APPENDIX C

ENVIRONMENTAL

FINAL REPORT

MOBILE HARBOR, MOBILE, ALABAMA

Integrated Final General Reevaluation Report
With Supplemental Environmental Impact Statement

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SECTION 1. INTRODUCTION

The Mobile Harbor Draft General Re-evaluation Report with Integrated Supplemental Environmental Impact Statement (Draft GRR/SEIS) characterizes the affected environment of the overall Recommended Plan (RP) project area. The information in this Appendix, is incorporated by reference into the Main Draft GRR/SEIS Report. Section 2 addresses the existing conditions of the projects area of influence and the areas included in the Recommended Plan (RP), specifically the geographic setting, biological, physical, chemical conditions, and socioeconomic conditions. Section 3 addresses the environmental consequences of the implementation of the RP as compared to the existing conditions. Section 4 provides a detailed discussion of the cumulative impacts as required under National Environmental Policy Act (NEPA), as implemented by Council on Environmental Quality (CEQ) regulations (40 Code of Federal Regulations [CFR] §§ 1500 -1508)

SECTION 2. AFFECTED ENVIRONMENT – INTRODUCTION

This Environmental Appendix 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. This information will be used to assess potential impacts resulting from the implementation of the RP as described in Section 4.1 of the GRR/SEIS Report. A comparative assessment of the alternatives and their potential environmental impacts is provided in Section 3 of this Appendix. A description of the project area can be found in Section 2.4.2 of the GRR/SEIS Report and Section 1.1 of Appendix A.

2.1. Geographic Setting

Coastal Alabama extends approximately 47 miles from about 87°30’ longitude at Perdido Pass to about 88°25’ longitude at Petit Bois Pass. About 47 miles of sandy shoreline along the open Gulf at about 30°15’ latitude (Byrnes et al., 2010) encompasses the southern portions of Mobile and Baldwin Counties (**Figure 2-1**). Byrnes et al. (2010) describes the Mobile Bay estuary as a bell-shaped, submerged river valley system approximately 31 miles from the mouth of the Bay extending northward to the Mobile River, and 23 miles wide from the Mississippi Sound across through Bon Secour Bay (Hummell, 1996). It receives water and sediment from the Mobile-Tensaw River system, the nation’s fourth largest river system relative to discharge and sixth largest in term of total drainage area (Isphording and Flowers, 1987), and it has an average width of 13 miles. The bay encompasses about 413 square miles of open water (Isphording et al. 1996) and has an average depth of about 9.7 feet (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 (Byrnes et al., 2010) as illustrated in (**Figure 2-2**). 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 Ship Channel) and the Gulf of Mexico. The entrance is about 3 miles wide. The east-west Gulf Intracoastal Waterway intersects the Mobile Ship Channel just inside the entrance to the bay. The waterway 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 is an estuary which serves as a transition zone where the freshwater from the rivers mixes with the tidally-influenced saltwater of the Gulf of Mexico. 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 Environmental Protection Agency (EPA). The outflow of the Mobile River into Mobile Bay has created the second largest intact river delta system in the nation (Mobile Bay National Estuary Program, 2008). The Mobile Bay and the Mobile-Tensaw river delta supports a diverse set of fish and wildlife habitats including: bogs, bottomland hardwoods, freshwater and hardwood swamps, freshwater wetlands, maritime forests, pine savanna, submerged aquatic vegetation (SAV), tidal and brackish water marshes and oyster reefs.

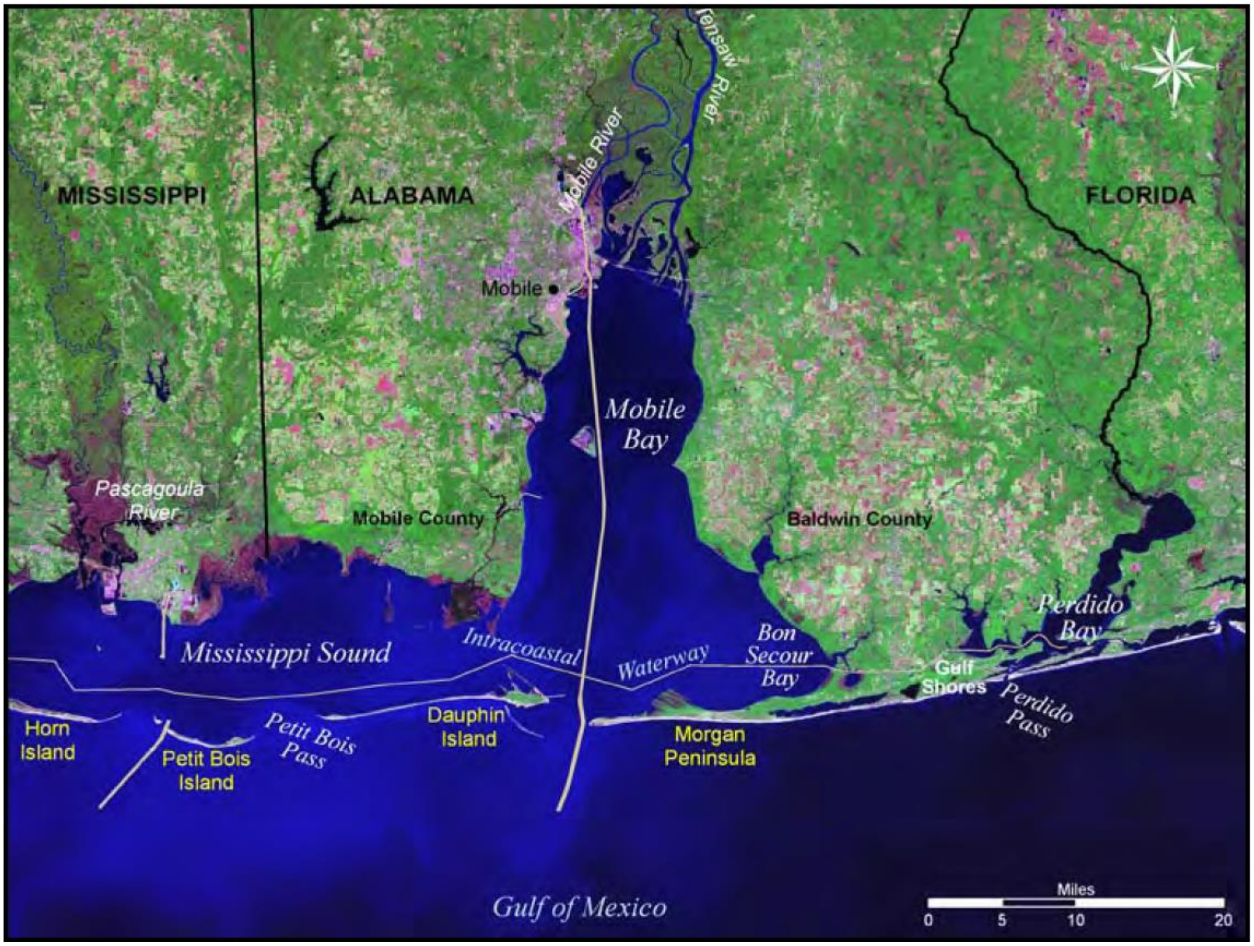
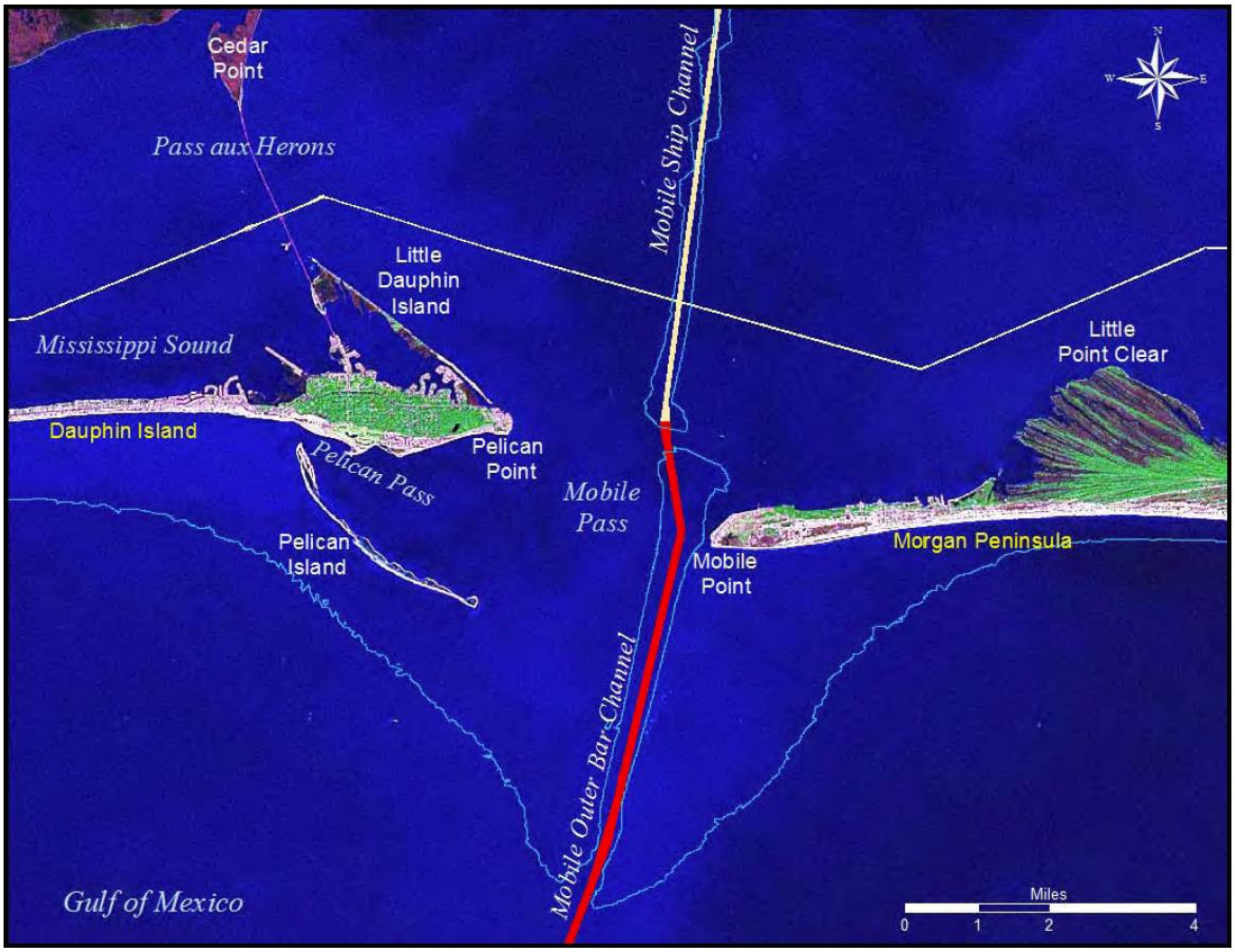


Figure 2-1. Features of Coastal Alabama (Byrnes et al. 2010)

Mobile Bay is about 413 square miles in area and 31 miles long with a maximum width of 24 miles. The deepest area, approximately 75 ft occurs within the navigation channel with an average depth around 10 ft. Mobile Bay is considered the sixth largest watershed in the U.S. and the fourth largest in terms of stream-flow (**Figure 2-3**). Water from three-fourths of Alabama and areas of Georgia, Tennessee and Mississippi flow into Mobile Bay. The Mobile and Tensaw Rivers flow into the northern end of the bay with smaller rivers such as Dog River, Deer River, and Fowl River enter on the western side of the bay. Fish River enters the bay on the eastern side of the 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.

Watershed. Byrnes et al. (2010) characterized the watershed as supplying Mobile Bay with water and sediment from an area about 43,200 square miles and with an average discharge through the Mobile-Tensaw River system of about 62,000 cubic ft per second (cfs). On an annual basis, this water carries approximately 3.58 million tons of suspended sediment from the Mobile River delta into Mobile Bay, composed almost entirely of silt and clay (Isphording and Imsand, 1991). About 0.61 million tons/year of sand and coarser fluvial sediment are retained at



The 30-foot depth contour defines the seaward extent of the ebb-tidal shoal (Byrnes et al. 2010)

Figure 2-2. Mobile Pass and adjacent environments

the head of the Mobile River Delta and in the main river channels. Two outlets from Mobile Bay provide discharge points for fluvial water and sediment from the watershed which includes Mobile Pass, discharging about 84 percent of the outflow; and Pass aux Herons discharging approximately 16 percent of flow into Mississippi Sound (Isphording et al. 1996). Of the sediment not retained in the bay, Isphording et al. (1996) estimates that 0.94 million tons/year is transported to the Gulf of Mexico and 0.18 million tons/year to Mississippi Sound.

<u>Mobile-Tensaw River Delta</u>. 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 Delta and transported into Mobile Bay reflects varying lithologies throughout the Mobile Bay watershed. The Mobile-Tensaw 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 300 square miles. Ecosystems include approximately 31 square miles of open water, 15 square miles of marsh, more than 114 square miles of swamp, and more than 140 square miles of bottomland forest (Johnson et al., 2002).

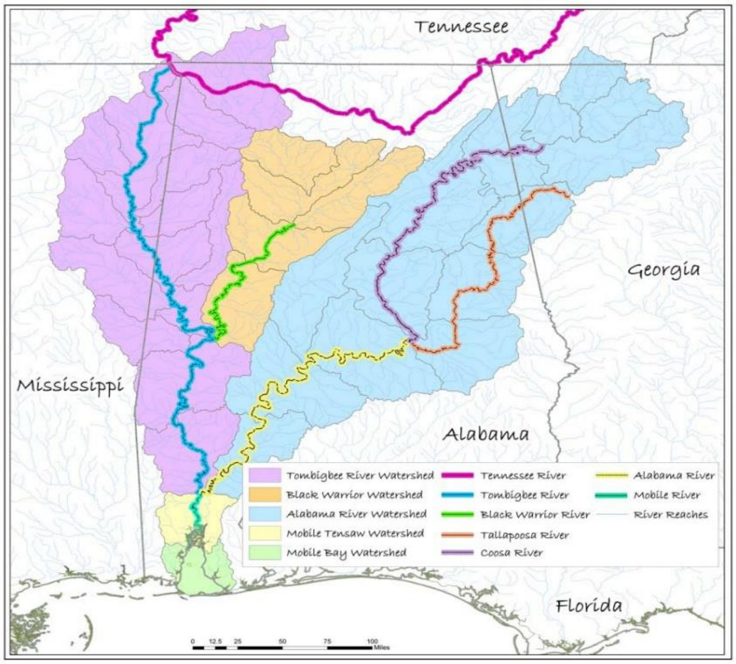


Figure 2-3. Mobile Bay Watershed Area

The Mobile Bay watershed drains through the Alabama and Tombigbee Rivers to the head of the Mobile-Tensaw Delta where they form the Mobile River as shown in **Figure 2-4**. Uplands flanking the delta drain approximately 345 square miles and 442 square miles on east and west sides, respectively (Isphording et al., 1996). The Mobile River flows about 5.6 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, Appalachee, and Blakeley Rivers (**Figure 2-4**).

