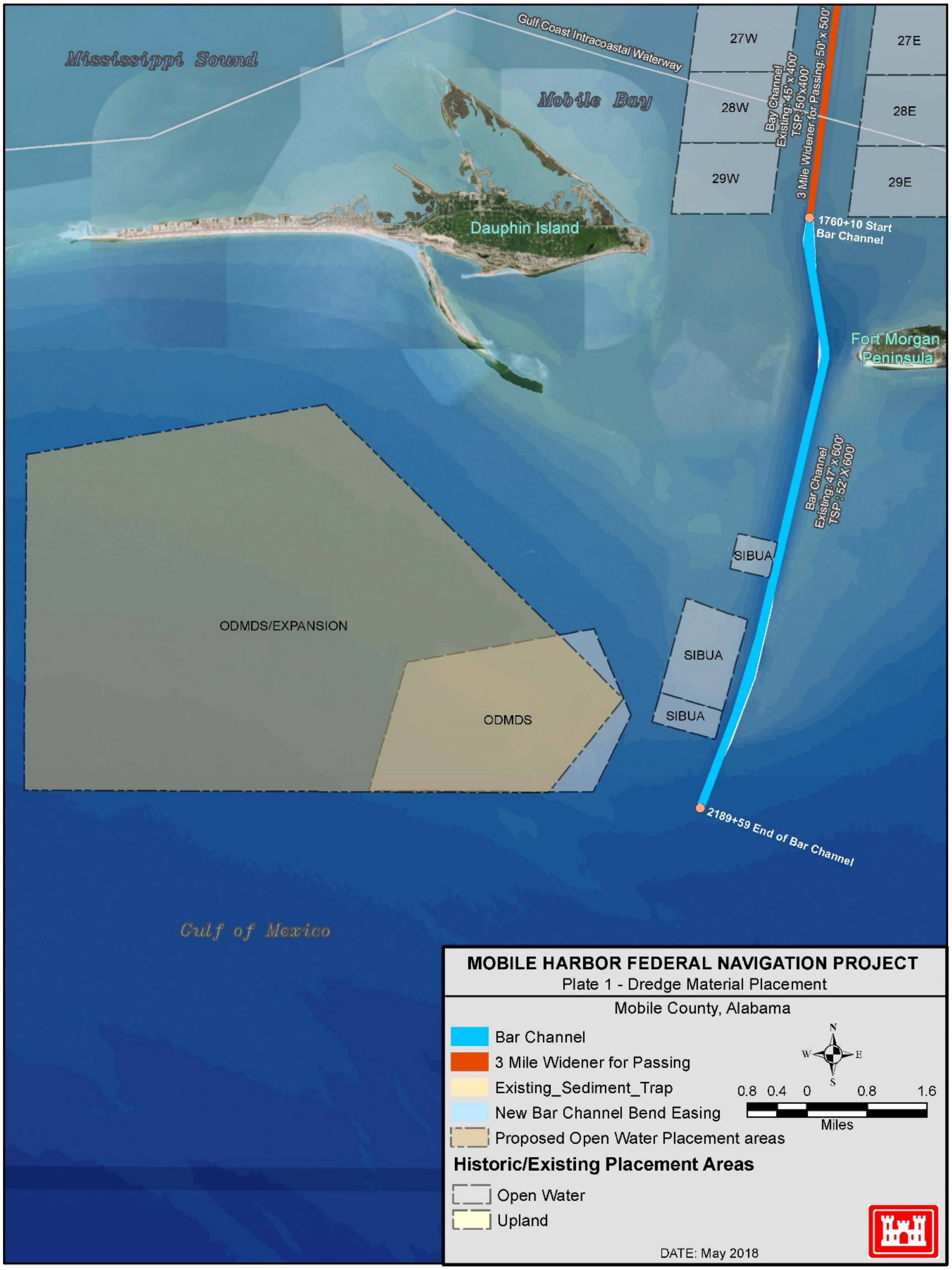


Figure 4-7. Expanded ODMDS Boundary

4.2.1.3. SIBUA and Northwest Extension

Currently, no new work material from the Bar Channel is anticipated to be placed in the SIBUA or the northwest extension (see Figure 4-8) as part of the TSP. The new work material in the Bar Channel is predominately clays and silts with some intermixed sands, and, per the geotechnical information obtained to-date, none of this material meets the suitability criteria for placement in the SIBUA. Placement of new work material in the SIBUA or the northwest extension will be considered in the future if sandy material is identified during additional geotechnical investigations of the Bar Channel.

4.2.2. Future Maintenance Material Placement Options

Material dredged as part of maintenance operations for the future With-Project conditions will continue to be placed in a combination of upland sites adjacent to the River Channel; open water placement sites within the bay; the SIBUA on the ebb tidal shoal, including a proposed northwestward expansion of the site; and the ODMDS in both the current limits and a future expansion area. Details of these areas are provided in the following paragraphs.

4.2.2.1. Upland Dredged Material Placement Sites for the River Channel

Material dredged as part of the routine maintenance of the River Channel (primarily fine-grained sediments) is currently placed in the upland dredged material placement sites located east of the River Channel, as shown in Figure 2-21. Existing capacity estimates for these sites were obtained from Resource Management Group, Inc., 2010 “Guidelines for Sustainable Maintenance Dredging and Long-Term Dredge Material Management of the Mobile River Federal Management of the Mobile River Federal Navigation Project,” and updated with the USACE, Mobile District dredge records for the River Channel to 2016. Volume estimates were evaluated in an effort to determine if sufficient capacity exists to accommodate projected increases in routine maintenance material associated with the TSP and are shown in Table 4-4. Per the estimates, adequate capacity exists to support the placement of maintenance material dredged from the River Channel over the next 20 years.

4.2.2.2. Open Water Dredged Material Placement Sites for Bay Channel

A portion of the material dredged as part of the routine maintenance of the Bay Channel (primarily fine-grained sediments) is currently placed in the open water placement areas adjacent to the channel, as shown in Figure 2-19 (the remaining material is placed in the

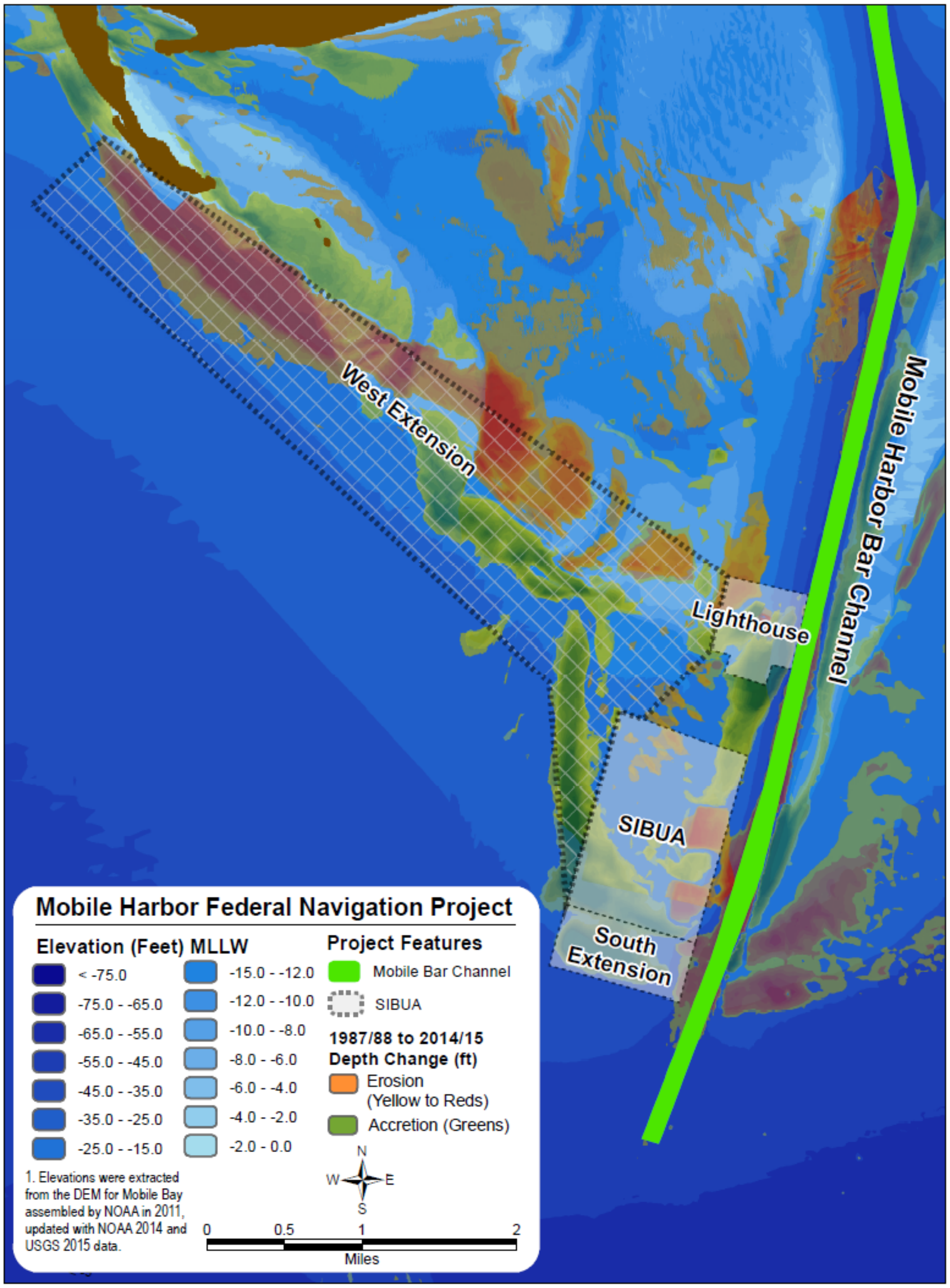


Figure 4-8. SIBUA Northwest Extension Limits

ODMDS). These areas were evaluated in an effort to determine if capacity exists for future maintenance associated with the TSP. Bathymetric surveys of the areas were obtained from the USACE, Mobile District Irvington Site Office and site capacities were calculated based on the most recent survey data available at the time of analysis (2012-2015) (see Table 4-5). The available survey data were limited to areas designated for placement in the survey year within the placement site, rather than over the entire site. Additional data for the sites were obtained from the NOAA nautical charts. A minus four (-4) ft MLLW upper elevation limitation was applied over the sites before analyzing capacity. Per results of the analysis, adequate capacity exists to support the placement of maintenance material dredged from the Bay Channel over the next 20 years.

Table 4-5. Open Water Dredge Material Placement Site Capacity

Open Water Placement Sites	Area (Acres)	Volume Capacity (CY)[1]
Placement Sites 1 - 29	21,560	140,974,000
20 Year Capacity Needs of the Bay Channel (4.5 mcy/year)		90,380,000
Capacity Remaining after 20 Years		**59,594,000**

Notes: 1) No estimate of sediment transport from the sites were incorporated into the capacity estimates.
2) Conservative estimate as it assumes all material dredged from the bay will be placed in open water sites. In actual practice open water sites in the bay and the ODMDS are used.

4.2.2.3. SIBUA for the Bar Channel

Material dredged (primarily sandy sediments) as part of the routine maintenance of the Bar Channel is placed in the SIBUA as a means of bypassing sand from the Bar Channel to the downdrift littoral system. The SIBUA, located west of the channel on the ebb tidal shoal (see Figure 1-2), was evaluated to determine whether capacity exists to accommodate projected increases in maintenance dredged material associated with implementation of the TSP. An additional level of analysis to evaluate transport rates leaving the SIBUA as well as capacity available within depth constraints of dredging equipment were made in an effort to balance safe and efficient dredge material placement practices, while ensuring sandy material dredged from the Bar Channel is maintained within the littoral system.

A bathymetric change analysis was conducted on the ebb tidal shoal over a time period from 1987-1988 to 2018 using the NOAA 1987-1988, NOAA 2014, USGS/USACE 2015, and the USACE 2008-2018 survey datasets. Particular focus was placed on the SIBUA and the sediment transport pathways feeding the Sand/Pelican Island complex. This analysis shows sand has been transported out of the SIBUA at rate of approximately 260,000 cubic yards per year. This material has primarily continued to move northwest to join in with the shallow platform associated with Sand and Pelican Islands (see Figure 4 8).

The main source of sedimentation within the Bar Channel is the dominate east to west sediment transport along Morgan Peninsula onto the offshore ebb shoal of the inlet complex forming the Dixey Bar. As discussed in Section 2.4.4.3, dredging of the Bar Channel since the last deepening has ranged from a longer term average of 525,000 cubic yards to a recent shorter term average of 624,000 cubic yards. The rate of dredged material placement has been higher than the rate of transport out of the SIBUA, leading to decreased depths and restricted use of the SIBUA for dredged material placement by a large hopper dredge to the southernmost extents of the site. An estimate using the USACE 2018 surveys (see Table 4-6) shows the majority of the site capacity is within the shallower depths, ultimately limiting the use of the existing the SIBUA boundaries over the next 20 years to hydraulic cutter heads and smaller hopper dredge fleet.

In an effort to ensure adequate placement capacity for maintenance dredging of the Bar Channel, the USACE, Mobile District is currently pursuing modifications to extend the SIBUA beyond its existing boundaries. The site will be extended to the northwest, following the shoal and pathway of sediment transport towards Dauphin Island. Figure 4-8 and Table 4-6 provide the proposed limits of the northwest extension as well as the estimated available capacity volumes. Per the estimates, adequate capacity exists to support the placement of maintenance material dredged from the Bay Channel over the next 20 years.

4.2.2.4. Expanded ODMDS

The expanded ODMDS, which can be used for the placement of maintenance material in the future, is discussed in Section 4.2.1.3 and shown in Figure 4-7. As shown in Table 4-3, adequate capacity will exist once the expansion is finalized.

4.2.3. Construction Methodology

The exact methodology to construct the TSP would be determined by the contractor selected through the contracting process; however, assumptions regarding various possible construction techniques were made for planning and estimating purposes. Dredged material from channel modifications would most likely be excavated using a cutterhead-suction dredge, hydraulic hopper dredge, or mechanical excavator.

4.2.3.1. Type of Dredging Equipment

The type of dredging equipment considered depends on the type of material, the depth of the channel, the depth of access to the placement site, the amount of material, the distance to the placement site, the wave-energy environment, etc. A detailed description of types of dredging equipment, which includes mechanical-clamshell, hydraulic hopper, cutter-suction, dredges with spider barges for transportation of dredged material to

Table 4-6. SIBUA Capacity

	2018 Volume (CY) Below -15' MLLW	2018 Volume (CY) Below -20' MLLW	2018 Volume (CY) Below -25' MLLW
SIBUA	7,487,906	2,202,690	644,437
SIBUA South Extension	4,679,635	2,891,301	1,415,534
SIBUA Lighthouse[3]	1,320,708	682,208	309,517
Total 2018 Capacity	**13,488,249**	**5,776,199**	**2,369,488**
20 Year Net Erosion out of SIBUA (260,000 cy/yr)	5,200,000	5,200,000	5,200,000
20 Year Projected Capacity Needs (624,000 cy/yr + 15% increase)	15,272,000	15,272,000	15,272,000
Remaining Capacity after 20 years	**3,416,249**	**-4,295,801**	**-7,702,512**
SIBUA Northwest Extension	9,294,614	6,241,179	1,014,424

NOTES:

(1) Capacity estimates displayed in this table due not account for uncertainty in volumetric change.
(2) Capacity estimates are rough order of magnitude assuming vertical side slopes. Final volume estimates will account for side slopes of the fill, which would likely result in reduced capacity.
(3) 2018 survey data did not cover the eastern section of the SIBUA Lighthouse Site therefore volume estimates for this area are based on NOAA 2014 Survey Data

designated placement sites, can be found in EM 1110-2-5025, Engineering and Design - Dredging and Dredged Material Disposal.

4.2.3.1.1. Mechanical – Clamshell Dredging

Mechanical dredges are classified by how the bucket is connected to the dredge. The three standard classifications are structurally connected (backhoe), wire rope connected (clamshell), and chain and structurally connected (bucket ladder). The advantage of mechanical dredging systems is that very little water is added to the dredged material by the dredging process and the dredging unit is not used to transport the dredged material. This is important when the placement location is remote from the dredging site. The disadvantage is that mechanical dredges require sufficient dredge cut thickness to fill the bucket to be efficient and greater resuspended sediment is possible when the bucket impacts the bottom and as fine-grained sediment washes from the bucket as it travels through the water column to the surface. Clamshell excavators are likely to be employed on portions of the Choctaw Pass Turning Basin. These dredges are able to work in confined areas, can pick up large material, and are less sensitive to sea conditions than other dredges.

For cost estimating purposes, it is anticipated given recent history that a clamshell dredge will be used within the Choctaw Pass Turning Basin. Conservatively estimating, it is assumed material from this area would be placed in a scow for transport to the ODMDS.

4.2.3.1.2. Hydraulic – Hopper Dredging

Hopper dredges include self-propelled ocean-going vessels that hydraulically lift dredged material from the bottom and deposit it into an open hopper within the vessel. The dragarm(s) operates like a vacuum cleaner being dragged along the bottom. When the hopper is full, the dredge transits to a placement location and releases the dredged sediment into an underwater placement site by opening doors on the hopper bottom or in some cases the vessel is designed to split open longitudinally. Hopper dredges can also be designed to hydraulically pump the material from the hopper. This is sometimes used for beach nourishment projects. Since hopper dredges are self-propelled, they are more maneuverable than dredges that rely upon tug boats to move. However, they require numerous passes over the same area to remove the required material; they are inefficient in small confined dredging areas and are most effective in removing sand and other unconsolidated materials.

Although mechanical clamshell and cutterhead-suction may be used for many segments of the channel, for initial cost estimating purposes and historical comparisons (Gulfport and Pascagoula), a hopper dredge is assumed for removal of sediment in the Bay Channel and Bar Channel. Most of the sediment transported by the hopper dredge is assumed to be placed in the ODMDS while a smaller portion of the material is assumed to be placed in the relic shell mined area.

4.2.3.1.3. Hydraulic – Cutterhead-Suction Dredge

Large cutter-suction dredges, or cutterhead dredges, are mounted on barges. The cutter suction head resembles an eggbeater with teeth. It mobilizes the dredged material as it rotates. The mobilized material is hydraulically moved into the suction pipe for transport. The cutter suction head is located at the end of a ladder structure that raises and lowers it to and from the bottom surface. The cutter suction dredge moves by means of a series of anchors, wires, and spuds. The cutter suction dredges as it moves across the dredge area in an arc as the dredge barge swings on the anchor wires. The discharge pipeline connects the cutter suction dredge to the placement area. The dredged material is hydraulically pumped from the bottom, through the dredge, and through the discharge pipeline to the placement location. Booster pumps can also be added along the discharge pipeline to move the material greater distances. Cutterhead-suction dredges are limited to dredging depths within reach of the ladder.

It is anticipated that a cutter-suction dredge may be considered for this project with further analysis. If it is determined that any dredging area appears too consolidated for a hopper dredge or less economical, a hydraulic cutterhead or mechanical clamshell dredge may be considered. Material may be placed in a scow barge or pumped depending on distance to placement area.

4.2.3.1.4. Post-Dredging Operations

Since dredging equipment does not typically result in a perfectly smooth and even channel bottom a drag bar, chain, or other item may be pulled along the channel bottom to smooth down high spots and fill in low spots. This finishing technique also reduces the need for additional dredging to remove any high spots that may have been missed by the dredging equipment. It may be more cost-effective to use a drag bar or other leveling device (and possibly less hazardous to sea turtles) than to conduct additional hopper dredging.

4.2.3.2. Beneficial Use of Dredged Material

The Federal Government has placed considerable emphasis on using dredged material in a beneficial manner. Statutes such as the WRDAs of 1992, 1996, 2000, and 2007 demonstrate that beneficial use has been a Congressional priority. The USACE has emphasized the use of dredged material for beneficial use through such regulations as 33 CFR Part 335, ER 1105-2-100, and ER 1130-2-520 and by Policy Guidance Letter No. 56. ER 1105-2-100 at E-69 states that “all dredged material management studies include an assessment of potential beneficial uses for environmental purposes including fish and wildlife habitat creation, ecosystem restoration and enhancement and/or hurricane and storm damage reduction”.

In accordance with ER 1105-2-100, the USACE, Mobile District considered beneficial use of dredged material as a part of the project. As shown on Figure 4-9, opportunities for beneficial use of dredged material were identified in the project vicinity. In addition to the agency scoping meeting, two meetings were held with the support agencies specifically addressing beneficial use opportunities associated with the placement of the new work material. The meetings were instrumental in the process of identifying realistic beneficial use opportunities associated with the proposed widening and deepening activities. Through these meetings, the agencies provided their input and support for a variety of potential placement options. Because it met the requirements of the guidance outlined above, the relic oyster shell mining area is included as a proposed placement area for the project.

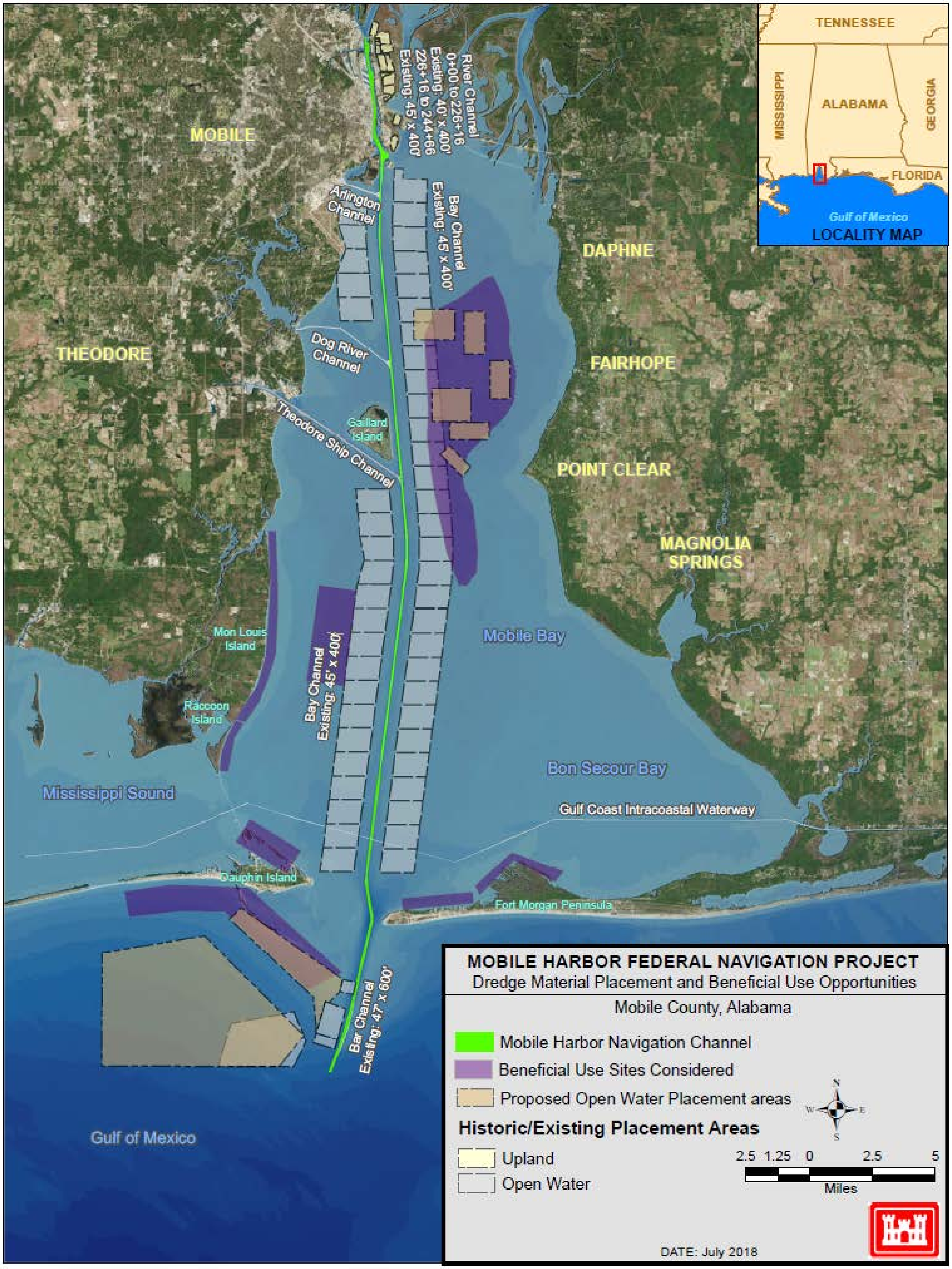


Figure 4-9. Opportunities for Beneficial Use of Dredged Material

Other beneficial use options that will require cost sharing with a willing sponsor include:

- Shoreline protection measures such as living shorelines
- Oyster reef restoration
- Thin-layer placement in strategic areas to reduce hypoxia
- Thin-layer placement for marsh conservation and restoration
- Raising bottom elevation in strategic locations to promote productivity
- Strategic placement of berms for shoreline protection

4.2.3.2.1. Beneficial Use Analyses

If a willing partner is found for an acceptable beneficial use option, a grain size/compatibility analysis and modeling of sediment transport and fate will be required. Because of the time and effort involved with the additional analysis, beneficial use measures will be discussed in the GRR/SEIS without detailed analysis. The detailed analysis along with the final designs, decisions to implement, and environmental considerations/clearances would be conducted during the PED phase or within a separate study in coordination with the cooperating agencies and the interested public.

4.3. Detailed Cost Estimates and Benefits

Section 7.0, Appendix A contains detailed information on project costs, cost assumptions, and the associated risks. Appendix B includes detailed discussions of the transportation cost savings and benefit analysis.

4.3.1. Project Costs and Cost Sharing TSP

Table 4-7 contains project cost sharing guidelines. Although currently developed costs are not for budgetary purposes, Table 4-8 is presented to show the application of USACE cost sharing guidelines for the TSP. The Final GRR/SEIS will include detailed costs for budgetary purposes. The estimates used for the cost sharing tables shown in Table 4-8 is based on the Project First Cost (Constant Dollar Basis) (second column) of the Total Project Cost Summary (TPCS) spreadsheet presented in Attachment A-7, Appendix A. The Constant Dollar Costs at current price levels serve as the basis for the cost of the project

Table 4-7. Cost sharing allocation for construction, operations, and maintenance

	For Project Depths < 50 ft	
Construction	**Federal**	**Non-Federal**
General Navigation Features (GNF)	75%	25+10% 1/
Aids to Navigation	100%	0%
Service Facilities	0%	100%
Lands, Easements, Rights-of-way and Relocations (LERR)	0%	100%
Operations and Maintenance	**Federal**	**Non-Federal**
GNF (including mitigation)	100%	0%
Aids to Navigation	100%	0%
Local Service Facilities	0%	100%
LERR	0%	100%
1/Ten percent (10%) post-construction contribution is reduced by credit amount for LERR		
Note: Table derived from ER-1105-2-100, Table E-12, Navigation, Construction, and O&M, pages E-62 and E-63.		
Note: ER 1105-2-100, Table E-11 Navigation PED, pages E-61 and E-62		
PED - All PED, and planning accomplished after the feasibility study is cost shared at 75% Federal and 25% Non-Federal, CECW-PC Memorandum on Modification of non-Federal contribution in Design Agreement, 24 May 2013, which changed PED cost sharing to the same as project construction.		

as required by the USACE regulations for feasibility studies. As detailed in Table 4-8, the TSP has a total first project cost of $387,762,000. This total includes costs for PED; construction management; construction of the GNF with both Federal and NFS in-kind contributions as applicable, Lands, Easements, Rights-of-way and Relocations (LERR) values; risk-based contingencies determined through the Abbreviated Risk Analysis (ARA); and associated costs for local service facilities and aids to navigation. The TPCS also includes a fully funded cost with escalation to the estimated midpoint of construction. Table 4-8 also reflects the estimated incremental annual maintenance costs ($2,358,000).

Table 4-8. Cost Allocation for the TSP (50' Bay Channel/52' Bar Channel)

Description	Total First Costs (K)	Implementation of Costs (K)			
General Navigation Features (GNF)		Federal	%	Non-Federal	%
Dredging: Deepening including Bend Easing and Turning Basin	$350,372	$262,779	75	$87,593	25
Dredging: 100' Widening 3 Nautical Mile Lane	$12,773	$9,580	75	$3,193	25
LERR	$40	$0	0	$40	100
Preconstruction, Engineering & Design	$8,542	$6,406	75	$2,136	25
Construction Management	$4,029	$3,022	75	$1,007	25
Subtotal of GNF	$375,756	$281,791	75	$93,969	25
10% of GNF		($37,576)	-	$37,576	-
GNF LERR credit		$40		($40)	
Associated Costs:					
Local Service Facilities: Berthing (ASPA)	$11,397	$0	0	$11,397	100
Aids to Navigations (U.S. Coast Guard)	$609	$609	100	$0	0
Total Estimated Costs:	$387,762	$244,860	63	$142,981	37
Incremental Annual Maintenance Cost (FY18 Price Level)					
Deepening, Bend Easing, Widening, Turning Basin	$2,358	$2,358	100	$0	0

GNF costs are cost shared 75% Federal and 25% NFS during construction. An additional 10% of the GNF costs, less the amount of LERR credit afforded to the NFS for the value of LERR, shall be paid by the NFS over a period not to exceed 30 years with interest. The average annual costs were determined to be approximately $17.5 million for the TSP. The average annual benefit for the TSP is approximately $52.0 million. Therefore, the benefit-to-cost ratio is estimated at 3.0 to 1 for the TSP plan. Also see Table 41, Appendix B for costs and benefits.

The cost estimate shown in Table 4-8 reflects all project features, including maintenance costs, real estate costs, and associated costs.

4.3.2. Project Schedule

Based on reasonable estimated productivities, the construction duration is estimated to range from 36 to 48months. The overall schedule and durations may change depending on the time required to obtain congressional appropriations. Other areas of schedule uncertainty include the availability of dredging equipment to complete the work and to comply with environmental requirements for endangered species, and delays due to unexpected severe weather conditions. Table 4-9 summarizes the PED and construction activities.

Table 4-9. Approximate PED and construction duration

Description	Duration in Months	Cumulative Months
Division Engineer's Transmittal (S= PED Start)	0	S
Plans and Specifications	12	S+12
Advertise (Contingent upon funding) Contract	3	S+15
Award Contract	3	S+18
Construction Start (C=Construction Start)	0	C
Construction Complete	36-48	C+36/48

4.3.3. Operation, Maintenance, Repair, Rehabilitation, and Replacement

Increased O&M costs over the existing project O&M costs result from modifications of the Federal navigation channel as described. For the described measures, the estimated increases in incremental quantities that will need to be dredged were determined from engineering analyses of expected shoaling rates. The majority of increased shoaling is due to the increase in channel footprints. The increased annual cost for O&M dredging between the existing condition (45-foot project depth) and the future With-Project condition for the TSP is estimated to be $2,358,000. O&M costs for the TSP is a 100% Federal expense. In cases of depths in excess of 50 ft, the O&M costs are 100% the responsibility of the NFS.

4.3.4. Financial Analysis of NFS's Capabilities

The NFS, the ASPA, concurs with the financial responsibility as it pertains to the cost sharing rules as outlined in Table 4-7, above. Under the WRDA of 1986, as amended by

Section 201 of the WRDA of 1996, Federal participation in navigation projects is limited to sharing costs for design and construction of the GNF consisting of breakwaters and jetties, entrance and primary access channels, widened channels, turning basins, anchorage areas, locks, and dredged material placement areas with retaining dikes. Non-Federal interests are responsible for and bear all costs for acquisition of necessary lands, easements, rights-of-way, and relocations; terminal facilities; as well as dredging berthing areas and interior access channels to those berthing areas. Current policy requires the NFS to document their ability to pay through submission of a self-certification of financial capability as described in CECW-PC memorandum dated 12 June 2007. Appendix E contains this certification.

4.3.5. View of NFS

The ASPA fully supports the TSP and has agreed to the cost sharing as outlined above. Appendix E contains the NFS's letter of intent which documents acceptance of, or desired departures from, the terms of the applicable model Project Partnership Agreement (PPA), including: 1) applicable cost sharing and financial policies; 2) policies regarding provision and valuation of non-Federal lands, easements, rights of-way, and dredged material placement areas provided by the NFS; 3) policies governing non-Federal project construction; and 4) other provisions required by law and policy for new start construction projects.

The NFS believes that there is opportunity to deepen and widen the navigation channel at Mobile Harbor to use current vessels more efficiently and accommodate larger vessels. Particularly important is the increase in the deployment of those larger vessels, which is occurring now and expected to increase with the completion of the Panama Canal expansion project.

The McDuffie coal shipments are currently utilizing Cape/Post-Panamax size vessels. At the current depth, vessels cannot fully utilize their capacity. Coal shippers forecast that availability of deeper drafts along with an expanded Panama Canal would increase the U.S. coal competitiveness in Asia.

In addition to the economic opportunities afforded by a larger channel, there also exists safety and potential environmental opportunities. Hazards of traffic moving in and out of Mobile Harbor as well as navigation features of the channel would be improved by a larger channel. There is also potential for beneficial use of sediment material that would be obtained from the channel dredging.

4.3.6. Risk and Uncertainty

Risk and uncertainty exists in the potential fluctuation of the Federal interest rate, changes in vessel operating costs, unexpected construction costs such as discovery of unmarked/unknown pipelines or cultural resources, and deviations from vessel or cargo forecasts. Interest rates, forecasts, and vessel operating costs are discussed further in the Appendix B. Cost contingencies for items such as discovery of cultural artifacts and/or pipeline relocations are discussed in Section 7, Appendix A. There are also additional risks which were addressed during the study using a Risk Register. The purpose of the register is to apply a risk-based decision making approach throughout the study. The register was used to highlight areas of study risks and identify ways to address those risks, such as reducing the schedule, optimizing the study area, and identifying the optimum amount of modeling to make a risk-based decision.

Several assumptions applied to analyses during the study result in conservative cost and impact estimates and reduce cost risks. Of particular note is the application of the “maximum” widening measures. This assumption generates the “maximum” dredging quantities, construction cost estimates, and construction duration times. The same assumptions were also applied to all of the engineering and environmental modeling efforts and generated the “maximum” shoaling rates and impacts to water quality, wetlands and all other habitat types and species. If some or all of these measures are reduced through additional analysis during PED, reductions can be expected across a broad range of cost, and minimal environmental impacts would be further reduced. Additionally, the hydrodynamic, water quality, and sediment transport models are based on a 5 nautical mile length of widener (rather than the TSP for a 3 nautical mile length of widener) leading to a very conservative estimate of the associated impacts of that feature.

4.4. Description of LERR

The requirements for LERR should include the rights to construct, operate, and maintain channel improvement works in connection with the proposed project. Based on the current plan/profile study drawings, no fee or easement acquisition would be required for staging, access, construction, or O&M in furtherance of the project except for that portion of Little Sand Island, which is already owned by the NFS, as more particularly described in the Real Estate Plan (REP), Appendix D.