<u>Gulf Beaches</u>. As described by Byrnes et al. (2010), Dauphin Island is the westernmost beach environment in coastal Alabama. Approximately 15 miles long, it extends from the Main Pass at the Mobile Bay entrance to Petit Bois Pass (see **Figure 2-2**). 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).

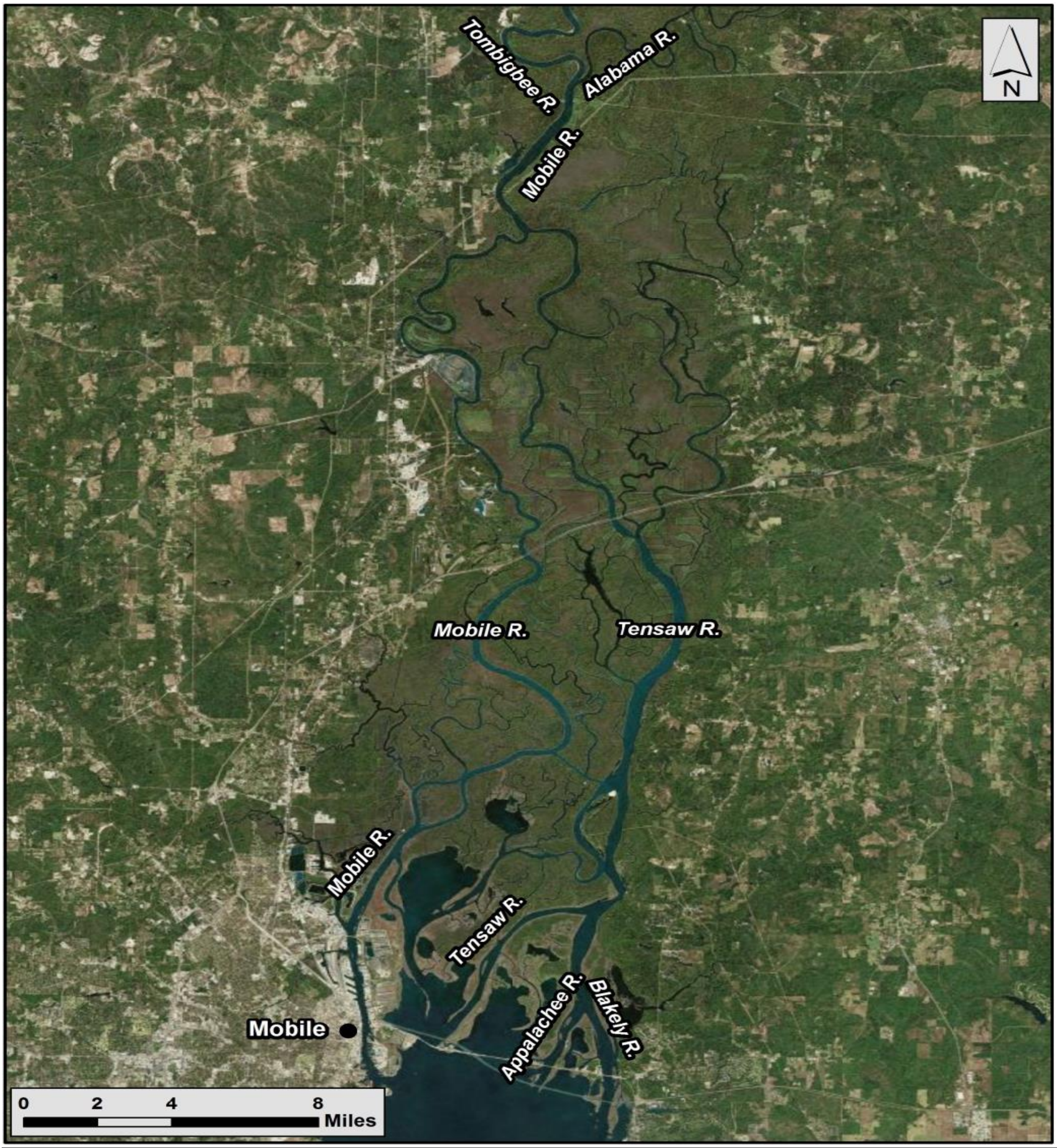


Figure 2-4. Mobile-Tensaw River Delta between the confluence of the Alabama and Tombigbee Rivers and the northern margin of Mobile Bay (Byrnes et al. 2013)

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 approximately 30 miles from Mobile Point, at the eastern margin of Mobile Pass, along the Morgan Peninsula east to Perdido Pass (**Figure 2-2**). 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).

In recent years, the Alabama coastline has undergone substantial modifications due to beachfront development, existing hard shoreline defense structures, beach nourishment, and tropical weather events (MBNEP, 2008).

2.2. 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 (^{o}F), 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 2-1**.

2.2.1. 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 eastsouth east during spring and summer months, and from the north northeast during fall and winter months. The strongest winds are recorded in February and March with the exception of frontal storms and tropical systems.

Table 2-1. Climatic 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 (F)	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 (F)	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.

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 eastsouth east during spring and summer months, and from the north northeast 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 are readily available from the United States 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 Mobile District for some coastal and navigation channel investigation design tasks. Wind data presented here are presented as a graphical representation of the wind regime in the area. Wind data for Mobile are shown in **Figure 2-5**. Wind rose data at this site show that wind speeds rarely exceed 25 knots.

2.2.2. 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. As seen in Figure 2-6 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 delta. A more detailed discussion of the area tides is located in Section 2.4 of Appendix A.

2.2.3. Waves

In general, wave intensity along coastal Alabama is low to moderate. The common wave direction is out of the southeast between 112.5 and 180 degrees as indicated by **Figure 2-7**. The most common peak wave periods fall between 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. The overall mean significant wave height is 2 ft.

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, indicates 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.

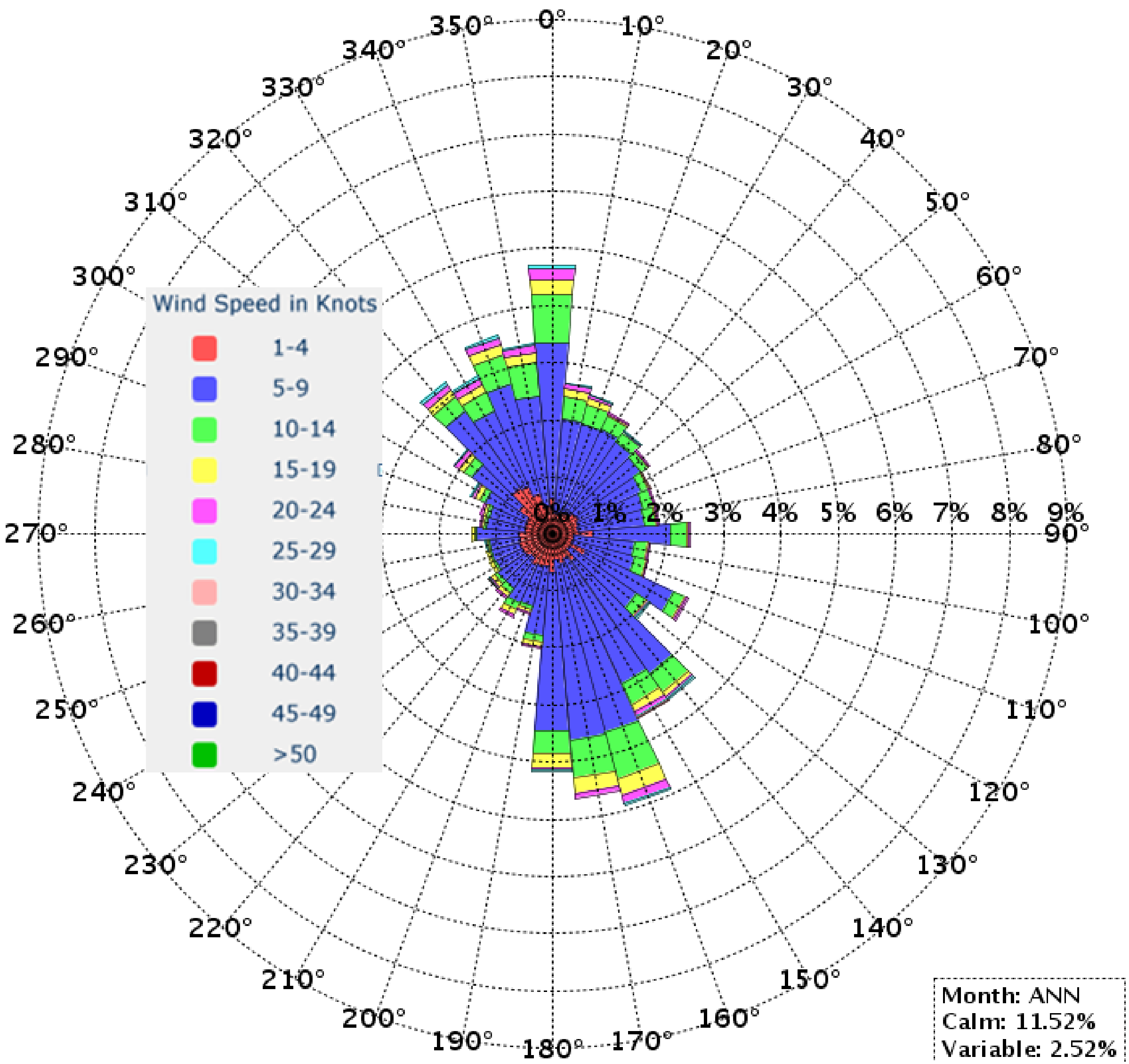


Figure 2-5. Wind Rose, Brookley Field, Mobile, Alabama.

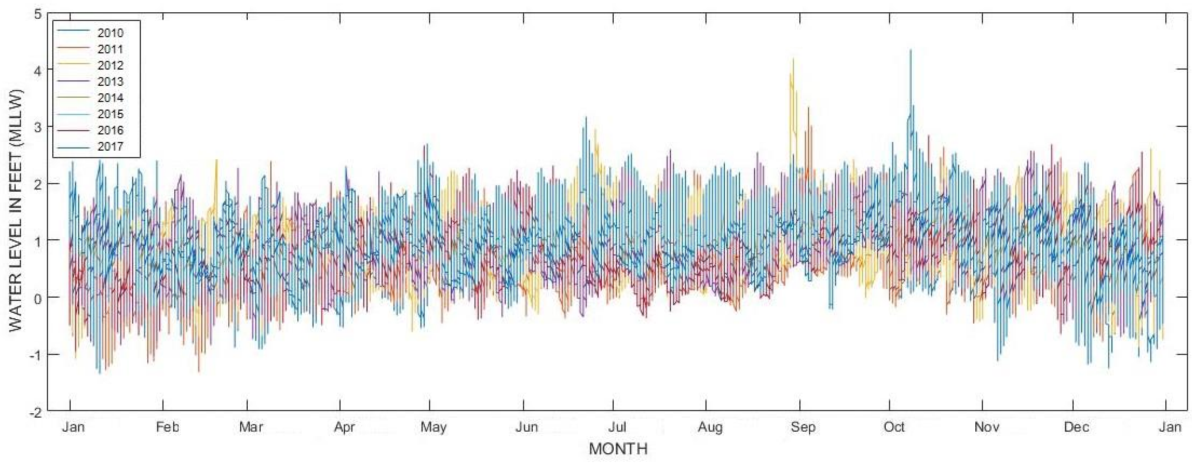


Figure 2-6. Hourly Water Levels 2010-2017, 0835180 Dauphin Island, AL

2.2.3.1. Vessel Generated Waves (Ship Wake)

A vessel generated wave energy (VGWE) assessment was conducted to quantify the relative changes in wave energy due to future vessels calling the port. The investigation included field data collection using a suite of 5 pressure sensors located north of Gaillard Island and a validation deployment using similar techniques in the southern part of the bay. 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 collected for this study proved to be valid when used for general trending.

VGWE representing current conditions were measured for 327 vessel transits collected during November 2017 through January 2018. Measurements were collected for vessels greater than 394 ft in length at 5 stations in Mobile Bay north of Gaillard Island. The Average VGWE represented as the statistically significant wave height, Hmo, for all sites ranged between 0.02 ft to 0.15 ft with the highest values being closer to the ship 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 D in Appendix A.

2.2.4. 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;

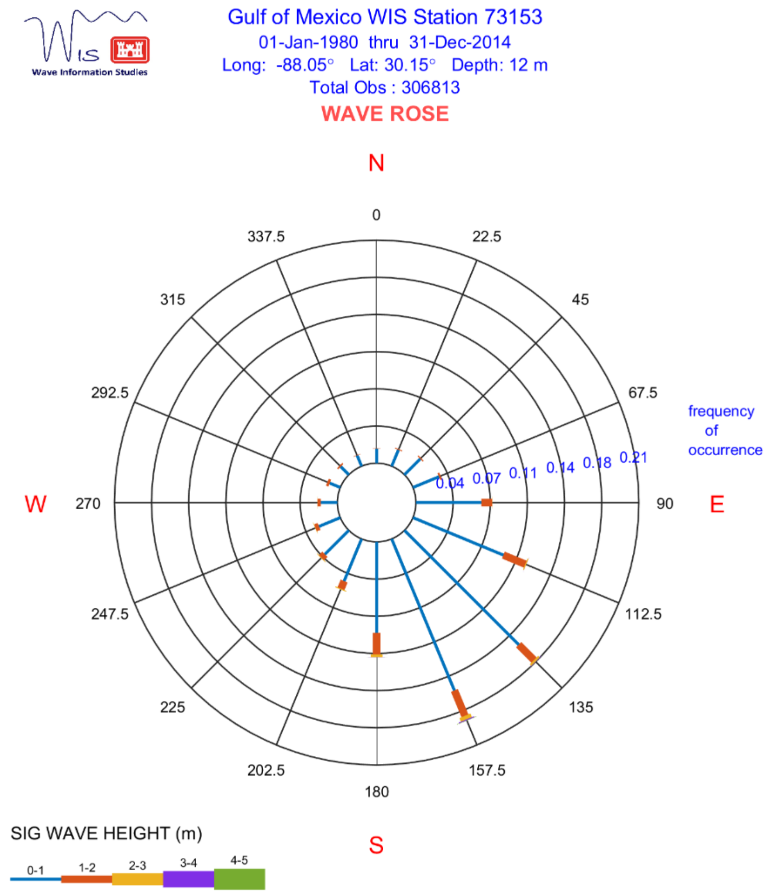


Figure 2-7. Wave Rose, WIS Station 73153

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 entrance channel of about 5 ft/sec (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 (Figures 4 and 5). 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 a100-year 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.

2.2.5. 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 °F or higher about 70 days per year; temperatures in excess of 100 °F occur occasionally (U.S. Navy, 1986).

According to the ClimaTemps.com (http://www.mobile.climatemps.com/temperatures.php) (2015), the mean annual temperature in Mobile 67.5°F (degrees Fahrenheit). 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**.

Table 2-2. Average Temperatures Table for Mobile, Alabama (from ClimaTemps.com)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max Temperature °C (°F)	15.4 (59.7)	17.6 (63.7)	21.6 (70.9)	25.8 (78.4)	29.2 (84.6)	32.2 (90)	32.9 (91.2)	32.5 (90.5)	30.5 (86.9)	26.4 (79.5)	21.3 (70.3)	17.2 (63)	25.2 (77.4)
Average Temperature °C (°F)	9.9 (49.8)	11.8 (53.2)	15.8 (60.4)	19.9 (67.8)	23.6 (74.5)	26.9 (80.4)	27.9 (82.2)	27.7 (81.9)	25.5 (77.9)	20.2 (68.4)	15.4 (59.7)	11.7 (53.1)	19.7 (67.5)
Average Min Temperature °C (°F)	4.4 (39.9)	5.9 (42.6)	10.1 (50.2)	13.9 (57)	18 (64.4)	21.5 (70.7)	22.9 (73.2)	22.7 (72.9)	20.4 (68.7)	14.1 (57.4)	9.5 (49.1)	6.2 (43.2)	14.1 (57.4)

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.

2.2.6. 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).

2.2.7. Sediment Transport

2.2.7.1. Riverine

Seven major rivers supply water and sediment to the Mobile-Tensaw River system that ultimately empties into the Mobile-Tensaw Delta and Mobile Bay. Based on 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. Twenty-five percent of this sediment deposits as delta fill (1.2 mt/yr), resulting in an average discharge of about 3.58 million tons 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 4.9 of Appendix A, maintenance dredged material quantity, roughly 1.3 mcy per year is deposited and dredged from the lower Mobile River Channel annually.

2.2.7.2. 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 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 (Fort 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 percent transported from the Bay through Pass aux Herons and Mobile Pass 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 2994; 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 on sediment re-suspension in those areas. In estimating suspended sediment concentration (SSC) 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 of ISS was primarily 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 mulit-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 dredged material within the bay and that the majority of the contribution was from the simulated hurricane events.

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 which was 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 minimum difference range of no greater than 0.3 ft of erosion when compared to the existing conditions and indicates no discernable net erosion or net deposition. Additional details of the estuarine sediment transport modeling effort are provided in Section 6.3.1 of Appendix A.

2.2.7.3. Coastal/Ebb Tidal Delta

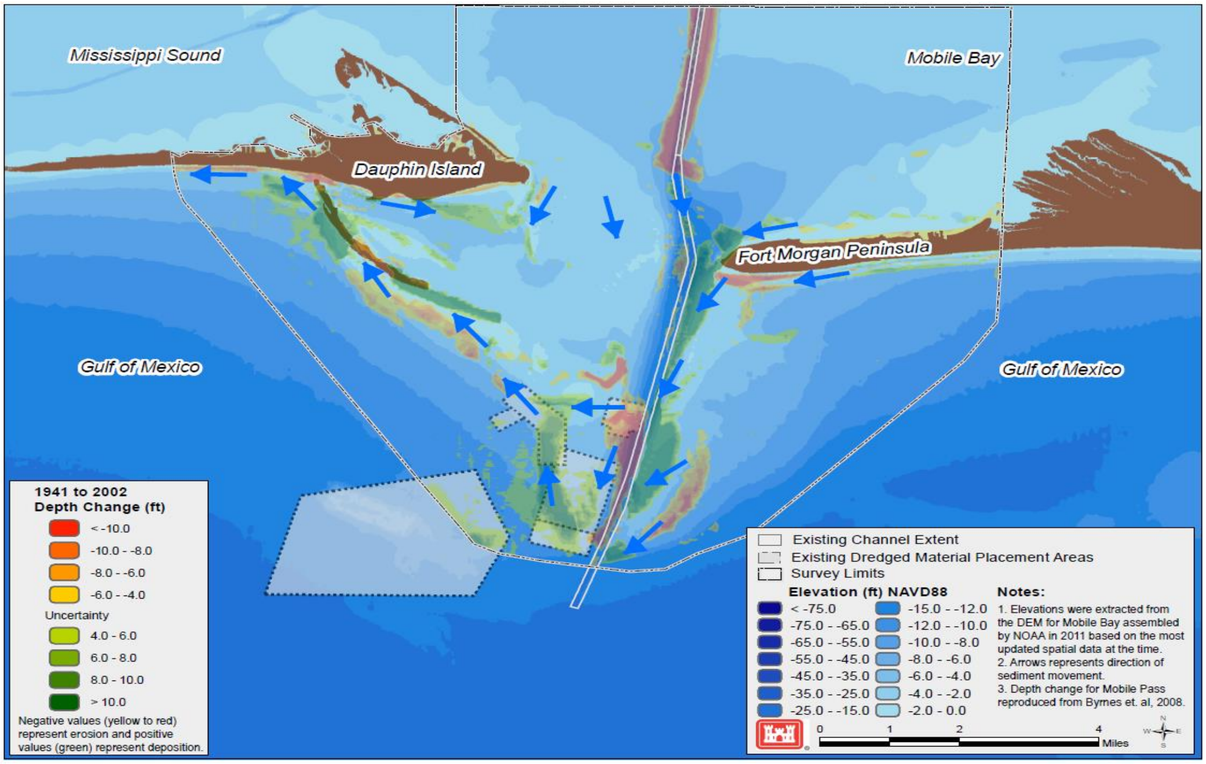
The analysis of multi-decadal seafloor change of the western ebb tidal shoal and the nearshore area around Dauphin Island, Alabama during periods of intense and non-intense tropical storms are documented in Flocks, J.G. et. al (2017) "Analysis of Seafloor Change around Dauphin Island, Alabama, 1987–2015." 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 (1847/48 to 1917/20) and another representing conditions after significant changes to the outer Bar Channel were made (1917/ to 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 demonstrated **Figure 2-8** and **Figure 2-9**. 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.

2.2.8. 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 coasts, referred to as “subsidence,” which becomes an additional factor in the relationship between the land’s elevation over time and changing sea levels. Because the coast of Alabama 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.

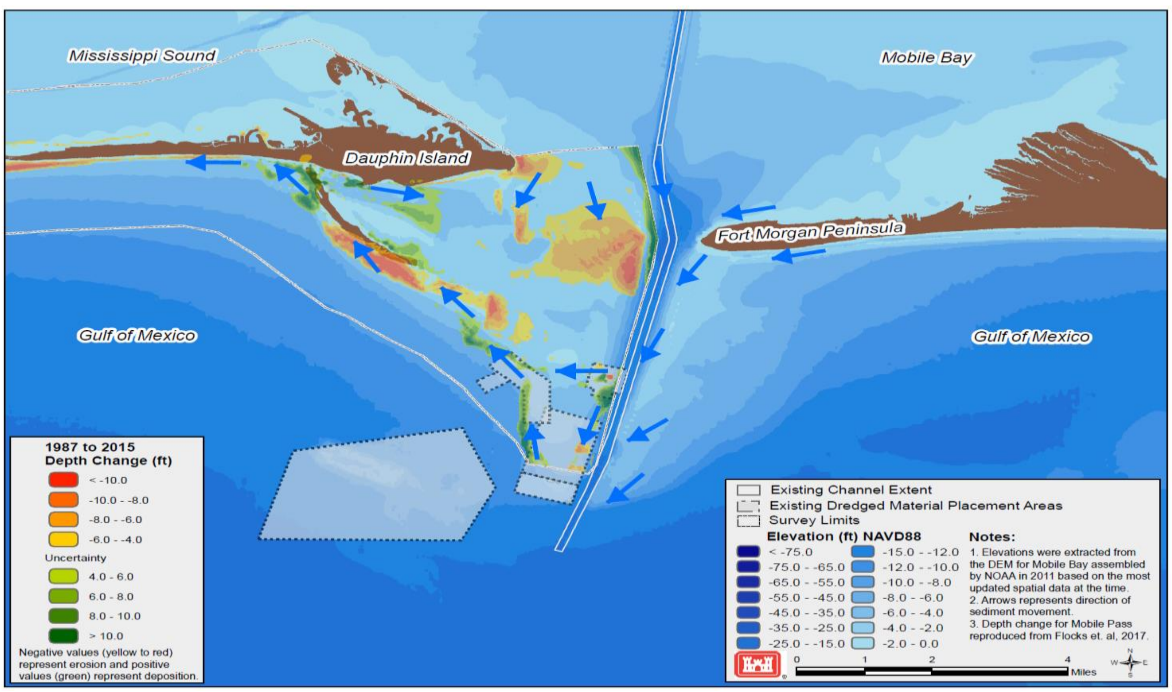
Bays and barrier islands are among the most vulnerable areas to the consequences of climate change. Serious threats to the islands come from the combination of elevated sea levels and intense hurricanes. The Alabama barrier islands consist primarily of low-lying topography with beach-ridge interior cores 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.



Source: Depth change reproduced from Byrnes et. al, 2008

Figure 2-8. Mobile Pass Bed Level Change 1941 to 2002 (+/- Erosion/Deposition, ft)



Source: Depth change reproduced from Flocks, et. al, 2017.

Figure 2-9. Mobile Pass Bed Level Change 1987 to 2015 (+/- Erosion/Deposition, ft)

Recent climate research by the Intergovernmental Panel on Climate Change (IPCC) predicts continued or accelerated global warming for the 21st Century and possibly beyond, which will cause a continued or accelerated rise in global mean sea level. Accounting for potential accelerated rise in global mean sea level in the future, it is projected that sea level over the next 50 years could increase as much as 0.8 foot–2.0 ft based on the 1987 National Research Council's low and high curves modified with the IPCC current estimate of historical global mean sea level change rate. Shoreline recession due to SLR projections based on the Brunn rule for erosion (Brunn, 1962) could range from 1.3 ft/year to upwards of 3 ft/year. In light of island background recession rates of up to 30 ft/year documented in Byrnes et al. (2012), the primary drivers of morphologic change during this period likely would continue to be sediment availability, prevailing winds, storm waves, and associated currents.

USACE guidance requires consideration of projected future sea-level changes and impacts in project planning, design, operations, and maintenance (Reference 1, or 'Ref. 1'). 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 SLR rate. Predictions of future sea level due to intermediate and high rates of SLR 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 SLR 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 SLR 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 rates for this location is shown in **Table 2-3**.

Predicted rise scenarios for Dauphin Island sites was computed in accordance with current USACE guidance. Predicted rise varies between about 1.3 ft by 2100 for the low current rate curve, 2.4 ft for the intermediate rate curves and 5.7 ft for the high rate curve.

Table 2-3. Historic SLR Rates

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

2.2.9. 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. The tidal prism of the bay, based on the weighted mean tidal range of 1.4 ft and a surface area of 236,000 acres, is about 330,000 acre-ft. 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 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.

2.3. Geology, Soils, and Sediments

2.3.1. 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 Counties 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 the county and broad flats with a few fairly large depressions and a few drainage-ways on the south side of the county. Petis Bois and Dauphin Islands are part of the barrier islands that encloses Mississippi Sound in Alabama. Elevation in the county ranges from sea level along the coast to about 340 ft above sea level near Citronelle in the northern part of the county.

2.3.2. General Soil Setting

The in situ soils of Mobile Bay consist of 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.

<u>Upland</u>. 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 layers are a very dark brown muck of about15 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.

<u>Sediment</u>. 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 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 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 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).

2.3.3. Subsurface Geotechnical Conditions

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 soils 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 with some pockets of silty sand. Clean and silty sands are present from elevation -39 ft down to the extent of the proposed deepening at elevation -54 ft. Fat clays and silts 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 one mile north of the Gulf Intracoastal Water Way 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.

Soil borings 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. The additional borings are now scheduled to be conducted during PED. Considering the nearby borings indicate predominate sediment characteristics to be soft FAT clay, there is very little risk that results will change the RP.

2.3.4. 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. In accordance with the MPRSA and EPA ocean dumping criteria (40 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 draft 404(b)(1) Evaluation Report has been prepared and is included in Attachment C-2.

2.3.4.1. Choctaw Pass Turning Basin Sediment Testing 2008

Sampling of new-work dredged material associated with improvements to the Choctaw Pass Turning Basin in 2008 (**Figure 2-11**) by EA Engineering, Science and Technology of Sparks, Maryland, included sediment physical analyses (grain size determination, specific gravity, and percent solids), bulk sediment analysis, standard and modified elutriate testing, water column bioassays, whole sediment bioassays, and bioaccumulation studies of sediment samples (full Tier III analyses). A more detailed analysis and sampling event description may be found in the *Final Evaluation of Dredged Material, Federally Authorized Navigation Project, Mobile Harbor Turning Basin, Mobile Harbor, Mobile, Alabama* (USACE/EA 2008).

In 2008, analyses for concentrations of metals, chlorinated pesticides, polychlorinated biphenyl (PCB) congeners, polycyclic aromatic hydrocarbons (PAHs), butyltins, dioxin and furan congeners, semivolatile organic compounds (SVOCs), ammonia (NH3-N), cyanide, total organic carbon (TOC), total sulfide, total Kjeldahl nitrogen (TKN), total phosphorus, nitrate, nitrite, acid volatile sulfides / simultaneously extracted metals (AVS/SEM) (sediment only) were conducted.

Bulk sediment samples were analyzed across a vertical stratum with six core samples collected at two intervals: “upper portion” (0-10 ft below surface) and “lower portion” (10-52 ft below surface). Results of the physical analyses indicated that sediment from the “upper portion” in the Choctaw Pass Turning Basin area were predominantly fine-grained silts and clays (greater than 50% silt and clay). Comparatively, sediment samples from the “lower portion” were predominately comprised of sand (50.5% to 89.9% sand).