The TSP set out herein follows an existing authorized and navigable watercourse and potential deepening of this channel falls within the jurisdiction of the navigable waters of the U.S. which is identified as that area below the ordinary high water mark. Furthermore, it is readily apparent that said purposes of the proposed project have a nexus to navigation. As a result of applying the Determination of Availability two-step process, the issue of navigational servitude is deemed applicable to this project as it relates to the Federal construction and subsequent operation and maintenance responsibilities. Therefore, no further Federal real estate interest is required for project construction and operation and maintenance in navigable waters below the ordinary high water mark.

There are no real estate requirements for upland dredged material placement sites for the placement of dredged material. Moreover, Section 201 of the WRDA of 1996 redefined disposal site preparation costs as being GNF and not a real estate requirement. There are no real estate requirements anticipated for project access or temporary staging areas.

No relocations of facilities or utilities will be required based on current research under the current TSP. Additional channel surveys will take place post-feasibility to better reduce risk associated with facilities/utilities traversing the channel. There are no additional lands, easements, or rights-of-way to be acquired by the NFS in furtherance of the TSP unless future real estate interests are required for beneficial use or mitigation sites not yet identified.

For additional information, refer to the Appendix D - Real Estate Plan attached to this report.

SECTION 5.0 ENVIRONMENTAL EFFECTS

This section describes the environmental effects of alternative actions for the proposed Mobile Harbor Federal Navigation Project. 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 compares the baseline conditions of the No Action Alternative which includes a projected SLR of 0.5 meters (from here on referred to simply as the No Action Alternative) to the modeled channel improvement dimensions as described in Section 4.1. The TSP consists of: deepening the existing channel an additional 5 ft (existing 45-foot deep channel in the bay to 50 ft and existing 47-foot deep channel in the bar to 52 ft); adding an additional 100 ft of widening for a distance of 3 nautical miles beginning at the upper end of the bend area at the 50-foot depth; including bend easing with the deepening at the upper end of the Bar Channel; and, modification to the Choctaw Pass Turning Basin to ensure safe operation at the 50-foot depth. For preparation of the Draft GRR/SEIS, the USACE, Mobile District conducted extensive modeling of a "maximum potential impacts" scenario with potential environmental effects equal to or greater than the TSP (i.e. dredging to a depth of 50 ft with widening of a 5 nautical mile channel section by 100 ft). It should be noted that the actual TSP represents conditions less than the modeled channel dimensions.

5.1. Geographic Setting

Neither the future Without-Project condition/No Action Alternative nor the proposed project including any future O&M activities would change the current general setting within the project area. The proposed project would not directly affect land use. It is not anticipated that the proposed project alone would result in the conversion of additional natural areas to urban use. The analysis is based on the existing throughput capacity estimated for Mobile Harbor and the project itself would have no effect on the conversion of additional natural area.

With the exception of Little Sand Island, the dredging templates lie entirely within the water column of Mobile Harbor and the project would not include dredging any natural upland or wetland areas. Maintenance dredging under the No Action Alternative, would place dredged material in existing dredged material placement areas and these actions would not affect land use. The effects to Little Sand Island is discussed in Section 5.7.

5.2. Climate, Tides, and Gulf Circulation

Generally, the scale and type of activities associated with the No Action Alternative, TSP, or future O&M activities would not result in overall regional climate, meteorological, or oceanographic impacts. No activities associated with any of the alternatives could result in impacts on regional processes and would not change the climate or weather patterns in the project area. As a result there would be no impacts to winds, rainfall, temperature, astronomic tides, or the Gulf of Mexico circulation patterns.

5.3. Mobile Bay and Coastal Processes

Hydrodynamic modeling was conducted by the ERDC to characterize the existing conditions (e.g., flows, circulation, waves, etc.) of the study area and determine the relative changes in those conditions due to proposed navigation channel modifications. A summary of the overall approach and results of these analyses are described in detail in Section 6.1, Appendix A.

5.3.1. Waves

As covered in greater detail in Appendix A, parallel versions of ADCIRC and STWAVE coupled via the CSTORM-MS framework (Massey *et al,* 2011) were utilized to provide the offshore water surface elevation tidal boundary, wave height, period, direction, and radiation stress gradient forcing to the GSMB hydrodynamic (MB-CH3D-WES) and sediment transport (MB-SEDZLJ) modules. The time period selected for GSMB hydrodynamic, sediment transport, and water quality modeling of Mobile Bay was January through December of 2010. This time period represented an average hydrologic year, as illustrated in Appendix A, and the annual mean flow for year 2010 also roughly falls into average condition; however, January and February are closer to high flow conditions, whereas July through December are within low flow conditions. The combination of this data results in a year (i.e., 2010) that covers the range of hydrological conditions (i.e., low, average, and high). In addition to the 2010 time period, CSTORM was used to provide a screening level comparison of storm tide levels in Mobile Bay between existing conditions and with project conditions for two historical hurricanes, Hurricane Katrina 2005 and Hurricane Ike 2008. These two hurricanes were selected as they produced some of the highest water levels on record in the area.

5.3.1.1. Alternative 1 – No Action

Under the No Action Alternative, current channel and harbor maintenance operations would continue. Dredging and placement operations would remain unchanged utilizing the current water quality certification for Mobile Harbor. Under this scenario, wave conditions in and around the project would be unchanged.

5.3.1.2. Alternative 2 – TSP

5.3.1.2.1. Project Construction

General Wave Climate. The model results indicate that implementation of the TSP produces only slightly elevated peak water levels and wave conditions as compared with the baseline channel configuration and negligible changes in pre-storm tides. The largest simulated difference in maximum water surface elevation between the With- and Without-Project depths was 0.07 ft, which is well within the uncertainty of the model and would result in negligible changes in the wave climate. Further details of this analysis are provided in Attachment A-1, Appendix A.

Ship Wake. A vessel generated wave energy (VGWE) assessment was conducted to quantify the relative changes in wave energy due to future vessels calling at Mobile Harbor. The investigation included field data collection using a suite of five pressure sensors located north of Gaillard Island. A unique and efficient method of data processing was employed using a continuous wavelet transformation (CWT) to extract the vessel generated disturbances from a continuous time series by utilizing frequency modulation or "chirp" signal produced and shown to be valid within the context of large data sets where random errors can be averaged. Overall, the field data collection collected for this study proved to be valid when used for general trending.

Potential impacts of VGWE were evaluated by comparing the relative difference of with and Without-Project conditions using forecasted vessel calls for years 2025 and 2035. Vessel speed was obtained from a statistical summary of 2016 Automatic Information System data categorized by vessel length. Results of the analysis indicates a reduction in vessel generated wave energy for the future With-Project condition relative to the future Without-Project condition. This is the case because the demand for future commodities and goods will be the same, with or without a wider/deeper channel; therefore, less vessels are required to call Mobile Harbor to meet that demand if the project is implemented. In other words, fewer vessels will call Mobile Harbor in the future if the channel is deepened/widened than if it's not. This reduced number of vessels anticipated to call Mobile Harbor results in less vessel generated wave energy affecting the study area. Further details on VGWE is located in Allen (2018) which is also provided as Attachment A-4, Appendix A.

5.3.1.3. Future Maintenance

Future maintenance and operations will be consistent with the current O&M dredging practices and would not be expected to cause any further impacts to the wave conditions in and around the project area.

5.3.2. Currents

The modeling conducted by the ERDC as described in Section 6.1.2, Appendix A utilized the three-dimensional, baroclinic, multi-block hydrodynamic circulation model CH3D-MB to conduct hydrodynamic computations on a non-orthogonal curvilinear or boundary-fitted grid of the study area. The physical processes impacting circulation and vertical mixing that were modeled included tides, wind, wave radiation stress gradients, density effects (salinity and temperature), freshwater inflows, turbulence, and the effect of the earth's rotation. Further details of this analysis are provided in Attachment A-1, Appendix A.

5.3.2.1. Alternative 1 – No Action

Under the No Action Alternative, current channel and harbor maintenance operations would continue. Dredging operations would remain unchanged utilizing the current water quality certification for Mobile Harbor. Under this scenario, the currents in and around the project would be unchanged.

5.3.2.2. Alternative 2 – TSP

5.3.2.2.1. Project Construction

The model results indicate implementation of the TSP produces only slightly elevated peak water levels as compared with the baseline channel configuration and negligible changes in pre-storm tides and currents. The largest simulated difference in maximum water surface elevation between the With- and Without-Project depths was 0.07 ft, which is well within the uncertainty of the model and would likely result in negligible changes to the currents in and around the project area. Further details of this analysis are provided in Attachment A-1, Appendix A.

5.3.2.3. Future Maintenance

Future maintenance and operations will be consistent with the current O&M dredging practices and would not be expected to cause any further impacts to the currents in and around the project area.

5.3.3. Sediment Transport

In an effort to help better understand the system and improve the sediment transport modeling of Mobile Bay, remote monitoring stations were installed as part of this study. Data collection was used to help quantify sediment fluxes into the bay from riverine sources and measure the discharge of the primary rivers entering north Mobile Bay. Details of this data collection and analysis can be found within Ramierz, M. et. al (2018). These stations were equipped with physical samplers, optical turbidity sensors, and acoustic instruments for measuring water velocity and acoustic backscatter. Long-term datasets were augmented with local, boat-based measurements of the same quantities to calibrate the remote records. The combined datasets were used to derive calibrated, continuous time series of water discharge and suspended sediment concentrations at each of the remote sites.

Sediment transport modeling of Mobile Bay was conducted to assess the relative changes in sedimentation rates within the navigation channel, dredged material placement sites, and surrounding areas as a result of channel modifications within the bay. As described in Section 2.9, Appendix A, the sediment transport model was built upon previous modeling conducted in 2012 to evaluate thin-layer placement of maintenance dredged material as described in Appendix A. Additional details of the estuarine sediment transport modeling effort are provided in Section 6.3.1, Appendix A.

Coastal sediment modeling was used to assess the relative changes in sediment pathways and morphological response on the ebb tidal shoal and adjacent coastal areas. This modeling work built upon the ongoing collaborative data collection and modeling efforts being conducted as part of the National Fish and Wildlife Foundation (NFWF) Alabama Barrier Island Restoration Assessment utilizing field experiments conducted as part of the study which included bathymetric, current, wave and sediment measurements. Additional details of the coastal sediment transport modeling effort are provided in Section 6.3.2, Appendix A.

5.3.3.1. Alternative 1 – No Action

Under the No Action Alternative, current channel and harbor maintenance operations would continue. Generally, dredging and disposal operations would remain unchanged utilizing the current water quality certification for Mobile Harbor. It is anticipated, however, that expansion of the SIBUA will extend its boundaries to include areas within the Sand Island-Pelican Island complex. The extension would be to the north and west which follows the shoal and pathway of sediment transport towards Dauphin Island. Doing so provides an effective means of continued bypassing of sand dredged from the Bar Channel to the downdrift littoral system. The necessary analysis and coordination actions will be conducted under the O&M program. Under this scenario, it is expected that sediment transport in and around the SIBUA would be modified to return sandy material to the local littoral system.

5.3.3.2. Alternative 2 – TSP

Sediment transport modeling of Mobile Bay and the ebb tidal delta was conducted to assess the relative changes in sedimentation rates within the navigation channel, dredged material placement sites, and surrounding areas. As a result, channel modifications within the bay were built upon previous modeling conducted in 2012 to evaluate thin layer placement of maintenance dredged material as described in Appendix A. The results from this effort indicated a minimal difference range of no greater than +/- 0.3 feet of erosion when compared to the existing conditions and indicate no discernable net erosion or net deposition. Additional details of the estuarine sediment transport modeling effort are provided in Section 6.3.1, Appendix A.

5.3.3.2.1. Project Construction

Estuarine/Mobile Bay. Channel modifications may change sedimentation rates and patterns, which directly impact maintenance dredging requirements. Field data collected in 2012 to parameterize cohesive sediment transport processes in the study area are documented in Gailani, J. Z. et al. (2014). The field experiments included Sedflume erosion and settling velocity measurements conducted using the Particle Imaging Camera System (PICS). Additional field studies were conducted in 2016 to more appropriately describe project boundary conditions. These consisted of measuring suspended sediment concentrations and discharges at the seven stations in the delta and upper bay (Ramirez et al. 2018). Cohesive sediment process descriptions were formulated from the data collection efforts and utilized in the development of the estuarine sediment transport model (GSMB-SEDZLJ).

GSMB-SEDZLJ is an advanced sediment bed model. This model accounts for the following coastal dynamic erosional processes: bed load transport, bed sorting, armoring, consolidation of fine-grain sediment dominated beds, settling of flocculated cohesive sediment, settling of individual non-cohesive sediment particles, and deposition which are further discussed in in Section 6.3, Appendix A. The model accounts for the effect of bottom slope in predicting bed load transport of the non-cohesive sediment size classes as well as in the equation (developed from the analysis of the Sedflume data) used to predict the re-suspension of mixed grain sediments. Also added was the capability to simulate the formation of a fluff layer on top of an existing sediment bed. Being able to represent the resuspension of this layer during the early stages of the accelerating flow following slack water is essential to accurately simulating sediment transport, in particular within stratified estuaries such as Mobile Bay.

Results from the one year model simulation with the TSP condition show a minimum difference range of no greater than +/- 0.3 ft of erosion when compared to the No Action Alternative. Subsequently, these results indicate that there is no discernable net erosion or net deposition throughout the bay. Similar results and conclusions were found for the future With- and Without- Project Conditions when accounting for mean sea level change. With no discernable impacts associated with waves, currents, and sediment transport throughout the project area, there would be no expected erosion or changes to the position of the Mobile Bay shorelines resulting from the TSP. Additional details of the estuarine sediment transport modeling effort are provided in Attachment A-1, Appendix A.

Ebb Tidal Delta. The purpose of the coastal sediment transport modeling was to assess the relative changes in sediment pathways and morphological response on the ebb tidal shoal and adjacent coastal areas as a result of the proposed channel modifications to deepen the existing Bar Channel by 5 ft. Details of these data collection efforts are contained within USACE and USGS (2017) *Alabama Barrier Island Restoration Assessment Interim Report*. Descriptions were formulated from these data sets and utilized in the development of the coastal sediment transport model (Delft-3D) as discussed further in Attachment A-2, Appendix A.

The model domain was expanded to include probable effects on shoreline changes with the minimum extent per USACE EM 1110-2-1613 guidance of 10 miles east and west of the channel and adequately represented the deep navigation channel, associated modifications, and irregular shoreline configurations of the flow system. Scenarios were also evaluated for climate, with the only difference being the With-Project Condition incorporated annual dredged material placement in the SIBUA as part of the 10-year simulations. The modeling results indicate minimal difference in bed level changes between the TSP and Existing Conditions in the bay and on the ebb tidal shoal. Similar results and conclusions were found for the future With- and Without-Project Conditions (i.e., accounting for mean sea level change).

Results of the modeling conducted by the USGS (2018) indicate minimal differences in morphologic change in the nearshore areas of Dauphin Island and Pelican Island as a result of the channel modifications. This suggests that sediment delivery away from the ebb tidal shoal to these areas is similar under these two scenarios and that shoreline positions are unlikely to be impacted as a result of the modified channel. Although comparison of the two simulations shows some spatial shifting of sand offshore of the Morgan Peninsula, the patterns of erosion/deposition in the two simulations are quite similar. Based on these results, it also appears unlikely that these changes would alter sediment delivery to the peninsula and only minor impacts to the terminal end of the peninsula closest to the channel could occur. Additional details of the coastal sediment transport modeling effort are provided in Attachment A-2, Appendix A.

5.3.3.3. Future Maintenance

Future maintenance and operations will be consistent with the current O&M dredging practices including the SIBUA expansion and would not be expected to cause any perceivable change to wave and current conditions which would not result in additional impacts to sediment transport processes in and around the project area.

5.3.4. Sea Level Change

Based on an extrapolation of the high curve values, sea level in the project area would be approximately 5 ft higher in the year 2100 relative to North American Vertical Datum

1988. The NOAA Digital Coast Sea Level Rise Viewer (NOAA Office for Coastal Management, 2011) was utilized to visualize the first estimate of the vertical and horizontal extents of the potential sea level change impacts.

A detailed description on the effects of sea level change in relation to the navigation project can be found Section 2.10.1, Appendix A. Generally, neither the No Action Alternative nor the TSP or future maintenance activities would have an effect on the rates of sea level change.

However, it is predicted that the future SLR scenarios over the next 50 years would cause changes in salinity and other water quality parameters and consequently result in impact to wetland assemblages and distributions as the SLR occurs (Kirwan and Megonigal, 2013). In many regions the predominant impact of long-term SLR will be excessive inundation leading to a conversion of wetland features to open water areas, especially in landscapes where landward retreat is restricted (USGS, others). Similarly, changes from Without-Project conditions to With-Project conditions with SLR show an increase in relative salinity tolerance thresholds for the SAV species as they exist today ranging from -1 to 5 ppt. A larger proportion of SAV habitat will be exposed to higher salinities due to SLR impacts than that from implementation of the TSP.

5.4. Geology, Soils, and Sediments

The significance criterion for geology, soils, and sediment would be a permanent change in underlying bedrock or sediment stratigraphy that interferes with the natural movement and deposition of sediments in the Mobile Bay and nearshore Gulf of Mexico.

5.4.1. Geological Setting

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 vicinity of the project. No activities from project construction, sediment placement, or future maintenance and operations will have an impact on the underlying geological framework.

5.4.2. Soils

5.4.2.1. Alternative 1 – No Action

Under the No Action Alternative, there would be no change in existing conditions and no impacts on soils. A Draft Section 404(b)(1) Evaluation Report has been prepared for this study which describes the existing sediment characterizations in the navigation channel and disposal areas. A copy of the Draft 404(b)(1) is included in Attachment C-2, Appendix C.

5.4.2.2. Alternative 2 – TSP

5.4.2.2.1. Project Construction

The sediment profile in the new work dredging areas would be altered as the sediment would be removed and placed in the disposal areas. Sediments placed within the relic shell mined area would result in a change of the surface sediments to be similar to the new work material. Underlying sediments will remain unchanged. More information pertaining to soils can be found in the Draft 404(b)(1) Report located in Attachment C-2, Appendix C

5.4.2.3. Future Maintenance

Other than the effects of the dredging operations, future maintenance practices will be consistent with the current O&M dredging practices and would not be expected to cause any further impacts to the underlying soil conditions.

5.4.3. Geotechnical Conditions

5.4.3.1. Alternative 1 – No Action

Under the No Action Alternative, current channel and harbor maintenance operations would continue. Dredging operations would remain unchanged utilizing the current water quality certification for Mobile Harbor. Under this scenario, there would be no change to the subsurface geotechnical properties and conditions associated with the existing navigation channel.

5.4.3.2. Alternative 2 – TSP

5.4.3.2.1. Project Construction

The existing channel side slopes were achieved by making a box cut to the excavation beyond the horizontal extents of the channel bottom. As this is done, the material falls to its angle of repose which creates side slopes at approximately 1V:5H. The slopes for the deepening and the widening will be cut in a similar manner. Slope stability is a concern where the Choctaw Pass Turning Basin will be expanded. The turning basin was initially constructed by creating slopes on the north, east, and south sides of Choctaw Pass, between Pinto Island and Little Sand Island. Slope stability analyses, performed during the design of the turning basin, informed the decision to design the basin slopes at a 1V:4H. Slopes of 1V:5H were also analyzed; however, it showed that flatter slopes would require excavation far enough back toward Pinto and Little Sand Island that it would, in effect, remove resisting material that supports nearshore portions of the Pinto Island upland disposal area. The expansion of the turning basin will require excavation in either the north or south directions to accommodate longer ships and will likely be towards the southern side of the basin into Little Sand Island. As such, slope stability analyses are necessary to account for the design of both submarine and upland slopes to avoid slope failure and subsequent deposition of material into the turning basin. The channel slopes will be excavated as has been done under other construction action for the channel and turning basin. It is not anticipated that the excavating the new slide slopes would have an effect on soil types or underlying stratigraphy. However, additional slope stability analyses will be performed during Planning, Engineering, and Design (PED) Phase of this project. Flatter slopes will be considered at that time in a suite of slope stability analyses.

5.4.3.3. Future Maintenance

Other than the effects of the dredging operations, future maintenance practices will be consistent with the current O&M dredging practices and would not be expected to cause any further impacts to the underlying geotechnical conditions

5.4.4. Sediment Quality

5.4.4.1. Alternative 1 – No Action

Under the No Action Alternative, there would be no change from existing conditions and no additional impacts on sediment quality from continued maintenance practices.

5.4.4.2. Alternative 2 – TSP

5.4.4.2.1. Project Construction

During the PED phase of the Mobile Harbor GRR/SEIS, sediment testing and evaluation will be required for all material proposed for placement in the Mobile ODMDS. Material dredged as part of routine O&M along with the proposed new work dredged material must comply with guidelines in accordance with the MPRSA of 1972, CWA, and the EPA ocean dumping criteria (40 Code of Federal Regulation (CFR) §227).

Sediment sampling will be required to obtain a MPRSA Section 103 concurrence from the EPA for placement in the Mobile ODMDS. Sampling will include physical sediment analyses, bulk sediment analysis, standard and modified elutriate testing (full Tier III testing), water column bioassays, whole sediment bioassays, and bioaccumulation studies of dredged material samples. These tests will follow guidance in the: *Inland Testing Manual* (EPA 1998); *Ocean Testing Manual* (USACE/EPA 1991); and the *Regional Implementation Manual, Requirements and Procedures for Evaluation of the*

Ocean Disposal of Dredged Material in Southeastern Atlantic and Gulf Coastal Waters (SERIM) (USACE/EPA 2008).

Sediment core samples are proposed to be taken at 14 locations in the Mobile Bay (to a depth of 54 ft MLLW) and the Bar Channel (to a depth of 56 ft MLLW). Ten sample locations in the Bay Channel will be similar to past O&M locations. Additionally, four samples to be taken in the Bar Channel will be new locations. One additional sample will be taken in the Choctaw Pass Turning Basin (to a depth of 54 ft MLLW).

The upper northeastern quadrant of the bay contains relic shell mined areas (highly hypoxic micro-environments) which were used for harvesting of relic shell material and have since left large voids/holes in the sediment. These holes could potentially be filled with new work dredged material associated with the TSP. To that end, grab samples from within the relic mines will be taken to assess the physical and chemical characteristics of the material in compliance with the Inland Testing Manual. These results will be compared to the physical and chemical characteristics of the dredged material from the channel prior to placement in the relic shell mined areas.

At this time, specific impacts associated with the new work sediment testing and evaluation during the PED phase of the study are not known. All current presumptions are that the new work material associated with project sampling would be similar to that already tested and should be suitable for placement within the identified placement areas. However, testing is still required to ensure compliance with the MPRSA and CWA material suitability determinations. Based on the results of new sediment testing for the turning basin and LRR, presented in Section 2.3.4, it is anticipated that no contaminants will be detected..

5.4.4.3. Future Maintenance

It is believed that the shoaling and characteristics of future maintenance material within the modified channel will be similar to current maintenance sediments. Future maintenance and placement practices will be consistent with the current O&M dredging practices with the addition of the expanded SIBUA and ODMDS. The sediment testing and evaluation requirements will continue as required for all future maintenance material as described above.

5.5. Water Quality

The output from the modeling efforts were analyzed to assess relative differences in DO, salinity, temperature, total suspended solids, and nutrients. A more detailed discussion on the modeling effort is included in Section 6.2, Appendix A.

5.5.1. Dissolved Oxygen

5.5.1.1. Alternative 1 – No Action

Under the No Action Alternative, there would be no change from existing conditions and no impacts on DO.

5.5.1.2. Alternative 2 - TSP

5.5.1.2.1. Project Construction

Hydrographic and water quality modeling performed by the ERDC is documented in the Appendix A. Results of simulations comparing the Without- and With-Project conditions of the bay and river characterizes changes in DO conditions were assessed. DO results for surface waters show that during the first period of the year, tributary inflows and their associated water quality provide more significant roles in many locations in the system. Stations located in rivers, channels or even the upper bay were dominated by the riverine flows and riverine water quality. In many instances the waters at these locations were completely mixed with there being little DO variation from surface to bottom. As tributary inflows decreased, tidal flushing and coastal processes dominated flow conditions with offshore waters imparting in larger influences in DO and water quality conditions. Bottom DO results on the Mobile River indicated that DO levels fluctuated with frequent swings of several mg/l of daily average DO which varied from 8 or greater mg/L to 3 mg/L. These swings were due to fluctuating inflows enabling an influx of bay waters with high salinities and lower DO. The model simulations showed DO levels decreased in response to a combination of factors including increasing temperature and salinity which decreased DO saturation levels. Simulated DO levels in the bottom waters are sensitive to several issues in which circulation and flushing are primary factors. Water column conditions in regards to oxygen demanding substances, temperature, and salinity all continually impact DO levels in the water column. External impacts include benthic fluxes, sediment oxygen demand, and boundary loads.

Section 3.5.1.2.1, Appendix C provides daily average surface and bottom DO concentrations for the Without- and With- Project conditions. As discussed, there are very minor differences in the DO concentrations. The same patterns, trends, and behavior exist after the channel widening and deepening. There are no changes in duration or exposure to any level of DO at any of the locations shown.

Since DO levels represent the end product of numerous water quality processes, changes in any of those processes can have an impact on DO levels. Values presented for January/February time period represents high water flow conditions, those values for the mid-year period represents typical or average flows, and the values for the fall (October) period represent low flow conditions.

The simulated results indicate very little change in DO resulting from implementation of the TSP. Differences in the monthly DO at the bottom between With-Project and Without-Project (existing condition) results indicate maximum differences of 0.3 milligrams per liter over the low flow/hot conditions. This in essence indicates no discernable DO changes, as this is well within the uncertainty of the water quality model. The results of the modeling analyses show that no impact from the project is predicted for DO levels in the surface or bottom waters at these locations and that the daily average DO conditions With-Project are the same as the Without-Project.

The same modeling approach and setup was used to evaluate the potential impact of a proposed SLR. For comparison purposes the Without-Project case was simulated using hydrodynamics incorporating SLR to generate a Future Without-Project condition. Surface and bottom time series comparisons of daily average model output for the same locations used for the Existing and With-Project cases were evaluated for the Existing and With-Project with SLR cases. The same patterns, trends, and behavior exist after the channel widening and deepening are incorporated in the model and no impacts to DO concentrations are expected as a result in future sea level change. The simulated results for the existing and project condition are nearly identical, indicating very little change in DO resulting from implementation of the TSP. Differences in the monthly DO at the bottom between With-Project and Without-Project (existing condition) results indicate maximum differences of 0.3 mg/L over the low flow/hot conditions. This indicates no discernable DO changes, as this is well within the uncertainty of the water quality model. The results of the modeling analyses show that no impact from the project is predicted for DO levels in the surface or bottom waters at these locations and that the daily average DO conditions With-Project are the same as the Without-Project.

The same modeling approach and setup was used to evaluate the potential impact of a proposed SLR. For comparison purposes the Without-Project case was simulated using hydrodynamics incorporating SLR to generate a future Without-Project condition. Surface and bottom time series comparisons of daily average model output for the same locations used for the Existing and With-Project cases were evaluated for the Without-and With-Project with SLR cases. The same patterns, trends, and behavior exist after the channel widening and deepening are incorporated in the model and no impacts to DO concentrations are expected as a result in future sea level change.

As presented in Section 3.8.8, Appendix C, almost 1,200 measurements of salinity and DO were taken during fish collections by both MRD and the ERDC. Mean DO was approximately 7.0 mg/l at all zones. However, hypoxia (minimum DO) was measured at all zones except for the transition and freshwater zones. Higher DO in the two latter zones may have been due to the low sample size compared to Mobile Bay. Specific predicted changes in DO as related to the various aquatic resources evaluated for this study such as wetlands, SAV, benthic communities, oysters, and fish can be found in Attachment C-1.

5.5.1.3. Future Maintenance

Other than the effects of implementing the TSP, future maintenance practices will be consistent with the current O&M dredging practices and would not be expected to cause any further changes to the overall DO conditions in the bay and river.

5.5.2. Nutrients

5.5.2.1. Alternative 1 – No Action

Under the No Action Alternative, there would be no change from existing conditions and no impacts on nutrient loads in the project area.

5.5.2.2. Alternative 2 – TSP

5.5.2.2.1. Project Construction

Model predictions for ammonium and nitrate were conducted in the water quality as presented in the Appendix A. Results indicate that the simulated nutrient levels are consistent with measured nutrient observations. Increases in ammonium at the mouths of the Mobile and Tensaw River correspond to changes in flow conditions. When very low flow conditions are specified, ammonium levels at the river mouths decrease correspondingly. Results of the water quality modeling also reveal that nitrate levels are consistent with observed values. Subsequently, increases in nutrient levels would not be expected resulting from implementation of the TSP.

5.5.2.3. Future Maintenance

Other than the effects of implementing the TSP, dredging operations, future maintenance and disposal practices will be consistent with the current O&M dredging practices and would not be expected to cause any further changes to the overall nutrient concentrations in the bay and river.

5.5.3. Salinity

5.5.3.1. Alternative 1 – No Action

Under the No Action Alternative, there would be no change from existing conditions and no impacts on salinity.

5.5.3.2. Alternative 2 – TSP

5.5.3.2.1. Project Construction

Hydrographic and water quality modeling performed by ERDC is documented in the Appendix A. Results of simulations comparing the Without- and With-Project conditions of the bay and river characterizes changes in conditions were assessed. In order to assess the changes in salinity distribution as a result of the project, model results were processed for monthly statistics. Monthly statistics shows long-term response of salinity distribution. First the results are analyzed for depth-averaged salinity, surface salinity, and bottom salinity. The monthly statistical parameters include mean, standard deviation, minimum, maximum, and percentiles (1, 5, 10, 25, and 50 percentiles) representing the varying flow conditions. These statistics were provided to the habitat assessment teams for further analysis of potential effects specific to different aquatic resources considered.

Differences in the monthly mean of depth-averaged salinity between results of the With-Project and Without-Project (existing condition) show changes ranging between 0 to 2 ppt. The figures presented in Section 2.4.3, Appendix C show the distributions for mean depth-averaged salinity for February (wet condition) and October (dry condition). The channel generally exhibits higher salinities than shoals. As shown for the Without-Project conditions, dry conditions typically experienced in the fall allows for more salt intrusion through the navigation channel to Mobile River than wet conditions of the winter months. As presented in Appendix C, the largest changes in salinities are located on the western side of the bay with the largest differences located closest to the channel in the vicinity of Gaillard Island and the turning basin. The results of the modeling indicate that the differences in the monthly mean depth-averaged salinity between the With-Project and Without-Project (existing condition) ranges between 0 to 2 ppt and that changes throughout the project area are considered minimal. Specific predicted changes in salinity as related to the various aquatic resources evaluated for this study such as wetlands, submerged aquatic vegetation, benthic communities, oysters, and fish can be found in Attachment C-1 and presented later in this report.

5.5.3.3. Future Maintenance

Future maintenance practices will be consistent with the current O&M dredging practices and would not be expected to cause any further changes to the overall salinity conditions in the bay and river.

5.5.4. Turbidity and Suspended Solids

5.5.4.1. Alternative 1 – No Action

Turbidity in the Mobile Bay and surrounding waterbodies would remain similar to existing conditions due to continued disturbance processes of sediments in the shallow areas. These impacts would be temporary and not increase turbidity levels above that of the existing conditions..

5.5.4.2. Alternative 2 – TSP

5.5.4.2.1. Project Construction

Dredging operations are likely to have a temporary and minor impact to water quality nearby the dredging and placement areas. The proposed project construction activities would have dredges operating in various areas of the channel for extended periods. Hopper dredges are also often associated with increased turbidity mostly at the discharge areas. The suction drag arms of the hopper dredge hydraulically remove sediment from the dredged site and discharge the material into storage hoppers on the dredge. During operations within the Bar Channel, fine sediments (primarily silt, clays, and fine sands) are allowed to wash overboard (overflow) to maximize the load of sediment for transport to the placement area. This overflow process if used during the construction activities is one source of turbidity plumes and sedimentation generated by the hopper dredge. The distance that sediment plumes may extend is dependent upon the type of dredge, how it is operated, currents, and the nature of the sediments within the dredged area. A study performed by Newell and Siederer (2003) (high current velocities) showed that, in most cases, coarse material up to sand-size particles settles within 650 to 1,970 ft of the point source of discharge, depending on depth of water, tidal velocity, and the velocity of flow from the discharge pipe. During hopper dredging operations in the Baltic, Gajewski and Uscinowicz (1993) noted that the main deposition of sand from hopper dredge overflow was confined to distances within 490 ft on each side of the dredge.

For cutterhead suction dredges, turbidity is only generated at the seafloor by the cutterhead where sediment suspension occurs during the process of removing sediments. However, sediments are usually confined to the immediate vicinity of the cutterhead and not widely dispersed into the water column (LaSalle et al., 1991). Impacts resulting from placement activities are presented in Section 3.7

Results of the water quality modeling indicate that the predicted levels of total suspended solids are representative of the observed data. Subsequently, there would be no expected increase in the concentrations of the turbidity as a result of the implementation of the TSP. The USACE is required to implement appropriate best management practices (BMPs) to minimize turbidity impacts to the maximum extent practicable under the ADEM

Section 401 Water Quality Certification conditions. Turbidity generated by the activity must not cause substantial visible contrast nor result in an increase of more than 50 Nephelometric Turbidity Units (NTU) above background turbidity levels in state waters. As part of the water quality certification by the ADEM, the USACE is required to conduct daily inspections of the sediment placement activities during the life of the project to ensure that in-stream turbidity resulting from active dredging and placement activities will not cause the discharge of sediment into wetlands, substantial visible contrast with the receiving waters greater than 400 feet from the activity or result in an increase of 50 NTUs above background turbidity levels in the receiving waters. Should these conditions be exceeded, the USACE must suspend operations and immediately notify the ADEM of any resultant work stoppages. Work will not be resumed until turbidity levels return to compliance conditions.

5.5.4.3. Future Maintenance

Future maintenance and operations will be much as they exist currently. Turbidity in the Mobile Bay and surrounding waterbodies would remain similar to existing conditions due to continued disturbance processes of sediments in the shallow areas. These impacts would be temporary and localized and would not increase turbidity levels above that of the existing conditions. The USACE will continue to implement BMP and turbidity compliance measures as required by the ADEM's water quality certification for the Mobile Harbor project.

5.5.5. Water Temperature

5.5.5.1. Alternative 1 – No Action

Under the No Action Alternative, there would be no change from existing conditions and no impacts on temperature would occur.

5.5.5.2. Alternative 2 – TSP

5.5.5.2.1. Project Construction

Hydrographic and water quality modeling performed by the ERDC is documented in Appendix A. Results of simulations compared the existing and With-Project conditions of the bay to characterize Mobile Bay's water temperatures. Figure 3-5, Appendix C illustrates the comparison between the simulated existing and With-Project daily average surface and bottom water temperatures for Mobile Bay. Values for January/February time period represents high water flow conditions, those values for the mid-year period represents typical or average flows, and the values for the fall (October) period represent low flow conditions.

The simulated results for the existing and project condition are nearly identical, indicating very little change in surface and bottom temperatures resulting from implementation of the TSP.

5.5.5.3. Future Maintenance

The future maintenance practices will be consistent with the current O&M dredging practices and would not be expected to cause any further changes to the overall water temperatures conditions in the bay and river systems.