In the “upper portion”, concentrations of four metals (arsenic, copper, mercury, and nickel), four PAHs [acenaphthene, acenaphthylene, ibenzo(a,h)anthracene, and pyrene], total PCB concentrations (ND=1/2 RL), and four chlorinated pesticides (4,4’-DDD, 4,4’-DDE, 4,4’-DDT, and dieldrin) were between the threshold effects level (TEL) and probable effects level (PEL) values in the sediment from at least one MHTB location. The concentration of 4,4’-DDD slightly exceeded the PEL at one location. Concentrations of dioxin and furan congeners and SVOCs were detected at low concentrations and none of the butyltins were detected in any of the sediment samples.

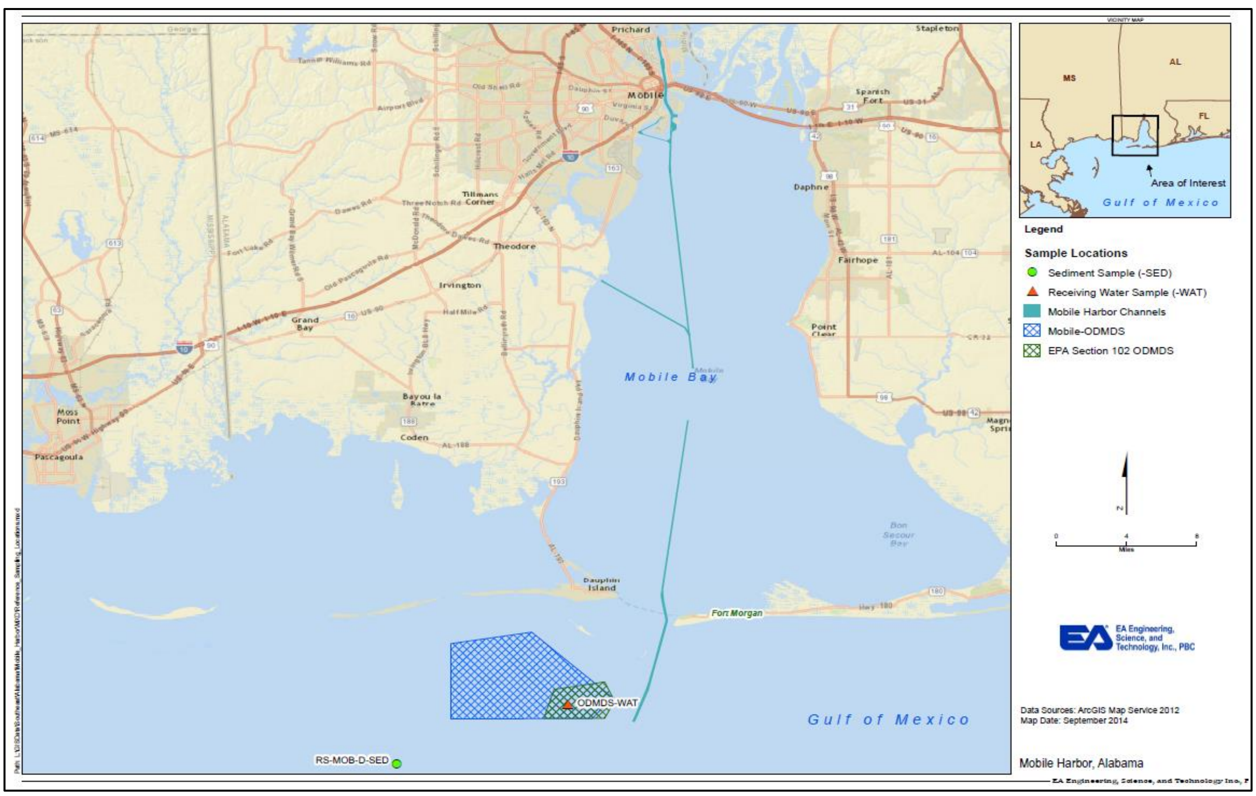


Figure 2-10. Mobile ODMDS location map

In sediment samples from the "lower portion", one metal (mercury), five PAHs (acenapthene, acenapthylene, dibenzo(a,h)anthracene, fluoranthene, and pyrene), total PCB concentrations (ND=1/2 RL), and four chlorinated pesticides (4,4'-DDD, 4,4'-DDE, 4,4'-DDT, and dieldrin) were detected at concentrations between TEL and PEL values in the sediment from at least one MHTB location. Concentrations of 4,4'-DDD exceeded PEL values at one location and in the sediment composite associated with MTB06-/03, and 4,4'-DDT concentrations exceeded the PEL value at two locations and in one sediment composite associated with MTB06-03.

Results from sampling and Short Term Fate (STFATE) model analyses indicated sediments from the Choctaw Pass Turning Basin met the Limiting Permissible Concentration (LPC) requirements for water quality, water column toxicity, benthic toxicity and bioaccumulation for placement in the Mobile ODMDS.

2.3.4.2. Mobile Harbor O&M Sediment Testing 2010.

Sampling of Mobile Harbor O&M material (**Figure 2-12**) was conducted in March 2010 by EA Engineering, Science and Technology of Sparks, Maryland, and included physical sediment analyses, bulk sediment analysis, standard and modified elutriate testing, water column bioassays, whole sediment bioassays, and bioaccumulation studies (full Tier III analyses) of sediment samples proposed for maintenance dredging. A more detailed analysis and sampling event description may be found in the *Final Evaluation of Dredged Material, Federally Authorized Navigation Projects, Mobile Harbor, Mobile, Alabama* (USACE/EA 2011).

In 2010, analyses for concentrations of metals, chlorinated pesticides, SVOCs, PAHs, PCB congeners, NH3-N, cyanide, total sulfide, TKN, total phosphorus, nitrate, nitrite, AVS/SEM (sediment only), and total organic carbon (TOC) were identified in sediment, site water, standard elutriate, and effluent elutriate samples.

In addition, the following physical analyses were conducted for bulk sediment samples: grain size determination, specific gravity, and percent solids. Of the 163 tested chemical constituents, 101 (62 percent) were detected in the sediments from Mobile Harbor O&M material. Concentrations of analytes detected in the sediments from Mobile Harbor were generally higher than concentrations of analytes detected at the reference site. None of the 101 chemical constituents detected in the Mobile Harbor sediments exceeded EPA PEL values. TOC concentrations in sediments from the Mobile River and Mobile Bay Channels ranged from 0.547 to 1.91 percent. Three metals (arsenic, copper, and nickel) had concentrations exceeding EPA TEL values by factors ranging from 1.0 to 1.8.

PAHs were generally detected at low concentrations below the laboratory reporting limit. The highest concentration of PAHs detected were observed in sediments from the Mobile River. Total PAH concentrations in sediments from the Mobile River and Mobile Bay locations were all below the TEL value (1,684 µg/kg). Total PCB concentrations for Mobile River and Mobile Bay sediments were also below the TEL value (21.6 µg/kg) at each of the sampling locations, except MH10-04 (33.1 µg/kg). 4,4'-DDE and gamma-BHC (lindane) were detected in Mobile River and Mobile Bay sediment samples at concentrations that exceeded the TEL value by factors ranging from 1.0 to 2.0. Dioxin and furan congeners were detected at low concentrations, and dioxin

Figure 2-11. Choctaw Pass Turning Basin sediment sampling map (2008).

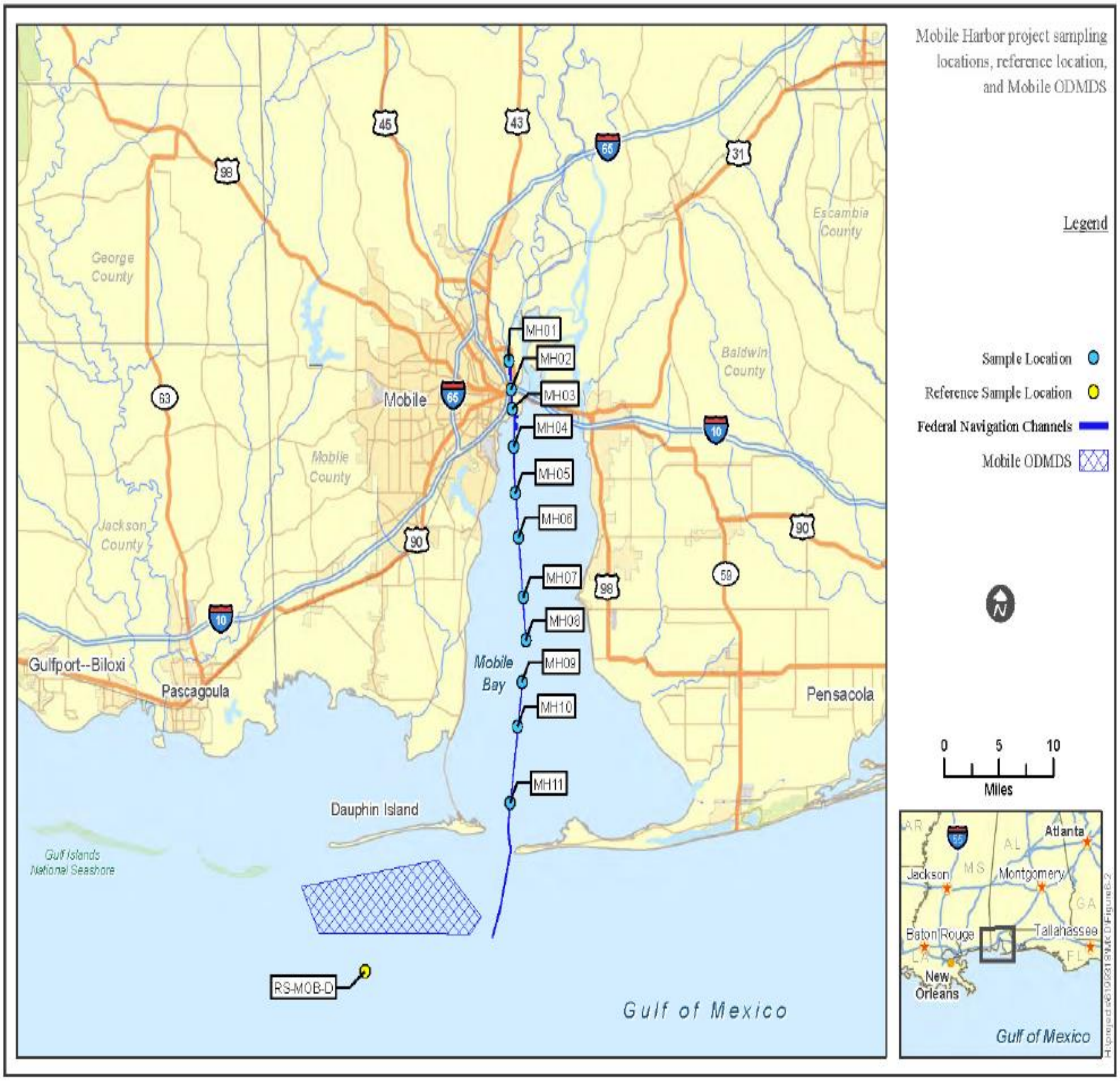


Figure 2-12 Mobile Harbor O&M sediment sampling map (2010)

toxicity quotients (TEQs) ranged from 5.81 to 19.1 ng/kg. SVOCs were detected at low concentrations, and did not exceed TEL values.

The EPA determined that according to Section 103 of the MPRSA, results from sampling and STFATE modeling of dredged material modeling indicated sediments from the Mobile Bay navigation channel met the LPC for water quality, water column toxicity, benthic toxicity, and benthic bioaccumulation for placement in the Mobile ODMDS.

2.3.4.3. Mobile Harbor LRR Widening Sediment Testing 2014

In 2014, sediment sampling was conducted (**Figure 2-13**) associated with the proposed LRR for widening an approximately 7-mile section of the Mobile Harbor Lower Bay and Bar Channels. Sampling was conducted by EA Engineering, Science and Technology of Sparks, Maryland, and included sediment physical analyses, bulk sediment analysis, standard and modified elutriate testing, water column bioassays, whole sediment bioassays, and bioaccumulation studies (full Tier III analyses) of dredged material samples. A more detailed analysis and sampling event description may be found in the *Final Evaluation of Dredged Material, Mobile Harbor Widening Project, Mobile Harbor, Mobile, Alabama* (USACE/EA 2015).

Seven, one-mile long dredging units (DU) were sampled resulting in twenty-one sampling locations across the entire widening project and collected at depths ranging from 5.4 to 13.5 ft below the sediment surface (-49 ft mean lower low water (MLLW) in the Lower Bay, and -51 ft (MLLW) in the Bar Channel). Site water from each channel reach (Lower Bay and Bar) was collected for chemical analysis, standard elutriate preparation, and ecotoxicological testing.

Receiving water was also collected from a location in the Mobile ODMDS and submitted for chemical analysis for use in STFATE modeling. Of the twenty-one discrete samples collected, seven composted samples (one for each dredging unit) were analyzed for physical, chemical, and ecotoxicological analyses.

Sediments from the Lower Bay Channel (DU1, DU2, DU3, and DU4) were comprised mostly of silts and clay, with percentages ranging from 45.5% to 93.5% in the individual and DU composite samples. DU5 had a higher sand content; silt and clay percentages ranged from 24.4% to 54.1% in the individual and DU5 composite samples. Sediments from the Bar Channel (DU6 and DU7) were higher in sand content with silt and clay percentages ranging from 30.4% to 79.8%.

Lower Bay Channel sediments showed arsenic and nickel concentrations detected between TEL (7.24 mg/kg) and PEL (41.6 mg/kg) values. No metals analyzed from Lower Bay Channel sediments exceeded the PEL. The majority of organic constituents (PAHs, PCB congeners, chlorinated pesticides, and SVOCs) were detected at concentrations estimated below the laboratory reporting limit in the Lower Bay Channel sediments. Two chlorinated pesticides, 2,4'-DDE and 4,4'-DDE, were detected above the reporting limit in the DU2 composite sample.

Ammonia was the constituent of concern (COC) in the Lower Bay sampling location DU2 requiring the greatest dilution factor (10.2), which was met, for placement at the Mobile ODMDS. Survival of test species analyzed for benthic toxicity of whole sediment samples from the Lower Bay Channel were not statistically different from reference material analyses, and therefore met the LPC requirements for placement in the Mobile ODMDS.

For *Macoma nasuta*, concentrations of lead in DU3 statistically exceeded mean reference site and pre-test concentrations. The 95 percent upper confidence level of the mean (UCLM) for lead did not exceed the EPA-Region IV background concentration range. Based on the assessment of chemical analyses performed on tissues exposed to sediment from the Lower Bay Channel and reference site sediment, it was anticipated that ocean placement of the dredged material from the Lower Bay Channel at the Mobile ODMDS was not expected to result in ecologically significant bioaccumulation of contaminants.

Results from sampling and STFATE modeling of dredged material modeling indicated sediments from both Lower Bay and Bar Channel sediments met the LPC requirements for water quality, water column toxicity, benthic toxicity, and benthic bioaccumulation for placement in the Mobile Ocean Dredged Material Disposal Site (ODMDS) as specified in Section 103 of the MPRSA.

2.3.4.1. Deepwater Horizon 2010.

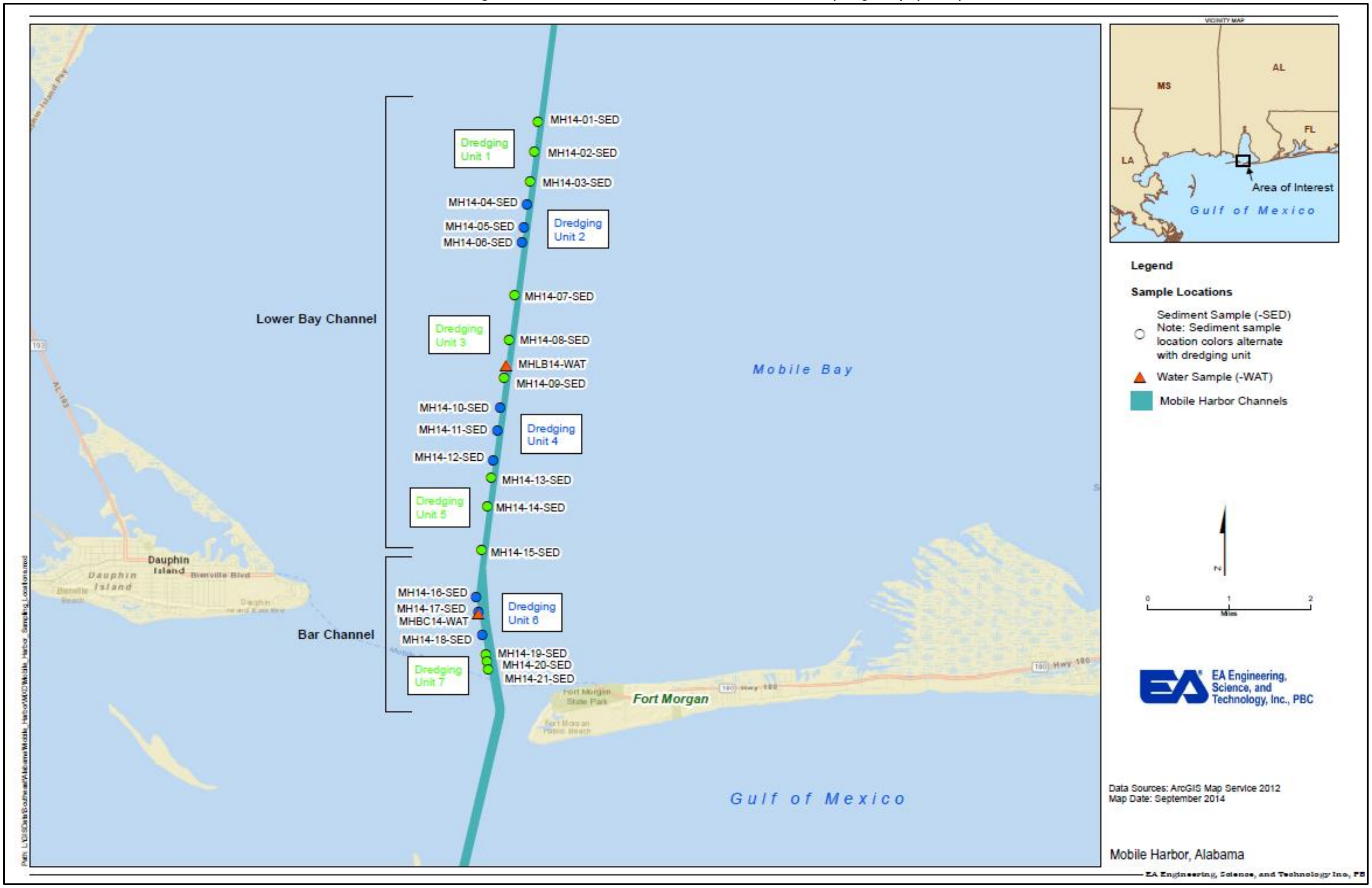
On April 20, 2010 *The Deepwater Horizon* exploded in the Gulf of Mexico while drilling on the Macondo oil well approximately 41 miles southeast of Louisiana. Oil spilled into the Gulf until it was capped on July 15, 2010. A sampling effort was conducted by EA on behalf of USACE–Mobile in late-November and early-December 2010 to determine if the surface sediment quality in the Mobile Harbor Federal Navigation Channels had been impacted by the oil spill. Based on results of PAH and total petroleum hydrocarbon (TPH) testing of surface sediments collected in the Mobile Lower Ship Channel, Mobile Bar Channel, EPA-designated reference site, and the Mobile-North ODMDS in November and December 2010, there were no discernable changes observed in the sediment quality that could be attributed to the *Deepwater Horizon* Oil Spill (EA 2011)

2.4. 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. The output from the modeling efforts 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 is included in Appendix A.

Six continuous environmental monitoring sites operated by the Dauphin Island Sea Lab and the Mobile Bay National Estuary Program (NEP) are located within the lower, middle and upper part of Mobile bay as shown in **Figure 2-14**. 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 ADCNR, 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.

Figure 2-13. Mobile Harbor LRR sediment sampling map (2014)



2.4.1. 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. EPA estimates that 4% of the bottom waters in the Gulf estuaries have hypoxic conditions or low DO on a continuing basis (USEPA, 2001). Hypoxia affects living resources, biological diversity, and the capacity of aquatic systems to support biological populations. When oxygen levels fall below critical values, those organisms capable of swimming (e.g., fish, crabs, and shrimp) evacuate the area and many bottom-dwelling organisms perish under those conditions. Hypoxic conditions are considered to be hazardous for less or non-mobile macrobenthos (e.g., polychaete worms and burrowing amphipods), with prolonged exposure having the potential to result in deterioration of the benthic community.

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).

Evaluation of DO 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 DO to hydrological and temperature conditions. **Figure 2-15** and **Figure 2-16** shows the distributions for DO at the bottom of the water column for February (high flow/cold) conditions and October (low flow/hot) conditions. As seen for existing conditions, the October (low flow/hot) conditions show decreased DO relative to the February (high flow/cold) conditions throughout the bay.

2.4.2. 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 too much 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 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.

2.4.3. 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 bathymetry (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 reaches 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 cf/s, the system could be considered fresh from the head to the mouth of the river.

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 nautical 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

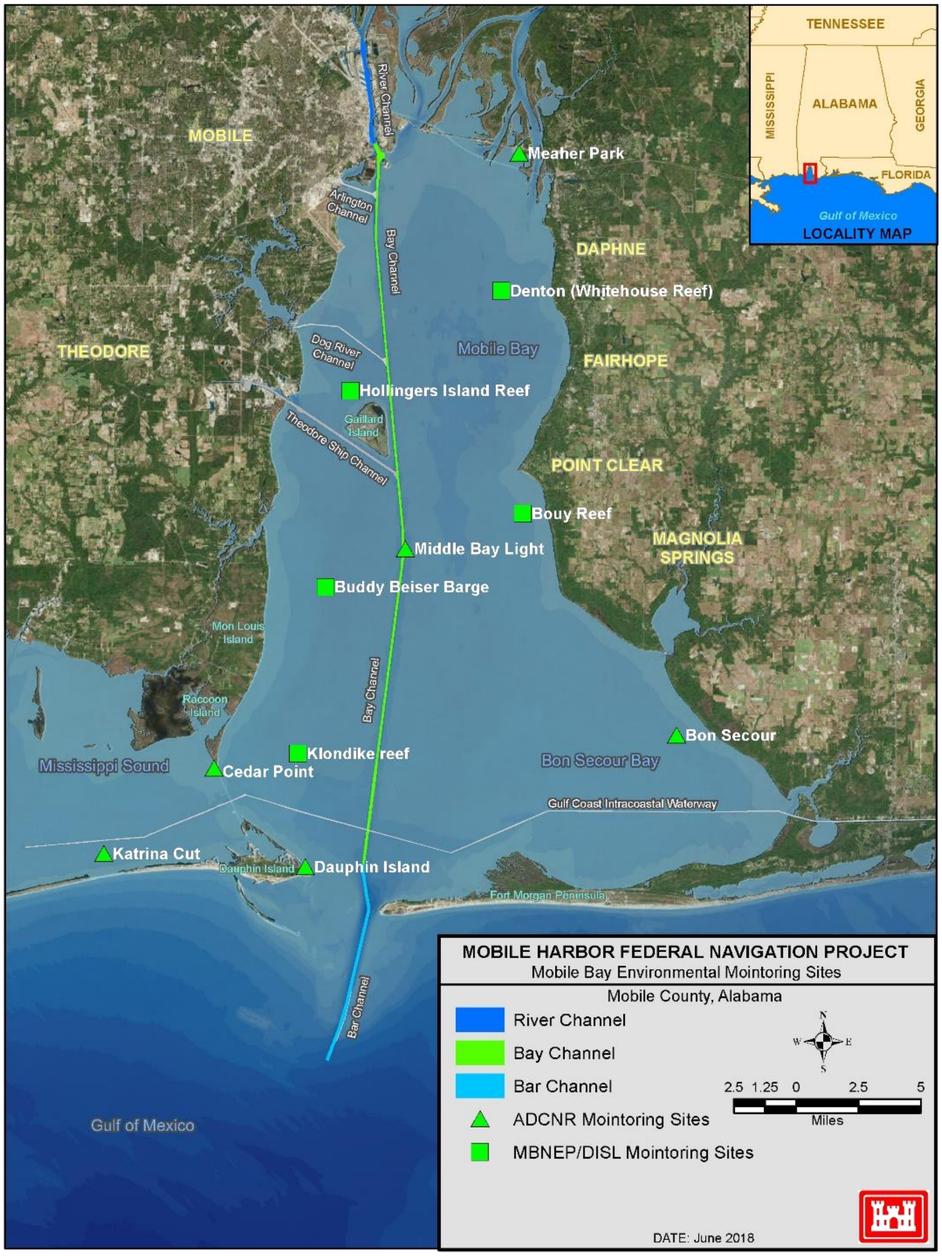


Figure 2-14. Continuous Environmental Monitoring Sites within Mobile Bay

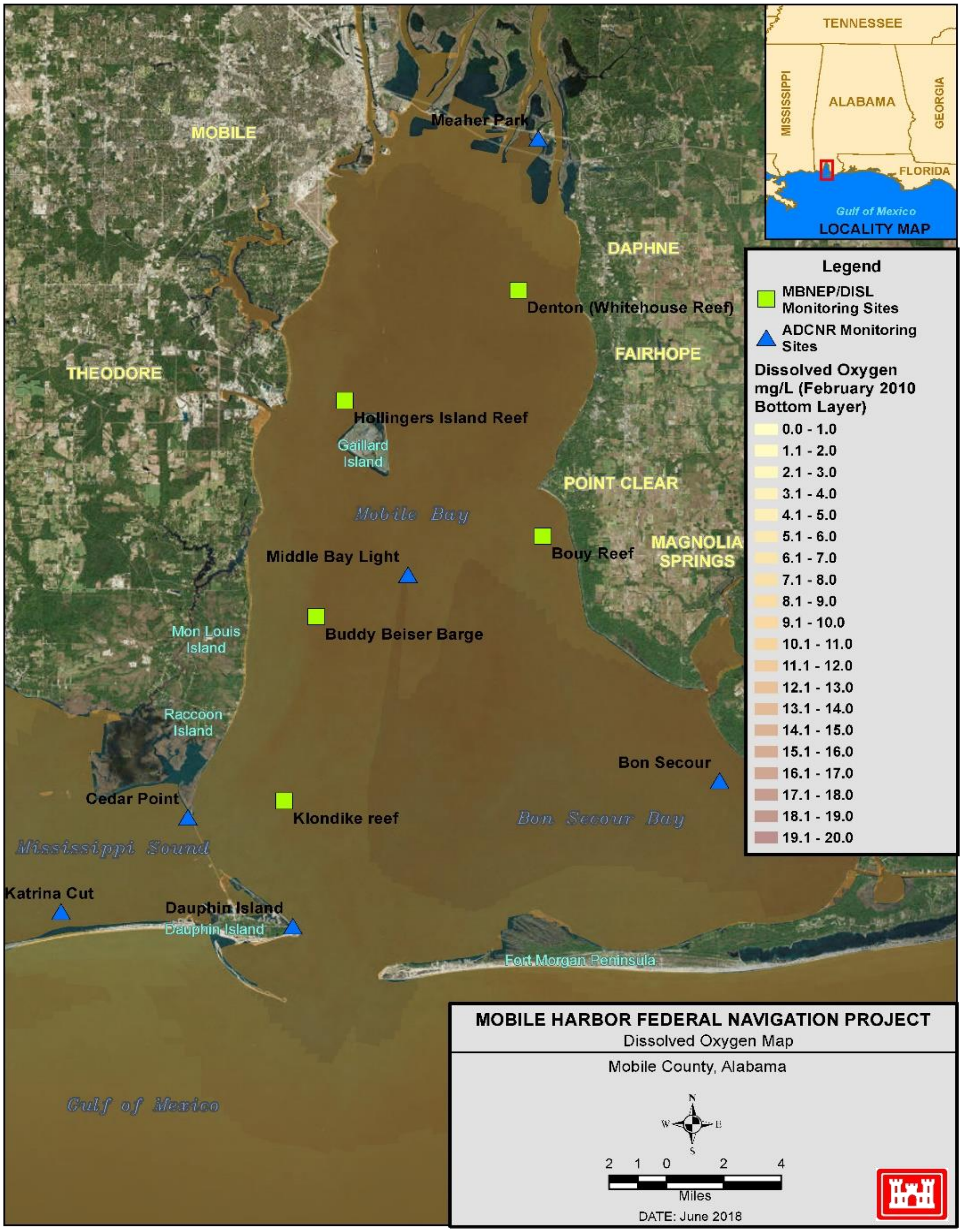


Figure 2-15. Distribution of monthly bottom Dissolved Oxygen for February (high flow/wet)