5.6. Groundwater

As also described in Section 5.4.2, Appendix A, there are two major aquifers in Mobile and Baldwin Counties that act as recharge areas (Gillet et al., 2000). These aquifers are referred to the Miocene-Pliocene Aquifer and the Watercourse Aquifer (Chandler et al., 1985). The Watercourse Aquifer is located in the Pleistocene and Holocene alluvial deposits, and the Miocene-Pliocene Aquifer lies within the underlying series of the same name. Clay deposits are present in both of these series, especially in the Miocene-Pliocene. These clay layers act as aquitards within the Miocene-Pliocene, allowing for multiple aquifers, which are hydraulically connected. The recharge areas for the Watercourse Aquifer are in close proximity to the bay, rivers, and other low-lying tributaries and waterways that are hydraulically connected to the bay. This aquifer is unconfined and also hydraulically connected to the Miocene-Pliocene Aquifer, making the two aquifers relatively subject to natural and manmade contaminants. Chandler et al. (1985) state that even though the Miocene-Pliocene Aquifer has a high yield, only a fraction of this groundwater can be used as there are many concerns with saltwater intrusion. Additionally, the Watercourse Aquifer is susceptible to contaminants via land source (Gillet et al., 2000), resulting in very few water supply wells that rely on the Watercourse Aquifer for potable water. A detailed discussion on these aquifers can be found in Section 5.4.2 of Appendix A.

5.6.1. Alternative 1 – No Action

Under the No Action Alternative, current channel and harbor maintenance operations would continue for Mobile Harbor. The aquifers and groundwater in the vicinity of the navigation channel have already been exposed during previous channel modifications. Since the aquifers and groundwater are not used as water supplies for the area, the No Action Alternative would have no impacts to the local groundwater supplies.

5.6.2. Alternative 2 – TSP

5.6.2.1. Project Construction

It is not anticipated that the deepening of the channel would result in adverse effects to these aquifers or associated groundwater used by the surrounding communities. The sediments that connect the aquifers have already been exposed since the 1991 deepening with no perceived effects. The upper portions of the Watercourse aquifer that has been directly exposed is not considered a source for water supply. Since the aquifers and groundwater are not used as water supplies for the area, the implementation of the TSP would have no impacts to the local groundwater supplies.

5.6.2.2. Future Maintenance

Future maintenance and operations disposal practices will not further expose the aquifers during maintenance dredging activities. Since it would not be expected that the channel modifications would have additional impacts to the aquifers and groundwater, future maintenance would also not be expected to cause additional impacts.

5.7. Dredging and Placement Areas

Dredging Areas. As described in detail in Section 4.1 of the Main Report, modifications to the channel features, as recommended in the TSP, are as follows:

- Deepen the existing Bar, Bay (including the Choctaw Pass Turning Basin), and River Channels (south of station 226+16) by 5 feet to project depths of 52, 50, and 50 feet, respectively, with an additional 2 feet for advanced maintenance plus 2 feet of allowable overdepth for dredging (total depths of 56, 54, and 54 feet, respectively).
- Incorporate minor bend easings at the double bends (at stations 1857+00 and 1775+26) in the Bar Channel approach to the Bay Channel.
- Widen the Bay Channel to 500 feet from the mouth of Mobile Bay northward for 3 nautical miles to provide a two-way traffic area for passing.
- Expand the Choctaw Pass Turning Basin 250 feet to the south (at a depth of 50 feet) to better accommodate safe turning of the design vessel and other large vessels.

Approximately 24.1 mcy of “new work” material will need to be dredged to construct the TSP for the Mobile Harbor Federal Navigation Project. In addition, increases of 5 to 15% in maintenance dredging volumes are anticipated post-implementation.

Placement Areas. Several sites were evaluated for potential placement of new work material for the TSP. These included six relic shell mining areas, the ODMDS, and the

SIBUA (if new work sand sources are found within the Bar Channel). Details of these areas are provided in Section 4.11 of Appendix A.

Relic Shell Mined Area. The Relic Shell Mined Area is located to the northeast of Gaillard Island on the eastern side of the ship channel as shown in Figure 4-6. The proposed placement within this site is the result of beneficial use discussions with the cooperating agencies. The agencies suggested that the USACE, Mobile District conduct open bay placement of the dredged material in strategic areas of the bay in an effort to improve bay bottom conditions. One of the primary concerns expressed by the group pertained to the conditions of the bay bottom in the northeastern portion of the bay where shell dredging operations were conducted prior to 1982. These operations resulted in an overall deepening of the bay bottom and are believed to be the cause of decreased ecological productivity resulting from hypoxia during certain times of the year.

Approximately 5.5 mcy of new work material are anticipated to be placed in the relic shell mined areas. Site selection and volume estimates for the six relic shell mined areas were based on NOAA compiled bathymetric surveys within the area between 1960 to 1961 and 1984 to 1987. The potential placement areas were laid out in sections where there were disturbances with 15-foot depths or greater based on those combined surveys. These areas encompass approximately 4,100 acres and, assuming a layered placement in these areas, they have capacity to accommodate approximately 5.5 mcy of new work material.

Placement is anticipated to be accomplished with a maximum thickness of approximately 3 ft due to the non-uniform and clumping characteristics of the new work material; however, the volume of material planned to be placed in the sites is based on an average material thickness of 1.5 ft throughout. The quantity of material planned for placement in each area is detailed in Section 4.11.1.1, Appendix A.

SIBUA. In Section 302 of the 1996 WRDA, Congress gave the USACE authority to modify placement practices for beneficial use of dredged material for Mobile Harbor. The USACE, Mobile District then coordinated with the ADEM to designate an area west of the Bar Channel in which suitable material could be placed when any opportunity arose. Designation of the SIBUA was completed in 1998 and this site became the preferred placement option of the sandy maintenance material from the Bar Channel.

As part of this study, analysis found that SIBUA material moves out at a slower rate than needed to ensure adequate placement capacity for maintenance material from the Bar Channel. An analysis was conducted to determine the location and size to ensure future capacity in the site. As such, the USACE, Mobile District is pursuing modifications to extend the site beyond the existing SIBUA boundaries to provide sufficient movement of material and capacity for maintenance material. Expansion of the SIBUA will extend its boundaries to include areas within the Sand Island-Pelican Island complex. The proposed SIBUA northwest extension is being conducted under O&M and not as part of this study.

Currently, no new work material from the Bar Channel is anticipated to be placed in the SIBUA or the northwest extension (see Figure 4-8) as part of the TSP. The new work material in the Bar Channel is predominately clays and silts with some intermixed sands, and, per the geotechnical information obtained to-date, none of this material meets the suitability criteria for placement in the SIBUA.

Material dredged as part of maintenance operations for the future With-Project conditions will continue to be placed in a combination of upland sites adjacent to the River Channel: open-water placement sites within the bay; the SIBUA on the ebb tidal shoal, including a proposed northwestward expansion of the site; and, the ODMDS in both the current limits and a future expansion area.

ODMDS. The WRDA 1986 authorization for the Mobile Harbor Project required that, all dredged material from the project shall be disposed of in open-water in the Gulf of Mexico in accordance with all provisions of Federal law. Since that time, the 1994 and 1996 WRDA authorizations included language that allowed placement options of suitable material in the SIBUA as well as open water (thin layer) placement within the bay adjacent to the channel. The remaining approximately 18.6 mcy of new work material (24.1 mcy total volume minus the 5.5 mcy going in the relic shell mined areas) are anticipated to be placed in the expanded ODMDS. The EPA Region 4 is pursuing the proposed ODMDS expansion pursuant to Section 102 of the MPRSA. An available/remaining capacity of approximately 52 mcy is expected after 20 years of future placement of maintenance material in the site. This volume is more than adequate to handle the anticipated 18.6 mcy of new work material that will be placed in the site during construction of the TSP. The boundaries of the current and expanded area is described in detail in Section 4.11.1.2, Appendix A.

5.7.1. Alternative 1 – No Action

Under the No Action Alternative, current channel and harbor maintenance operations would continue utilizing the authorized placement areas identified under the current water quality certification for Mobile Harbor. The current placement of O&M material consists of using several authorized upland sites, the ODMDS, open-water thin-layer placement area, and the SIBUA. Gaillard Island is also authorized for use under emergency conditions. The USACE, Mobile District will continue to implement BMP and turbidity measures in compliance with the current ADEM water quality certification for the Mobile Harbor project.

5.7.2. Alternative 2 – TSP

5.7.2.1. Project Construction

The USACE, Mobile District is required to implement appropriate BMP for all dredging and placement activities (including current, new work, and future maintenance) to minimize turbidity impacts as per the ADEM Section 401 Water Quality Certification conditions. Turbidity generated by the activity must not cause substantial visible contrast nor result in an increase of more than 50 NTU above background turbidity levels in state waters. As part of the water quality certification by the ADEM, the USACE, Mobile District is required to conduct daily inspections of the sediment placement activities during the life of the project to ensure that in-stream turbidity resulting from active dredging and placement activities will not cause the discharge of sediment into wetlands, substantial visible contrast with the receiving waters greater than 750 feet from the activity or result in an increase of 50 NTUs above background turbidity levels in the receiving waters. Should these conditions be exceeded, the USACE must suspend operations and immediately notify the ADEM of any resultant work stoppages. Work will not be resumed until turbidity levels return to compliance conditions.

Dredging Areas.

Channel Deepening. Adverse impacts to wetlands, oyster reefs, or SAV from dredging activities associated with the implementation of the TSP would be minimal and temporary. Most of the motile benthic and pelagic fauna, such as crab, shrimp, and fish, should be able to avoid the areas where dredging will occur and should return shortly after the activity is completed. No long-term direct impacts to managed species of finfish or shellfish populations are anticipated as the deepening is taking place where maintenance dredging operations regularly occur. However, it is reasonable to anticipate some non-motile and motile invertebrate species will be physically affected by the dredging process. These species are expected to recover rapidly soon after the operations are complete. No significant long-term impacts are expected as result of dredging within the existing navigation channel. Increased water column turbidity during dredging would be temporary and localized. No change is anticipated to occur to the existing habitat types. Overall, dredging impacts to existing resources would be temporary and localized in nature and would be no greater than the maintenance dredging operations regularly occurring within the navigation channel. Based on the minimal abundances of aquatic resources within and around the navigation channel and the temporary nature of the impact, the overall impact to resources is considered negligible. The potential effects to water quality and sediment transport resulting from channel deepening are addressed in Section 3.5 and Section 3.3.3, Appendix C, respectively.

Widener and Bend Easing. Adverse impacts would minimal and temporary. Based on the limited aquatic resources within and around the navigation channel and the temporary nature of the impact, the overall impact to resources is considered negligible. Potential effects to water quality and sediment transport resulting from channel widening and bend easing activities are addressed in Section 3.5 and Section 3.3.3, Appendix C, respectively.

Choctaw Pass Turning Basin. As shown in Figure 4-5, expansion of the Choctaw Pass Turning Basin involves removing a small portion of the northern shoreline of Little Sand Island, a man-made island located in a highly disturbed area. Berkowitz et al. (2018), mapped the existing wetlands as described in Section 2.6.2, Appendix C. Figure 2-20 and Figure 2-21, Appendix C show the wetland communities that exist on and around Little Sand Island. Berkowitz et al. (2018) indicates these wetlands are typical of those found in disturbed areas. Additionally, Berkowitz et al., (2018) mapped existing SAV in the area which includes areas adjacent to Little Sand Island. SAV, shown in Figure 2-23, Section 2.5.6.3, do not exist in the area where material is to be excavated for modification of the turning basin. Based on Berkowitz et al., (2018), presentation of baseline conditions on and around Little Sand Island, no significant losses to wetland communities and SAV would occur from the proposed modification of the Choctaw Pass Turning Basin.

Placement Areas.

Relic Shell Mined Area. The relic shell mined area serves as habitat for prey species such as gulf menhaden, shad, croaker, and spot. These species are consumed by other Federally managed species including Spanish and king mackerel, various snappers and groupers, bluefish, dolphin and cobia found in Mobile Bay and/or the Gulf of Mexico that may be temporarily impacted by placement operations. Other recreational and commercial species that have been documented in the area are spotted sea trout, southern flounder, and blue crab. The proposed action will not fill or destroy habitat considered necessary to sustain these species.

Placement of new work material in the Relic Shell Mined area would result in some unavoidable impacts. While most of the immobile organisms within the upper reaches of Mobile Bay area are quite adaptable to seasonal changes in temperature, salinity, DO, water clarity and water level fluctuations due to the tidal cycle and weather conditions, the direct placement of the dredged material would destroy some sediment dwelling organisms. Although there would be some destruction of benthos, disturbance of aquatic organisms, reduced aesthetics, and increase in turbidity, the adverse impacts would be minimal and temporary in nature.

An example used to exhibit the effects to the relic shell mined placement area is a similar project in upper Mobile Bay that was conducted and monitored. The area, known as

Brookley Hole, was a demonstration project in 2012 to illustrate this concept for using dredged material to fill holes created by past dredging and borrow actions. Brookley Hole is an historic borrow pit, used decades ago for the construction of the Brookley Airfield. This site is located in the western upper portion of Mobile Bay in close proximity to the Mobile Bay channel as illustrated in Figure 3 7, Appendix C. Baseline surveys indicate that the deepest portion of Brookley Hole, at approximately 23 feet, exhibited hypoxic conditions resulting in degraded environmental productivity. Dredged material from the upper Mobile Bay channel was used to partially fill the basin to historic bathymetric conditions to improve environmental productivity of the bay bottom. Subsequent monitoring efforts included a combination of fisheries acoustic techniques to determine fish density and spatial and temporary distribution patterns, as well as conventional fisheries to determine species composition, fish length, water quality, and sediment grain size analysis. Benthic macro-invertebrates were sampled seasonally to evaluate recruitment and community structure.

The post-restoration study conducted by Reine et al. (2014) indicated a significant improvement in water quality conditions. From an ecological perspective, the partial filling of Brookley Hole resulted in benefits to fishery resources through elimination of hypoxic zones common to these features. The partial filling of the hole rapidly restored the degraded habitat, while avoiding impacts to the upper portion of the water column utilized by a variety of fish and shellfish species. In addition to the ecological benefits, filling the Brookley Hole basin provided a partial restoration of the bay bottom to historical bathymetric conditions. Since the depth of placement in the relic shell mined areas are shallower than the placement in Brookley Hole as described above, a rapid recovery of fishery resources and degraded habitat would be expected

Discussions with local fisherman have indicated that at certain times of the year, an area to the south of the Relic Shell Mined area where sediments are known to be predominantly shell hash, can be productive fishing grounds for some species of finfish such as sheephead. As discussed above in Section 3.3.3, Appendix C, sediment transport modeling of Mobile Bay was conducted to assess the relative changes in sedimentation rates within the navigation channel, dredged material placement sites, and surrounding areas from channel modifications within the bay. This modeling was built upon previous modeling conducted in 2012 to evaluate thin layer placement of maintenance dredged material as described in the Section 6.3, Appendix A. The modeling conducted specifically for the open water thin-layer disposal sites indicates that once the material was placed, with the cohesive nature of the material, it rapidly consolidated and stabilized. The placement material was not transported along the bottom and any remobilization of the material was directly into the water column. Given the nature of the new work material, which is more consolidated and cohesive than maintenance dredged material, it would not be expected to remobilize along the bay bottom into the fishing areas.

SIBUA. Currently, no new work material from the Bar Channel is anticipated to be placed in the SIBUA or the northwest extension as part of the TSP. The new work material in the Bar Channel is predominately clays and silts with some intermixed sands. The geotechnical information obtained to-date, indicates that this material does not meet the suitability criteria for placement in SIBUA. Placement of new work material in SIBUA will be considered in the future if sandy material is identified during additional geotechnical investigations of the Bar Channel. Beneficial use of sandy material dredged from the modification other channel segments, if found suitable will be coordinated with the Cooperating Agencies and the interested public.

Under a separate O&M action to increase the long term capacity of maintenance dredged material, the SIBUA will be expanded to the north and west which follows the shoal and pathway of sediment transport towards Dauphin Island. Doing so provides an effective means of continued bypassing of sand dredged from the Bar Channel to the downdrift littoral system.

ODMDS. The implementation of the TSP would not result in additional impacts to the affected environment within the ODMDS. The ODMDS is a historically utilized site and overlaps the existing EPA Section 102 Mobile ODMDS. As this is primarily an administrative change to expand the aerial footprint of the EPA Section 102 Mobile ODMDS, no aspects of the local environment should experience adverse impacts from implementation of the TSP, since the areas have been used extensively in the past. All further discussion of effected resources will be compared back to the Without-Project conditions of continuing with the currently sized EPA Section 102 Mobile ODMDS.

There will, however, likely be some unavoidable and temporary and localized impacts resulting from the ODMDS placement. Placement operations will result in the temporary increase of suspended sediments and nutrients, loss of benthic organisms, and bathymetric changes in the ocean bottom. The increase in turbidity will reduce light penetration through the water column, thereby reducing photosynthesis, surface water temperatures, and aesthetics. These conditions could potentially alter visual predator-prey relations in the immediate project vicinity. In addition, sediment adheres to fish gills resulting in respiratory stresses and, natural movement of eggs and larvae could be potentially altered as a result of sediment adherence. However, the salinity of water associated with the Mobile ODMDS is high enough to promote rapid settling of finer particles. All of these described impacts are temporary and are anticipated to return to previous conditions shortly after placement operations. Based on recent sediment evaluations (EA Engineering 2011) and ODMDS surveys (Anamar, 2010) of dredged material from Mobile Bay and native ODMDS material, the sediment quality and texture of the dredged material is expected to be homogenous to that existing in the Mobile

ODMDS. This is due to the proximity of the Federal Navigation Channel to the ODMDS and the fact that the area has historically received dredged material from the Mobile Harbor area.

The aquatic community would be temporarily disrupted by placement of dredged materials within the proposed Mobile ODMDS. Non-motile benthic fauna within the area would be destroyed by ocean placement operations, but should repopulate after completion. Some motile benthic and pelagic fauna, such as crabs, shrimp, and fishes, are able to avoid the disturbed area and should return shortly after the activity is completed. Larval and juvenile stages of these forms may not be able to avoid the activity due to limited mobility.

Rates of benthic community recovery observed after dredged material placement ranged from a few months to several years. The relatively low species diversity of benthic assemblages associated with low salinity estuarine sediments can recover in periods of time ranging from a few months to approximately one year (Leathem *et al.*, 1973; McCauley *et al.*, 1976 and 1977; Van Dolah *et al.* 1979 and 1984; Clarke and Miller-Way, 1992), while the more diverse communities of high salinity estuarine sediments may require a year or longer.

Ocean placement activities will result in the mounding of dredged material after release from the hopper dredge in a relatively thick layer. Deposits greater than 20-30 cm (8-12 inches) generally eliminate all but the largest and most vigorous burrowers (Maurer *et al.*, 1978). The sediment quality and texture of dredged material are expected to be homogenous to that existing in the Mobile ODMDS. Placement of material similar to ambient sediments (e.g., sand on sand, etc.) has been shown to produce less severe, long-term impacts (Maurer *et al.* 1978, 1986). Temporary loss of benthic invertebrate populations would occur within the Mobile ODMDS during disposal operations but are expected to return to pre-placement conditions within six to nine months (Bolam & Rees 2003).

The proposed Mobile ODMDS does not provide habitat that is not abundant in other areas of the Gulf of Mexico. There is no significant resource at this site that is essential for the continued survival of any particular species. This site has historically been utilized for placement of dredged material from the Mobile Harbor project area. These operations have not resulted in long-term adverse impacts to benthos, motile invertebrates, and fishes (Shipp 1983) (Froese & Pauly 2007) (Anamar 2010). Therefore, it was determined that no long-term adverse impacts are expected to the aquatic community from the continued use of the Mobile ODMDS.

5.7.3. Future Maintenance

Future maintenance and operations disposal practices will be consistent with the current O&M disposal areas. The main navigation channel in the bay typically requires the annual removal of about 5.9 mcy of material to maintain the channel dimensions. However, due to the increased dimensions it is predicted that there is likely to be an increase volume of maintenance material. Material dredged as part of maintenance operations for the future with-project conditions will continue to be placed in a combination of upland sites adjacent to the River Channel; open-water placement sites within the bay; the SIBUA on the ebb tidal shoal, including a proposed northwestward expansion of the site; and the ODMDS in both the current limits and a future expansion area. Details of these areas are provided in Section 4.11.2 of Appendix A. Material dredged as part of the routine maintenance of the Bar Channel (primarily sandy sediments) is placed in the SIBUA. The SIBUA, was evaluated to determine whether capacity exists to accommodate projected increases in maintenance dredged material associated with implementation of the TSP. In an effort to ensure adequate placement capacity for maintenance dredging of the Bar Channel, the Mobile District is currently pursuing modifications to extend the SIBUA beyond its existing boundaries which is discussed further in Section 4.11.2 of Appendix A. The site will be expanded to the northwest, following the shoal and pathway of sediment transport towards Dauphin Island and no adverse impacts to Dauphin Island are expected.

Future maintenance activities of the navigation channel and material placement will result in temporary increases of suspended sediments, the loss of benthic organisms, increases in nutrients, and bathymetry changes in open water placement sites. The increase in turbidity will reduce light penetration through the water column, thereby reducing photosynthesis, surface water temperatures, and aesthetics. Once construction of the project is complete, the effects will be similar to the no action conditions and no additional long term impacts are expected.

5.8. Biological Resources

5.8.1. Upland Communities

This section addresses potential impacts on upland biological communities resulting from the considered alternatives. Existing data on specific species occurrences in the project area are limited, and the discussion of impacts is based on the presence of (and changes in) habitat within the project area combined with reasonably foreseeable impacts from the alternatives. The discussion of potential impacts is descriptive in nature rather than relying on quantitative data. Upland communities may be affected in three ways: temporary displacement of individuals, habitat alteration, and exposure to contaminants. Each of these areas of potential impact is discussed.

5.8.1.1. Alternative 1 – No Action

Under the No Action Alternative, existing conditions in the project area would continue. There would be no disturbance from dredging and placement of sediments and no associated displacement of upland species during such operations.

5.8.1.2. Alternative 2- TSP

The actions associated with navigational modifications and subsequent placement of new work sediments will be conducted totally within the openwaters of the Gulf of Mexico and Mobile Bay.

5.8.1.3. Future Maintenance

Future maintenance of the project will utilize already existing and certified dredged material placement sites. Therefore, there would be no disturbance from dredging and placement of sediments and no associated displacement of any additional upland species during such operations.

5.8.2. Wetlands

In order to determine potential wetland effects within the project area, a characterization of baseline wetland community assemblages and distribution in estuarine, transitional, and freshwater habitats throughout Mobile Bay and the associated Delta region was conducted (Berkowitz et al., 2018). Salinity tolerance classes were established for each wetland community using existing literature sources; including thresholds for decreased productivity and mortality. The study area focused on the central and southern portions of the Mobile-Tensaw River Delta region. These areas were identified as having the highest likelihood of potential impacts associated with the proposed channel modifications as described in Section 2.5.2. The study area included the portions of the delta south of the I-65 Bridge, where freshwater communities are dominant. The southern extent of the sampling included wetlands dominated by wetland communities adapted to saline conditions. As a result, the study area encompasses the entire salinity gradient occurring within the Mobile Bay region, ranging from salt-intolerant bottomland hardwood forest species assemblages in the north to the halophytic plant communities common throughout coastal wetlands of the northern Gulf of Mexico.

The proposed channel modifications pose potential environmental concerns because the possible influx of saltwater into upstream areas may alter wetland habitat assemblages, distribution, or productivity. Salinity in Mobile Bay is affected by river inflow, wind, and tides as well as periodic storm surges resulting from hurricanes and other weather events (Park et al. 2014). These natural patterns of spatial and temporal salinity fluctuations resulted in the development of diverse and resilient wetland community types within Mobile Bay. However, potential changes in water quality resulting from proposed channel modifications were evaluated to determine if post-project water quality conditions will impact wetland resources. The analysis also considered the effects of sea level change over the life of the project.

Quantitative species composition data were collected at over 800 field locations to document the distribution and community assemblages of wetlands within the potential area of influence (AOI) of the harbor modification project. Sample locations were selected at representative locations within specific wetland communities to characterize wetland community classes and support the large scale mapping objectives using a targeted sampling approach (Environmental Laboratory 1987). Field work occurred during a seasonal low rainfall, low discharge period (late summer-fall), limiting the availability of surface waters within many sample locations. The field measurements were linked with aerial imagery and other resources to map the location and extent of each wetland community observed in the study area. Salinity tolerance classes were established for each wetland community using existing literature sources which includes thresholds for decreased productivity and mortality. Salinity thresholds as related to wetland species productivity is listed in (Table 5-1). The salinity mortality thresholds are documented in the United States Department of Agriculture (USDA) PLANTS database (https://plants.usda.gov). Hydrodynamic and water quality model results conducted by ERDC (see Attachment A-1, Appendix A) were evaluated to determine if post project conditions would increase salinity values beyond the established salinity thresholds to a degree that would alter wetland community productivity or distribution within Mobile Bay. The ground based wetland sampling was conducted during November 2017 as this is considered representative when the full cohort of species has undergone the annual growth cycle (USDA-NRCS 2006). During that period, data from 802 distinct locations within the Bay were evaluated to enable development of a comprehensive map of wetland features within the study area as described in Section 2.6.2, Appendix C. At each sample location, the species composition of each vegetation community was documented using established measurement techniques including determinations of percent groundcover, establishment of species dominance, and other factors according to the guidance provided for the Gulf and Coastal Plain regions as outlined in USACE (2010). As a result of the climatic and hydrodynamic conditions, in-channel and wetland community surface water salinities likely remained at or near its annual maximum.

Wetland features within the study area were digitized based on direct observations, aerial imagery interpretation, topographic maps, National Wetland Inventory data, high-resolution ortho-imagery, light detection and ranging (LiDAR) analysis, data layers available in the geospatial data gateway (https://datagateway.nrcs.usda.gov/) and other resources (USFWS 2016). Digitization efforts resulted in the high resolution mapping of over 77000 acres of wetlands within the study area. Each mapped wetland feature was uploaded to an ARC-GIS database in which each feature was given a unique identifier and wetland classification code within the database attribute table.

Table 5-1. Salinity tolerance ranges for each wetland plant community. Salinity thresholds are based upon ideal growth conditions and do not reflect mortality (USDA plants database).

Class name	ppt	Class name	ppt
Baldcypress – black willow – Chinese tallow	2.6-6.4	Pine flatwoods	0-1.30
Baldcypress – tupelo	1.31-2.59	Saltmeadow cordgrass	2.6-6.4
Baldcypress – tupelo – bottomland mix (Maple, Hickory, Ash, Oak, Elm)	0-1.30	Sawgrass	2.6-6.4
Baldcypress – tupelo – slash pine	1.31-2.59	Sawgrass – tidal shrub mix	2.6-6.4
Baldcypress – tupelo – slash pine – Atlantic white cedar	1.31-2.59	Slash pine – live oak – tidal shrub mix	1.31-2.59
Baldcypress – tupelo – swamp bay – palmetto – shrub mix	2.6-6.4	Smooth cordgrass	>6.4
Big cordgrass	>6.4	Sweetbay – swampbay – yellow-poplar – netted chainfern	0-1.30
Big cordgrass – switchgrass	2.6-6.4	Tidal shrub mix	2.6-6.4
Big cordgrass – switchgrass – bagpod	2.6-6.4	Torpedograss	2.6-6.4
Big cordgrass – switchgrass – sawgrass	2.6-6.4	Typha	1.31-2.59
Black needlerush	>6.4	Typha – arrowhead – alligatorweed	1.31-2.59
Black needlerush – Big cordgrass	>6.4	Typha – bulltongue	1.31-2.59
Black needlerush – Big cordgrass – switchgrass	>6.4	Typha – bulltongue – three-square – alligatorweed	1.31-2.59
Bottomland mix (Maple, Hickory, Ash, Oak, Elm)	0-1.30	Typha – bulltongue – wild-rice	1.31-2.59
Bulrush	1.31-2.59	Typha – bulrush	1.31-2.59
Chinese tallow – Black willow – tidal shrub mix	2.6-6.4	Water hyacinth – water spangles – Cuban bulrush	0-1.30
Giant cutgrass	1.31-2.59	Water lotus	0-1.30
Live oak – Magnolia – Pine (Hammock)	0-1.30	Wild-rice	0-1.30
Mexican water-lily	1.31-2.59	Yellow pond-lily	0-1.30
Phragmites	>6.4		

Salinity tolerance thresholds for each wetland community type were obtained from peer reviewed journal publications and salinity classes documented within the USDA PLANTS database (https://plants.usda.gov). Two sets of species salinity thresholds were established for evaluation. First, plant species were evaluated to determine if changes in salinity would impact productivity and growth pattern as defined as a reduction in plant productivity (i.e., growth) of more than ten percent. Second, plant species were evaluated to determine if changes in salinity would exceed available mortality thresholds. For example, Crain et al. (2004) documented that Spartina patens (a halophyte) displayed significant mortality at very high salinity values

(>60 ppt). However, the species tolerates salinities of 2.6 - 6.4 ppt (Table 3-2, Appendix C) and up to 35 ppt (Hester et al., 2005) without decreasing productivity. Many of the plant communities examined contained a mixture of species. When mixed species communities were evaluated, the dominant species with the lowest established salinity threshold was applied. This approach ensured that the assessment of potential wetland impacts provided a conservative estimate throughout the analysis. Once established the salinity thresholds were input into a database for each mapped wetland feature. Detailed descriptions of each the wetland community classes found in Section 3, Attachment C-1, Appendix C.

The water quality data included baseline condition and estimated post product conditions for greater than 48,000 individual cells organized into 30 blocks (or groups of cells) encompassing the entire area of Mobile Bay (Figure 5-1). Within each individual cell, surface water quality data was generated for three scenarios 1) baseline conditions, 2) post project implementation condition, and 3) post project condition with an estimated 0.5 m sea level projection. Scenario 3 was included in the analysis based upon current USACE guidance which requires incorporation of estimated SLR implications. A 0.5 m SLR projection was selected for analysis because it represents the intermediate projection for the study area.

Note: Each individual block was comprised of hundreds of smaller individual cells (right) each of which contained unique water quality data under the three scenarios: baseline, post project, and SLR.

Figure 5-1. Overview of the area evaluated for potential changes in water quality consisting of 30 blocks (left).

In order to conduct the wetland assessment, the difference in monthly mean salinity values was determined between the three scenarios examined. For example, within each individual cell, the difference between future Without-Project and estimated future With-Project conditions were determined (scenario $2_{SALINITY}$ – scenario $1_{SALINITY}$). Similarly, the difference between the baseline condition and estimated SLR values was determined (scenario $3_{SALINITY}$ – scenario $1_{SALINITY}$). Following the determination of anticipated salinity differences between model scenarios, all cells with estimated changes in salinity ≥0.5 ppt for any month during the year were extracted from the grid and identified for further analysis. Once each wetland feature was linked with the appropriate cell, estimated changes in monthly salinity data were evaluated under the baseline condition, as well as under the TSP condition, and the post project condition plus 0.5 m SLR projection scenarios outlined above. The scenario results associated with each wetland feature were compared to the established salinity thresholds in order to identify potential impacts.

The water quality models utilized for the wetland assessment assessed riverine and tidal inputs, providing data for each individual cell in 10 equally spaced depth intervals. For example, if the water depth in a given cell is 33 feet, water quality data is generated in 33-foot increments. Similarly, if the water depth is 3.3 feet, the water quality outputs are generated in 33 – 0.33-foot increments. As a result, an analysis was conducted to evaluate differences between surface water salinities (i.e., upper increment of water quality outputs only) and the integrated upper third of the water column (i.e., top three water quality outputs) which confirmed that water quality cells adjacent to wetland features displayed little or no differences in salinity between the two approaches. The close association of the two depth intervals results from the location of wetland features in predominately shallow shoreline geomorphic positions. Where present, differences between depth intervals were associated with the navigation channel itself and other deep water areas of Mobile Bay that lack wetlands. As a result, surface water salinities were selected for all further wetland analysis.

5.8.2.1. Alternative 1 – No Action

Under the No Action Alternative, existing conditions in the project area would continue. There would be no expected environmental changes in association with maintaining the navigation project. However, it is predicted that future SLR scenarios over the next 50 years would cause changes in salinity and other water quality parameters, and consequently result in impact to wetland assemblages and distributions as SLR occurs (Kirwan and Megonigal, 2013). In many regions, the predominant impact of long-term SLR will be excessive inundation leading to a conversion of wetland features to open water areas, especially in landscapes where landward retreat is restricted.

The modeling efforts suggest that as many as 930 wetland features may be inundated as a result of the 0.5 m SLR projection, representing an area of 8,440 acres. This includes forested areas dominated by freshwater communities (e.g., bottomland hardwoods), salt-tolerant halophytic communities (e.g., black needle rush, big cordgrass), and transitional communities (e.g., tidal shrub mix, Typha). Increases in sea level inundation may not result in the loss of wetlands but may lead to a shift of wetland types. Such changes have the potential to alter both species composition and structure, occurring over multi-years to multi-decadal timescales.

5.8.2.2. Alternative 2 – TSP

5.8.2.2.1. Project Construction

Within the study area, species richness generally increased as salinity decreased (Gough 1994). As a result, tidally influenced freshwater marshes (≤0.5 ppt salt) in the northern portion of the study area exhibit the highest species richness found within tidal continuum. Polyhaline (18-30 ppt salt) and mesohaline (5-18 ppt salt) communities tend to have lower species richness, with several characteristic species (e.g., black needlerush, smooth cordgrass) forming predictable, abruptly zonated, monotypic stands. Oligohaline communities (0.5-5 ppt salt; “brackish”) may contain a variety of species that are representative of both saline and freshwater environments (Tiner, 1993; Cowardin et al., 1979). These observations hold true within both baseline and post project conditions, as anticipated shifts in salinity are limited. For example, within the study area most wetland features are anticipated to experience negligible increases in salinity, with only 636 (17%) of the 3,525 wetland features identified displaying potential salinity increases > 0.5 ppt (herein referred to as the “potential impact area”). This represents an area of 7,153 acres, or 9.8% of the 72,505-acre study area. As a result, the post project conditions are not anticipated to have any potential impacts on the majority (>90 %) of wetland resources within the study area. Examining only the communities with a potential to display salinity changes > 0.5 ppt, the mean monthly surface salinity increase across all months and wetland communities was 0.68 ±0.38 ppt (mean ±standard deviation) with monthly minimum and maximum values of 0.2 and 1.1 ppt respectively. The text, Table 3-3, Table 3-4, Figure 3-9, Figure 3-10, and Figure 3-11, Appendix C provide data on the post project salinity conditions of wetland communities within the potential impact area, evaluating potential exceedance of mortality and productivity thresholds.

Wetland Mortality Analysis. The study conducted by Berkowitz et al. (2018) evaluated wetland features using mortality threshold data available in the published literature. It should be noted that species specific mortality data was not available for many of the species observed. However, available mortality thresholds are provided for the wetland species and associated community assemblages for which data was available. Because wetlands are adapted to the conditions within the study area, the analysis evaluated potential changes in water quality as opposed to absolute water quality values. This approach accounts for local variation in salinity tolerance ranges which differ regionally and genetically across a given species or vegetation assemblage (Kozlowski 1997; Munns 2008).