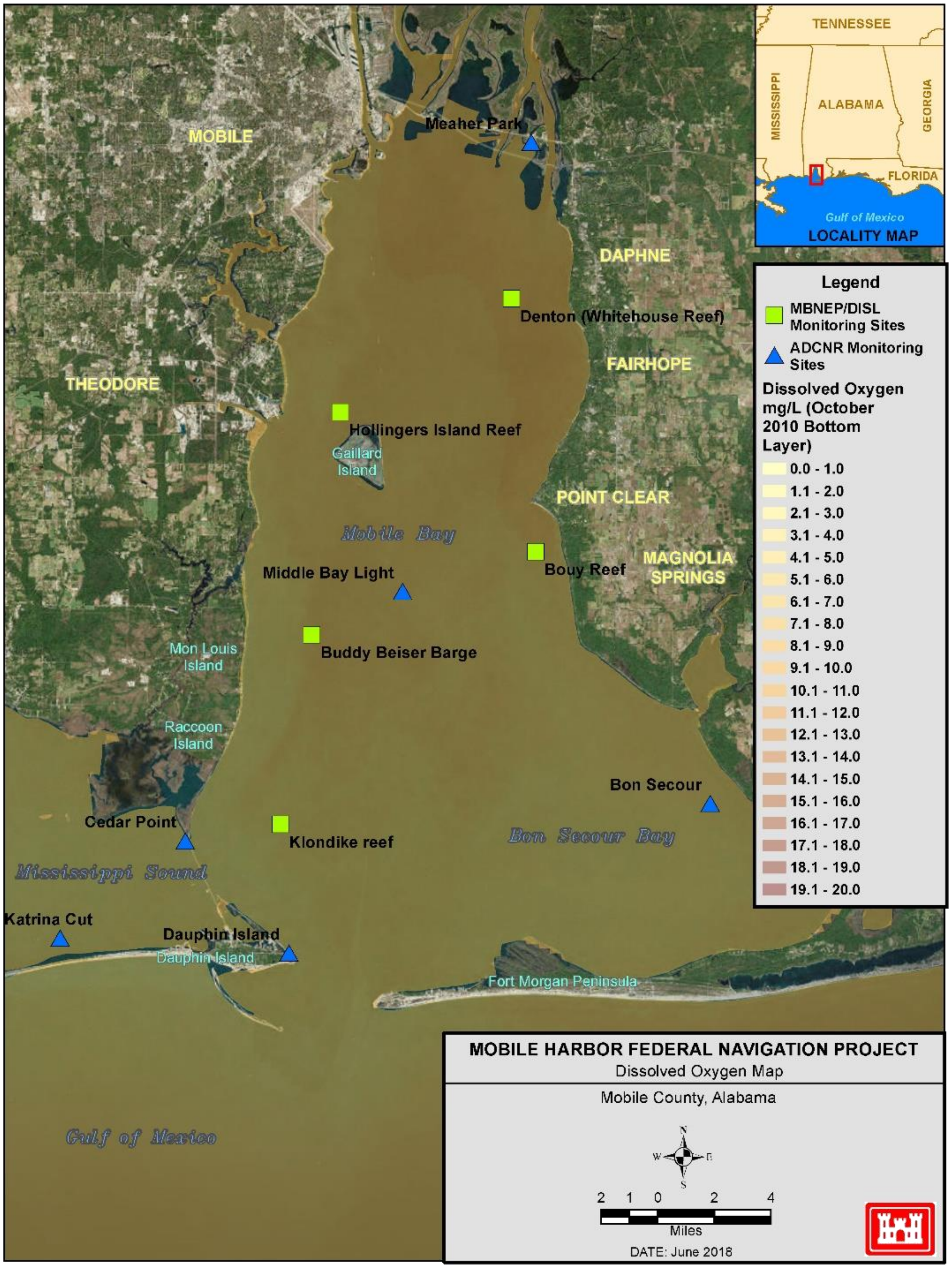


Figure 2-16. Distribution of monthly bottom dissolved oxygen for October (low flow/dry)

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 indicates 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.
Monthly distribution from the 2010 existing condition hydrodynamic and water quality model simulations conducted as part of this study as shown below provide the response to hydrological conditions. **Figure 2-17** and **Figure 2-18** show the distributions for mean depth salinity values for February (high flow/wet condition) and October (low flow/dry condition). As shown in the figures for existing conditions the channel exhibits higher salinity than the shoals and shallower areas. In addition, in the existing condition more salt intrusion through the navigation channel to Mobile River is observed under the existing low flow/dry (October) conditions than the existing high flow/wet (February) condition.

2.4.4. Turbidity and Suspended Solids

Turbidity, defined as “muddiness created by stirring up sediment or having foreign particles suspended” in the water column (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

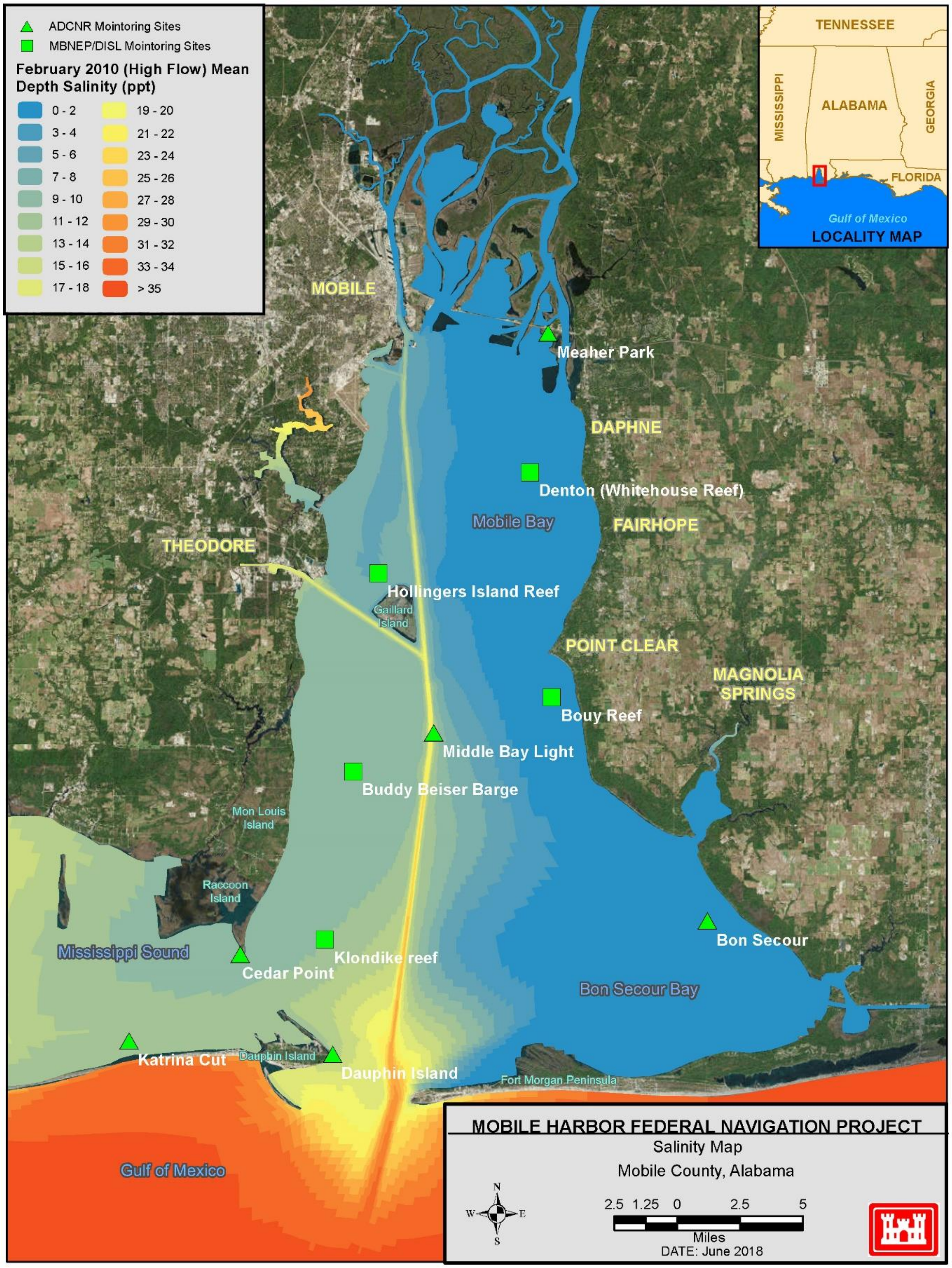


Figure 2-17. Monthly mean of depth-average salinity (ppt) for February (wet conditions)

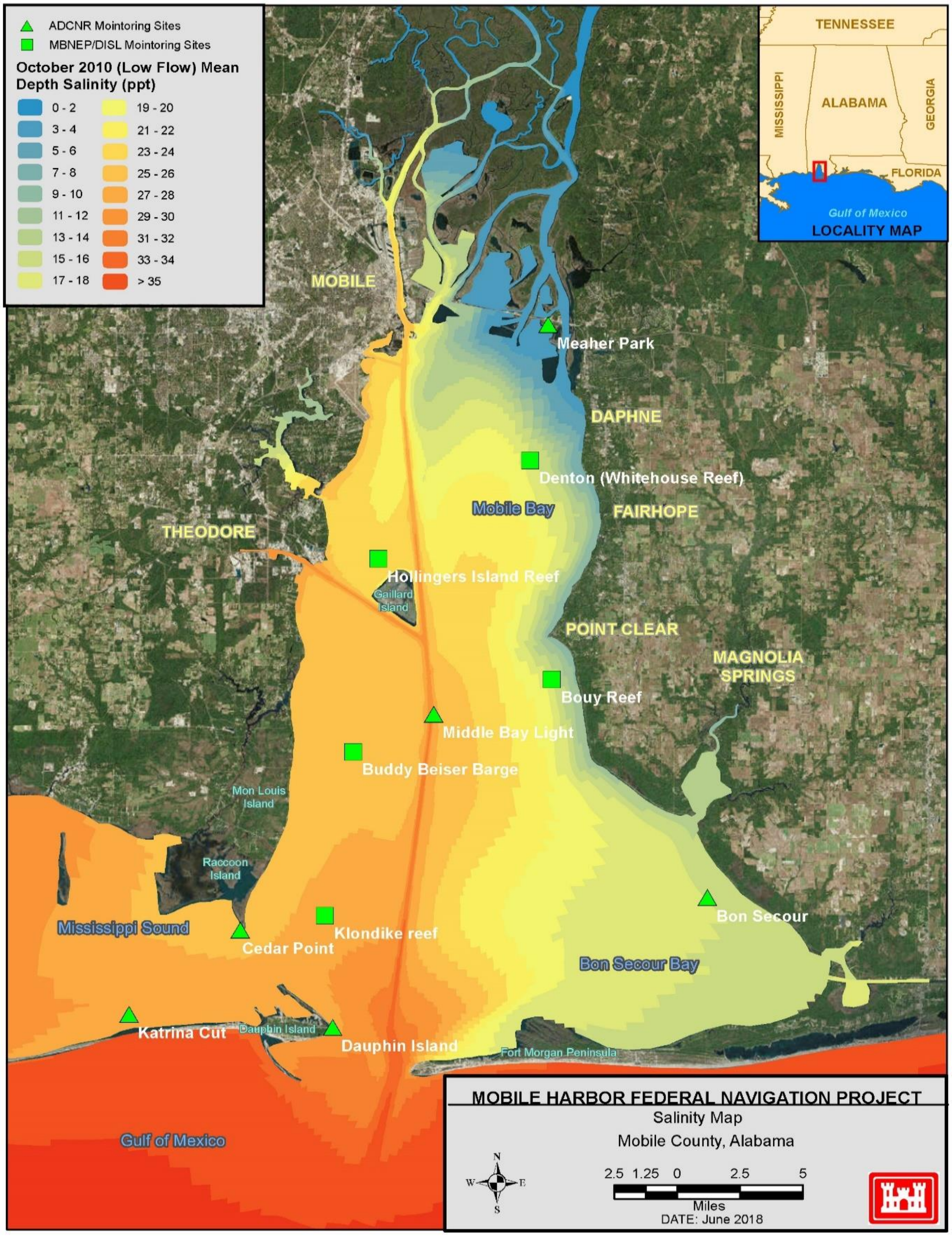


Figure 2-18. Monthly mean of depth-average salinity (ppt) for October (dry conditions)

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 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 monitoring 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 ft from the activity or result in an increase of 50 NTU above background turbidity levels in the receiving waters. Should these conditions be exceeded, the USACE, Mobile District 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.

2.4.5. Water Temperature

Temperature distribution in Mobile Bay and the study area is influenced by the interaction of freshwater discharge, tides, currents, winds and circulation. 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.

Table 2-4 which can be found at 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.

Table 2-4. Monthly average min/max water temperatures for Mobile Bay at Point Clear, Alabama

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Min °F	58.5	57.4	60	67.6	73.2	81.1	83.8	85.1	81.8	76	68.3	62.7
Max °F	63.5	63.3	67.9	73.9	80.5	85.6	87.5	87.8	84.8	81.3	73.1	67.1

Information taken from NOAA https://www.seatemperature.org/north-america/united-states/point-clear.htm

Evaluation of temperature data from the continuous monitoring sites within the bay indicates temporal trends of highest temperatures between July and October, when river discharges are normally low and air temperatures high. Lowest temperatures generally occur 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 50^{o} to 86 ^{o}F.

Monthly distribution from the 2010 existing condition hydrodynamic and water quality model simulations conducted as part of this study as shown below provide the response to hydrological conditions. **Figure 2-19** and **Figure 2-20** show 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. Groundwater

Groundwater provides an important source of drinking water (public and private) in the Mobile Bay area. 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 Holocene alluvial and coastal deposits and are generally recharged by area rainfall. Stratigraphically different yet hydraulically connected are the Upper Miocene and Pliocene aquifers, and most wells tap these units. The Pliocene Citronelle Formation, which can crop at the surface (Springhill area of Mobile) and is up to 200 ft thick, is often tapped. The Mobile Clay, a mostly impervious unit, separates shallow groundwater 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).

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 communities within Mobile and Baldwin Counties which rely on the Miocene-Pliocene Aquifer for drinking water. It is possible that brackish and salt water intrusion rates of the bay and bar areas could be potentially affect the quality of water at the well locations. A detailed discussion on these aquifers can be found in Section 5.4.2, Appendix A.

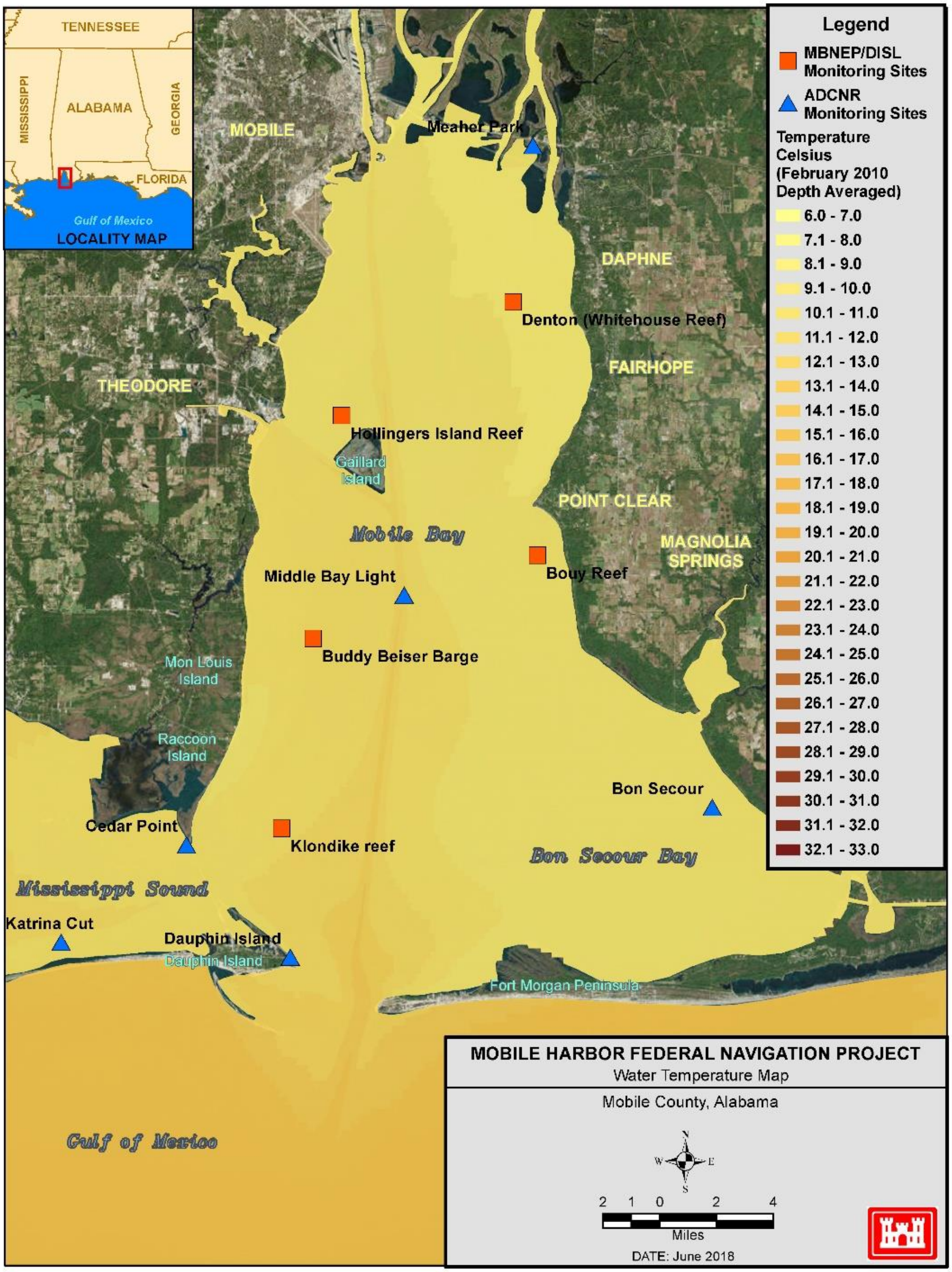


Figure 2-19. Distribution of monthly mean depth temperatures for February (High flow)

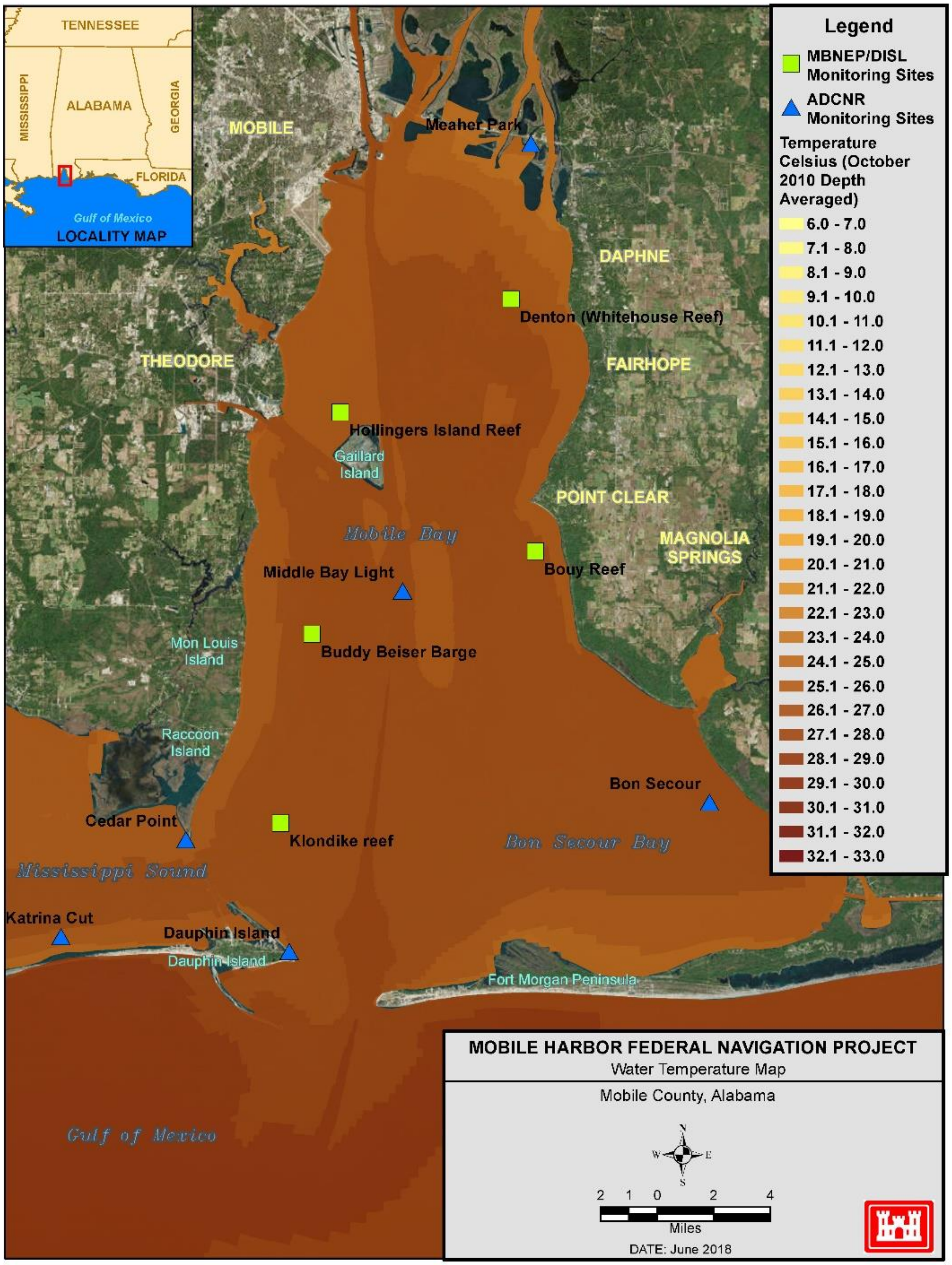


Figure 2-20. Distribution of monthly mean depth temperatures for October (Low flow)

2.6. Biological Resources

Characterizations of baseline aquatic resources in estuarine, transitional, and freshwater environments are important to establish prior to channel modifications 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. 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 and is captured in the report prepared by Berkowitz et al. (2019). A draft of this report can be found in Attachment C-1. 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 portions of Mobile Bay and northern shores of the barrier islands.

2.6.1. 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.

2.6.2. 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 (Engineer Research and Development Center (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).

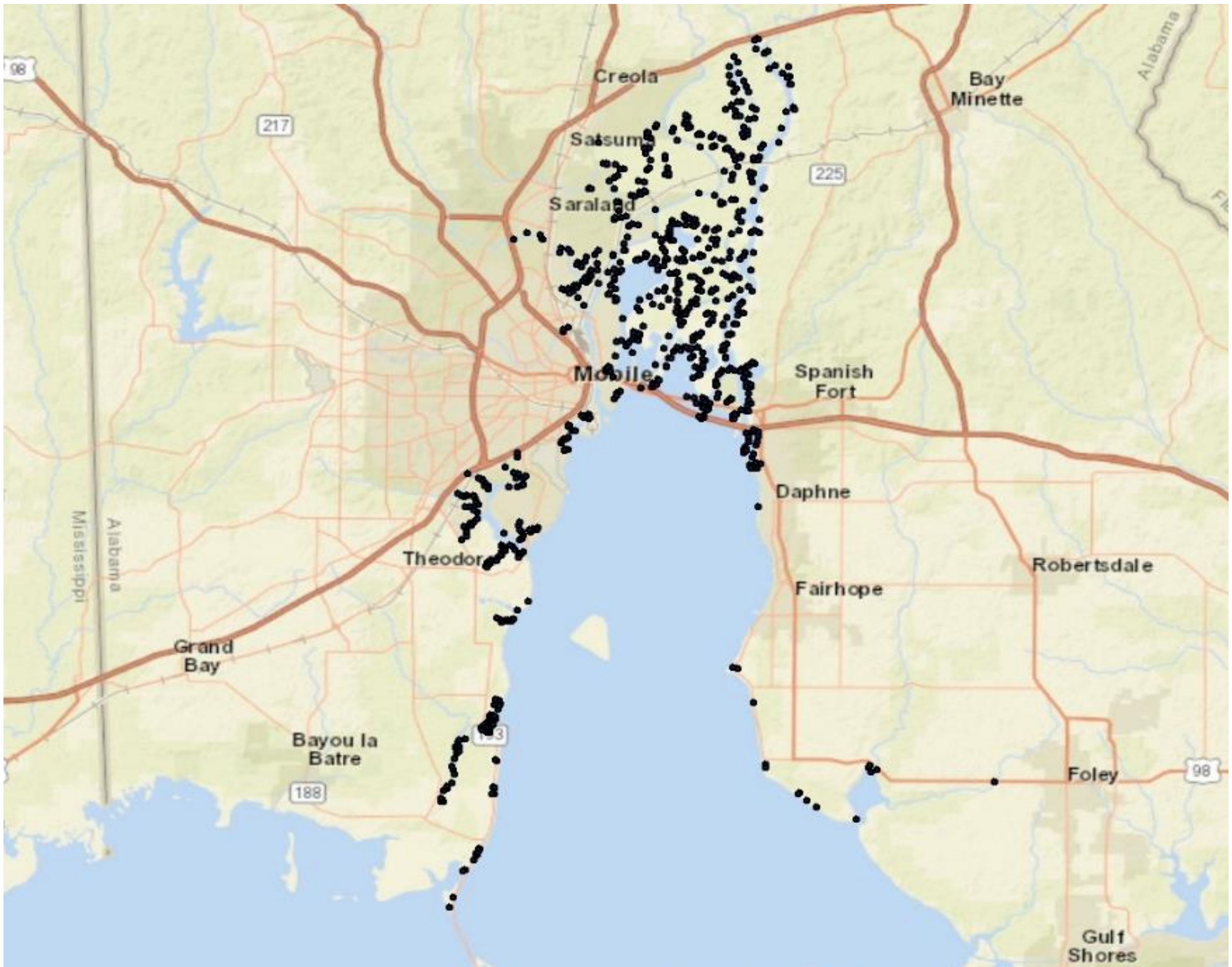
Mobile Bay supports one of the largest intact wetland ecosystems in the U.S., including over 250,000 acres within the Mobile-Tensaw River Delta (AWF 2018). Wetlands within the bay provide essential habitat for a wide variety of recreational and commercially valuable species, including rearing and cover 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., 2019). 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 seasonally with high flows typically occurring in the late winter and early spring and low flows dominating during the summer. The lower and mid-portions of the Bay (e.g., estuarine habitats) receive seawater during normal tidal exchanges.

The study area focused on the central and southern portions of the Mobile Bay and the Five River Delta region. Area identified as having the highest likelihood of potential impacts associated with the proposed channel modifications and locations of field verification sampling was conducted are shown in **Figure 2-21**. The study area included the portions of the Delta south of the Interstate 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 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.

Berkowitz et al. (2019) 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 *Typha domingensis, T. latifolia, Sagittaria lancifolia, Schoenoplectus americanus*, and *Alternanthera philoxeroides* are also included. Additionally a number of aquatic bed species (e.g*., Nuphar sp., Nelumbo lutea*) can be found adjacent to open water reaches in many of the 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 highway 98 causeway) and natural portions of the bay.

Mapping of the existing wetlands (Berkowitz et al., 2019) illustrates 39 wetland communities occurring over an area of >73,000 acres (**Table 2-5; Figure 2-22 and Figure 2-23)**. The most abundant wetland community observed in the study area was the Baldcypress – 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 Mobile 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 in the upper to middle of the transition zone between freshwater and estuarine habitats. The distribution of wetlands within the study area reflects a combination of elevation (**Figure 2-24**) and salinity tolerance (**Table 2-6**). Specific details of the study conducted by ERDC (Berkowitz et al., 2019) can be accessed in Attachment A-1.



Note: The study area focusing on portions of the Mobile Bay and Five River Delta region south of the Interstate 65 bridge, encompassing the dog river area and extending southward to Heron Bay in the west and Weeks Bay to the east. The points indicate on-site ground truthing sample locations (Berkowitz et al., 2019).

Figure 2-21. The study area focusing on portions of the Mobile Bay and Five River Delta region south of the Interstate 65 Bridge

Table 2-5. Wetland classes, species names, and area of extent within the study area

Class Name	Representative Species	Area (ac)
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

Table 2-5. Wetland classes, species names, and area of extent within the study area

Class Name	Representative Species	Area (ac)
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
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

Table 2-5. Wetland classes, species names, and area of extent within the study area

Class Name	Representative Species	Area (ac)
Water lotus	*Nelumbo lutea*	78
Wild-rice	*Zizania aquatica*	153
Yellow pond-lily	*Nuphar advena/N. ulvaceae*	28
Total		73741

Source: (ERDC 2018)

Table 2-6. Estimated salinity class for each wetland plant community. Salinity thresholds are based upon ideal growth conditions and do not reflect mortality (USDA).