The analysis linked each wetland feature with an adjacent water quality cell as described above to determine if the estimated changes in salinity between Without- and With-Project conditions would exceed published mortality thresholds. To provide a conservative approach the mortality analysis utilized the maximum estimated increase in salinity for each vegetative community. Results indicate that maximum estimated increases would not exceed salinity thresholds for the vegetation communities examined. For example, across all vegetation communities containing baldcypress the maximum estimated salinity increase was 2.0 ppt (average increase of 0.7 ppt). No cases were identified where a 2.0 ppt increase in salinity above baseline conditions would surpass the 10 ppt required to induce mortality. Similarly, the understory species, wax myrtle, was associated with Live oak - Magnolia - Pine (Hammock) and Pine flatwoods communities and those communities exhibited a maximum estimated salinity increase was 1.5 ppt (average 0.53 ppt) and 1.3 ppt (average 0.39 ppt) respectively, below the 8.7 ppt increase required to induce mortality. This analysis suggests no wetland feature mortality thresholds would be surpassed based upon With-Project conditions. While the number of species with specific mortality thresholds is limited, the available species occur in a number of common wetland community types within the study area. As a result the mortality analysis accounts for 3,108 ac (43%) of the 7,153 potential impact area. Therefore the analysis provides supporting evidence that no mortality is anticipated under the post project scenario across the study area.

Wetland Productivity Assessment. In addition to the mortality threshold study presented above, an analysis was conducted utilizing the ideal growth tolerances developed by USDA (2000). Ideal growth tolerances are available for all wetland community types occurring within the potential impact area, while only a subset of wetland plants have mortality thresholds available in published literature. These salinity ranges are not associated with mortality, but represent salinity levels required to induce an estimated 10% reduction in plant productivity. As a result, the assessment represents a conservative approach to evaluating potential wetland impacts. Each wetland feature within the potential impact area was assessed to determine if growth salinity tolerance ranges were exceeded. This was conducted on a monthly and seasonal basis. For example, the Baldcypress - Black Willow - Chinese Tallow wetland community has an estimated growth salinity tolerance range of 2.6 - 6.4 ppt. Estimated salinity increases are limited to 0.11, 0, 0.25, and 0.44 during winter, spring, summer and fall, respectively. As a result, no negative impacts to wetland productivity are anticipated in that community. None of the estimated salinity increases within the potential impact area exceed the salinity tolerance threshold ranges, suggesting no impacts to wetland productivity. In areas where salinity increases may occur in the upper Bay, wetland communities are adapted to predicted conditions. Within the central (transitional) portion of areas containing wetlands display salinity increases of 0.0, or <0.5 during the summer and 0.0, <0.5, or <1.0 ppt during the winter, summer, and fall periods. In areas where wetland salinity increases may occur across the central portion of the study area, wetland communities are adapted to predicted conditions. During winter and spring, higher increases in salinity (e.g., >2 ppt) may occur adjacent to the navigation channel, but no wetlands are located in those areas. These areas currently experience significant salinity and as a result, wetland communities are adapted to predicted conditions. During the fall period, higher salinity values (>3.0 ppt) may occur adjacent to the navigation channel, but no wetlands are located in those areas.

SLR. Changes in salinity and other water quality parameters are expected to impact wetland assemblages and distributions as SLR occurs (Kirwan and Megonigal, 2013). However, in many regions the predominant impact of long-term SLR will be excessive inundation leading to a conversion of wetland features to open water areas, especially in landscapes where landward retreat is restricted (USGS, others). As a result, the wetland assessment conducted as part of the proposed navigation channel expansion focuses on increased inundation, with an emphasis on determining wetland features that would become submerged following the 0.5 meter SLR scenario. To conduct the analysis, the water elevation provided in hydrodynamic models was appended to the wetland mapping and classification attribute table for each wetland feature. The projected elevation change in the nearest model cell was compared with the current elevation of each wetland feature. Features were considered impacted (i.e., inundated) when the projected elevation differences exceeded the current wetland feature elevation.

As many as 930 wetland features may be inundated as a result of the 0.5 m SLR projection (which affects about 8,440 acres). This includes forested areas predominantly dominated by freshwater communities (e.g., bottomland hardwoods), salt-tolerant halophytic communities (e.g., black needle rush, big cordgrass), and transitional communities (e.g., tidal shrub mix, Typha). Incorporating With-Project conditions into the assessment, a potential exists for inundation of four additional wetland features occupying an area of 10 acres. Notably, the inundation assessment does not account for the potential landward migration of wetlands into adjacent areas which may offset SLR impacts. Additionally, increased inundation may not result in the loss of wetlands but may lead to a shift of wetland types. For example, seasonally inundated wetlands may convert to more permanently saturated conditions. These changes have the potential to alter both species composition and structure, occurring over multi-years to multi-decadal timescales. Given the limited estimated extent of potential project-induced impacts (10 acres) in the context of much larger potential SLR implications (>8,000 acres) occurring over a 50 year interval suggests that any wetland impacts related to implementation of the project remain negligible within the larger SLR rise context. Additional research into SLR implications for wetlands in the region are needed to further account for future conditions, but remains beyond the scope of the current assessment which focuses on the proposed navigation channel expansion only.

5.8.2.3. Future Maintenance

The future maintenance dredging of the navigation channel and placement of material in the approved placement sites will result in temporary increases of suspended sediments, the loss of benthic organisms, increases in nutrients, and bathymetry changes in open water placement sites. However, these temporary and local conditions will be far removed from existing wetlands and no long term impacts are expected.

5.8.3. Submerged Aquatic Vegetation (SAV)

This discussion of potential impacts on SAV communities resulting from implementation of the TSP is a summary of the SAV assessment conducted by ERDC (2018). The detailed report is included in Section 4, Attachment C-1, Appendix C.

In order to determine potential effects of the proposed project modifications on the SAV environments, baseline conditions were assessed by groundtruthing and utilizing baseline maps of SAV habitat within the system, identifying variation in SAV distribution across several years and seasons. Baseline data from existing maps of SAV distribution were field verified to check accuracy and temporal variation in order to establish baseline distribution, within Mobile Bay. Salinity tolerance thresholds were identified for local SAV species through a review of published literature. Following establishment of salinity thresholds and ranges, outputs from hydrodynamic and water quality model results were used to 1) estimate salinity values for SAV polygons outside of model domain, 2) assess change in depth averaged mean and 75th percentile (as defined in Section 4, Attachment C-1, Appendix C) monthly salinity during 2015 due to project implementation (With/Without Project salinity), and 3) identify SAV patches that would be impacted with above threshold salinity values due to project implementation. The impact of salinity changes With- and Without-Project under a SLR scenario were also assessed. Finally, predicted DO changes and impacts were assessed as a result of the TSP.

Salinity tolerances of SAV were estimated using a literature review of published salinity thresholds for local SAV species. In cases in which salinity threshold data were not available, reports of species distribution coupled with known salinity conditions were used to estimate the salinity range. Salinity range refers to the expected salinity conditions a species is exposed to within a given location, whereas salinity threshold tolerance refers to the lowest and highest salinity values a species can withstand. For most species, even when a salinity threshold has been identified, the impact of duration or length of time of exposure to that threshold value is not known. Where more than one tolerance threshold was published, the report with the closest geographic proximity (i.e., nearest study sites to Mobile Bay) and the lowest reported maximum threshold value in an effort to provide conservative estimates of tolerance were used. October was selected for comparisons as a conservative approach because it has the highest salinity values, and represents the month in which plants are exposed to the most saline conditions in the year

Hydrodynamic and water quality data were modeled for Mobile Bay, estimating baseline (i.e., existing, Without-Project) conditions as well as conditions post-project implementation using the Geophysical Scale Multi-Block (GSMB) system, the Curvilinear Hydrodynamic in three-dimension Waterways Experiment Station (CH3D-WES) approach, and the CE-QUAL-ICM water quality component developed and maintained by the ERDC (Cerco and Cole 1995), as described earlier in this report. The hydrodynamic and water quality models were used to predict baseline conditions, conditions following project implementation, and baseline and project conditions under a 0.5m SLR projection scenario. Specifically, the monthly depth averaged mean salinity value was calculated for each individual model cell, under baseline and post project conditions and with and without SLR. SAV occurs in shallow water, therefore, the depth averaged model outputs for parameters of interest were used as this provided the most relevant conditions to what the entire plant, roots to shoots, would experience. To estimate the changes, Without-Project salinity values were compared to With-Project salinity values. This process was completed on a cell by cell basis, so that salinity change could be determined for the entire model domain. Once predicted salinity change was estimated for the whole model domain, the mapped SAV beds within the domain using ArcGIS software were intersected to isolate salinity output to regions where SAV were present. A comparison was made to the change in mean, depth averaged salinity from baseline to project as predicted by the hydrodynamic model to the relative salinity threshold values established for local SAV species an reported any predicted increases. In cases where an SAV bed contained multiply species, the salinity tolerance of the species most intolerant of increased salinity (i.e., the species with the lowest salinity tolerance values) was used to evaluate impacts. In addition to the mean monthly salinity values, the 75th percentile hydrodynamic model outputs for salinity was investigated, following the same methodology. As described in other chapters, an analysis of the 75th percentile was included to provide an indication and assessment of the variation in modeled salinity that were similar, but more conservative than a standard deviation approach. Note that extreme salinity values predicted using the 75th percentile have very short durations and small geospatial footprints. The same approach was used in determining the potential impacts of salinity change due to project implementation in combination with 0.5m modeled SLR scenario. In addition to salinity, DO outputs were assessed from the Water Quality model to determine whether a prediction could be made of any impact of decreased DO on submerged plants from baseline to post project conditions..

Species specific salinity tolerance thresholds and range estimates are detailed in Section 3.8.3, Appendix C. As is expected in a geographic region that encompasses freshwater, brackish, and estuarine conditions, SAV species have tolerance ranges that vary considerably on whether the plant is adapted to variable salinity exposure or not.

5.8.3.1. Alternative 1 – No Action

Under the No Action Alternative, existing conditions in the project area would continue with no expected environmental changes in association with maintaining the navigation project. However, it is predicted that future SLR scenarios over the next 50 years would cause salinity changes and other water quality parameters which could impact SAV communities and distributions (Kirwan and Megonigal, 2013). As sea level continues to rise, a larger proportion of SAV habitat will be exposed to higher salinities due to increased depths resulting in impacts greater than project implementation impacts.

5.8.3.2. Alternative 2 – TSP

5.8.3.2.1. Project Construction

The predicted impact assessment is based on the results of hydrodynamic and water quality modeling results. A detailed discussion of the potential impacts is included in Section 3.8.3.2, Appendix C.

Salinity. Predicted depth averaged salinity changes due to project implementation are less than 2 ppt during the months of January-June. An increased range in predicted depth averaged mean salinity occurs starting in July, and peaking in October, with a range above 5 ppt. These results indicate that October is the most critical month in terms of potential salinity impact. Thus, the majority of SAV habitat was not predicted to experience an increased salinity regime or be impacted by salinity changes due to the proposed channel modifications. Over 94% of the mapped fall 2015 SAV habitat is predicted to experience a negligible (≤0 ppt) monthly mean change in salinity. Similar patterns were seen when evaluating the monthly 75th percentile hydrodynamic model output.

Salinity threshold values increased following the TSP implementation at a total of 421 (mean) and 510 (75th percentile) acres of SAV habitat in October. Fifty percent of this potentially impacted SAV acreage was exposed to 1-2 ppt (mean) or 2-3 ppt (75th percentile) above threshold values, subsequently, a species specific analysis for potential impacts to those species with low salinity thresholds was conducted. These species include Water Star Grass, Eurasian Watermilfoil, Southern Naiad, Widgeon Grass, Sago Pondweed, Wild Celery, Carolina Fanwort and Coon's Tail. Of these, only four species, Eurasian Watermilfoil, Wild Celery, Southern Naiad, and Widgeon grass were predicted to experience an increase in salinity.

The majority of the potentially impacted SAV habitat is made up of Widgeon Grass, followed by Southern Naiad. Widgeon Grass can tolerate hypersaline conditions up to 100 ppt, so an increase in salinity of 1.5 ppt of up to 22 acres of Widgeon Grass does not represent an impact to this species. Southern Naiad has a salinity range up to 10ppt, with best growth occurring in a salinity range of 0-5 ppt and decreasing growth up to salinities of 10 ppt (Moore 2012). However, mortality does not occur until plants experience an exposure duration of 10 ppt for a month or more (Moore 2012). Therefore, the duration of high salinities is critical. An increase of 1.5 ppt above relative threshold values is unlikely to impact the 21 acres of Southern Naiad in question, unless these increased salinities have extended (i.e. multiple weeks) duration.

SLR. Results from the hydrodynamic model indicate that a 0.5 m SLR projection will contribute to salinity changes in the Mobile Bay region. Changes from existing baseline condition to baseline conditions with SLR (i.e., future Without-Project) show an increase in relative salinity tolerance thresholds for mapped SAV species ranging from -1 to 3 ppt. Although this is the same range of change seen post-project without SLR conditions, the distribution of change is different. A larger proportion of SAV habitat will be exposed to higher salinities due to SLR impacts than project implementation impacts. To illustrate this point further, the increase in salinity above relative SAV salinity thresholds due to project implementation under a 0.5 m SLR scenario shows the same range in salinity increases and distribution as those with SLR under baseline conditions, therefore, no additional changes to salinity is expected to occur as a result of SLR.

Dissolved Oxygen. While low levels of DO in the water column can cause mortality, and can impact the bay system, SAV, like all vascular plants, produce oxygen and some release oxygen from their roots under low oxygen conditions (Sand-Jensen et al, 1984). In order for DO conditions to create stressful condition for SAV, the DO conditions would need to be persistently very low. As reported in other sections, the lowest post-project DO levels predicted in the water quality model were minimal summer (June-September) DO concentrations ranging from 6.7-7.1 mg/L. These concentrations of DO would not have an impact on the SAV species present.

5.8.3.3. Future Maintenance

Future maintenance dredging of the navigation channel and placement of material in the approved placement sites will result in temporary increases of suspended sediments, the loss of benthic organisms, increases in nutrients, and bathymetry changes in open water placement sites. The increase in turbidity will reduce light penetration through the water column, thereby reducing photosynthesis, surface water temperatures, and aesthetics. However, these conditions will be no greater than existing conditions and are far removed from existing SAV areas considered in the study. No additional impacts are expected.

5.8.4. Hard Bottom Habitat and Structural Habitats

5.8.4.1. Alternative 1 – No Action

Under the No Action Alternative, existing conditions in the project area would continue with no expected environmental changes in association with maintaining the navigation project. Additionally, the modeling and impact assessments conducted for the various aquatic resources throughout the study area indicate no appreciable changes in water quality parameters such as salinity and DO. Thus, no impacts to the hardbottom and structural biological resources would be expected. Future SLR scenarios over the next 50 years would cause changes in salinity and other water quality parameters. As sea level continues to rise, the manmade hardbottom and structural habitats will be exposed to higher salinities and increased depths.

5.8.4.2. Alternative 2 – TSP

5.8.4.2.1. Project Construction

Indirect impacts to the manmade hardbottom habitats, as described in Section 2.6.4, Appendix C, associated with dredging and placement activities are expected to be minimal and short term. These impacts from turbidity resulting from the dredging and placement operations of material from the Bay and Bar Channels and any subsequent sedimentation that could occur on these reefs and structures. Additionally, the modeling and impact assessments conducted for the various aquatic resources throughout the study area indicate that there would be no appreciable changes in water quality parameters such as salinity and DO. These same parameters apply to the hardbottom and structural resources, therefore, no impacts to the hardbottom and structural biological resources would result from implementation of the TSP.

5.8.4.3. Future Maintenance

Future maintenance of the navigation channel will result in temporary increases of suspended sediments and nutrients. However, these conditions will be far removed from the existing manmade hard bottoms and structures considered in the study and no long term impacts are expected. The USACE, Mobile District will continue to implement BMP and turbidity compliance measures as required under the current ADEM water quality certification for the Mobile Harbor project.

5.8.5. Plankton and Algae

5.8.5.1. Alternative 1 – No Action.

Under the No-Action Alternative, background conditions would not result in overall increases in turbidity or salinity within Mobile Bay and surrounding waterbodies, which would not have a negative impact on plankton in the area..

5.8.5.2. Alternative 2 – TSP

5.8.5.2.1. Project Construction

Elevated turbidity levels and decreased light transmission during construction which 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. The study included an evaluation of water quality and plankton in dredging and placement areas over a 40-square-mile grid centered on the Gulfport Shipping Channel in the Mississippi Sound. Sediment plumes of silts, clays, and sands were identified in localized areas that had 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 placement sites within two to three hours. No observable effects on the resident plankton community were observed in terms of stimulatory effects, species composition, or community structure (USACE, 1975).

Nutrients released during placement could indirectly support a localized temporary increase in phytoplankton. Planktonic organisms would be carried into and out of the project area during construction. Water quality modeling has predicted that salinity and nutrient levels in the project area would not be affected by the expansion of the navigation channel. Impacts would be restricted to localized areas of plankton, therefore, any impacts would not be significant.

5.8.5.3. Future Maintenance

Future maintenance would be conducted similar to existing O&M activities. Thus, no negative impact on plankton in the area is anticipated.

5.8.6. Benthic Invertebrates

Berkowitz et al. (2018), forecasted potential salinity intrusion using a predictive analysis to identify benthic communities impacts (Section 3.8.7, Appendix C). Berkowitz et al. (2018) examined the benthic macroinvertebrates and established how benthic communities transition from estuarine to freshwater habitat, which largely reflected a change from relatively high abundances of polychaetes to insects, respectively. Channel dredging can affect this relationship, for instance, saltwater intrusion increased in the Pearl River estuary (Yuan and Zhu 2015), Tampa (Zhu et al. 2014), and Lake Pontchartrain (Junot et al. 1983) following dredging. Other factors affecting habitat quality and the salinity balance within an estuary include severe storms, sediment changes, and development; therefore, understanding the influence of a single factor, such as channel dredging, is challenging. Alterations to freshwater inputs (e.g., droughts, floods, flood control levees) or saltwater (e.g., channel deepening) can affect biotic communities adapted to particular salinity zones by changing their taxonomic composition and distributions. Important estuarine biota includes benthic invertebrates, which are relatively stationary. Their abundances and distributions serve as an indicator of environmental conditions in an area as they are important prey items for bottom-feeding fishes and crustaceans. Changes to invertebrate distributions and abundances could affect these higher trophic organisms.

Channel modification is an environmental concern because the possible influx of saltwater into upstream habitats may affect benthic invertebrates and their fish predators. Salinity in Mobile Bay is affected by river inflow, wind, and tides. Commercially and recreationally important estuarine fish that feed on benthic invertebrates in these estuarine and freshwater habitats include Atlantic croaker, southern kingfish, spot, and hardhead catfish.

Benthic macroinvertebrates were sampled in October 2016 and May 2017. A total of 240 benthic samples were collected, 120 samples in each season. Samples were collected at 40 stations within each zone (freshwater, brackish and estuarine (upper bay). The field data collection procedures and the statistical approach used to analyze the data are described in detail in Section 2.6.7, Appendix C.

Water quality parameters were collected during both the fall (October 2016) and spring (May 2017). A total of 1,789 individual benthic macrofauna from 54 taxa was collected during baseline (October 2016) with the highest number of taxa and individuals collected in freshwater habitat. A total of 2,165 individual benthic macrofauna from 44 taxa were collected during spring (May 2017) with the highest number of individuals collected in estuarine habitat. A detailed summary of the water quality information, species distributions and abundances, and the taxonomic composition of the macroinvertebrate assemblages is presented in Appendix C.

5.8.6.1. Alternative 1 – No Action

Under the No Action Alternative, existing conditions in the project area would continue. There would be no expected environmental changes in association with maintaining the navigation project. Future SLR scenarios over the next 50 years would cause changes in salinity and other water quality parameters which result in impact to the benthic invertebrate communities and distributions. As sea level continues to rise, benthic habitat will be exposed to higher salinities due to increased depths.

5.8.6.2. Alternative 2 – TSP

5.8.6.2.1. Project Construction

In the fall, when salinities were relatively high, the extent of saltwater influence on benthic macroinvertebrates was evident well into the freshwater zones located south of Bucks, Alabama. At this location, the Mobile River takes two sharp 90 degree bends, first east, then north, which may contribute to the abrupt salinity decline if tidal forces were weaker than the opposing conditions created by flow and river sinuosity. These results indicate that under the environmental conditions present in the fall of 2016, a clear break in the upstream influence of estuarine waters occurred near Bucks, Alabama. Downstream from this location, fall benthic macroinvertebrate assemblages were similar through the transitional habitat and into the estuary.

In the spring, salinities were less than 1 ppt throughout all transitional and freshwater stations, therefore, a clear break in benthic macroinvertebrate composition related to salinity change was not evident.

Salinity. Model results were used for the bottom strata to characterize projected salinities following the proposed channel deepening. To evaluate a worst case scenario, the maximum salinity difference projected by the model under TSP deepening conditions was considered for each month for cells within the aforementioned buffer. In the fall, maximum projected salinity differences ranged from 1.9 to 3.6 ppt and the greatest salinity changes were projected for the estuarine habitat where benthic macrofauna are well-adapted to salinity fluctuations of this magnitude. In the winter, maximum salinity changes ranged from 2.5 to 3.2 ppt. In the spring, maximum salinity changes were projected to be 2.2 to 3.2 ppt, whereas summer maximum changes ranged from 1.6 to 2.9 ppt. These most extreme projected salinity changes occurred within the transitional and estuarine zones where benthic macrofaunal assemblages are dominated by polychaete worms that experience greater salinity fluctuations during tidal exchanges. Differences in benthic macrofaunal assemblages occur where freshwater habitat begins, which in the fall, was further upstream than the water quality grid extended. There is no indication that the location of the freshwater transition point will be affected by the TSP. Impacts to higher trophic levels, such as fish, will be negligible because prey availability and distributions are unlikely to be affected.

SLR. Maximum potential salinity changes projected did not predict more extreme conditions than reported above. For instance, fall maximum salinity changes could be as small as 1.2 ppt instead of 1.9 ppt, whereas spring maximum salinity predictions were as low as 0 ppt. Based on these model predictions, there is no indication that SLR will substantially affect benthic macrofaunal assemblage distribution.

Dissolved Oxygen. Estuarine organisms respond to decreasing DO in various ways depending on their life stage and mobility. In general, however, a consistent pattern of response occurs at very low DO concentrations, i.e., below 2 mg/L. Mobile fish and crustaceans avoid benthic habitats with oxygen concentrations below 2 mg/L. Less mobile benthic invertebrates, such as burrowing species, exhibit stress behaviors (e.g., emerging from sediments) at oxygen concentrations from 1.5-1 mg/L, with mortality occurring if durations of low DO concentrations are extensive (Rabalais et al., 2001). A worst case scenario of deepening impacts on DO concentrations was evaluated by determining the minimum concentrations predicted under project conditions in the summer. High temperatures combined with low DO concentrations create the most deleterious biological impacts. Minimum summer (June – September) DO concentrations ranged from 6.7 -7.1 mg/L, which is a concentration well above hypoxic levels that would induce stress responses or mortality in benthic macroinvertebrates.

Relic Shell Mined Area. As discussed in Section 2.6.7, Appendix C, sampling within the oyster shell mining area was conducted in the fall of 2016 and spring of 2017 at 90 benthic stations comprised of four types:

- Baseline: randomly selected stations spaced equidistance across the study area,
- Control: stations selected as most probable to be undisturbed by oyster shell mining,
- Placement: stations located at previous thin-layer placement sites, and
- Impact: stations in areas of known disturbance from oyster shell mining.

Monitoring of a beneficial use site in Mobile Bay was conducted to determine the status of benthic habitat in areas known to have been mined for oyster shell compared to control areas. “Impact” stations (where oyster shell dredging had occurred) were significantly deeper than other station types and at the time of sampling, water quality was favorable, i.e., DO concentrations were well above hypoxic levels. However, total organic content was elevated throughout the study area and highest at the impact stations, reaching a maximum value of 8.9%. Sediment grain size distributions were similar among station types and characterized by fine grained sediments, with sandier sediments present at stations close to the southern and eastern borders of the study area. Low salinities during the spring indicate sampling coincided with a freshet.

Benthic macrofauna were numerically dominated by polychaetes and biomass was dominated by mussels. Fall macrobenthic assemblage composition differed among station types, primarily because abundances of nematodes, some polychaetes (*Pilargiidae*), gastropods, and dwarf clams were higher at stations located at previous thin-layer sites (placement stations). In the spring, placement stations had lower Capitellid polychaete abundances and higher gastropod Acetocina canaliculata (*Cyclichnidae*), and Orbiniid, Spionid, and Pilargiid polychaete abundances. The lower salinities in the spring influenced the benthic community as evidenced by the presence of insects (*Chaoberidae* and *Chironomidae)*, which are indicative of low salinity environments.

Sediment Placement. Benthic organisms occurring in the bay bottom sediments may be destroyed or severely impacted by the physical placement of sediment. However, affected areas are small in relation to surrounding areas and would rapidly recover within 12 to 18 months to pre-project conditions. Several studies have been conducted pertaining to the effects of benthic communities in response to thin-layer placement activities (Wilbur et al. 2008, Wilbur et al. 2007, USACE 1999, Wilbur and Clarke 1998, and USACE 1994). The response of benthic communities to thin-layer placement of dredged material was assessed at three sites in Mississippi Sound in 2006. The findings indicated adults re-colonized newly deposited sediments either through vertical migration or lateral immigration from adjacent areas within a period of 3 to 10 months.

A major parameter influencing benthic recovery rates is the prior disturbance history of a particular area. Studies indicate that benthic recovery occurs more rapidly in shallow areas, such as Mobile Bay, where the resident benthic communities are already adapted to dynamic conditions and shifting sediments. Being that Mobile Bay is a depositional shallow waterbody with dynamic sediment processes, it would be expected that benthic recovery would be consistent with that shown by previous studies.

5.8.6.3. Future Maintenance

Future maintenance would result in similar environmental conditions as current O&M activities. Thus, no additional environmental changes are anticipated. However, it is predicted that the future SLR scenarios over the next 50 years would cause changes in salinity and other water quality parameters which result in impact to the benthic invertebrate communities and distributions as the SLR occurs. As sea level continues to rise benthic habitat will be exposed to higher salinities due to increased depths.

5.8.7. Fish

This discussion of the fisheries assessment and potential impacts resulting from implementation of the TSP is a summary of the study conducted by Berkowitz et al.

(2018). The detailed fisheries assessment report is included in Section 6, Attachment C-1.

Study outputs for the fisheries assessment included baseline conditions, With-Project conditions and the numerical difference (change) between baseline and project values. Basic summary statistics were generated (i.e., mean, minimum, maximum, standard deviation, percentile) for each modeled cell within the grid and for each respective condition as described in the Section 3.8.8, Appendix C. Physical and water quality habitat measurements were collected in conjunction with fishery collections at each site that included depth, temperature, pH, conductivity, salinity, and DO. Substrate type (i.e., sand or mud/silt) was visually assessed from otter boards or using a stadia rod to probe the bottom.

All data, including FAMP (2000-2005) and the ERDC (2016-2017) were analyzed using the Statistical Analysis System 9.4. Salinity tolerance for project alternatives was the principal focus of the analysis. Salinity tolerance guilds of the fish community in Mobile Bay study areas were identified according to the Gulf Coastal Research Laboratory publication by Christmas (1973) following the recommendations by Elliott et al (2007). Guilds included: freshwater only, freshwater entering estuary, resident estuary, marine entering estuary, and marine only. Guilds representing species that are anadromous, catadromous, and freshwater introduced were not included.

5.8.7.1. Alternative 1 – No Action

Under the No Action Alternative, existing conditions in the project area would continue with no expected environmental changes in association with maintaining the navigation project. However, it is predicted that future SLR scenarios over the next 50 years would cause changes in salinity and other water quality parameters which may result in impacts to the benthic invertebrate communities and distributions as well the fish communities that prey upon them. As sea level continues to rise benthic and fish habitats will be exposed to higher salinities and increased depths, however, the No Action Alternative would not be expected to impact the Mobile Bay fishery as they would be able to tolerate the conditions resulting from future SLR.

5.8.7.2. Alternative 2 – TSP

5.8.7.2.1. Project Construction

Salinity. The overwhelming majority of the values for mean salinity are below the 2 ppt threshold suggesting little concern for impact. Those values exceeding 3 ppt were projected for January – May were associated primarily with Little Sand Island adjacent to the current shipping channel. A similar pattern was exhibited for bottom salinity (without

SLR). Salinity changes evaluated under the "with SLR" condition exhibited a narrower range in values for both mean and bottom salinity conditions. There was a slight reduction in central tendencies of the dataset for both mean and bottom salinity when considering comparisons to values generated under both project conditions (with/without SLR). However, the distribution of extracted model values from each condition was not significantly different indicating no appreciable differences in salinity values between current conditions and those projected under the SLR scenario (Section 6, Appendix C).

Dissolved Oxygen. Conditions for DO (without SLR) showed a smaller range in variability in the extracted values for both mean and bottom conditions compared to responses of salinity under similar conditions. The distribution of extracted values for DO were significantly different between mean water column and bottom conditions. Bottom conditions experienced less variability with 98% of the values occurring between -0.5 and 0.5 indicating little projected change in DO levels for benthic oriented fishes. In contrast, 70% of the values for mean water conditions occurred between -0.5 and 0.5. Nearly 29% of the values exceeded the 0.05 mg/L condition with 1% exceeding the 2.0 mg/L condition. These results suggest overall changes in DO are likely to occur, but the extent of change would likely be minimal and expressed in reduced spatial and/or temporal basis.

A total of 2,097,836 individuals representing 162 species were recorded and used in the analysis. Species were classified according to the salinity tolerance guilds. The relationship between guild abundance and salinity is portrayed in Section 3.8.7, Appendix C. Two of the guilds showed a narrow range of salinity tolerance: marine only between approximately 20-33 ppt and freshwater only less than 5 ppt. However, both of these guilds were rarely collected in the Mobile Bay. The three other guilds had a much wider range of salinity utilization suggesting that major changes in salinity were necessary to impact these groups of species.

The mean abundance of freshwater entering estuary guild was negatively correlated to salinity, whereas the marine entering estuary and marine only were positively correlated. The resident estuarine model suggested little to no correlation with salinity indicating their overall tolerance and ability to osmoregulate as they move between salinity gradients. Given these relationships, and the physical model results presented, impacts to the Mobile Bay fishery are not expected. The freshwater entering estuary guild is likely the most susceptible to changes in salinity due to project construction, but the range they occupy suggests that differences between baseline and project alternative With- and Without-SLR would have to be much greater than the physical model suggests.

5.8.7.3. Future Maintenance

Future maintenance will continue similar to existing dredging and placement practices. Dredging and placement will result in temporary and localized increases of suspended sediments, the some loss of benthic organisms, and minor bathymetry changes in open water placement sites. These conditions will be no greater than current conditions. No additional to impacts to the Mobile Bay fishery are expected from future maintenance operations.

5.8.8. Mollusks

Important bivalves in the project area include the 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). These species are among the bivalves identified in estuaries around the northern Gulf and barrier islands (Cake, 1983). The Eastern oyster is one of the more valuable shellfish resources of the Gulf coast and is addressed in Section 2.6.2.1, Appendix C. Other abundant mollusks found in the Mobile Bay include various gastropods including snails, limpets, nudibranchs, and sea slugs as well as cephalopods including octopods and squids.

5.8.8.1. Alternative 1 – No Action

Under the No Action Alternative, existing conditions in the project area would continue. There would be no expected environmental changes in association with maintaining the navigation project. However, predicted future the future SLR scenarios over the next 50 years would cause changes in salinity and other water quality parameters and consequently result in some effects to existing mollusk resources and their distributions as the SLR occurs. In many regions the predominant impact of long term SLR will cause increased depth and salinities in the areas where mollusks are abundant. Under current conditions, there would be no changes to salinity and DO levels that would cause any impacts to mollusks in the project area.

5.8.8.2. Alternative 2 – TSP

5.8.8.2.1. Project Construction

In general, the mollusks require conditions similar to that of the oysters which is described in detail in Section 3.8.9, Appendix C. These organisms live within the sediments and in the water column. Berkowitz et al. (2018) conducted field studies and analyses looking at changes in water quality and hydrodynamics to evaluate the potential for impacts to benthic macroinvertebrates, wetlands, SAV, oysters, and fish. The assessment included extensive characterization of baseline conditions, followed by evaluation of estimated post project conditions related to aquatic resource habitat (e.g., changes in salinity, DO). Additionally, an analysis of potential impacts related to a 0.5 m SLR scenario were evaluated. No substantial impacts to aquatic resources within the study area are anticipated due to project implementation, as the area of greatest potential changes to environmental conditions are already adapted to natural shifts in salinity and other factors as well as conditions resulting from the existing navigation channel. Although SLR has the potential to alter aquatic resource habitats in Mobile Bay, additional impacts related to project implementation remain negligible.

5.8.8.3. Future Maintenance

Future maintenance dredging and placement of material will be similar to current O&M activities. There would be no additional changes in salinity and DO levels as they would stay well above the minimum thresholds during future maintenance activities. These conditions will be no greater than those existing after project construction and no additional impacts to mollusks would be expected to occur.

5.8.8.4. Oysters

This section includes a summary discussion of potential impacts study on oysters and oyster larvae conducted by Berkowitz et al. (2018). The detailed report is included in Section 3.8.9, Appendix C.

Oyster recruitment is the key driver for maintaining oyster population over time. However, this process is poorly understood due to the difficulty in tracking oyster larva over time. Recruitment occurs through the settlement of larval from their natal reef (intra-reef recruitment), or from other reefs within the system (inter-reef recruitment). Intra-reef recruitment has been shown to be relatively low, indicating that inter-reef recruitment is crucial for sustaining oyster populations in hydrodynamically-driven systems.

Oyster larvae have limited swimming abilities so their movement is controlled in large part by hydrodynamic transport. Oyster larvae have a maximum swim speed on the order of 2 to 3 millimeters per second (North et al., 2006, 2008), which is negligible in comparison to the horizontal velocities typically observed in most estuarine systems. However, vertical velocities are much lower, and larvae, also referred to as veligers, are able to overcome vertical velocity gradients to change their vertical position in the water column. In addition to hydrodynamic forcings, oyster veligers also respond to changes in water quality (e.g. temperature, salinity, DO). Understanding the oyster larvae movement and reef recruitment dynamic is critical towards understanding how potential project actions will impact oyster populations within a project footprint.

Using information provided by the ADCNR, MRD, 13 adult oyster reefs were assessed (>3,600 acres) for salinity and DO potential impacts based on juvenile and adult oyster tolerance thresholds. The locations of the known oyster reefs used in this assessment are included in Section 2.6.2, Appendix C. Specifically, if oyster recruitment within the Mobile Bay area is altered so that a higher percentage of oyster larvae are flushed out of the bay due to hydrodynamic changes caused by modifications to the navigation channel, this could affect the local oyster recruitment (Berkowitz et al., 2018).

5.8.8.5. Alternative 1 – No Action

Under the No Action Alternative, existing conditions would continue. No expected environmental changes would occur in association with maintaining the navigation project. However, predicted future SLR scenarios over the next 50 years would cause changes in salinity and other water quality parameters and consequently result in some effects to existing oyster reefs and their distributions as SLR occurs. In many regions the predominant impact of long-term SLR will cause increased depth and salinities in the areas where there are existing oyster resources.

5.8.8.6. Alternative 2 – TSP

5.8.8.6.1. Project Construction

For analyzing differences in larval transport and survival, the release locations were randomized or located at the Brookley Reef. Sensitivity analyses were conducted by adjusting the environmental parameter survival thresholds or exposure times. Exposure time consisted of the cumulative time that oyster larvae could be exposed before mortality occurred. Based on the tolerance threshold values from Kjelland et al. (2015), the minimum tolerance threshold for oyster survival is ≥ 2.4 ppm and the minimum DO values did not drop below 2.4 ppm indicating no impact. Salinity was also within the tolerance ranges for the TSP, based on tolerance thresholds. Based on salinity and DO survival tolerance thresholds of juvenile and adult oysters, Environmental conditions stay well above the minimum oyster tolerance threshold for simulated scenarios.

Oyster larvae particle tracking resulted in 100% survivorship under all scenarios when particles were released using a randomized location. However, the scenarios with SLR resulted in a much higher mortality of oyster larvae when released at Brookley Reef, although that was not the case for the scenarios without SLR. Importantly, the oyster model results do not project an increase in larvae flushing out of Mobile Bay under the with channel modification project scenarios (i.e., Scenarios 2 & 4). A detailed description of the analysis performed for the oyster larvae particle tracking is presented in Section 3.8.10, Appendix C.

5.8.8.7. Future Maintenance

Future maintenance will be similar to current O&M activities. The existing oyster reefs which are able to handle turbid water conditions will not experience additional impacts. The USACE, Mobile District will continue to avoid dredging and placement of material in areas that would impact existing reefs.

5.8.9. Crustaceans

Abundant crustaceans in Mobile Bay and its vicinity include a variety of amphipods, isopods, shrimps, and crabs. Four commercially important species found in Alabama coastal waters are: 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 these important species are discussed in detail in Section 2.6.3, Appendix C.

5.8.9.1. Alternative 1 – No Action

Under the No Action Alternative, existing conditions in the project area would continue. There would be no expected environmental changes in association with maintaining the navigation project. Future SLR scenarios over the next 50 years would cause changes in salinity and other water quality parameters and consequently result in some effects to existing crustacean resources and their distributions as SLR occurs.

5.8.9.2. Alternative 2 – TSP

5.8.9.2.1. Project Construction

In general, crustaceans require conditions similar to fish and mollusks which are described in detail below. These organisms live on the bay bottom and in the water column. Berkowitz et al. (2018) conducted field studies and analyses looking at changes in water quality and hydrodynamics to evaluate the potential for impacts to benthic macroinvertebrates, wetlands, SAV, oysters, and fish. The assessment included extensive characterization of baseline conditions, followed by evaluation of estimated post project conditions related to aquatic resource habitat (e.g., changes in salinity, DO). Additionally, an analysis of potential impacts related to a 0.5 m SLR scenario were evaluated. Results of the detailed analyses suggest that no substantial impacts in aquatic resources within the study area are anticipated due to project implementation, as the area of greatest potential changes to environmental conditions are already adapted to natural shifts in salinity (and other factors) as well as conditions resulting from the existing navigation channel. Although SLR has the potential to alter aquatic resource habitats with Mobile Bay, additional impacts related to project implementation remain negligible under the 0.5 m SLR scenario.

Occupying much of the same habitats as finfish, a fisheries assessment was conducted by Berkowitz et al., 2018 and is discussed in Section 3.8.8, Appendix C. Shrimp and crabs generally prey on bottom detritus and benthic invertebrates. The benthic macroinvertebrate assessment indicate post project conditions suggest mean bottom salinity increases of 1-3 ppt. The greatest salinity increases are projected within the transitional and estuarine zones where benthic macrofaunal assemblages are dominated by polychaete worms. Impacts of harbor modifications on benthic macrofauna due to salinity intrusion are predicted to be negligible, with no effects on higher trophic levels, such as fish, shrimp, and crabs because prey availability and distributions are unlikely to be affected.

Shrimp and crabs utilize the wetlands and SAV areas as nursery grounds. Results of the impact assessments for these resources indicate those areas would not be negatively impacted such as discussed in Sections 3.8.2 and 3.8.3. Considering the habitats widely used by the crustaceans, no negative impacts to these species would be expected by the implementation of the TSP.

5.8.9.3. Future Maintenance

Future maintenance dredging of the navigation channel and placement of material in the approved placement sites will result in temporary increases of suspended sediments, the loss of benthic organisms, increases in nutrients, and bathymetry changes in open water placement sites. The increase in turbidity will reduce light penetration through the water column, thereby reducing photosynthesis, surface water temperatures, and aesthetics. There would be no additional changes in salinity and DO levels as they would stay well above the minimum thresholds during future maintenance activities. These conditions will be no greater than what exists after project construction and no additional impacts to crustacean in the project area would be expected to occur.

5.8.10. Essential Fish Habitat

5.8.10.1. Alternative 1 – No Action

Under the No Action Alternative, existing conditions in the project area would continue. There would be no expected environmental changes in association with maintaining the navigation project. However, it is predicted that the future SLR scenarios over the next 50 years would cause changes in salinity and other water quality parameters and may result in impacts to distribution of benthic communities and distributions as the SLR occurs. As sea level continues to rise benthic habitat will be exposed to higher salinities due to increased depths. Based on the model predictions, however, there is no indication that SLR will substantially affect benthic macrofaunal assemblage distribution. Impacts to higher trophic levels, such as fish, will be negligible because prey availability and distributions are unlikely to be affected. Subsequently, there not be no expected impacts to EFH.

5.8.10.2. Alternative 2 – TSP

5.8.10.2.1. Project Construction

Potential impacts of the channel modifications on biological resources in Mobile Bay are a concern to natural resource managers because changes in saltwater – freshwater exchanges in the estuary could affect the distribution of biotic communities, including benthic macroinvertebrates and the fish that feed on them.

Mobile Bay contains a variety of natural resources. An assessment of aquatic resources was conducted by an interagency team to evaluate potential changes in salinity and water quality as a result of the proposed project implementation and those impacts on habitat related to five aquatic resource categories including: benthic macroinvertebrates, wetlands, SAV, oysters, and fish. The assessment described baseline characterization and distribution of existing resources, followed by analysis of projected post-project conditions (e.g., salinity, DO) with the potential to impact the presence and productivity of each target aquatic resource. A 0.5 m SLR scenario was also evaluated. The results of the hydrodynamic and water quality modeling indicate that minimal changes in salinity and water quality are expected between the existing and with project conditions for the 0 and 0.5 m SLR cases.

The wetland assessment identified >40 habitat types occurring across a wide range of salinity regimes. Projected changes in water quality will not exceed wetland plant community mortality or productivity thresholds within the study area, suggesting that impacts to wetlands are not expected. While the 0.5 m SLR scenario will increase wetland inundation within portions of Mobile Bay, implementation of the project is expected to have limited additional impacts on wetlands.

SAV assessments identified > 600 acres encompassing 55 community types. Expected post project conditions suggest > 93% of SAV communities will not experience substantial salinity increases. Where potential salinity thresholds may be exceeded, affected species are dominated by invasive species (Eurasian watermilfoil) or occur during short duration (<7 day) events. DO levels remain within SAV tolerance limits across all scenarios examined.

Simulated oyster larvae movement through integrated hydrodynamic, water quality, and larval tracking modeling. DO levels stay well above the minimum oyster tolerance threshold for with and without SLR. Similarly, salinity stays within oyster tolerance survival threshold for all scenarios. Importantly, the oyster model results do not project an increase in larvae flushing out of Mobile Bay due to project implementation.

The fisheries assessment included five salinity tolerance guilds ranging from freshwater to marine habitat conditions. The mean abundance of freshwater entering estuary guild was negatively correlated to salinity, whereas the marine entering estuary and marine only were positively correlated. The resident estuarine model suggested little to no correlation with salinity indicating their overall tolerance and ability to osmoregulate as they move between salinity gradients. Given these relationships, impacts to the Mobile Bay fishery are not expected.

The benthic macroinvertebrate assessment results indicate a benthic assemblage transition from polychaete-rich assemblages in the estuary to being dominated by insects in freshwater habitat. Expected With-Project conditions suggest mean bottom salinity increases 1 - 3 ppt. The greatest salinity increases are projected in the transitional and estuarine zones where benthic macrofaunal assemblages are dominated by polychaete worms that are well adapted to experiencing salinity fluctuations that occur during tidal exchanges. Impacts of implementing the TSP on benthic macrofauna due to salinity intrusion are predicted to be negligible, with no effects on higher trophic levels, such as fish, because prey availability and distributions are unlikely to be affected.

The USACE, Mobile District implements environmental protection measures to reduce and avoid potential impacts to EFH as well as other significant area resources. No adverse impacts to wetlands, oyster reefs, or SAV from the implementation of the project would be anticipated. Most of the motile benthic and pelagic fauna, such as crab, shrimp, and fish, should be able to avoid the disturbed area and should return shortly after the activity is completed. No long-term direct impacts to managed species of finfish or shellfish populations are anticipated. However, it is reasonable to anticipate some non-motile and motile invertebrate species will be physically affected through dredging and placement operations. These species are expected to recover rapidly soon after the operations are complete. No significant long-term impacts to this resource are expected as result of this action. Increased water column turbidity during dredging would be temporary and localized. No change is anticipated to occur to the habitat types. Overall, Impacts to EFH would be temporary and localized in nature associated with the dredging and placement activities in Mobile Harbor. The proposed activities would not significantly affect coastal habitat identified as EFH in the project area. Based on the limited occurrence of this habitat in the general vicinity of the project and the temporary and localized in nature of the impact, the overall impact to fisheries resources is considered negligible.

Beneficial impacts would occur from the use of dredged material to fill in relic mined shell areas. The excavation of these oyster holes which created depressions in the bay bottom that were associated with poor water quality conditions, such as high organic content and low dissolved oxygen (DO) concentrations. The Mobile GRR/SEIS cooperating agencies and the USACE Mobile District recognized the potential for beneficial use of dredged material from the Mobile Bay navigation channel to restore these areas to the pre-mining bathymetry. Studies indicate that benthic recovery occurs more rapidly in shallow areas, such as Mobile Bay, where resident benthic communities are already adapted to dynamic conditions and shifting sediments. Being that Mobile Bay is a depositional shallow water body with dynamic sediment processes, it would be expected that benthic recovery would be consistent with that shown by previous studies. Placing new work material in shell mined impact areas would aid in returning the bay bottom to historic characteristics by increasing environmental productivity.

Consultation has been initiated with NMFS, Habitat Conservation Division (HCD) as required under MSFCMA. It is expected that this consulted will be completed prior to release of the Final GRR/SEIS Report. A copy of the consultation letter sent to NMFS is included in Attachment C-4, Appendix C.

5.8.10.3. Future Maintenance

Other than the impacts discussed above for the implementation of the TSP, future maintenance will utilize already existing and certified placement sites. Therefore, no additional disturbance from future dredging and placement of sediments and no associated disturbance of EFH would be expected.

5.9. Threatened and/or Endangered Species

This section addresses potential impacts on species listed as threatened or endangered by the USFWS and NMFS, PRD. Discussion of impacts is based on the presence of and potential changes in habitat within the project area resulting from implementation of the TSP. The discussion of potential impacts on listed species is descriptive in nature rather than relying on quantitative data. All protected species with known or historical occurrences near the project area were considered in this evaluation.

5.9.1. Alternative 1 – No Action

Under the No Action Alternative, existing conditions in the project area would continue. There would be no expected environmental changes in association with maintaining the navigation project. However, it is predicted that future SLR scenarios over the next 50 years would cause changes in water depth and salinity. In many areas the predominant impact of long term SLR will be excessive inundation leading to a possible conversion of some areas exhibiting upland characteristics to wetland features and consequently inundation of existing wetland features to open water areas, especially in landscapes where landward retreat is restricted (USGS).

The modeling efforts conducted for this study suggest that as many as 930 wetland features may be inundated as a result of the 0.5 m SLR projection, representing an area of 8,440 acres. This includes forested areas predominantly dominated by freshwater communities (e.g., bottomland hardwoods), salt-tolerant halophytic communities (e.g., black needle rush, big cordgrass), and transitional communities (e.g., tidal shrub mix, *Typha*). Increases in sea level inundation may not result in the loss of wetlands but may lead to a shift of wetland and habitat types. Such changes have the potential to alter both species composition and structure, occurring over multi-years to multi-decadal timescales. It would be reasonable to expect that there would be some effects resulting from SLR to those protected species dependent on the effected habitats.

5.9.2. Alternative 2 – TSP

5.9.2.1. Project Construction

The USFWS lists the following species as either threatened and/or endangered that may occur within the project area for Baldwin and Mobile Counties: dusky gopher frog, Mississippi sandhill crane, saltmarsh topminnow, tanriffle shell, wood stork, piping plover, red knot, Alabama heelsplitter, Atlantic sturgeon (Gulf subspecies), loggerhead sea turtle, Eastern indigo snake, black pine snake, gopher tortoise, southern clubshell, Alabama sturgeon, West Indian manatee, hawksbill sea turtle, leatherback sea turtle, Kemp's ridley sea turtle, American chaffseed, Maui remya, Alabama beach mouse, Perdido Key beach mouse, and the Alabama red-bellied turtle (Section 2.5.7). The NMFS-PRD lists the following species as either threatened and/or endangered in the State of Alabama: fin, sei, Bryde's (candidate species soon to be listed) and sperm whales, green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles, Gulf sturgeon, oceanic whitetip shark, and giant manta ray. Critical habitats are designated for loggerhead sea turtles (nearshore reproductive and nesting habitats), and piping plovers in the counties but outside the project footprint. Bald eagles are no longer federally listed as threatened or endangered but are still protected under the Bald and Golden Eagle Protection Act. NMFS-PRD determined impacts from hopper dredging operations are "not likely to adversely affect" (NLAA) listed whales species *(*NMFS, 2003, and amended 2005 and 2007). NMFS-PRD announced in the Federal Register (81 FR 88639), dated December 8, 2016, its effort to conduct a 12-month finding and listing determination on a petition to list the Gulf of Mexico Bryde's whale (*Balaenoptera edeni*) as threatened or endangered under the ESA. Based upon scientific and commercial data available, the Gulf of Mexico Bryde's whale is taxonomically a subspecies thus meeting the ESA's definition of a species. Less than 100 individuals of this subspecies exist in a limited habitat range in the northeastern Gulf of Mexico making it extremely vulnerable to existing threats, such as vessel collisions. NMFS-PRD concluded the Gulf of Mexico Bryde's whale is in danger of extinction throughout all of its range and meets the definition of an endangered species. Currently, the agency is pursuing a final endangered species listing determination and designation of critical habitat. The Bryde's whale is protected under the MMPA.

Of these identified listed species above, those of particular concern for the Mobile Harbor Federal Navigation modification project include the Alabama red-bellied turtle, Gulf sturgeon, sea turtles and the West Indian manatee. Potential impacts to the Bryde's whale will also be discussed given its anticipated endangered listing.

Byrde's whale sightings have been documented along the continental shelf break in an area known as the DeSoto Canyon. The northern Gulf of Mexico is an area of considerably high amount of ship traffic in addition several important commercial shipping lanes pass through the whale's habitat, particularly vessel traffic from ports in Mobile, Pensacola, Panama City, and Tampa. In general, hazards from vessel collisions due to large vessel traffic in the world fleet would continue. Increased number of Post Panamax vessels and the forecasted transition to larger vessels in the Gulf of Mexico are anticipated to occur with or without the proposed channel improvements. These improvements would allow for those vessels to move more efficiently through Mobile Harbor, and carry more cargo per call. Thus, the total number of vessels required to meet the demand at the port would decrease. Therefore, the proposed channel improvements are not expected to increase the risk of vessel collisions to the Bryde's whale.

Proposed channel improvements are within the congressionally authorized project dimensions; therefore, the USACE, Mobile District will implement terms and conditions for sea turtles and Gulf sturgeon identified in NMFS-PRD's *Gulf Regional Biological Opinion for Dredging of Gulf of Mexico Navigation Channels and Sand Mining Areas Using Hopper Dredges by COE Galveston, New Orleans, Mobile, and Jacksonville Districts (Consultation Number F/SER/2000/01287)* (GRBO) dated November 19, 2003 (amended 2005 and 2007). These protective measures will be utilized if a hydraulic hopper dredge constructs the improvement features or performs routine future maintenance of the navigation channel. The project area is outside of designated Gulf sturgeon critical habitat and placement of material will not breach the water surface. Thus, based upon this previous coordination, NMFS-PRD concluded these activities will not likely jeopardize the continued existence of these species.

Based upon the USFWS, Daphne Field Office's Planning Aid Letter (PAL) dated December 9, 2016, the Alabama red-bellied turtle is known to inhabit streams, lakes, and sloughs associated with the lower part of the Mobile-Tensaw Delta estuary and streams adjacent to Mobile Bay. Extensive beds of submerged and emergent aquatic vegetation are considered to be the principal habitats of these species. Destruction of nesting habitat, sand banks and beaches, is the primary cause for the decline in species numbers. Other threats are disturbances from human activities, loss of aquatic vegetation, and collection for food and pets. The Alabama red-bellied turtle is known to inhabit the River Channel and the upper channel reaches. Past maintenance dredging of the navigation channels and placement operations in existing upland/open-water placement areas have not been identified as actions that would be threatening to this species. Improvements proposed in this Draft GRR/SEIS study are limited to those identified navigational features with subsequent placement of new work material in open-water areas (i.e. relic shell mined areas, ODMDS, and if applicable, SIBUA). The USACE, Mobile District anticipates any impacts from constructing the TSP and maintaining future channel dimensions would be similar in nature to those previously coordinated maintenance activities.

West Indian manatees are known to exist throughout the entire project area as they move during warmer periods of the year. Manatees are frequently reported in Dog River, a river emptying into Mobile Bay. A group of manatees were most recently sighted in Dog River in June 2018. Although unlikely given the project location occurs mostly in the Bay and Bar Channels, a West Indian manatee could be possibly encountered during the project construction. Given this possibility, the USACE has historically agreed to implement "Standard Manatee Construction Conditions" during maintenance dredging and placement operations in Alabama. The USACE recommends these conditions be implemented during the construction activities and associated future maintenance so no adverse impact to West Indian manatees are anticipated.

Based on this information, the USACE, Mobile District finds that the proposed modification activity is not likely to adversely affect any listed endangered and/or threatened species or their associated critical habitat. The USACE, Mobile District has initiated consultation with the USFWS under Section 7 coordination of the ESA. It is expected that this consultation will be completed prior to the release of the Final GRR/SEIS Report. A copy of the consultation letter sent to the USFWS is included in Attachment C-4, Appendix C. .

5.9.3. Future Maintenance

The future maintenance of the navigation channel and placement of material in the approved placement sites would be similar to existing practices. There would be no expected additional environmental changes above that described for the construction activities. The USACE, Mobile District will continue to implement all conservation measures for future maintenance activities as required by the GRBO and consultations with the USFWS. However, as with all future scenarios, it is predicted that future SLR scenarios over the next 50 years would cause changes in water depth and salinity as described under the No Action Alternative.

5.10. Marine Mammals

Marine mammals are covered under the MMPA, regardless of their status under the ESA. There are a total of six threatened or endangered whale species (i.e., whale species protected under both the ESA and MMPA) in the Gulf of Mexico, with only two whale species that may occur in the project area. The West Indian manatee is also listed as endangered and, therefore, is protected under the ESA. A more detailed discussion of marine mammals, their habitats, and status is included in Section 2.8.1, Appendix C.

5.10.1. Alternative 1 – No Action

Under the No Action Alternative, marine mammals would continue to utilize the area without additional disruption from localized temporary impacts.

5.10.2. Alternative 2 – TSP

5.10.2.1. Project Construction

A dredge transitting to the offshore ODMDS could encounter a marine mammal but such interactions are rare. Noise generated from dredging equipment has the potential to harm marine mammals, including large whales. Although behavioral impacts are possible (i.e., a whale changing course to move away from a vessel), the number and frequency of vessels present within a given project area is small and any behavioral impacts would be expected to be minor. Furthermore, for hopper dredging activities, endangered species observers (ESOs) would be on board and would record all large whale sightings and note any potential behavioral impacts.

West Indian Manatee. The proposed project may affect, but is not likely to adversely affect the manatee. The dredging contractors would adhere to the standard manatee conditions during construction in order to avoid vessel strikes. The standard manatee conditions apply annually from 1 June to 30 September. The dredging contractors will be instructed to take the necessary precautions to avoid contact with manatees. If manatees are sighted within 100 yards of the dredging activity, all appropriate precautions would be implemented to insure protection of the manatee. The Contractor would stop, alter course, or maneuver as necessary to avoid operating moving equipment (including watercraft) any closer than 100 yards of the manatee. Operation of equipment closer than 50 ft to a manatee shall necessitate immediate shutdown of that equipment.

5.10.3. Future Maintenance

The future maintenance of the navigation channel and placement of material in the approved placement sites will continue and use the same placement areas as with the current maintenance practices. As with project construction, the USACE, Mobile District, does not anticipate sperm, blue, fin, humpback, sei, or Byrde's whales would be adversely affected by the sediment placement activities within the proposed disposal areas. The possibility of collision with the dredge or pipelines will be remote since these are deepwater species and very low likelihood of interaction. The USACE, Mobile District does not anticipate the proposed actions identified in this study will affect these species. Additionally, future maintenance operations will continue to implement the manatee precautions to avoid animal within the dredging and placement areas.

5.11. Other Wildlife Communities

The Gulf coast, including Alabama, Mobile Bay, and associated watershed is host to wildlife communities discussed in more detail in Section 2.9, Appendix C. The coastal marshes, islands, and beaches of Alabama are utilized by large populations of waterfowl, passerines, wading birds, and shorebirds. The area 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 here. 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).

Species likely to be found in the project area are common throughout Mobile and Baldwin Counties, and are somewhat opportunistic species such as the nine-banded armadillo (*Dasypus novemcinctus*), opossum (*Didelphis marsupialis*), and raccoon (*Procyon lotor varius*) (U.S. Navy, 1986). Fox (Vulpes sp.) have been spotted in the area. The swamp rabbit (*Sylvilagus aquaticus littoralis*) may also be found throughout the coastal marshes of Alabama.

The Alabama red-bellied turtle (*Pseudemys alabamensis*), a Federally listed endangered species, has been sighted in the brackish marshes within the project area but generally prefers freshwater habitats and potential impacts to this species is covered above in Section 3.9, Appendix C. The only snake to habitually occupy the salt marsh habitat in Alabama is the Gulf salt marsh water snake.

5.11.1. Alternative 1 – No Action

Under the No Action Alternative, existing conditions in the project area would continue. There would be no expected environmental changes in association with maintaining the navigation project. However, predicted future SLR scenarios over the next 50 years would cause changes in water depth and salinity. In many areas the predominant impact of long-term SLR will be excessive inundation leading to a possible conversion of some areas exhibiting upland characteristics to wetland features and consequently inundation of existing wetland features to open water areas, especially in landscapes where landward retreat is restricted (USGS, others).

The modeling efforts conducted for this study suggest as many as 930 wetland features may be inundated due to the 0.5 m SLR projection, representing an area of 8,440 acres. This includes forested areas predominantly dominated by freshwater communities (e.g., bottomland hardwoods), salt-tolerant halophytic communities (e.g., black needle rush, big cordgrass), and transitional communities (e.g., tidal shrub mix, Typha). Increases in sea level inundation may not result in the loss of wetlands but may lead to a shift of wetland and habitat types. Such changes have the potential to alter both species composition and structure, occurring over multi-years to multi-decadal timescales.

5.11.2. Alternative 2 – TSP

5.11.2.1. Project Construction

With the exception of Little Sand Island's highly disturbed shoreline, the TSP will be implemented in submerged areas. The upland communities will not be subjected to the potential impacts as presented for the numerous aquatic resources. As discussed in Berkowitz et al. (2018), evaluations looking at changes in water quality and hydrodynamics for potential for impacts to benthic macroinvertebrates, wetlands, SAV, oysters, and fish were conducted. The assessment included extensive characterization of baseline conditions, followed by evaluation of estimated post project conditions related to aquatic resource habitat (e.g., changes in salinity, DO). Additionally, an analysis of potential impacts related to a 0.5m SLR scenario were evaluated. Results of the detailed analyses suggest that no substantial impacts in aquatic resources within the study area are anticipated due to project implementation, as the area of greatest potential changes to environmental conditions are already adapted to natural shifts in salinity (and other factors) as well as conditions resulting from the existing navigation channel. Although SLR has the potential to alter aquatic resource habitats with Mobile Bay, impacts to upland wildlife communities related to project implementation would not be expected and would likely be negligible under the 0.5 m SLR scenario.

5.11.3. Future Maintenance

The future maintenance dredging of the navigation channel and placement of material in the approved dredged material placement sites will result in temporary increases of suspended sediments, the loss of benthic organisms, increases in nutrients, and bathymetry changes in open water placement sites. The increase in turbidity will reduce light penetration through the water column, thereby reducing photosynthesis, surface water temperatures, and aesthetics. There would be no additional changes in salinity and DO levels as they would stay well above the minimum thresholds during future maintenance and operational activities. These conditions will be no greater than what exists after project construction and no additional impacts to crustacean in the project area would be expected to occur.

Future maintenance practices will be consistent with the current O&M dredging practices and would not be expected to cause any further impacts to upland communities. However, future SLR scenarios over the next 50 years would cause changes similar to those described in the No Action Alternative.

5.12. Fisheries Resources

Commercial and recreational fishing is a vital part of both the economy and quality of life in south Alabama. In fact, fisheries have been an integral part of Mobile Bay's culture and surrounding area for an amazing 10,000 years (MBNEP, 2001). The MBNEP (2001) in their Comprehensive Conservation and Management Plan credits the Alabama commercial seafood industry and its related support industries, such as shipbuilding and marine supply, to account for employment of nearly 4,000 workers and generating somewhere around $450 million annually in related products. Historically, the seafood fisheries have been a major contribution to the seafood economy since the 1880s. Blue crab, shrimp, oysters, and finfish landings have historically experienced a relatively stable harvest but has declined somewhat in recent years. The most recent summary of the most valuable commercial fisheries and their harvest values as provided by the MRD (2018) are presented in Section 2.5.10. The commercial fisheries included in that section include the brown and white shrimp, oysters, crab, and finfish.

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 leading to a change in species composition or long-term changes in revenue for fisheries within Mobile Bay.

5.12.1. Alternative 1 – No Action

Under the No Action Alternative, existing conditions in the project area would continue. There would be no expected environmental changes in association with maintaining the navigation project. However, predicted future SLR scenarios over the next 50 years would cause changes in salinity and other water quality parameters and consequently result in some effects to existing fisheries resources and their distributions as SLR occurs. In many regions the predominant impact of long-term SLR will cause increased depth and salinities in the areas where resources are abundant. Under current conditions, there would be no changes to salinity and DO levels that would cause any impacts to valuable fisheries resources in the project area.

5.12.2. Alternative 2 – TSP

5.12.2.1. Project Construction

Dredging Activities. In general, the commercial species require similar conditions presented for the fish, crustaceans, and mollusks which is described in Sections 3.8.8, 3.8.9, 3.8.10, and 3.8.11, Appendix C. Results of the detailed analyses suggest no substantial impacts in aquatic resources within the study area are anticipated due to project implementation, as the area of greatest potential changes to environmental conditions are already adapted to natural shifts in salinity (and other factors) as well as conditions resulting from the existing navigation channel. Although SLR has the potential to alter aquatic resource habitats with Mobile Bay, additional impacts related to project implementation remain negligible under the 0.5 m SLR scenario.

Shrimp and crabs generally prey on bottom detritus and benthic invertebrates. The benthic macroinvertebrate assessment results indicate that expected With-Project conditions suggest mean bottom salinity increases of 1-3 ppt. The greatest salinity increases are projected to occur within the transitional and estuarine zones where benthic macrofaunal assemblages are dominated by polychaete worms are well adapted to experiencing salinity fluctuations that occur during tidal exchanges. Impacts of harbor deepening on benthic macrofauna due to salinity intrusion are predicted to be negligible, with no effects on higher trophic levels, such as fish, shrimp, and crabs because prey availability and distributions are unlikely to be affected.

Shrimp and crabs utilize the wetlands and SAV areas as nursery grounds. Results of the impact assessments for these resources indicate areas such as the wetlands and SAV are not expected to be negatively impacted by the implementation of the TSP as discussed in Sections 3.8.2 and 3.8.3, Appendix C. Considering that the habitats widely used by the shrimp and crabs considered in this section are unlikely to be affected by the implementation of TSP, no negative impacts to these species due to changes in water quality would be expected by the implementation of the TSP..

Placement Activities. *Relic Shell Mined Areas*. The effects of placement activities of the new work material is described previously in Section 3.7. Activities associated with placement of new work material in the Relic Shell Mined Areas would result in a number of unavoidable but minor and temporary impacts to the immediate project area as previously described. The adverse impacts are minimal and temporary in nature and include destruction of benthos, increased turbidity, and aquatic organism disturbance. Compliance with the State of Alabama's water quality standards would not be adhered to and water clarity would return to ambient conditions shortly after sediment placement at the dredge and placement sites.

Studies of similar actions have indicated that recovery of the benthos will rapidly approach the same levels that exist in the adjacent bay bottom areas, especially after the basin transitions to surrounding bay bottom characteristics. Restoring the bay bottom to more closely resemble previous conditions will have beneficial effects by improving ecological productivity in the area. In doing so, no long-term impacts would be expected to occur to commercial fishing activities. The USACE, Mobile District will notify the commercial fleet on the times and locations of placement activities in this area.

SIBUA. Sandy material from deepening the Bar Channel may be placed in the SIBUA. However, it is believed that there will be not be a significant amount of sandy material from this channel section to warrant the SIBUA placement. Should placement occur from deepening this reach of channel, temporary perturbations in water quality would be expected. Ninety-eight percent of discharged sediments from hydraulic dredging have been observed to settle out within 200 ft of discharge points during similar operations in the project vicinity (USACE 1978). Heaviest concentrations observed during this study occurred near the bottom and extended approximately 1,800 ft from the discharge point. Placement at the SIBUA is conducted on a regular basis as part of the current maintenance activities. There would be no expected impacts to commercial fishing activities above what already exists from normal maintenance operations.

ODMDS. The ODMDS is frequently used for placement of fine grained sediments for the current maintenance dredging of the existing navigation channel. There would be no expected impacts to commercial fishing activities above what already exists from normal maintenance operations.

5.12.3. Future Maintenance

Future maintenance of the navigation channel would be similar to the current O&M practices. These conditions will be no greater than what currently exists after project construction and no additional impacts to the dredging and placement areas would be expected to occur.

5.13. Invasive Species

Nutria and cattle egret, inhabit wetland and upland areas, respectively. The plants, Eurasian watermilfoil and water hyacinth are freshwater species known to occur in the Mobile Delta and Mobile Bay areas (USGS 2018a).

5.13.1. Alternative 1 – No Action

Under the No Action Alternative, existing conditions in the project area would continue. There would be no expected environmental changes in association with maintaining the navigation project. However, predicted future SLR scenarios over the next 50 years would cause changes in salinity and other water quality parameters and consequently impact invasive species communities and distributions as SLR occurs (Kirwan and Megonigal, 2013). As sea level continues to rise, a larger proportion of vegetative invasive species habitat will be exposed to higher salinities due to increased depths and higher salinities resulting in impacts greater than project implementation impacts.

5.13.2. Alternative 2 – TSP

5.13.2.1. Project Construction

As indicated in Section 3.8.3, Appendix C, Eurasian watermilfoil composed the majority of the potentially impacted SAV habitat (and the majority of the SAV habitat itself). Due to its invasive status, impacts to this species are unlikely to require mitigation or have a negative impact on local SAV species. Water hyacinth also occurs in the Mobile-Tensaw River Delta in local coastal drainages (USGS 2018b) and is typically found in freshwaters, wetlands, and marshes.

5.13.3. Future Maintenance

Future maintenance will not result in additional impacts greater than current O&M activities.

5.14. Air Quality

This section provides a summary of the potential impacts to air quality. The impact analysis is detailed in Attachment C-3, Appendix C.

5.14.1. Alternative 1 – No Action

Under the No Action Alternative, the proposed project would not be constructed. Therefore, no air pollutants or GHGs would be generated from equipment or vehicles from construction of channel improvements. No air quality impacts from construction and enhanced channel improvements would occur. Maintenance operations would still continue.

Due to the anticipated economic growth in the future, it is anticipated that on-port vessel calls would increase approximately by 78% over the 2011 baseline condition in 2035. This ratio of increase due to economic growth in vessel traffic was applied to the 2011 emissions inventory and predicted the 2035 No Action Alternative emission inventory. It should be noted that this predicted inventory is considered to be conservatively high because future combustion engines used for vessels, trucks, locomotives, and non-road equipment would be cleaner as a result of implementation of emission control programs on both Federal and state levels. The use of cleaner engines would partially offset the adverse emission impacts from an increased demand of harbor operational activities in the future.

5.14.2. Alternative 2 – TSP

5.14.2.1. Project Construction

The proposed deepening and widening of the Mobile Harbor Federal Navigation Project would be a major construction project requiring certain large dredges to be used over several years. Two dredges are currently used for channel maintenance dredging activities. One additional dredge would be required during the widening and deepening activities. Since the deepening activity emissions would not take place along the channel at the same location for a long duration, they are considered temporary resulting in less than significant air quality impacts to the community along the channel.

5.14.3. Future Maintenance

Due to the upcoming increase of the number of Post Panamax vessels in the world fleet and the opening of the Panama Canal expansion, the transition of larger vessels in the Gulf of Mexico is anticipated to occur with or without the proposed channel deepening. Previous navigation analyses indicate that channel improvements alone will not have an impact on the forecasted demand of commodities handled at a particular port. The proposed channel improvements at Mobile Harbor would allow for those commodities that are transported through the harbor to move more efficiently. With the ability of these vessels calling on the harbor to transit more efficiently (carrying additional cargo per call), the total number of vessels required to meet the anticipated demand at the port during the period of analysis will decrease compared to the current channel configuration (USACE 2017). As a result, it is predicted that the short-duration (e.g., worst-case) daily emissions at the port including vaporized volatile organic compounds released during the fueling process between larger ships and fuel farms could increase as a result of introducing large vessels, but the overall annual emissions associated with ship traffic would likely be less under the implementation of the TSP than the No Action Alternative.

Given the uncertainty of the mix and size of vessels using the port and the change in vessel travel time after channel deepening, a precise calculation of the annual emissions is not feasible. It is assumed that the widening associated with the implementation of the TSP and the associated reduction of demurrage fees currently associated with vessel delays may result in an increased volume of petroleum products passing through the port. However, the level of increased throughput at the various terminals will be limited by tank capacity, dock availability, and available land for expansion. Likewise, with the harbor deepening, it is anticipated that the overall count of ships would essentially remain the same, with a slight reduction of containerships, compared to the No Action Alternative. The deepening would also allow coal carrying vessels to load to full capacity and potentially increase the volume of coal products passing through the port. The increased volume would be limited by the availability of storage space at the coal terminal.

According to the emissions forecasted for the Charleston Harbor deepening project, the alternative with the largest deepening from a No Action depth of 45/45 to the 2037 build alternative with a deepening of 52/48 depth would result in emission reduction ratios ranging from approximately 1 to 3% pending on individual criteria pollutant (USACE 2014). Given the similarity of the proposed harbor navigation improvement scheme, ratios were applied to roughly predict the overall changes in emissions that could be expected in 2035 as summarized in Table 5-2 under the TSP condition as compared to the No Action Alternative.

Table 5-2. Projected Changes in 2035 Emissions under Channel Deepening Alternative

Source Category	NO_x (tons)	CO (tons)	SO_2 (tons)	$PM_{2.5}$ (tons)	PM_{10} (tons)
Estimated Change from 2035 No Action Alternative to Build Alternative from Mobile Harbor Deepening Project	-65.3	-12.5	-10.7	-1.9	-2.1
Prevention of Significant Deterioration (PSD) Threshold	250	250	250	250	250

Reasonably foreseeable changes in emissions associated with the implementation of the TSP were estimated and compared to the 250 tons per year PSD threshold on an annual basis to determine potential air quality impacts. If the total emissions exceed the PSD threshold, a further evaluation of the emissions resulting from the proposed action should be conducted to assess the emissions impact on sensitive land uses to determine the potential significance of air quality impacts.

The modernized channel would deliver shipping efficiencies by allowing larger vessels, and by extension, more cargo per transit at the port, requiring more outbound transportation of the additional cargo by rail, cargo vessels, heavy-duty diesel trucks, and private automobiles. The widening associated with the implementation of the TSP and the associated reduction of demurrage fees currently associated with vessel delays will result in an increased volume of petroleum products passing through the port. Each terminal maintains its own air permit and any potential increase in air emissions would be addressed and mitigated, if appropriate, through the individual permits, resulting in minor impacts to air quality. Increased $PM_{2.5}$ and PM_{10} emission could result from a potential increase in coal throughput through the McDuffie terminal. However, due to the overall reduction in coal demand and the limited storage capacity at the terminal, it is more likely that fewer ships (at larger capacities) would be the primary outcome. Based on the 2011 predicted baseline operational emissions, $PM_{2.5}$ and PM_{10} emissions from the coal pile were less than 1% and 3.8%, respectively. Should an increased coal demand arise and the number of shipments increase, the overall increase in $PM_{2.5}$ and PM_{10} emissions associated with the coal pile would still be minimal compared to the overall $PM_{2.5}$ and PM_{10} emissions from port-wide operations. The increase in truck traffic associated with buildout of the container terminal would result in an approximate 25% increase in truck traffic. Therefore, truck traffic related emissions would likely increase by 25% on port. Based on the 2011 on-port emissions inventory as discussed in Attachment C-3, Appendix C, truck emissions would be approximately in a range of 1 to 2%, pending on individual pollutants, of total port-wide emissions and are not major emissions contributors. With an overall improvement in annual emissions at Mobile Harbor under the proposed action, such an increase in truck traffic would unlikely result in significant air quality impacts. Additionally, one additional dredge may be required for maintenance of the deeper and wider harbor and channels. This mobile source of potential air emissions would not cause a significant impact to air quality.

As indicated in Table 5-2 the proposed action would result in a net emission reduction for each criteria pollutant and therefore, the proposed action would result in minor air quality impacts. A detailed report on Air Quality is located in Attachment C-3, Appendix C.

5.15. Hazardous and Toxic Materials

5.15.1. Alternative 1 – No Action

Under the No Action Alternative, current channel and harbor maintenance operations would continue. The levels of hazardous materials and petroleum products traveling through the channel and harbor would remain similar. Over the next 50 years, channel traffic may increase independently of a deepening and widening project. Therefore, under the No Action Alternative, hazardous materials in the channel may increase slightly, but would only be related to vessels traveling in the channel and would be insignificant. Hazardous materials trucks currently detoured over the Cochrane-Africatown Bridge would continue to travel that route. Overall, under the No Action Alternative, minor impacts associated with hazardous materials may occur over the next 50 years.

Indirect impacts associated with hazardous materials and petroleum products in Mobile Harbor and channel are possible. If the channel is not widened and deepened, it is possible that the larger container ships would choose another available harbor for loading and unloading. This would result in less maritime traffic and less rail and vehicular traffic associated with the port. This would result in a decrease in the amounts of hazardous materials and petroleum products traveling in the project vicinity, but this decrease would be insignificant.

5.15.2. Alternative 2 – TSP

5.15.2.1. Project Construction

Under the TSP, no direct impacts to hazardous materials would occur. However, direct impacts associated with petroleum products would occur. During construction, petroleum product levels could increase in Mobile Harbor and channel area due to construction dredging and placement activities. Dredge equipment carrying fuels and other lubricants could be present in larger numbers, as only one additional dredge is proposed, these increases would be minimal. These impacts would also be temporary. Once implementation of the TSP is complete, the equipment would leave the area and/or continue to operate in a maintenance mode in other areas of the channel. Although petroleum product levels could temporarily increase, these increases would not be significant as levels would return to normal after dredging is complete. Additionally, all the Federal and state hazardous materials regulations would apply to the dredging operations as they currently do, there could simply be more dredging occurring for a period of time. Although exposure risks may increase slightly due to the potential for more vessels in the channel and harbor during dredging operations, this increase would be minor. Petroleum product trucks currently detoured over the Cochrane-Africatown Bridge would continue to travel that route. Overall, under the TSP, minor impacts associated with hazardous materials and petroleum products may occur.

5.15.3. Future Maintenance

With the widening associated with the implementation of the TSP and the associated reduction of demurrage fees currently associated with vessel delays, it is anticipated that volume of petroleum products passing through Mobile Harbor may increase. The level of increased throughput at the various terminals will be limited by tank capacity, dock availability, and available land for expansion. Likewise, with the harbor deepening, ships serving the McDuffie Coal Terminal should be able to load to greater capacities and potentially increase the volume of coal products passing through the port. The increased volume would be limited by the availability of storage space at the terminal. In addition, the volume of the container terminal will continue to increase through the Phase III buildout of 1.5 million TEUs annually, with the potential for increased hazardous materials shipments.

Using the AADT traffic counts for 2016 for the Cochrane-Africatown Bridge (Section 2.5.20), in addition to the FHWA and ALDOT estimates proprietary hazardous materials truck counts provided by the tenants of the port terminals, approximately one percent of the traffic crossing the Cochrane-Africatown Bridge is a direct result of hazardous materials associated with port activities. Since port activities account for approximately one percent of the hazardous materials traffic over the Cochrane-Africatown Bridge and the increase in total truck traffic associated with the TSP is only 25 percent (as discussed in Section 2.5.20), the hazardous materials detoured over the Cochrane-Africatown Bridge as a result of implementation of the TSP would still be less than 2.5 percent of the total bridge traffic.

All shipping and handling activities would require compliance with applicable Federal and state hazardous materials regulations. Petroleum product and hazardous materials trucks would continue to be detoured over the Cochrane-Africatown Bridge until completion of the new I-10 Bridge. Once the I-10 Bridge is completed, truckers would have the option to use the new bridge or continue to detour over the Cochrane-Africatown Bridge. With compliance of state and Federal regulations related to the transport and handling of hazardous materials and the eventual completion of the new I-10 Bridge, minor impacts would be associated with any additional volumes of hazardous materials associated with implementation of the TSP.

Direct impacts associated with hazardous materials and petroleum products due to future maintenance dredging required to maintain the new depth and width of the channel would be similar to those during construction operations and current maintenance activities. Typically two dredges would carry fuels and lubricants on board during dredging, and would then leave the channel and harbor once maintenance is complete. These temporary increases in petroleum products would be insignificant. Indirect impacts associated with hazardous materials and petroleum products are unlikely during maintenance dredging.

5.16. Noise

This section describes the potential impacts to the airborne and underwater ambient sound environment.

5.16.1. Alternative 1 – No Action

Airborne Noise. Under the No Action Alternative, current channel and harbor maintenance operations would continue. Traffic levels on I-10 and surface streets are projected to increase over the 50-year timeframe. Under the No Action Alternative, the projected port vessel calls would likely increase below 50% as compared to the baseline condition. According to the noise fundamentals, doubling source strength or traffic volume would result in a 3 dBA noise increase, which is a barely perceptible change to human hearing. Therefore the anticipated increase in noise levels would be less than significant.

Underwater Noise. Under the No Action Alternative, there would be no increased dredging in Mobile Bay. Maintenance activities would continue as they currently are. Under operational conditions, although the port process capacity would increase as compared to the With-Project condition, the underwater noise from individual vessels would remain the same since it is anticipated that similar types of vessels would be present in the harbor. Subsequently, under the No Action Alternative, no adverse underwater noise impacts would occur.

5.16.2. Alternative 2 – TSP

5.16.2.1. Project Construction

Airborne Noise. Under the TSP, direct impacts to noise levels would occur. These impacts would only be felt at the portions of the project which are adjacent to Mobile Harbor. During construction, noise levels would increase in Mobile Harbor area due to dredging and dredged material placement activities. These noise levels would approximate current levels as there is only one additional dredge proposed for the construction activities. Sources of sound from dredging include machinery noise, propulsion noise, pumping noise and aggregate noise. Noise radiation depends on the type of dredging equipment used, and its operational mode (NPL 2015). The precise nature of the noise from construction activities is not known at this time. Once deepening of the harbor area was complete the equipment would leave the area and continue to operate in areas where there are no sensitive noise receptors. Although noise levels would temporarily increase, these increases would not be significant due to the existing high noise levels in the vicinity.

Underwater Noise. It is anticipated that the maintenance dredges presently being used in the harbor would also be used for harbor deepening and widening, with the addition of one dredge as necessary. The underwater noise levels for the TSP during the construction period would, therefore, be comparable to the No Action Alternative. Given the temporary nature of dredging activities, underwater noise impacts would be less than significant.

5.16.3. Future Maintenance

Airborne Noise. Direct impacts to airborne noise levels during maintenance activities would only occur near the harbor area, as no sensitive noise receptors are located near the channel. Noise at the harbor would increase while dredging was actively occurring. The possible addition of another dredge to complete maintenance activities would have a minimal impact on noise levels. Once the harbor portions of the maintenance dredging were complete, noise levels would return to normal. Since maintenance dredging already occurs within Mobile Harbor, no additional impacts to airborne noise are anticipated. No indirect impacts to air noise are anticipated.

The future on-road traffic volumes along the truck routes used at the port were predicted to be slightly more than double the existing 2016 levels (see Section 5.21). Since a doubling of traffic volume would result in approximately a 3-dBA increase in traffic noise, it is anticipated that the future traffic noise increase along the truck routes would be slightly over 3 dBA but well below the ALDOT-adopted 15-dBA substantial traffic noise increase that requires noise abatement. The on-road traffic noise impacts under the TSP would not be significant.

Underwater Noise. The underwater noise conditions around Mobile Harbor would essentially remain the same under the TSP with an exception of the likely presence of some large ships as compared to the current ship mix. Based on the available levels measured for a variety of marine vessels in a range of 157 to 182 dB at a distance of 3 ft, the noise levels from large ships are still below the range of Permanent Threshold Shift and Temporary Threshold Shift thresholds developed by the NMFS resulting in less than significant underwater noise impacts.

5.17. Cultural and Historic Resources

5.17.1. Alternative 1 – No Action

Under the No Action Alternative, the proposed project would not be implemented. Dredging operations would remain unchanged utilizing the current water quality certification for Mobile Harbor. Under this scenario no additional historic resources would be disturbed or impacted.

5.17.2. Alternative 2 – TSP

5.17.2.1. Project Construction

As referenced in Section 2.15, Appendix C, the APE of the TSP has a very high potential for cultural resources, including prehistoric sites on now-submerged landforms as well as historic shipwrecks. Some portions of the TSP have been previously surveyed for cultural resources. Other portions of the TSP have been subject to a recent Phase I level maritime (to include shipwrecks and prehistoric landforms) survey. Phase II evaluations may be necessary, dependent upon the Phase I findings. Section 106 coordination and consultation with the Alabama SHPO and the USACE, Mobile District Tribal Partners will be necessary. If impacts to listed, eligible, or potentially eligible cultural resources cannot be avoided, a Memorandum of Agreement (MOA) will be necessary in order to mitigate adverse effects to historic properties. Shipwrecks identified as foreign vessels such as those of French, Spanish, or English origin would be property of that sovereign nation, if no direct title of ownership can be established. If ownership is identified as the Foreign Sovereign Nation, consultation with Foreign Sovereign Nation would be necessary. At this time, the following investigation recommendations have been made.

Direct Effects

Bay Channel. No survey is recommended for the portion of the existing Bay Channel that is proposed to be deepened. The channel was surveyed for submerged resources with a Phase I survey conducted based upon the authorized dimensions (Mistovich and Knight, 1983). Underwater archaeologists also investigated significant anomalies via diving (Phase II investigations) in 1986 (Irion). During the Phase II investigations, all anomalies were found to be modern harbor debris. Although the Phase I investigation is outdated, anomalies were physically investigated via diving by underwater archaeologists. The confidence in physical examination combined with the fact that ground disturbance proposed in deepening the channel would take place in soils below the depth of cultural resources had led to the recommendation of no additional investigations for this portion of the TSP.

Although the 1983 Phase I investigation is outdated, additional Phase I investigations area are very unlikely to identify previously unrecorded resources within the Bay Channel deepening corridor. Within this corridor, the potential for previously unrecorded shipwreck sites is quite low. Upon sinking, shipwrecks settle on the surface of the seafloor and the depth of the current channel greatly exceeds the seabed of the historical sailing era, thus extremely limiting the potential for intact shipwrecks or partial shipwrecks. The potential for previously undiscovered submerged prehistoric resources is also quite low in the existing channel. The existing channel follows the deepest natural part of the relic river which has a low probability for occupation sites. It is the margins and banks of the relic river, such as those areas included in the widening and bend easing portions of the TSP, that would have a higher probability for submerged prehistoric sites.

Choctaw Pass Turning Basin. The Choctaw Pass Turning Basin as described in Section 1.1.3, Appendix A, was not constructed with the other project improvements during the late 1980s/early 1990s at the request of the NFS (i.e., the ASPA). A GRR was later prepared (in May 2007), per the NFS's request, to re-evaluate the turning basin. The 2007 GRR recommended the turning basin be moved north to Choctaw Pass and deepened to 45 ft to match the adjacent channel dimensions. Construction to recommended dimensions was completed in 2011. The TSP calls for expanding the Choctaw Pass Turning Basin to the southeast, adding an additional 250' of width to the turning basin and matching the depth of the larger part of the turning basin (50' deep). The area proposed for widening was recently investigated for submerged resources (Hall 2007). No significant anomalies were recorded during the survey. No additional investigations are recommended.

Bay Channel Widening. The proposed 3 nautical mile stretch of the lower Bay Channel included in the TSP for channel widening will require a Phase I maritime survey. As referenced in Section 2.15, Appendix C, the Bay Channel has an extremely high potential for cultural resources. Although the areas to be widened fall within the survey parameters of 1983 Phase I survey (Mistovich and Knight, 1983), these soils have not been disturbed by dredging and advances in technology and maritime archaeological survey techniques combined with the dynamics of a maritime environment mean that there is a high potential for previously undiscovered intact cultural resources. The Phase I survey fieldwork has been completed but the report is forthcoming. The results and recommendations will of the survey will be reported in the Final GRR/SEIS as well as used in Section 106 consultation.

Bar Channel. The proposed Bar Channel deepening and bend easing as described in Section 1.1.1, Appendix A will require a Phase I maritime survey. As referenced in Section 2.15, Appendix C, the Bar Channel has an extremely high potential of cultural resources. Although the areas to be widened fall within the survey parameters of the 1983 Phase I survey (Mistovich and Knight, 1983), these soils have not been disturbed by dredging and advances in technology and maritime archaeological survey techniques combined with the dynamics of a maritime environment mean that there is a high potential for previously undiscovered intact cultural resources. The Phase I survey fieldwork has been completed but the report is forthcoming. The results and recommendations will of the survey will be reported in the Final GRR/SEIS as well as used in Section 106 consultation.

Relic Shell Mined Area. Selected as one of the new work placement areas, it is a concentration of fossilized shell which was mined for shell borrow material for roads, chemicals and poultry feed The locations where material would be placed have been disturbed to a depth of 15 ft or greater. Due to the extreme disturbance by mining operations this area lacks potential for cultural resources. No cultural resource survey is recommended.

SIBUA. The southernmost portion of the existing SIBUA area was recently investigated by USACE archaeologists (2009) for submerged resources. Although some anomalies were identified, none were significant anomalies associated with cultural resources. No additional investigations are recommended.

SIBUA Northwest Expansion. An area northwest of the existing SIBUA was identified for expansion to accommodate future maintenance capacity. As referenced in Section 2.15, Appendix C, the SIBU northwest extension has an extremely high potential of cultural resources. The Phase I survey fieldwork has been completed but the report is forthcoming. The results and recommendations of the survey will be reported in the Final GRR/SEIS as well as used in Section 106 consultation.

ODMDS. In order to ensure compliance, cultural resources were evaluated via a literature review and through analysis of remote sensing data, focusing on archaeological resources. The information gathered from these sources was used to characterize and assess potential effects. The data search revealed there were several possible shipwrecks in the vicinity. In November 1985, the USACE, Mobile District prepared the "Final Supplemental EIS, Mobile Harbor, Alabama, Channel Improvements, Offshore Dredged Material Disposal." The following was extracted from that document: "The historical associations of the area range from the earliest explorers of this continent through more recent events in Alabama which include historical buildings, lighthouses, and existing forts, such as Fort Gaines (1818) on Dauphin Island and Fort Morgan (1833) at the Mobile Point lighthouse (lighthouse no longer extant) (Alabama Historical Commission, 1978). The Union ironclad, U.S.S. Tecumseh, is under 30 feet of water in Mobile Bay, north of Fort Morgan. The historical richness of the area is seen by the number of listings in historical site registers; over 50 listings in the National Park Service's National Register of Historic Places and nearly 20 listings in the Alabama Historical Commission's Alabama Register (USACE 1985)".

Historically, the USACE, Mobile District has consulted with the Alabama SHPO regarding placement of maintenance material in the Mobile ODMDS as described in Public Notice Numbers FP86-MH06-02, FP91-MH07-04, FP95-MH07-02, FP97-MH08-02, FP97-MH09-02, FP11-MH01-06, and FP14-MH01-10, and FP16-MH01-04. Additional coordination with the Alabama SHPO for placement of new work material has also been conducted with each navigation improvement.

In August 1982, the USACE, Mobile District conducted cultural resources investigations of the current project area. These studies, which have provided the basis for previous consultation with the Alabama SHPO, included archival and historic research on the prehistory and history of the Mobile Bay area and remote sensing surveys (i.e. magnetometer side-scan sonar and shallow-seismic profiles) of all areas that could be affected. Survey methodologies for areas in Mobile Bay and in the Gulf (ODMDS) varied. The surveys within Mobile Bay were conducted at 50 meter intervals while survey of the Mobile ODMDS, including the current APE, was based on a sampling strategy designed to establish high and low probability zones, with lane spacing in the Gulf widened to 150 meter intervals. The 1982 report recommended three high probability zones in the placement areas in the Gulf, including much of the northern section of the current project area. The report recommended that the high probability zones should be avoided during placement operations, if possible. Although the survey of the roughly 4,000 acre Mobile ODMDS (current project area) focused on designating zones of high probability, the survey identified 33 magnetic anomalies. Of these, six anomalies were recommended for avoidance or additional evaluation. Given the passage of time, technological improvements, and possible changes in environmental conditions, additional surveys are being considered prior to site use of areas previously undisturbed. As part of that EPA Region 4's designation effort, the USACE, Mobile District will coordinate with the Alabama SHPO through the release of the Public Notice and via letter to discuss avoidance of any culturally sensitive resources in the Mobile ODMDS. If avoidance is not feasible, a mitigation plan will be developed in consultation with the Alabama SHPO and the Advisory Council on Historic Preservation (ACHP) prior to site usage of areas previously undisturbed. Additional stakeholders will also be identified during this process including interested tribes, local governments, and special interest groups in order that they might be allowed to participate in this process. The USACE, Mobile District will obtain Section 106 concurrence and that coordination documentation will be included in the ODMDS EA and the Mobile Harbor GRR/SEIS.

Indirect Effects

Estuarine Sediment Transport. As channel modifications may change sedimentation rates and patterns, sediment transport modeling was conducted for the navigation channel, dredged material placement sites, and surrounding areas. The methodology and results of the estuarine sediment transport analysis are discussed in Section 6.3.1, Appendix A. No discernable net erosion or net deposition was indicated in the study results when compared to the future Without-Project conditions. As such, no investigations are recommended.

Coastal Sediment Transport. Since channel modifications might change sedimentation rates and patterns, sediment transport modeling was conducted to assess the relative changes in sediment pathways and morphological response on the ebb tidal shoal and adjacent coastal areas. The methodology and results of the coastal sediment transport analysis are discussed in Section 6.3.2, Appendix A. The modeling results indicate minimum difference in bed level changes between the With-Project and Existing Conditions in the bay and on the ebb tidal shoal. As such, no investigations are recommended.

Vessel Generated Wave Energy. As making Mobile Harbor navigable by larger, deeper draft vessels is an objective of the project, the change in vessel generated wave energy and possible effects of that energy on the shoreline was assessed. The methodology and results of that vessel generated wave energy assessment are discussed in Section 6.4, Appendix A. The modeling results indicate minimum difference in bed level changes between the With-Project and Existing Conditions in the bay and on the ebb tidal shoal. As such, no investigations are recommended.

5.17.3. Future Maintenance

Future maintenance placement practices will be consistent with the current O&M placement areas. Material dredged as part of maintenance operations for the future With-Project conditions will continue to be placed in a combination of upland sites adjacent to the River Channel; open water placement sites within the bay; the SIBUA on the ebb tidal shoal, including a proposed northwestward expansion of the site; and the ODMDS in both the current limits and a future expansion area. The current O&M disposal areas have been previously reviewed and approved through the Section 106 process and will not require additional Section 106 review until those disposal areas require recertification. Future O&M use of new disposal areas proposed in this TSP, will be considered during Section 106 review of the TSP. The continued use of those disposal areas will be required to adhere to any avoidance plans, mitigation plans, MOA, or any other requirements and stipulations that result from the Section 106 process, as well as undergo Section 106 review during future recertification.

5.18. Protected and Managed Lands

According to the ADCNR, Alabama is home to 11 national wildlife refuges that represent a cross-section of Alabama's diverse natural environment as well as state and privately managed areas. Alabama's protected lands and resources encompass the beaches and estuaries of the Gulf Coast, the waters of the Tensaw River, and the swamps and wetlands along the Tombigbee River. The ADCNR is the state agency responsible for the conservation and management of Alabama's natural resources, including state parks, state lands, wildlife, and aquatic resources. A summary of the Protected and Managed Lands considered in this report is provided in Section 2.17, Appendix C.

5.18.1. Alternative 1 – No Action

Under the No Action Alternative, existing conditions in the project area would continue. There would be no expected environmental changes in association with maintaining the navigation project. It is predicted that future SLR scenarios would cause changes in salinity and other water quality parameters that impact aquatic resources residing in these protected areas as the SLR occurs (Kirwan and Megonigal, 2013). In many regions the predominant impact of long term seal level rise will be excessive inundation leading to a conversion of wetland features to open water areas, especially in landscapes where landward retreat is restricted (USGS, others).

The modeling efforts conducted for the aquatic resources considered as characteristic to national wildlife refuges and Alabama's diverse natural environment as well as state and private managed areas suggest that some wetland features in these areas may be inundated as a result of the 0.5 m SLR projection. This includes forested areas predominantly dominated by freshwater communities (e.g., bottomland hardwoods), salt-tolerant halophytic communities (e.g., black needle rush, big cordgrass), and transitional communities (e.g., tidal shrub mix, *Typha*). Increases in sea level inundation may not result in the loss of wetlands but may lead to a shift of wetland types. Such changes have the potential to alter both species composition and structure, occurring over multi-years to multi-decadal timescales.

5.18.2. Alternative 2 – TSP

5.18.2.1. Project Construction

Field studies analyzed changes in water quality and hydrodynamics to evaluate the potential for impacts to benthic macroinvertebrates, wetlands, SAV, oysters, and fish were conducted by Berkowitz et al. (2018) which include the areas and habitats considered characteristic of the national wildlife refuges and Alabama's natural environments as well as those state and privately managed areas described in Section 2.17, Appendix C. Results of the detailed analyses suggest that no substantial impacts in aquatic resources within the Federal Reserves and other managed areas are anticipated due to project implementation, as the area of greatest potential changes to environmental conditions are already adapted to natural shifts in salinity (and other factors) as well as conditions resulting from the existing navigation channel. Although SLR has the potential to alter natural resources associated with the reserves and managed areas, additional impacts related to project implementation remain negligible under the 0.5 m SLR scenario.

5.18.3. Future Maintenance

Future maintenance of the navigation channel would be no greater than current conditions after project construction and no additional impacts to national wildlife refuges and private managed areas in the project area would be expected to occur.

5.19. Recreation/Aesthetics

As described in Section 2.18, Appendix C, coastal-based tourism and recreation account for a significant portion of Alabama's tourism and recreation industry. Opportunities for recreation include arts and entertainment, boating, golfing, sightseeing, picnicking, swimming, bird watching, and fishing. Alabama's Gulf Coast, located between Mississippi and the Florida Panhandle, includes just two counties: Mobile and Baldwin. These counties border Mobile Bay, the Mississippi Sound and the Gulf of Mexico, which provide ample opportunity for boating, swimming, fishing and relaxing on coast beaches. Alabama's coastline stretches 60 miles and is home to beaches along the Gulf and which provides quality of life for many Alabamians and plays a major role in the State's economy as well as being recognized as valuable environmental asset.

5.19.1. Alternative 1 – No Action

Under the No Action Alternative, existing conditions in the project area would continue. There would be no expected changes to recreation and esthetics association with maintaining the navigation project.

5.19.2. Alternative 2 – TSP

5.19.2.1. Project Construction

The degree to which any adverse feature affects aesthetics is frequently based on scale, position, and proximity relative to the viewer. Commercial and recreational vessel traffic patterns, shoreline land uses, and natural resources that define the aesthetic characteristics of the area would not be adversely affected. Temporary impacts to aesthetics would occur in the immediate vicinity of placement activities during construction. Many people utilize Mobile Bay and vicinities within the project area and would likely be temporarily disturbed by the presence of dredges, pipelines, and other working vessels during construction activities. Subsequently, overall activities in any specific area would be short-term. Impacts would be minor, and therefore not significant.

Aesthetic resources in the majority of the project area include open water areas along the Bar and Bay Channels, and industrial settings in the River Channel. These are highly different visual areas, one consisting of a natural setting, occasionally disturbed by passing vessels and oil platforms, the other consisting of a densely industrial area with constantly operating large scale equipment and vessels and vehicles. The proposed project would not change the aesthetic resources of Mobile Harbor and surrounding areas, nor the numerous recreational opportunities. Commercial and recreational vessel traffic patterns, shoreline land uses, and natural resources that define the aesthetic characteristics of the area would not be adversely affected.

As a public safety measure, boating and fishing activities would be prohibited near the operating construction equipment (and sediment placement locations). Recreational access to these areas would return to pre-construction conditions following completion of the project. Although short-term impacts could occur, no long-term adverse effects are anticipated. Commercial shipping would continue in the Federal navigation channel. Information would be provided to the USCG so they could issue a “Notice to Mariners” prior to initiation of construction and for each major change in the construction activities. This would alert public boaters of areas to avoid and the possibility of limited and restricted access. No significant adverse impacts to public safety are expected from the proposed project.

5.19.3. Future Maintenance

Future maintenance and operations have the potential to have minor impacts on recreational activities. Operational activities would remain much as they are today and it would be unlikely that Mobile Harbor and River Channel operations would be visible from recreational areas as these impacts would be minor and insignificant as they would not be present for long periods of time and would not completely block or severely disrupt the overall views and boating activities. Overall, although minor disturbances to recreational activities may occur during dredging and placement activities, these disturbances would be insignificant as they would be short in duration and small in effect.

5.20. Socioeconomics

This section describes the potential impacts to socioeconomics should the TSP or No Action Alternative be implemented.

Components of socioeconomic resources that are analyzed include population, employment, and income. The Region of Interest (ROI) encompasses Alabama’s two southernmost coastal counties - Mobile and Baldwin. It includes the developed urban area of the City of Mobile, the maritime facilities, and residential areas along the east and west banks of the Mobile River and Mobile Bay. Mobile and Baldwin Counties form the economic ROI, which is the geographic area in which the predominant social and economic impacts of the Proposed Action are likely to occur.

5.20.1. Alternative 1 – No Action

Under the No Action Alternative, the proposed project would not be implemented. Therefore, existing socioeconomic conditions would be expected to remain as they are at present for the short-term. However, medium to long-term detrimental economic impacts may result from the No Action Alternative. If improvements are not made to Mobile Harbor to meet the shipping industry's need for the port to accommodate larger shipping vessels coming online internationally, the port may not reach its full potential and Alabama's share of global trade may be negatively impacted. International trade could be limited, which may hinder long-term growth trends causing an indirect negative impact to employment levels, salary levels and tax collections in the ROI, surrounding counties and the state of Alabama.

5.20.2. Alternative 2 – TSP

5.20.2.1. Project Construction

There is an initial capital cost of approximately $387.8 million associated with dredging operations. A minimal amount of materials and services (primarily fuel) may be purchased locally in Mobile and Baldwin Counties. The direct impact to the economy associated with dredging activities, if any, would be short-term, minor and beneficial to the local economy.

The onsite construction workforce is estimated to be 34 workers during the construction period (estimated to be approximately three years). The majority of these workers would be transient workers residing outside of the ROI. Beneficial indirect impacts to the hospitality and service industries for accommodations, food and entertainment purchases by the temporary workers are likely, but minor. Changes to population levels in the area as a result of construction activities are not expected.

The adverse environmental impacts of implementation of the TSP during construction are minimal and temporary in nature and include reduced air quality, increased noise from dredging operations and increased traffic from workers. These environmental impacts can contribute to socioeconomic impacts. Air quality would be temporarily and insignificantly affected due to emissions resulting from dredge operations and other necessary equipment. The project area is currently in attainment with NAAQS, and the proposed action is not expected to affect the attainment status of the project area or region. Noise from the single additional dredge would be evident in the immediate vicinity of the work area, but would not be prolonged or atypical for the area, and would have a minimal impact on existing noise levels. While air quality and noise impacts may be experienced by persons in vessels on the water, in the vicinity of these construction activities, they would not be expected to be experienced by residents or communities on the shore due to the distance separating the dredging area from these receptors. Traffic would not be impacted due to the small amount of workers changing rotations on the dredge equipment such that air quality, noise and traffic impacts would not contribute to adverse socioeconomic impacts. Overall, socioeconomic impacts from implementation of the TSP are anticipated to be positive and short-term during construction although small relative to the total economy of the counties.

5.20.3. Future Maintenance

The long-term socioeconomic impacts associated with implementation of the TSP are beneficial. As the world's shipping vessels continue their transition to larger ships, Mobile Harbor would maintain its competitive position as a center for international trade because of its ability to accommodate larger ships. It is anticipated that the number of vessels calling at Mobile Harbor would not increase based on implementation of the TSP, and the amount of cargo moving through Mobile Harbor would remain the same. The completion of the APM Terminals expected in 2019 would result in additional full-time longshoremen jobs and the increase in the volume of commodities would also put a larger demand on truck traffic, creating additional trucking jobs.

Additionally, over the long-term, implementation of the TSP may have a minor beneficial impact to air quality and noise. The proposed channel improvements would allow for more efficient transport of commodities, which results in the ability of vessels to carry more cargo per trip, resulting in a decrease of the total number of vessels required to deliver the same throughput. Newer ships will replace older ships with less fuel efficiency, resulting in a minor beneficial impact to air quality of the region. In addition, newer ships would also likely have a different, probably lower noise profile. Overall, socioeconomic impacts from implementation of the TSP would have positive effects.

5.21. Transportation

This section provides a summary of the potential impacts to transportation should the Proposed Action or No Action Alternative be implemented. The impact analysis is provided in more detail in Section 3.22, Appendix C.

5.21.1. Alternative 1 – No Action

Under the No Action Alternative, no changes to the current transportation system would occur. Maintenance dredging of the harbor and channel would continue. Over the next 50 years, channel traffic and harbor operations will increase independently of a deepening and widening project. This could potentially lead to increased traffic on local roads, railroads and airports. Vehicular traffic volumes in the general area will also increase proportionally, but this increase would be insignificant. If proposed road improvements are made on the I-10, these impacts would be further reduced.

5.21.2. Alternative 2 – TSP

5.21.2.1. Project Construction

During construction, harbor operations are expected to continue without construction related interruption. Dredge activity would be halted and moved to accommodate vessel traffic. Currently, two dredges operate in the harbor and the channels for maintenance activities. The construction of the TSP would only require one additional dredge. Therefore, no significant change to existing transit methods and routes of goods entering and exiting the harbor are anticipated. Only an additional 34 workers would be required, which would not impact existing road traffic characteristics in the area. No change in surface transportation routes used to and from the harbor are anticipated as a result of construction. Under the proposed action, direct impacts to harbor traffic and surrounding transportation systems would be minor.

Indirect impacts to transportation as a result of construction activity in the harbor would be insignificant. Dredging equipment would yield to vessel traffic, minimizing any associated change in the water or land transportation patterns. The increase of approximately 34 workers travelling to and from dredge crew boat landing spots would not increase traffic on roads in the area.

5.21.3. Future Maintenance

Port traffic, including a 25% increase in truck traffic associated with build-out of the container terminal, is included in the existing traffic volumes and in the 1.5% growth rate applied to the future volumes and includes the expected increase in truck traffic associated with the build-out of the container terminal.

Direct impacts to transportation over the long-term are possible. Although the harbor and channel enlargement is not predicted to increase the volume of products being shipped through the harbor, the method of transportation (in larger vessels) could change. The larger container ships would transport larger volumes at once. This may lead to a minor increase in traffic on local roads during loading/unloading operations as more longshoremen may be required loading/unloading of the larger vessels. Fewer un-loadings would occur, but each unloading would require more transportation vehicles than currently needed; however, this increase in vehicles is accounted for in the 1.5% growth rate applied to future volumes.

Overall, changes to transportation could occur under the proposed alternative, such as short-term increased traffic during loading/unloading operations. With proper management by the ASPA, these impacts would be minimized and would result in the same level of service currently available in the area. As stated above, possible local and interstate roadway improvements would also decrease the possible negative impacts to transportation in the port area.

Indirect impacts to transportation could occur under the proposed action over the long-term. A general reduction in the number of large shipping vessels could occur over time as shipping larger volumes at once is more efficient. Shipping companies may elect to retire their existing vessels in favor of larger ones. Overall, switching from a higher number of smaller vessels to fewer larger vessels would not be considered a significant indirect impact to transportation.

5.22. Utilities and Infrastructure

5.22.1. Alternative 1 – No Action

This section provides a summary of the potential impacts to the area's utilities and infrastructure should the Proposed Action or No Action Alternative be implemented. The impact analysis is included in greater detail in Section 3.23, Appendix C.

5.22.2. Alternative 2 – TSP

The minimum depth necessary for any utility line crossing would be 64 ft below Mean Lower Low Water (MLLW) for the Upper and Lower Bay, and 66 ft below MLLW for the Bar Channel, taking into consideration two ft for advanced maintenance and two ft for allowable overdepth.

There are existing utilities in the Mobile River area that are outside the area of impact of the TSP. There are no facility or utility relocations within the limits of the proposed harbor channel widening or deepening. No roads, highways, railroads, pipelines or utilities would be impacted by the proposed project (USACE 2018). No direct or indirect adverse impacts to utilities are anticipated as a result of implementation of the TSP, and future maintenance and operations activities. Any possible future installation of utilities would require coordination with the USACE, Mobile District.

5.23. Environmental Justice

This section provides a summary of the potential impacts to the Environmental Justice communities in the project's area of influence should the Proposed Action or No Action Alternative be implemented. A more detailed analysis concerning Environmental Justice is presented in Section 4, Appendix C.

5.23.1. Alternative 1 – No Action

Under the No Action Alternative, the TSP would not be implemented and no channel improvements would be made. Shippers would not be able to load their vessels more efficiently or use larger vessels with greater capacity. For the short-term, cargo volumes at port would continue to increase, driven by export demand for steel, coal and other commodities, as well as recent and on-going port-side infrastructure upgrades that meet shipper's needs for efficiency and productivity. Increased shipping volumes would necessitate the use of more ships to transport cargo, since the new Super Panamax vessels would not be able to load to capacity due to inadequate channel depths. Increased number of ships and transportation related traffic would increase the opportunities for accidents in the channel and on the roads. Truck and rail traffic in the area would increase to support the transport of goods. As a result, total air emissions are expected to increase over time, but not in significant amounts; thus no violation to National Ambient Air Quality Standards (NAAQS) would be anticipated. For the short-term, current employment trends in the area would likely continue with most of the employment in the existing economic sectors of government and health care. There would be little or no new job creation.

The cargo volume of commodities, including petroleum, coal as well as hazardous materials passing through the port is expected to increase with or without the implementation of the TSP. As described in Section 2.5.13 (Hazardous Materials) the transportation of hazardous materials is subject to a variety of regulations. With the buildout of the container terminal, increased shipments of hazardous materials are expected to increase. Currently, trucks transporting hazardous materials are re-routed on local roads through the CBD and use the Cochrane-Africatown Bridge to cross the Mobile River. It was estimated that 257 hazardous material trucks traveled this route in 2005, 280 in 210, and a projected 396 trucks by 2030 (FHA and ALDOT 2014). The areas surrounding the Cochrane-Africatown Bridge is considered an environmental justice community and since hazardous materials are specifically detoured through this area (via urban principal arterial roads, collector roads, and local roads and side streets) the impacts of increased traffic and specifically traffic related to hazardous materials movement have been evaluated to determine if there is disproportionate impact on environmental justice communities.

Using the 2016 AADT traffic counts for the Cochrane-Africatown Bridge (Appendix C), in addition to the FHWA and ALDOT estimates above and confidential hazardous materials truck counts provided by the operators of the port terminals, approximately one percent of the traffic crossing the Cochrane-Africatown Bridge is a direct result of hazardous materials associated with port activities. Since port activities account for approximately one percent of the hazardous materials traffic over the Cochrane-Africatown Bridge and the increase in total truck traffic associated with the build-out of the container terminal is only 25 percent, as discussed in Section 5.21., the hazardous materials detoured over the Cochrane-Africatown Bridge would still be less than 2.5 percent of the total bridge traffic. Unless there is an unavoidable accident or other unforeseeable conditions, the transportation of increased volumes of hazardous materials and petroleum products should not harm human health or the environment.

With compliance with state and Federal regulations related to the transport and handling of hazardous materials and the eventual completion of the new I-10 Bridge, minor impacts would be associated with any additional volumes of hazardous materials truck traffic associated with the build-out of the container terminal. After build-out of the container terminal, impacts associated with hazardous materials truck traffic over the Cochrane-Africatown Bridge could increase by 25 percent, but would still be less than 2.5 percent of overall traffic crossing the bridge and impacts associated with hazardous materials traffic would be minor. These impacts would be disproportionate to Africatown and other environmental justice communities along the existing detoured truck route. Once the new I-10 Bridge is completed, these impacts would be mitigated because trucks carrying hazardous materials will no longer be forced to detour through these communities. Most likely, the majority of truckers will utilize the I-10 Bridge as it is associated with the predominant east-west highway in this area. The new route via the I-10 Bridge would transverse other environmental justice communities south of the CBD. Overall, there would be minor, disproportionate impacts to environmental justice communities due to the transport of hazardous materials. The ASPA utilizes a Port-Wide Mass Notification System to alert ASPA employees, tenants, visitors and interested stakeholders in the event of an emergency within the ASPA's seaport facilities (ASPA 2018). Once the I-10 Bridge is completed, truckers would have the option to use the new I-10 Bridge or continue to use the Cochrane-Africatown Bridge.

In addition, over the long-term, detrimental economic impacts may result from the No Action Alternative, as the Port may not reach its full potential; resulting in loss of trade causing an indirect negative impact to employment levels, salary levels and tax collections, which could reduce funding for schools and other state supported services.

Under the No Action Alternative, there would be no impact to subsistence consumption.

Under the No Action Alternative, there would be minor long-term impacts to low-income or minority populations, with respect to the potential for accidents, decreased air quality and increased traffic. Over the medium to long-term, indirect detrimental economic impacts may occur. The general absence of significant adverse impacts to human health, environmental health risks, subsistence consumption patterns and safety risk indicates the proposed project would not have disproportionately high and adverse impacts to any communities, including environmental justice communities or children.

5.23.2. Alternative 2 – TSP

5.23.2.1. Project Construction

The adverse environmental impacts of implementation of the TSP are minimal and temporary in nature and include reduced air quality, increased noise from dredging operations and increased traffic from workers.

Air quality would be temporarily and insignificantly affected by the proposed action. Emissions are expected to occur from construction activities and would result from the operation of the dredge, and any other support equipment which may be on or adjacent to the job site. Emissions from the single additional dredge proposed would not impact air quality. The project area is currently in attainment with NAAQS parameters. The proposed action is not expected to affect the attainment status of the project area or region. Fugitive dust emissions generally originate from land based operations. The TSP project site is located in the water, and has no land-side construction staging areas. As a result, fugitive dust emissions are anticipated to be minor and temporary during implementation of the TSP, and during future maintenance and operations dredging operations.

Dredging operations do not generate high levels of air noise. Dredging equipment moves frequently, thereby limiting the exposure of any one location to construction noise for a prolonged period of time. Noise would be evident to those workers on the job but would not likely be perceived by residents in the area. Noise levels would be similar to those generated during the existing maintenance activities. The impact of construction related noise would be short-term and insignificant.

Impacts to traffic from the approximate 34 temporary workers would be minor and temporary. Dredge crew members typically drive to the crew boat located at a private marina, then proceed to the dredge. The employees start work between 6:30 to 8:30 am, and switch out the crew every 8 or 12 hours. Crew may seek accommodations in area hotels or utilize crew quarters on the dredge equipment, if available. None of these activities would cause a noticeable increase in area traffic. Therefore, impact from traffic to environmental justice communities would be minor.

The general absence of significant adverse impacts to human health, environmental health risks, and safety risk indicates the proposed three year construction project would not have disproportionately high and adverse impacts to any communities, including environmental justice communities or children.

5.23.3. Future Maintenance

The implementation of the TSP would result in navigation channel improvements allowing vessels to utilize full capacity and carry more cargo per trip. The completion of the APM container terminal expected in 2019 would result in additional full-time longshoremen jobs and the increase in the volume of commodities would also put a larger demand on truck traffic, creating additional trucking jobs. Although not directly a result of implementation of the TSP, these impacts would be long-term and beneficial.

Similar to the No Action Alternative, the cargo volume of commodities, including petroleum, coal as well as hazardous materials passing through the port is expected to increase. Under the TSP, increased shipments of hazardous materials could increase, but the increase would be minimal compared to the increase associated with the build-out of the container terminal. As indicated under the No Action Alternative, currently, trucks transporting hazardous materials are re-routed on local roads through the Mobile Central Business District (CBD) and use the Cochrane-Africatown Bridge to cross the Mobile River. Unless there is an unavoidable accident or other unforeseeable conditions, the transportation of increased volumes of hazardous materials and petroleum products should not harm human health or the environment. Once the I-10 Bridge is completed, truckers would have the option to use the new I-10 Bridge or continue to use the Cochrane-Africatown Bridge. Most likely, the majority of truckers will utilize the I-10 Bridge as it is associated with the predominant east-west highway in this area

With compliance with state and Federal regulations related to the transport and handling of hazardous materials and the eventual completion of the new I-10 Bridge, minor impacts would be associated with any additional volumes of hazardous materials truck traffic associated with implementation of the TSP. With implementation of the TSP, impacts associated with hazardous materials truck traffic over the Cochrane-Africatown Bridge would be minimal; however, these impacts would be disproportionate to Africatown and other environmental justice communities along the existing detoured truck route. Once the new I-10 Bridge is completed, these impacts would be mitigated because trucks carrying hazardous materials will no longer be forced to detour through these communities. The new route via the I-10 Bridge would transverse other environmental justice communities south of the CBD. Overall, there would be minor, disproportionate impacts to environmental justice communities due to the transport of hazardous materials in association with implementation of the TSP.

As discussed in Section 2-4, dredged material from navigation projects are exempt from solid and hazardous waste consideration but are subject to the requirements of permitting authorities.

Implementation of the TSP does not require relocation of any persons or businesses, and is not expected to adversely impact subsistence consumption patterns.

Impacts of channel modification (to the extent landside areas are appreciably impacted) are spread proportionately among census tracts; therefore, construction of any of the TSP would not have a disproportionally high and adverse impact on areas with high concentrations of low-income, minority, juvenile, or elderly populations. Schools/childcare facilities and hospitals are dispersed throughout the area and are not disproportionately located near the harbor (EJScreen 2018) (NEPAssist 2018). Thus, no disproportionately high and adverse impacts to children are expected.

The ASPA participates in Green Marine, the largest voluntary environmental certification program for the maritime industry in North America that addresses key environmental issues, such as Prevention of Spills and Leakages, Pollutant Air Emissions, and Dry Bulk Handling and Storage to minimize community impacts. The program requires participants to adopt practices and technologies that will have a direct impact on the ground, and are independently verified, with results made public each year.

The general absence of significant adverse impacts to human health, environmental health risks, and safety risk indicates the proposed project would not have disproportionately high and adverse impacts to any communities, including environmental justice communities or children for most resource areas. As in the No Action Alternative, there would be minor disproportionate impacts to environmental justice communities from truck traffic transporting hazardous materials.

5.24. Public and Occupational Health and Safety

5.24.1. Alternative 1 – No Action

Under the No Action Alternative, current channel and harbor maintenance operations would continue. No additional dredging operations would occur throughout the project area. Therefore, no increased risks to public and occupational health safety are expected to occur. However, safety issues due to larger vessels being unable to load to full capacity, but still using the current port, would continue. Additionally, safety hazards related to vessel traffic in the channel and turning basin would also continue. All activities in the Mobile Bay Harbor and Channel are governed by Federal and State regulations, and would continue to be so governed. These regulations would continue to ensure that minimal risk to public health and safety is present in the vicinity. Under the No Action Alternative, safety hazards due to large vessel traffic would continue, but as these are minimalized by scheduling, they would still be minimal.

The increase in truck traffic associated with build-out of the container terminal would result in a 25 percent increase in truck traffic and truck traffic related emissions would likely increase by 25 percent. As discussed in Section 3-15, Appendix C truck emissions are not major emissions contributors and an increase in truck traffic would unlikely result in significant air quality impacts or occupational or public health concerns.

Indirect impacts to public and occupational health and safety are possible under the No Action Alternative. If the channel is not widened and deepened, it is possible that Mobile Harbor may not reach its full potential and larger container ships could choose another available harbor for loading and unloading. Over the long-term, this could result in less traffic in the channel and harbor over time, and a minor reduction in the possibility of transportation accidents. This may also reduce the potential for spills of petroleum products in Mobile Bay, due to lower traffic numbers. Generally, however, these impacts would be negligible as there is currently a very small risk of accidents and spills in the project area.

5.24.2. Alternative 2 – TSP

5.24.2.1. Project Construction

Under the TSP, direct impacts to public and occupational health and safety could occur. A minor increase in activity in the harbor and channel could result in a minor increase in the potential for accidents involving the workforce or bulk liquid spills. Currently two dredges are required for maintenance of the harbor and channel. During construction an additional dredge would be present in the area. This would not pose a significant increase in risk due to collisions or other accidents. Additionally, as dredging equipment would yield to accommodate vessel traffic so as not to disturb normal port operations, accident risk levels would be similar to those under normal maintenance dredging routines. The USACE and contractor safety programs provide sufficient training and supervision of new workers hired specifically for the project. If more vessels are concentrated in the harbor or other channel areas due to increased dredging operations, it is possible that an increased risk for collisions and spills could occur. However, with proper management of vessel operations and planned dredging locations, this risk would be minor and insignificant. Once dredging vessels have completed operations in one area, they would move to the next area designated for dredging, returning conditions in the harbor and channel to the current conditions.

Increases in air emissions from additional equipment could occur, but due to the existing air quality and the minimal amount of population over the general project area, these increases would be minor and would not generate any additional health risks. Although a slight increase in risk to public and occupational health and safety may occur during the construction process, this increase could be managed and would be insignificant and temporary.

Indirect impacts to public health and safety could occur under the proposed action. An increase in workforce may slightly increase the amount of traffic in the Mobile area if significant numbers of additional workers would be required for construction/dredging activities. This traffic increase could lead to an increase in the risk of traffic accidents in the vicinity of the project area, as a total of approximately 34 additional workers working in shifts are anticipated, road conditions should remain similar to those currently in the project area. Indirect impacts to air quality due to increased traffic are not anticipated. Both of these minor increases in risks to public and occupational health and safety would be temporary during construction activities and would be insignificant.

5.24.3. Future Maintenance

With the widening associated with the implementation of the TSP and the associated reduction of demurrage fees currently associated with vessel delays, it is anticipated that volume of petroleum products passing through the port may increase. The level of increased throughput at the various terminals will be limited by tank capacity, dock availability, and available land for expansion. Likewise, with the harbor deepening, ships serving the McDuffie Coal Terminal should be able to load to greater capacities and potentially increase the volume of coal products passing through the port. The increased volume would be limited by the availability of storage space at the terminal. In addition, the volume of the container terminal will continue to increase through the Phase III build-out of 1.5 million TEUs annually, with the potential for increased hazardous materials shipments.

Each terminal maintains its own air permit and any potential increase in air emissions resulting from increased vessel and cargo-related traffic would be addressed and mitigated, if appropriate, through the individual permits, resulting in minor impacts to air quality. Increased $PM_{2.5}$ and PM_{10} emission could result from a potential increase in coal throughput through the McDuffie terminal. Due to the overall reduction in coal demand and the limited storage capacity at the terminal, it is more likely that few ships (at larger capacities) would be the primary outcome. Based on the 2011 predicted baseline operational emissions, $PM_{2.5}$ and PM_{10} emissions from the coal pile were less than 1% and 3.8% respectively. Should an increased coal demand arise and the number of shipments increase, the overall increase in $PM_{2.5}$ and PM_{10} emissions associated with the coal pile would still be minimal compared to the overall $PM_{2.5}$ and PM_{10} emissions from port-wide operations.

As indicated in the No Action Alternative, the increase in truck traffic associated with build-out of the container terminal would result in a 25% increase in truck traffic and truck traffic related emissions. However, as discussed in Section 3-15, Appendix C truck emissions are not major emissions contributors and an increase in truck traffic would unlikely result in significant air quality impacts or occupational or public health concerns.

The larger volume of containerized cargo will lead to an increase of traffic on the roads in the vicinity of the port. Higher traffic numbers may lead to an increase in the possibility of accidents. If mitigation is needed, the Port may consider staging unloading operations such that traffic and associated risks are reduced to a minimal level. Overall, although a slight increase in the risk of traffic accidents may occur on local roadways, the impact would be insignificant. Additionally, one additional dredge may be required for maintenance of the deeper and wider harbor and channels. This mobile source of potential air emissions would not cause a significant impact to air quality.

With the compliance with Federal safety regulations and appropriate safety programs and processes, impacts associated with the implementation of the TSP on public and occupational health and safety would be minor.

5.25. Summary of Impacts

The potential impacts on the resources within the project area were considered as part of this study and are addressed herein. A number of resources were determined to have little risk of being impacted as a result of the implantation of the TSP. These included climate, groundwater, marine mammals, Man-made hard bottoms and structures, protected and managed lands, recreation, socioeconomics, public health and safety, and public infrastructure.

Those resources determined to have potential to contribute to adverse impacts where evaluated in greater detail. A summary of the findings of those evaluations are included below:

Water Quality

Salinity. Evaluation of monthly salinity distribution has shown the response to hydrological conditions for mean of depth-averaged salinity for February (wet condition) and October (dry condition). Differences in the monthly mean of depth-averaged salinity between results with project and without project show changes ranging between 0 to 2 ppt. Salinity changes greater than 1.5 ppt are found primarily in the vicinity of Gaillard Island and turning basin. Specific predicted changes in salinity as related to the various aquatic resources evaluated for this study such as wetlands, submerged aquatic vegetation, benthic communities, oysters, and fish were assessed using the results from the water quality and hydrodynamic modeling. The predicted changes in the salinity regime associated with aquatic resources indicate that estimated changes in salinity remain below tolerance thresholds. Salinity is predicted to increase considering a 0.5 m SLR, however, increases and distribution of salinity under that scenario would be the same as those under the baseline conditions.

DO. The results of the modeling analyses show that no impact from the project is predicted for DO levels in the surface or bottom waters and that the daily average DO conditions With Project are the same as the Without Project. The same modeling approach and setup was used to evaluate the potential impact of a proposed SLR. The same patterns, trends, and behavior exist for the SLR scenarios and no impacts to DO concentrations are expected as a result in future sea level change.

Nutrients. Modeling results indicate that the simulated nutrient levels are in good agreement with measured nutrient observations. Increases in ammonium at the mouths of the Mobile and Tensaw River correspond to changes in flow conditions. Results of the water quality modeling also reveal that nitrate levels agreed well with observed values. Subsequently, increases in nutrient levels would not be expected resulting from implementation of the TSP.

Turbidity. Results of the water quality modeling indicate that the predicted levels of total suspended solids are representative of the observed data. Subsequently, there would be no expected increase in the concentrations of the turbidity as a result of the implementation of the TSP.

Water Temperature. Results of simulations comparing the existing and With-Project conditions of the bay characterize Mobile Bay's water temperatures. Values for January/February time period represents high water flow conditions, those values for the mid-year period represents typical or average flows, and the values for the fall (October) period represent low flow conditions. The simulated results for the existing and project condition are nearly identical, indicating very little change in surface and bottom temperatures resulting from implementation of the TSP.

Waves

General Wave Climate. Model results indicate that implementing the TSP produces only slightly elevated peak water levels and wave conditions as compared with the baseline channel configuration and negligible changes in pre-storm tides. The largest simulated difference in maximum water surface elevation between the With- and Without-Project depths was 0.07 ft, which is well within the uncertainty of the model and would results in negligible changes in the wave climate. These results are captured in detail in Attachment A-1, Appendix A.

Ship Wake. Potential impacts of VGWE were evaluated by comparing the relative difference of With- and Without-Project conditions using forecasted vessel calls for years 2025 and 2035. Results of the analysis indicates a reduction in vessel generated wave energy for the future With-Project condition relative to the future Without-Project condition. Fewer vessels will call on the port in the future considering the TSP, which results in less vessel generated wave energy affecting the study area.

Sediment Transport

Estuarine/Mobile Bay. Results from the one year model simulation with the TSP condition show a minimum difference range of no greater than +/- 0.3 ft of erosion when compared to the No Action Alternative. Subsequently, these results indicate that there is no discernable net erosion or net deposition throughout the bay. Similar results and conclusions were found for the future With- and Without-Project Conditions when accounting for mean sea level change. With no discernable impacts associated with waves, currents, and sediment transport throughout the project area, there would be no expected erosion or changes to the position of the Mobile Bay shorelines resulting from implementation of the TSP. Additional details of the estuarine sediment transport modeling effort are provided in Attachment A-1, Appendix A.

Ebb-Tidal Delta. The sediment transport modeling as described in Attachment A-2, Appendix A was conducted to include probable effects on shoreline changes within 10 miles east and west of the channel and adequately represented the deep navigation channel, associated modifications, and irregular shoreline configurations of the flow system. Results of the modeling indicate a minimum difference in bed level changes between the TSP and Existing Conditions in the bay and on the ebb tidal shoal. Similar results and conclusions were found for the future With- and Without-Project Conditions (i.e., accounting for mean sea level change). Additional details of the coastal sediment transport modeling effort are provided in Attachment A-2, Appendix A.

Aquatic Resources. An extensive evaluation of the major aquatic resources considered to be potentially impacted by the proposed action was conducted and reported by Berkowitz et al. (2018). Field studies and analyses were conducted looking at changes in water quality and hydrodynamics to evaluate the potential for impacts to benthic macroinvertebrates, wetlands, SAV, oysters, and fish. The assessment included extensive characterization of baseline conditions, followed by evaluation of estimated post project conditions related to aquatic resource habitat (e.g., changes in salinity, DO). Additionally, an analysis of potential impacts related to a 0.5 m SLR scenario were evaluated. Results of the detailed analyses suggest that no substantial impacts in aquatic resources within the study area are anticipated due to project implementation, as the area of greatest potential changes to environmental conditions are already adapted to natural shifts in salinity (and other factors) as well as conditions resulting from the existing navigation channel. Although SLR has the potential to alter aquatic resource habitats within Mobile Bay, additional impacts related to project implementation remain negligible under the 0.5 m SLR scenario.

Cultural Resources. . The literature review conducted for the Draft GRR/SEIS shows that there is a high potential for cultural resources to be present within the APE. Due to the ground disturbing nature of the project, there is a potential for those resources to be affected by this project. Maritime Phase I cultural resource investigations area recommended for portions of the APE that have not been adequately surveyed including the SIBUA northwest expansion, and the Bay Channel widening and bend easing. After the inventories have been completed, formal Section 106 consultation with the Alabama SHPO and the appropriate Tribal Nations will commence. Phase II investigations may be required to determine National Register (NR) eligibility of significant anomalies. Avoidance of significant anomalies or eligible resources, minimization of impacts as well as mitigation of adverse effects will be considered during Section 106 consultation. If adverse effects to significant anomalies or National Register eligible sites cannot be avoided, a Memorandum of Agreement (MOA) between USACE, the Alabama SHPO, and all appropriate Tribes, would be necessary in order to properly address adverse effects. If shipwrecks belonging to a foreign sovereign nation are involved, that nation would also need to be involved in the MOA.

Essential Fish Habitat. The USACE, Mobile District takes extensive steps to reduce and avoid potential impacts to EFH as well as other significant area resources. Adverse impacts to wetlands, oyster reefs, or SAV from the implementation of the project would be anticipated to be no-effect, limited or negligible. Most of the motile benthic and pelagic fauna, such as crab, shrimp, and fish, should be able to avoid the disturbed area and should return shortly after the activity is completed. No long-term direct impacts to managed species of finfish or shellfish populations are anticipated. However, it is reasonable to anticipate some non-motile and motile invertebrate species will be physically affected through dredging and placement operations. These species are expected to recover rapidly soon after the operations are complete. No significant long-term impacts to this resource are expected as a result of this action. Increased water column turbidity during dredging would be temporary and localized. No change is anticipated to occur to the habitat types. Overall, impacts to EFH would be temporary in nature associated with the dredging and placement activities in Mobile Harbor. The proposed activities would not significantly affect coastal habitat identified as EFH in the project area. Based on the extent of this habitat in the general vicinity of the project and the temporal nature of the impact, the overall impact to fisheries resources is considered negligible. This determination is being coordinated with the NMFS Protected Resources Division according to the Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. 1801-1882).

Threatened and Endangered Species. Based on this information presented herein, the USACE, Mobile District has made the determination that the proposed dredging and sediment placement activities is not likely to adversely affect any listed endangered and/or threatened species or their associated critical habitat. The USACE has initiated consultation with the USFWS under Section 7 coordination of the Endangered Species Act. It is expected that this consultation will be completed prior to the release of the Final GRR/SEIS.

New Work Sediments. During the PED Phase of the Mobile Harbor GRR, sediment testing and evaluation will be required for all material proposed for placement in the ODMDS. O&M, along with proposed new work dredged material suitability must comply with guidelines in accordance with the Marine Protection, Research and Sanctuaries Act (MPRSA) of 1972, and the EPA ocean dumping criteria (40 Code of Federal Regulation (CFR) §227). At this time, specific impacts associated with the new work sediment testing and evaluation during the PED phase of the study are not known, however, current presumptions are that the new work material associated with the GRR sampling would be similar to that already tested and should be suitable for placement in the Mobile ODMDS.

Placement Areas. Several sites were evaluated for placement of new work material for the TSP. These included six relic shell mining areas within the bay for the placement of mixed sand, silts, and clays dredged from the River and Bay Channels; the Ocean Dredged Material Disposal Site (ODMDS), including an expansion of this site, for placement of mixed sand, silts, and clays from within the River, Bay, and Bar segments; and a northwest extension of the SIBUA if new work sand sources are found within the bar channel. All of the proposed placement sites were found to be acceptable. Results of modeling indicate that material placed within the Relic Shell Mined Area will remain stable and not be transported outside of the placement area. Furthermore, placement of material may help to restore bay bottoms within this site. Future maintenance dredge material will continue to be placed in the existing approved disposal areas. Mobile District is currently pursuing certification for the SIBUA and ODMDS extensions.

Noise. During construction, air noise levels would increase in the Mobile Harbor area due to dredging activities. These noise levels would approximate current levels as there is only one additional dredge proposed for the construction activities. When considering underwater noise, it is anticipated that the maintenance dredges presently being used in the harbor would also be used for harbor deepening and widening. It has been determined that the noise levels, both air and underwater, for the TSP during the construction period would be comparable to current activities and impacts would be less than significant.

Air Quality. The proposed deepening and widening of the Mobile Harbor Federal Navigation Channel would be a major construction project requiring certain large dredges to be used over several years. Two dredges are currently used for channel maintenance dredging activities. One additional dredge would be required during the widening and deepening activities. Since the deepening activity emissions would not take place along the channel at the same location for a long duration, they are considered temporary resulting in less than significant air quality impacts to the community along the channel.

Transportation. During construction, harbor operations are expected to continue without construction related interruption and therefore, no significant change to existing transit methods and routes of goods entering and exiting the harbor are anticipated. No change in surface transportation routes used to and from the harbor are anticipated as a result of construction. Under the proposed action, direct impacts to harbor traffic and surrounding transportation systems would be minor. Therefore, impacts to transportation as a result of construction activity in the harbor would be insignificant.

Environmental Justice. The general absence of significant adverse impacts to human health, environmental health risks, and safety risk indicates the proposed three year construction project would not have disproportionately high and adverse impacts to any communities, including environmental justice communities or children.

5.26. Mitigation

In accordance with the mitigation framework established by Section 906 of the WRDA of 1986 (33 USC 2283), as amended by Section 2036 of the WRDA of 2007 and Section 1040 of the Water Resources Reform and Development Act of 2014, the Council on Environmental Quality (CEQ)'s NEPA regulations (40 CFR Sections 1502.14(f), 1502.16(h), and 1508.20), and Section C-3 of ER 1105-2-100, the USACE, Mobile District will ensure that project-caused adverse impacts to ecological resources are avoided or minimized to the extent practicable, and that any remaining, unavoidable impacts are compensated to the extent justified.

For adverse impacts to wetlands which cannot be avoided or minimized, options include compensatory mitigation in the form of restoration, establishment, enhancement, and/or preservation. Any proposed mitigation should be practicable and ensure that the project will not have more than negligible adverse impacts on ecological resources. Mitigation planning is an integral part of the overall planning process. The USACE, Mobile District began the mitigation evaluation early in feasibility study process. In order to evaluate appropriate mitigation options, an estimate was made of the type, location, and level of potential adverse ecological impacts. The USACE, Mobile District worked closely with the ERDC in Vicksburg, Mississippi to forecast potential ecological impacts to fisheries, benthic invertebrates, oysters, wetlands, and SAV in addition to analyzing possible changes to sediment transport and water quality conditions. The USACE, Mobile District also solicited public input during the NEPA scoping phase of the study to identify additional concerns.

Practicable avoidance and minimization measures were considered. Should impacts not be avoided and minimized, the Mobile Harbor PDT prepared to assess potential compensatory mitigation measures and identify a rough order of magnitude cost for those measures.

This process included multiple consultations with Federal and State resource agencies. Early at the onset of the Draft GRR/SEIS, the PDT hosted a charette on January 28 and 29, 2015 in Mobile. At that meeting, the PDT presented the SMART planning process, identified modeling approaches planned, and acknowledged assumptions necessary to proceed with the modeling. Participants were asked to provide any suggestions to the USACE, Mobile District's modeling approach, including identifying any known data sets. The Mobile Harbor PDT hosted several additional resource agency meetings to present status updates and solicit their knowledge throughout the planning process.

The first step in mitigation planning involves efforts to avoid and/or minimize impacts. The PDT was able to avoid known resources during the channel modification development. The initial array of alternatives was coordinated with the resource agencies. These meetings centered on the primary ecological concerns of the project (DO, salinity increase, wetlands, fish habitat, endangered species, wetland, oysters, and sediment transport) as also identified during the NEPA scoping.

Studies were conducted through a combination of 1) direct measurements of aquatic resources and 2) modeling approaches to characterize the existing conditions within the project area which contains a variety of natural resources that are comprised of wetlands, SAV, oysters, benthic invertebrates and fish. Baseline conditions were established for oysters, SAV, fisheries, benthic invertebrates, and wetlands.

A characterization of baseline wetland community assemblages and distribution in estuarine, transitional, and freshwater habitats throughout Mobile Bay and the associated Mobile-Tensaw River Delta region were conducted (Berkowitz et al., 2018). Salinity tolerance classes were established for each wetland community using existing literature sources; including thresholds for decreased productivity and mortality. The study area focused on the central and southern portions of the Mobile Bay and the Mobile-Tensaw River Delta region, the area identified as having the highest likelihood of potential impacts associated with the proposed channel modifications. As a result, the study area encompasses the entire salinity gradient occurring with the Mobile Bay region, ranging from salt-intolerant bottomland hardwood forest species assemblages in the north to the halophytic plant communities common throughout coastal wetlands of the northern Gulf of Mexico. Ground truthing surveys conducted by the ERDC covered a distance of 40 miles throughout the Mobile Bay, with the goal of mapping the edges of various SAV beds to compare to beds recently mapped by Vittor, which represents the baseline SAV conditions. Baseline conditions were also established for benthic infaunal communities in estuarine, transitional, and freshwater habitats in the Mobile Bay Watershed (ERDC 2018). Changes in benthic community composition among these habitat types are documented along the salinity gradient and are used to estimate how far upriver changes may occur following channel deepening. Since Mobile Bay ranks first in the number of freshwater species in the Southeastern Atlantic and Gulf of Mexico drainages, the ERDC conducted sampling in the freshwater, transition and upper bay zones for a total of 11 sites utilizing the same gear and protocol as with the FAMP database (seine and trawl) used by the ADCNR, MRD. Outputs from the fishery study provided for the fisheries baseline conditions. Using information provided by the ADCNR, MRD, 13 known adult oyster reefs were assessed (>3,600 acres) for salinity and DO potential impacts based on juvenile and adult oyster tolerance thresholds. Understanding the oyster larvae movement and reef recruitment dynamic is critical towards understanding how potential project actions will impact oyster populations within the project area of influence. Specifically, if alterations to the navigation channel cause hydrodynamic changes a higher percentage of oyster larvae could be flushed out of the bay, affecting the local oyster recruitment (ERDC, 2018). Detailed discussions of all of these findings are found in Section 3.25 above. Water circulation and quality model results were assessed to determine whether projected salinity increases affected those identified ecological habitats.

A summary of impacts is included in Section 3.25 above. Based on the minimal level of impacts determined for the implementation of the TSP and future project maintenance and operations, no compensatory mitigation is proposed for this action as no loss of wetlands, SAV, oysters, and recreational and/or commercial fisheries are anticipated nor are any significant adverse effects to ESA-listed species or marine mammals anticipated based on the analyses in this document. Additionally, detailed analyses have demonstrated the general absence of significant adverse impacts to human health, environmental health risks, and safety risk and that the proposed construction of the TSP would not have disproportionately high and adverse impacts to any communities, including environmental justice communities or children.

Several avoidance and minimization measures are proposed to ensure that impacts are insignificant; these include the following:

1) Comply with all water quality standards and conditions issued in the water quality certification and adhere to monitoring protocols in the water quality monitoring plan.
2) Dredge practices will adhere to the GRBO (2003, and amended in 2005 and 2007).
3) Implement additional conservation measures required by NMFS and USWFS for ESA-listed species.
4) Beneficial placement strategies for new material.
5) Continue working with cooperating agencies during the planning, PED, and construction phases.

SECTION 6.0 ENVIRONMENTAL COMPLIANCE

6.1. Cumulative Impacts

This section provides a summary of the potential cumulative impacts associated with the proposed TSP. These potential impacts would result from other facilities, operations, and activities that in combination with potential impacts from the Proposed Action may contribute to cumulative impacts in the geographical area of interest. A more detailed analysis concerning cumulative impacts is presented in Section 4, Appendix C.

The National Environmental Policy Act (NEPA), as implemented by Council on Environmental Quality (CEQ) regulations (40 Code of Federal Regulations [CFR] §§ 1500-1508) requires Federal agencies, including the USACE, to consider cumulative impacts in rendering a decision on a Federal action under its jurisdiction.

According to 40 CFR § 1508.7, a cumulative impact is the impact on the environment that results from the incremental impact of the proposed project when added to other past, present, and reasonably foreseeable future actions regardless of the agency (Federal or non-Federal) or person that undertakes such other actions; cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. Cumulative effects include, but are broader than, the direct and indirect effects described in other sections of the Draft GRR/SEIS. According to 40 CFR 1508.8, "direct effects" are caused by the action and occur at the same time and place, while "indirect effects" are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable. Indirect effects may include growth inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems. A cumulative impact analysis assesses the total impact of the direct and indirect effects of the proposed action in combination and interaction with the effects of all other activities impacting the same resources (Parson et al. 2015).

An inherent part of the cumulative effects analysis is the uncertainty surrounding actions that have not yet been fully developed. The regulations provide for the inclusion of uncertainties in the Draft GRR/SEIS analysis, and state that "when an agency is evaluating reasonably foreseeable significant adverse effects on the human environment in an environmental impact statement and there is incomplete or unavailable information, the agency shall always make clear that such information is lacking" (40 CFR Part 1502.22). The CEQ has also recognized that "the complexities of cumulative effects problems ensures that even rigorous analyses will contain substantial uncertainties about predicted environmental consequences" (Considering Cumulative Effects Under the National Environmental Policy Act, CEQ 1997)(Parson et al. 2015).

For the purpose of evaluating the effects of past, present, and reasonably foreseeable future actions, this evaluation focuses on (1) actions that would impact the geographic areas (noted below) that would be impacted by the proposed Federal action, (2) actions that affect the resources that are affected by the proposed action, and (3) the actions that would be induced by the proposed action. In accordance with the intent of the USACE planning modernization initiative, the analysis focuses on specific resources and impact areas of concern and excludes analysis related to areas and resources that would not be meaningfully impacted by the proposed action or induced actions. Also, in accordance with CEQ guidance, "agencies are not required to list or analyze the effects of individual past actions unless such information is necessary to describe the cumulative effect of all past actions combined. Generally, agencies can conduct an adequate cumulative effects analysis by focusing on the current aggregate effects of past actions without delving into the historical details of individual past actions" (Guidance on the Consideration of Past Actions in Cumulative Effects Analysis, CEQ 2005). Focusing the analysis only on resources where there is a likelihood of reasonably foreseeable cumulative impacts supports the intent of the NEPA process, which is "to reduce paperwork and the accumulation of extraneous background data; and to emphasize real environmental issues and alternatives" [40 CFR Part 1500.2(b)] (Parson et al. 2015).

Actions undertaken by Federal, state, local agencies and private companies and individuals are highlighted in Sections 4.2, 4.3, and 4.4, Appendix C. Federal and State agencies are given broader attention because their results have typically affected the widest geographic portion of the project area, have been ongoing for decades and are likely to continue throughout the life of the project, and have impacted many of those resources affected by the proposed action (e.g., water quality, wetlands, etc.). Past and present actions are those projects and activities that have contributed and continue to contribute to cumulative impacts on local resources. Future proposed actions consider projects which could contribute to cumulative impacts if undertaken. These projects and activities do not comprise the only actions to affect resources cumulatively in the project area, but the detailed projects have had (and will continue to have) the greatest effect on Mobile Harbor and channel ecosystem and a working knowledge of these actions provides an important context for understanding the scope and scale of cumulative effects.

A study for Mobile Bay was prepared to develop a sediment budget for assessing net changes in seafloor configuration relative to wave and current processes and engineering activities within the bay. The study concluded that despite the large volumes dredged from the Bay Channel the most significant changes occurring during the intervals evaluated were associated with deposition in the northern portion of the bay at the mouth of the Mobile-Tensaw River Delta; deposition in the southern part of the bay resulting from current flow and sediment movement at Mobile Pass, including sand transport into Mobile Bay along the north side of Mobile Point (Morgan Peninsula); and localized erosion and deposition associated with navigation channel dredging and placement. Elsewhere in the bay, only minor deposition and erosion patterns were identified within a large estuarine system that is net depositional basin. Other studies have shown that while subsequent channel alterations had influenced sedimentation dynamics at and adjacent to the channel, periodic storm processes were most influential relative to bay sediment infilling and redistribution.

The majority of the potential direct and indirect impacts from implementation of the TSP on the various resources that were evaluated would be temporary, localized, and not significant. These incremental effects, when combined with relevant past, present, and reasonably foreseeable future projects, are unlikely to result in any adverse cumulative impacts. As previously mentioned, a full and detailed cumulative impact analysis is included in Section 4, Appendix C.

6.1.1. Magnitude and Significance of Cumulative Effects

Implementation of the TSP and other foreseeable projects such as the Port of Mobile APM terminal expansion and the I-10 River Bridge and Bayway Widening project would not significantly impact geology. Based on geological setting, depth and thickness of the local stratigraphy, minor or no impact is anticipated on the aquifer system as a result of implementing the TSP or other relevant projects. No incremental adverse cumulative effects on geology of the Mobile Bay area are expected.

Upland soils would not be affected by the deepening project. Bay sediments are not expected to be impacted from implementation of the TSP, though upland soils could be affected by foreseeable future projects involving terrestrial soils. Current and foreseeable future projects that impact the bay bottom could have a minor effect on sedimentation, shoaling or siltation rates due to possible changes in hydrology. Historical dredging records have not shown increased shoaling rates resulting from ship channel maintenance or improvements. Significant mounding of bay bottom resulted from the placement of new work material from channel deepening in the 1960's. However, recent sediment transport modeling to evaluate possible effects on sediment transport in the bay and nearshore coastal areas showed that minimum bed level changes are expected in the bay and on the ebb-tidal shoal. Shoaling rates are expected to increase between 5 to 15%. Impacts to sediment from implementation of the TSP are expected to be minor and temporary with no long-term adverse effects anticipated. Net sediment movement within the bay suggests that open-Bay placement of sediment is most similar to natural long-term depositional processes. Testing has shown that sediment from the navigation channel met the Limiting Permissible Concentration for water quality, toxicity, and bioaccumulation, and is suitable for open-water placement. Implementation of the TSP is not expected to have a significant incremental cumulative impact on soils or sediments.

Mobile Bay is an estuarine transition zone where freshwaters from the rivers mix with saltwater from the Gulf of Mexico. Water quality changes are dynamic in tidally-influenced estuarine areas and biological resources are adapted to accommodating short-term, periodic changes in water quality such as turbidity, salinity and nutrient loading.

Under the TSP, water quality in the immediate vicinity of the dredging area and open-water placement sites would be temporarily impaired for a short period of time due to an increase in turbidity. The dredging and dredged material placement would be controlled and monitored so that none of these operations would cause an increase in turbidity greater than 50 NTUs above background levels outside a 400-foot mixing zone. Adverse effects on biota from changes in water quality would be temporary and localized. Permanent loss of shallow water habitat due to channel widening and other improvements would be relatively minor considering the magnitude of shallow water habitat available in this estuarine area. The habitat loss due to the widening would be inconsequential, representing approximately 0.02% of available bay habitat. Permanent loss of habitat would be offset by the benefits of open-water placement and restoration of the relic oyster shell mined areas. No other permanent adverse impacts are anticipated.

Water quality and habitat loss from past actions have been or are being considered for mitigation by the passage of Federal and state environmental statutes, regulatory controls and mitigation measures to protect these resources. The TSP would comply with environmental statutes and commitments and would not result in significant long-term adverse effects on biological resources, protected species, marine mammals, or birds. Relevant proposed future actions would result in minor loss of wetlands, SAV and shallow bottom habitat, but would be subject to the same regulatory controls as the TSP. Further, it is unlikely that future actions would occur at the same time as the TSP, thereby exacerbating temporary adverse effects. Due to lack of suitable habitat and their location in coastal freshwater or nearshore coastal estuarine environments, species other than those discussed above would not occur in the TSP area. Effects from the TSP, when considered with other past, present, and reasonably foreseeable future actions are not expected to result in significant cumulative adverse impacts on biological resources.

Impacts to commercial and recreational fishing and shellfish harvesting from implementation of the TSP are expected to be minor and temporary with no long-term adverse effects anticipated. While the proposed new work dredging, open-water thin-layer placement for future maintenance material, beneficial use placement of new work material for restoring the relic shell mined areas, and placement at the ODMDS and the SIBUA may be a temporary inconvenience to commercial and recreational fishermen during construction, it is not expected to have any long-term adverse effects on fishing activities or fishery resources in the area. Beneficial use of dredged material may improve habitat important for sustaining fishery resources. Widening and deepening the channel also would result in improved vessel transit safety. Incremental impacts from other known and foreseeable future projects such as the I-10 project, APM Terminal expansion, and proposed NFWF restorations also are expected to have minor, temporary impacts on water quality and fishery resources. Incremental effects from implementation of the TSP would result in insignificant cumulative impact on fishery resources.

The USACE, Mobile District has determined that the proposed maintenance dredging activities associated with the Mobile Harbor Federal Navigation Project does not fall within any zones established under CBRA, therefore the CBRA considerations are not applicable.

Widening and deepening the navigation channel would result in improved vessel transit safety and efficiency. Beneficial use of dredged material by placement in the SIBUA may improve coastal resources. The proposed NFWF Salt Aire Shoreline and Little Dauphin Island restorations and the USGS/USACE joint restoration project at Dauphin Island also are expected to improve coastal resources. Incremental adverse effects on coastal barrier resources from implementation of the TSP would not occur.

6.1.1.1. Effects on Coastal Sediment Transport

Numerous studies have investigated historical shoreline changes and sediment transport in the nearshore coastal areas and along the ebb tidal delta (e.g., Hardin et al. 1976; USACE, 1978; Douglass, 1994; Otvos, 2006; Morton, 2007;, Byrnes et al. 2008 and 2010; and Flocks et al. 2017). Most of these suggested that construction and maintenance dredging in the Bar Channel have produced a deficit of sand in the littoral drift system west of the channel; however, none, with the exception of Byrnes et al. 2008 and 2010, conducted a detailed evaluation of historical dredging records for the Bar Channel or a quantitative comparison of historical shoreline and bathymetry surveys to document historical sediment transport pathways and net rates of change across the ebb shoal and along the shoreline of Dauphin Island (Byrnes et al. 2008 and 2010). As such, the focus of Byrnes et al. (2008 and 2010) was to quantitatively investigate and document ebb-shoal changes and shoreline responses relative to dredging, storms, and normal conditions/forces to determine the extent to which erosion and shoreline change could be attributed to channel construction and maintenance dredging operations (Byrnes et al. 2008 and 2010).

Byrnes et al. (2008 and 2010) concluded that, overall, net sediment transport from east-to-west between 1917-1920 and 1986-2002 has been supplying sand quantities necessary to produce net deposition on the islands and shoals of the ebb-tidal delta, infill and nourish storm breaches and washover surge channels on Dauphin Island, and promote growth of western end of the island. Based on all available information, (Byrnes et al. 2008 and 2010) concluded that there appears to be no measurable negative local impacts to ebb-tidal delta or Dauphin Island shorelines associated with historical channel dredging across the Mobile Pass Outer Bar.

Additionally, the USGS published the results of a study in late 2017 (i.e., Flocks et al. 2017) that evaluated seafloor change around Dauphin Island between the years of 1987 and 2015. The submerged environment around Dauphin Island was divided into five areas: two ebb-tidal deltas (Mobile Pass and Petit Bois Pass) at the inlets on either end of Dauphin Island; Pelican Island/shoal on the western flank of the Mobile ebb-tidal delta; the shoreface of Dauphin Island facing the Gulf of Mexico; and, the shoreface of Dauphin Island facing Mississippi Sound. Bathymetric (i.e., seafloor) change in these areas was analyzed over two time periods (1987 – 2006 and 2006 – 2015) and compared to the overall long-term (1987 – 2015). The 1987 – 2006 period corresponds to a period of frequent and intense storm impacts with 12 tropical storms passing near the island, 4 of them severe. The years 2006 – 2015 corresponds to a less-stormier period with only two tropical storms impacting the areas during that time. Results of this analysis indicate the most erosion occurs along the central and western shorefaces of Dauphin Island, both on Gulf and sound sides, with reduced net erosion occurring during the non-storm period; however, the ebb-tidal deltas at either end of the island appear to be in dynamic equilibrium, despite sediment being dredged from the navigation channel over this same time period.

Most recently, the USGS conducted coastal sediment transport modeling as part of this study to assess the relative changes in sediment pathways and morphological response on the ebb tidal shoal and adjacent coastal areas as a result of the proposed channel modifications to deepen the existing Bar Channel by 5 ft. This is documented in Section 6 and Attachment A-2, Appendix A. Simulation time periods included a 2010 wind/wave climatology as well as a 10-year long-term climatology derived from the European Centre for Medium-Range Weather Forecast (ECMWF) ERA-Interim reanalysis model over the Delft-3D hindcast period of 1988-2016. The modeling results indicate minimal differences in morphologic change in the nearshore areas of Dauphin Island and Pelican Island as a result of the proposed channel modifications. This suggests that sediment delivery away from the ebb tidal shoal to these areas is similar under these two scenarios and that shoreline positions are unlikely to be impacted as a result of the modified channel. Although comparison of the two simulations shows some spatial shifting of sand offshore of the Morgan Peninsula, the patterns of erosion/deposition in the two simulations are quite similar. Based on these results, it also appears unlikely that these changes would alter sediment delivery to the peninsula and only minor impacts to the terminal end of the peninsula closest to the channel could occur.

6.1.1.2. Effects on Estuarine Sediment Transport

Byrnes et al. (2013) “Sediment Dynamics in Mobile Bay, Alabama: Development of an Operational Sediment Budget” and Byrnes et al. (2017) “Regional Sediment Dynamics in Mobile Bay, Alabama; A Sediment Budget Perspective used bathymetric surveys for the periods 1917–1918, 1984–1987, and 2004–2011 to develop a sediment budget for assessing net changes in seafloor configuration relative to wave and current processes and engineering activities within the bay. Byrnes et al. (2013 and 2017) found despite the large volumes dredged from the bay channel the most significant changes occurring during the intervals evaluated were associated with deposition in the northern portion of the bay at the mouth of the Mobile-Tensaw Delta; deposition in the southern part of the bay resulting from current flow and sediment movement at Mobile Pass, including sand transport into Mobile Bay along the north side of Mobile Point (Morgan Peninsula); and localized erosion and deposition associated with navigation channel dredging and placement. Elsewhere in the bay, only minor deposition and erosion patterns were identified within a large estuarine system that is net depositional basin (Byrnes et. al, 2013). In addition, to Byrnes et al. (2013 and 2017), earlier studies (Isphording et al. 1989; Schroeder et al. 1998) found that while subsequent channel alterations had influenced sedimentation dynamics at and adjacent to the channel, periodic storm processes were most influential relative to bay sediment infilling and redistribution.

In addition to work documented in Byrnes et al. (2013 and 2017), field data collection and sediment transport modeling evaluating thin layer placement of dredged sediments within Mobile Bay, Gailani, J. Z., et. al (2014) were conducted as part of a regional sediment management (RSM) effort to bring lessons learned through application of RSM principles and practices for sediment and related environmental planning for the bay. These analyses concluded that despite the localized influence on sedimentation dynamics from channel dredging and dredge material placement, thin layer placement of dredged material is most similar to natural long-term depositional processes in the bay.

Most recently, ERDC conducted estuarine sediment transport modeling as part of this study, to assess relative changes in sedimentation rates within the navigation channel, dredged material placement sites, and surrounding areas as a result of channel modifications within the bay. As documented in Attachment A-1, Appendix A, results from one year (2010) model simulations with proposed channel modifications and new work placement within the bay show a minimum difference range of no greater than +/- 0.3 ft of erosion within the bay when compared to the existing condition. This in essence indicates no discernable net erosion or net deposition, as this is within the uncertainty of the sediment transport model.

6.1.2. Irreversible and Irretrievable Commitments 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.

Dredging the new work material would result in the consumption of sediment deposits and bay bottom resources in the Mobile Bay as well as fossil fuels for operation of dredging and placement equipment. A portion of the sediment would remain in the bay but would be located in the Relic Shell Mined Areas which allows to remain in the system. The bulk of the new work material will be placed in the ODMDS which would permanently remove that sediment from the Mobile Bay natural sediment system.

In general, impacts to biological resources would occur to individual organisms and small portions of populations especially benthic organisms that would be covered during placement activities. They would not constitute an irreversible commitment of resources, since the biological systems would be expected to recover. These changes could cause a long-term alteration of the bay bottom habitats for biological resources and local hydrology and currents around the project area.

6.2. Table of Compliance

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.

6.2.1. National Environmental Policy Act of 1969 (NEPA), as amended, 42 U.S.C. 4321 et seq.

The 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 Record of Decision (ROD) for the Mobile Harbor GRR/SEIS will be provided in the Final GRR/SEIS to complete 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 1980 EIS. Specifically, this SEIS evaluates the sediment dredging and placement impacts associated with the widening and deepening activities for Mobile Harbor.

6.2.2. Clean Water Act

The Federal Water Pollution Control Act of 1972, as amended, commonly called the Clean Water Act, or CWA, authorizes the EPA 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 U.S. are evaluated following guidelines implementing Section 404 of the CWA. Evaluation of the impacts associated with the placement of material related to the Mobile Harbor Federal Navigation Channel modifications will be completed. Coordination will be conducted with the ADEM to determine that elements described in the SEIS support 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, Section 401 water quality certification will be requested from the ADEM.

Modeling results have predicted that impacts to critical water quality parameters from implementation of the TSP would be minimal. Overall, impacts to existing resources associated with predicted changes in water quality from the proposed dredging and placement activities have been shown to be temporary and localized in nature and would be similar to the existing maintenance dredging operations regularly occurring within the navigation channel. Based on the limited resources within and around the navigation channel and placement sites, the overall impact to water quality and aquatic resources are considered negligible. The USACE, Mobile District will pursue the Water Quality Certification (WQC) from the ADEM as required under Section 401 of the CWA prior to completion of the final report.

6.2.3. Federal Coastal Zone Management Act (CZMA), 16 U.S.C. 1451 et seq.

The 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.

The ADEM is the lead agency for administering the state's coastal program. The USACE, Mobile District will make a determination on whether the TSP is consistent with the Alabama Coastal Program to the maximum extent practicable and following review of the SEIS, the USACE, Mobile District will request ADEM's concurrence with the USACE's determination.

6.2.4. Clean Air Act (CAA), as amended, 42U.S.C. 7401 et seq.

The CAA of 1990 is a Federal law that authorizes the EPA to regulate emissions of airborne pollutants, although the states do much of the work to implement the Act. Under this law, the EPA sets limits on how much of a pollutant can be present in an area anywhere in the U.S. 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 X. 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.

6.2.5. U.S. Fish and Wildlife Coordination Act, 16 U.S.C.661-666(c)\

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 U.S., or by any public or private agency under Federal permit or license "(16 U.S.C. § 662(a)). The USFWS submitted the initial Planning Aid Letter for the preparation of the Draft SEIS. A Fish and Wildlife Coordination Act Report (FWCAR) will be prepared during the preparation of the Final SEIS. Information received in this process will be instrumental in guiding the analysis of the TSP.

6.2.6. 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 the NOAA Fisheries, 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 will initiate formal consultation with both the USFWS and the NOAA Fisheries . Based on the assessments in this report, the USACE, Mobile District finds that the proposed modification activity is not likely to adversely affect any listed endangered and/or threatened species or their associated critical habitat. The USACE has initiated consultation with the USFWS under Section 7 coordination of the Endangered Species Act.

Magnuson-Stevens Fishery Conservation and Management Act (MSA), 16 U.S.C.1801 et seq.

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)
- 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 potential impacts on fish species and associated essential habitats are evaluated in this SEIS. The proposed TSP complies with the Act.

6.2.7. Anadromous Fish Conservation Act, 16 U.S.C. 757, et seq.

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 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.

6.2.8. Marine Mammal Protection Act (MMPA), 16 USC 1631 et seq.

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 the potential impacts to marine mammals resulting from the TSP and protective measures to offset the potential impacts are considered. Agency consultation addressing marine mammals included discussions with both the USFWS and the 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.

6.2.9. Section 106 and 110(f) of the National Historic Preservation Act (NHPA), 54 U.S.C. 300101 et seq.

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 U.S. According to EO 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 Alabama SHPO has been initiated concerning the specific aspects of the TSP.

6.2.10. 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 by the EPA under the MPRSA for dredged material. The EPA 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 dredged material placement permit conditions.

The TSP includes the dredging and placement of material for Mobile Harbor Federal Navigation Channel modifications. Sediment 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. Some placed material will be for beneficial-use purposes and therefore, not governed by MPRSA but rather the CWA.

6.2.11. EO 13112, Invasive Species

This EO 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. The TSP would not promote invasive species and would comply with this EO.

6.2.12. EO 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations

This EJ Policy, based on EO 12898 of 1994, requires agencies to incorporate into the NEPA documents an analysis of the environmental effects of their proposed programs on minorities and low-income populations and communities. Environmental Justice is defined by the EPA 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. Based on this evaluation, the USACE has determined that the TSP addresses EO 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations.*

6.2.13. EO 13045, Protection of Children from Environmental Health Risks and Safety Risks

On April 21, 1997, President Clinton issued EO 13045, *Protection of Children from Environmental Health Risks and Safety Risks.* This EO 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. Based on this evaluation, the USACE has determined that the TSP addresses EO 13045, *Protection of Children from Environmental Health Risks and Safety Risks.*

6.2.14. Migratory Bird Treaty Act, 16 U.S.C. 703 et seq.; EO 13186, Responsibilities of Federal Agencies to Protect Migratory Birds

The Migratory Bird Treaty Act (MBTA) of 1918 established Federal responsibilities to protect birds migrating between the U.S. 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 U.S., their eggs, and their nests are protected. There are 836 bird species protected by the MBTA in the U.S., 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. The TSP is in compliance with the Act.

6.2.15. 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 channel improvements would obstruct navigation.

6.2.16. 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 U.S. 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).

6.1. Public Involvement

6.1.1. Public Involvement Management Strategy

The Public Involvement Management Strategy (PIMS) developed for the Mobile Harbor study outlines the outreach strategy to engage the project stakeholders in the planning process. The strategy includes opportunities for the USACE to share information with the public and for the public to provide input on project components. Involving the public in the process helps to ensure that the study's work and products reflect the realities in the watershed while also providing outcomes that are measurable, understood, and beneficial. The PIMS identifies tools and activities such as publications, web pages, public meetings, and public notices etc. that the Corps and the NFS use to communicate with the general public and stakeholders as the project moves through the SEIS process.

The public involvement management strategy was last updated March 8, 2017 and can be found on the Mobile Harbor Website on the following link:

http://www.sam.usace.army.mil/Missions/Program-and-Project-Management/Civil-Projects/Mobile-Harbor-GRR/Mobile-Harbor-GRR-Downloads/

The website also contains project updates, quarterly newsletters, and a public document library that includes the scoping report, the project review plan, past Mobile Ship Channel records, and slides presented at the public meeting.

6.1.2. Table of Compliance

Relationship of the Proposed Action to Federal Laws and Policies		
Title of Public Law	**U.S. Code**	**Compliance Status**
National Environmental Policy Act of 1969 (NEPA), as amended	42 U.S.C. 4321 *et seq*.	Compliant: Draft SEIS complete
Clean Water Act	33 U.S.C. § 1341	Compliant
Federal Coastal Zone Management Act (CZMA),	16 U.S.C. 1451 et seq.	Compliant
Clean Air Act (CAA), as amended	42U.S.C. 7401 *et seq.*	Compliant
U.S. Fish and Wildlife Coordination Act	16 U.S.C.661-666(c)	Compliant: Received Planning Aid Letter from USFWS.
Endangered Species Act (ESA) of 1973	16 U.S.C. § 1531–1543	Compliant: Section 7 coordination in the progress.
Magnuson-Stevens Fishery Conservation and Management Act (MSA)	16 U.S.C.1801 *et seq*.	Compliant: EFH coordination in progress.
Anadromous Fish Conservation Act	16 U.S.C. 757, *et seq.*	N/A
Marine Mammal Protection Act (MMPA)	16 USC 1631 et seq.	Compliant
National Historic Preservation Act (NHPA) Section 106 and 110(f)	16 U.S.C. 470 *et seq.*	Compliant: Will be conducting cultural resources surveys and coordinating with SHPO
Marine Protection, Research and Sanctuaries Act (MPRSA)	33 USC 1401	Compliant
Estuary Protection Act of 1968	16 U.S.C. §1221–1226; P.L. 90-454; 82 Stat 625	Compliant
Section 10 of the Rivers and Harbors Act of 1899	33 U.S.C. § 407	Compliant

Relationship of the Proposed Action to Federal Laws and Policies		
Title of Public Law	**U.S. Code**	**Compliance Status**
Migratory Bird Treaty Act	16 U.S.C. 703 *et seq*.; EO 13186	Compliant
Sunken Military Craft Act (SMCA) October 28, 2004		Partially CompliantCompliant: Appropriate consultation will be completed prior to final report.
Floodplain Management	EO 11988	N/A
Protection of Wetlands	EO 11990	CompliantCompliant: Conducted wetland impact assessment.
Invasive Species	EO 13112	Compliant
Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations	EO 12898	Partially Compliant: Initial determination that project would not have disproportionately high and adverse impacts to any communities, including environmental justice communities or children.
Protection of Children from Environmental Health Risks and Safety Risks	EO 13045	Partially Compliant: Initial determination that project would not have disproportionately high and adverse impacts to any communities, including environmental justice communities or children.

6.1.3. Scoping Meeting

A public scoping meeting was held in downtown Mobile, Alabama on Tuesday, January 12, 2016 to introduce the preparation of the Mobile Harbor study for evaluating the deepening and widening of Mobile Harbor, including the preparation of the SEIS. The scoping report and associated comments can be found on the Mobile Harbor Website in the document library.

6.1.4. General Public Meetings

To date, three general public meetings have been held (March 16, 2017, September 14, 2017, and February 22, 2018). Two of the general public meetings were in an open house format, and one was in the town-hall format. The meeting locations were in downtown Mobile, South Mobile County, and Daphne, Alabama on the eastern shore of Mobile Bay. The slides/information boards presented at these meetings can be found on the Mobile Harbor website in the document library.

6.1.5. Focus Group Meetings

Focus group meetings have been held throughout the study process. Focus groups have included Seafood interests and commercial fisherman, environmental non-governmental organizations, Dauphin Island property owners and interests, and Environmental Justice communities. The focus group meetings were as follows:

Focus Group Meetings	
Aug 09, 2016 – Meeting with Dauphin Island Interests in Mobile District Office	Sep 28, 2017 – Focus Group Meeting in Africatown
Feb 10, 2017 – Col. DeLapp Meeting with Audubon Society, Mobile District Office	Dec 08, 2017 –Eastern Shore Commercial Seafood Interests, Bon Secour
Mar 01, 2017 – Col. DeLapp Meeting with Mobile Baykeepers, Mobile District Office	Dec 12, 2017 – Meeting with Dauphin Island Property Owners and Interests, Mobile District Office
Apr 20, 2017 – Attended Propeller Club Meeting, Battle House Conference Room	Dec 13, 2017 – Local Environmental NGO's, Mobile District Office
May 11, 2017 – Meeting at Dauphin Island between Col. DeLapp, DI Mayor and property owners	Jan 18, 2018 – Recreational Sportsmen Interests, ASPA Office
May 18, 2017 – Attended Partners for Environmental Progress Meeting	Mar 16, 2018 – Meeting with DIPOA Boards Members and Engineering reps, ASPA Office
Jun 14, 2017 – Col DeLapp presentation at Coastal Business and Environmental Issues, Dauphin Island	Jun 05, 2018 – Meeting with Maysvillle Community, Maysville
Jul 12, 2017 – Meeting with Crabbers and Fishmongers, Bayou La Batre	Jun 25, 2018 – Ecumenical Ministries, Mobile
Jul 19, 2017 – Sierra Club, NEPA compliance Concerns for the SEIS, Mobile District	Jun 25, 2018 – Meeting with Down the Bay Community, Mobile
Aug 17-18, 2017 – Focus Group Meeting, South Mobile County Commercial Fishing Interests, Bayou La Batre	

6.1.6. Agency Coordination

The Mobile Harbor PDT has been actively engaged with the cooperating agencies and has hosted a number of meetings with the agency team. The meetings were part of the ongoing agency scoping activities for the Mobile Harbor GRR/ SEIS. The purpose of the meetings were to inform the agencies on the progress of the study, obtain comments and information regarding natural resources of concern, and beneficial use opportunities. The meetings also briefed them on the selected channel dimensions for deepening and widening and presented and discussed results from the modeling efforts and aquatic resources impact assessments. The cooperating agencies involved in this process included:

- ASPA
- Alabama Dept. of Environmental Management (ADEM), Mobile Field Office
- ADEM, Water Quality Branch
- ADCNR, MRD
- GSA
- USFWS
- NMFS, Habitat Conservation Division (HCD)
- EPA, Region 4
- MBNEP
- USGS

Meetings were held on the following dates:

3 March 2016
5 May 2016
22 September 2016
26 January 2017
2 February 2017
13 September 2017
15 February 2018

A Memorandum for Record (MFR) for each meeting is included in Attachment C-6, Appendix C.

6.1.7. Comments Received and Response

All public comments received through the public involvement process and where their general concern is addressed in this report can be found in Appendix E.

6.2. List of Preparers

The PDT for the Mobile Harbor GRR was extensive. The PDT members listed below provided substantial text to the Draft GRR/SEIS.

Name (First Last)	Affiliation
David Newell	Project Manager, Civil Works Programs and Project Management Branch, Mobile District
Joe Paine	Plan Formulator, Plan Formulation Branch, Mobile District
Justin McDonald	Senior Engineering Technical Lead for Civil Works, Water Resources Branch, Mobile District
John Bass	Geotechnical Engineer, Geotechnical, Environmental, & HTRW Branch, Mobile District
Elizabeth Godsey	Lead Coastal Engineer, Hydrology and Hydraulics Branch, Mobile District
Julie McGuire	Economist, Deep Draft Navigation Planning Center of Expertise (DDNPCX)
Larry Parson	Environmental Planner, Environmental Resources Branch, Mobile DIstrict
Rita Perkins	Cost Engineer, Technical Support Branch, Mobile District
Angelia Lewis	Environmental Planner, Environmental Resources Branch, Mobile DIstrict
Ashley Kleinschrodt	Operations Manager, Operations Management Branch, Mobile District
Richard Allen	Coastal Engineer, Hydrology and Hydraulics Branch, Mobile District
Russell Blount	Realty Specialist, Acquisition Branch, Mobile District
Allen Wilson	Archeologist, Environmental Resources Branch, Mobile District
Jennifer Winter	Archeologist, Environmental Resources Branch, Mobile District
Bobbie Hurley	Cumulative Impacts, Air, Noise, Environmental Justice, AECOM

SECTION 7.0 RECOMMENDATION

This Draft GRR/SEIS presents the TSP of modifications to the Mobile Harbor Federal Navigation Channel for public, agency, policy and independent external peer review. Based on the comments received, updates to the report will be made and an agency decision will be reached on the Recommended Plan. The Recommended plan will be presented in the Final GRR/SEIS scheduled for release in summer 2019.

Upon consideration to all significant aspects in the overall public interest, including environmental, social, and economic effects; and engineering feasibility; the TSP consists of the following:

- Deepen the existing Bar, Bay (including the Choctaw Pass Turning Basin), and River Channels (south of station 226+16) by 5 ft to project depths of 52, 50, and 50 ft, respectively, with an additional 2 ft for advanced maintenance plus 2 ft of allowable overdepth for dredging (total depths of 56, 54, and 54 ft, respectively).
- Incorporate minor bend easings at the double bends (at stations 1857+00 and 1775+26) in the Bar Channel approach to the Bay Channel.
- Widen the Bay Channel from 400 ft to 500 ft from the mouth of Mobile Bay northward for 3 nautical miles to provide a two-way traffic area for passing.
- Expand the Choctaw Pass Turning Basin 250 ft to the south (at a depth of 50 ft) to better accommodate safe turning of the design vessel and other large vessels.

Figures Figure 4-1 thru Figure 4-5 provide key information and illustrate the general locations of the most important project features.

The TSP conforms to the essential elements of the U.S. Water Resources Council's Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies and complies with other Administration and legislative policies and guidelines on project development. If the project were to receive funds for Federal implementation, it would be implemented subject to the cost sharing, financing, and other applicable requirements of Federal law and policy for navigation projects including WRDA 1986, as amended. Aids to navigation are to be funded by the U.S. Coast Guard. Federal implementation is contingent upon the NFS agreeing to comply with applicable Federal laws and policies. Prior to implementation, the NFS shall agree to:

a. Provide, during the periods of design and construction, funds necessary to make its total contribution for commercial navigation equal to 25 percent of the cost of design and construction of the GNFs.

b. Provide all LERRs, and perform or assure the performance of all relocations, including utility relocations, all as determined by the Federal Government to be necessary for the construction or operation and maintenance of the GNFs.

c. Pay with interest, over a period not to exceed 30 years following completion of the period of construction of the GNFs, an additional amount equal to 10 percent of the total cost of construction of the GNFs less the amount of credit afforded by the Government for the value of the LERR as provided by the NFS for the GNFs. If the amount of credit afforded by the Government for the value of LERR, and relocations, including utility relocations, provided by the NFS equals or exceeds 10 percent of the total cost of construction of the GNFs, the NFS shall not be required to make any contribution under this paragraph, nor shall it be entitled to any refund for the value of LERR and relocations, including utility relocations, in excess of 10 percent of the total cost of construction of the GNFs.

d. Provide, operate, and maintain, at no cost to the Government, the local service facilities in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and state laws and regulations and any specific directions prescribed by the Federal Government.

f. Give the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon property that the NFS owns or controls for access to the project for the purpose of completing, inspecting, operating and maintaining the GNFs.

g. Hold and save the U.S. free from all damages arising from the construction or operation and maintenance of the project, any betterments, and the local service facilities, except for damages due to the fault or negligence of the U.S. or its contractors.

h. Keep, and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project, for a minimum of 3 years after completion of the accounting for which such books, records, documents, and other evidence are required, to the extent and in such detail as will properly reflect total cost of the project, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and local governments at 32 CFR, Section 33.20.

i. Perform, or ensure performance of, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 USC 9601–9675, that may exist in, on, or under LERR that the Federal Government determines to be necessary for the construction or operation and maintenance of the GNFs; however, for lands, easements, or rights-of-way that the Government determines to be subject to the navigation servitude, only the Government shall perform such investigations unless the Federal Government provides the NFS with prior specific written direction, in which case the NFS shall perform such investigations in accordance with such written direction.

j. Assume complete financial responsibility, as between the Federal Government and the NFS, for all necessary cleanup and response costs of any hazardous substances regulated under CERCLA that are located in, on, or under LERR that the Federal Government determines to be necessary for the construction or operation and maintenance of the project.

k. Agree, as between the Federal Government and the NFS, that the NFS shall be considered the operator of the local service facilities for the purpose of CERCLA liability.

l. To the maximum extent practicable, perform its obligations in a manner that will not cause liability to arise under CERCLA.

m. Comply with Section 221 of PL 91-611, Flood Control Act of 1970, as amended, (42 U.S.C. 1962d-5b) and Section 101(e) of the WRDA 86, PL 99-662, as amended, (33 U.S.C.2211(e)) which provide that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until the NFS has entered into a written agreement to furnish its required cooperation for the project or separable element.

n. Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, PL 91-646, as amended, (42 U.S.C. 4601-4655) and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way necessary for construction, operation, and maintenance of the project including those necessary for relocations, the borrowing of material, or the placement of dredged or excavated material; and inform all affected persons of applicable benefits, policies, and procedures in connection with said act.

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

p. Provide the NFS share of that portion of the costs of mitigation and data recovery activities associated with historic preservation, that are in excess of 1 percent of the total amount authorized to be appropriated for the project.

q. Not use funds from other Federal programs, including any non-Federal contribution required as a matching share therefore, to meet any of the NFS's obligations for the project unless the Federal agency providing the Federal portion of such funds verifies in writing that such funds are authorized to be used to carry out the project.

The TSP contained herein reflects the information available at this time and current departmental policies governing formulation of individual projects. It does not reflect program and budgeting priorities inherent in the formulation of a national civil works construction program or the perspective of higher review levels within the executive branch.