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		

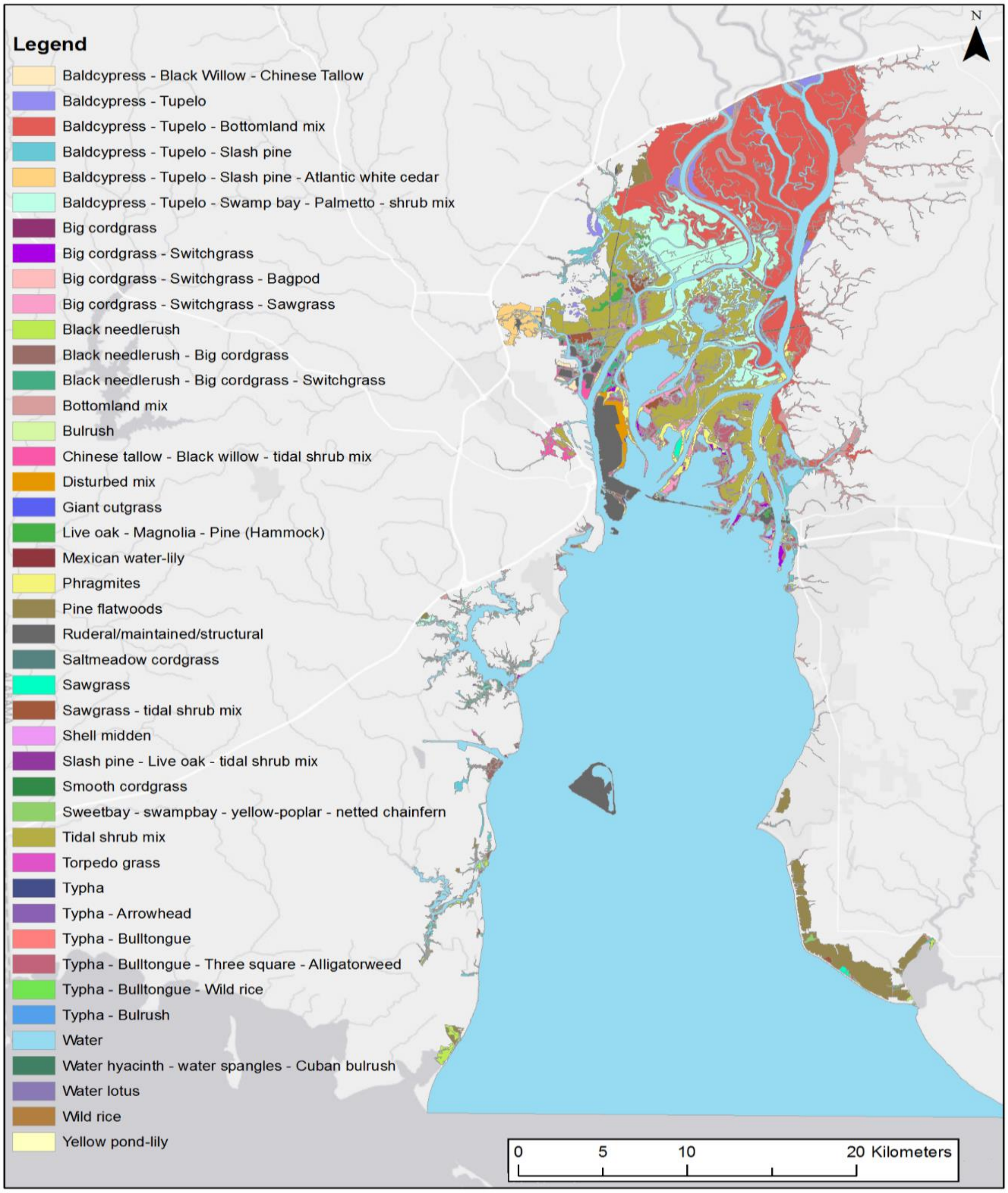


Figure 2-22. Distribution of wetland communities within the study area (Berkowitz et al., 2019)

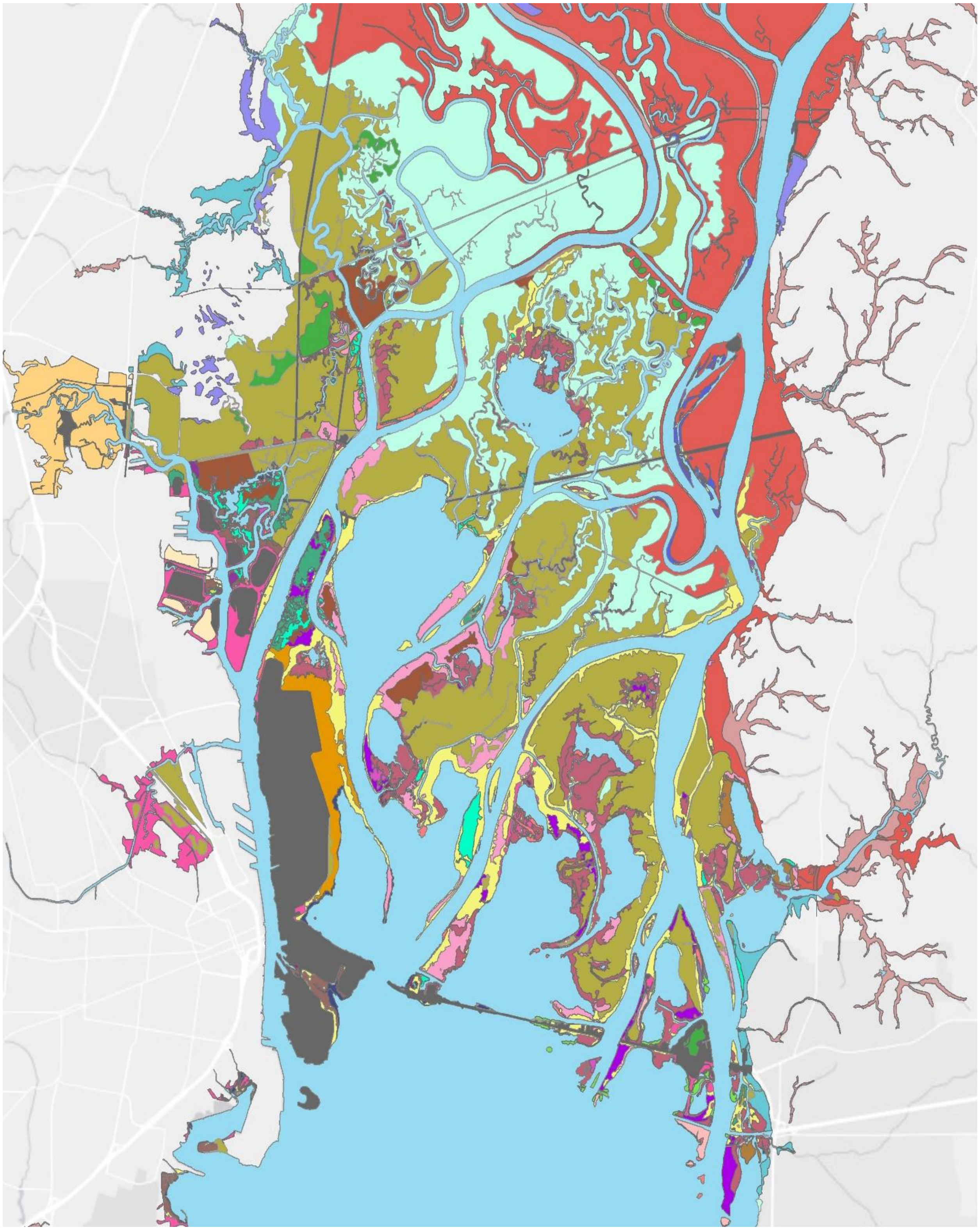


Figure 2-23. Detail of wetland community distribution within the lower Delta and upper Bay portions of the study area (Berkowitz et al., 2019)

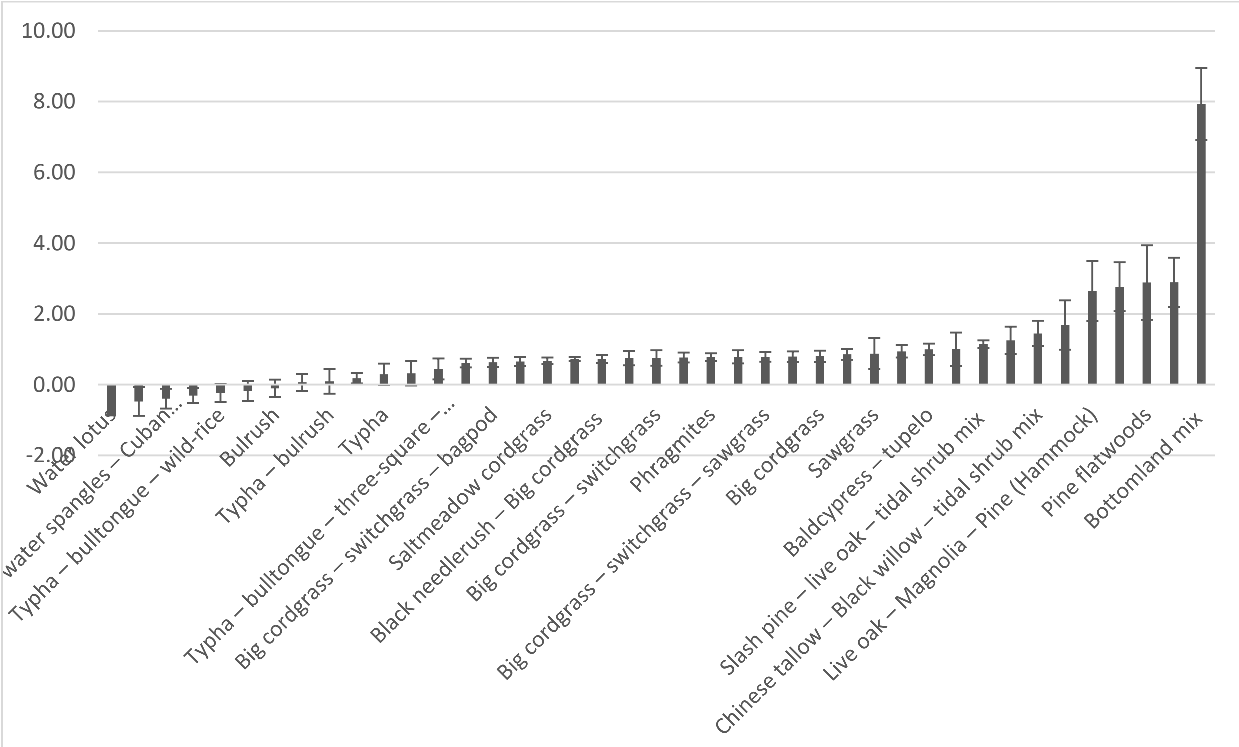


Figure 2-24. Elevation distribution (ft) of wetland community classes based upon digital elevation map (error bars represent one standard deviation of the mean) (Berkowitz et al., 2019).

2.6.3. Submerged Aquatic Vegetation

Coastal seagrass beds represent one of the most productive ecosystems on the planet (Berkowitz et al., 2019). 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. Recent surveys conducted by Berkowitz et al. (2019) has shown that these areas are dominated in coverage by Eurasian Watermilfoil *(Myriophyllum spicatum*), Water Celery (*Vallisneria neotropicalis*), Southern Naiad *(Najas guadalupensis*), Water stargrass (*Heteranthera dubia*), and Coons Tail (*Ceratophyllum demersum*). 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, as measured through Photosynthetically Active Radiation (PAR) and turbidity, 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 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.

Vittor identified species composition of the SAV beds using surveys that were conducted in 2002, 2009, and the summer (July/August) and fall (October) of 2015 (Vittor and Associates, Inc. 2004, 2010, 2016). This study focused on their mapping efforts from the fall of 2015 to establish baseline conditions for assessing potential impacts to SAV species as a result of the proposed channel deepening. For additional QA/QC of the baseline maps developed earlier, ERDC (2018) ran a hydroacoustic survey in October of 2016 to ground truth and compare to the 2015 Vittor et al survey. ERDC’s SAV hydroacoustic survey utilized the Submersed Aquatic Vegetation Early Warning System (SAVEWS Jr.) which incorporated a boat mounted Humminbird high-frequency sonar that can detect SAV in high turbidity water and is integrated with a GPS system (Sabol et al. 2014). The transducer is synced with a GPS enabling estimation of the edges of SAV beds within 3.3 ft resolution. Variation in SAV coverage by year was examined by comparing mapped SAV polygon size using ArcGIS 10.3.1.

Ground truthing surveys conducted by Berkowitz et al. (2019) 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 (**Figure 2-25**), which represents the baseline SAV conditions for this study. A legend identifying the species represented in **Figure 2-25** is listed in **Table 2-7**. A total of 31,684 points were mapped and 1788 of these points (~0.06%) detected the presence of SAV. Because of variance in SAV coverage seasonally and annually, the October 2016 hydroacoustic survey against the fall 2015 shapefile data supplied by Vittor. Of the 1,788 points, the hydroacoustic survey detected SAV about 85% overlapped with the SAV polygons mapped by Vittor. The remaining 15% of hydroacoustic SAV detections were within 33 ft of the Vittor SAV polygons. The 15% difference can likely be attributed to annual variation. The hydroacoustic survey could only determine absence or presence of SAV and not species composition. During the hydroacoustic survey, a rake was used to collect SAV for species identification and the GPS position was recorded for every rake sample. The species identification for each rake sample location had 100% agreement with the Vittor fall 2015 survey. The agreement of the two techniques shows the SAV coverage of Mobile Bay is accurately portrayed in the Vittor (2015) fall survey and is suitable for the use of potential impacts that the Mobile Bay deepening project may have on SAV.

Year to year and seasonal variation in SAV coverage is both common and extensive (**Table 2-8**). 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 1000 acres each and all but Widgeon Grass (*Ruppia maritima*) covered less than 400 acres each. It should be noted that Eurasian watermilfoil is an aquatic invasive species native to Europe, Asia and North Africa introduced to the U.S. in the early 1940s and is now present nationwide. This species reproduces through fragmentation and outcompetes many native species. Due to its invasive status, impacts to this species are unlikely to have a negative impact on local SAV species. Specific details of the study conducted by ERDC (Berkowitz et al., 2019) can be accessed in Attachment A-1.

2.6.4. 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).

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 valuable artificial structural habitats.

2.6.4.1. Artificial Reefs and Structures.

<u>Offshore</u>. 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 1260 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 the old Mobile Bay Causeway bridges (Tensaw, Blakeley, and Apalachee rivers). The locations of the inshore reefs within the project area are illustrated in **Figure 2-26**.

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 2-26**. 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.

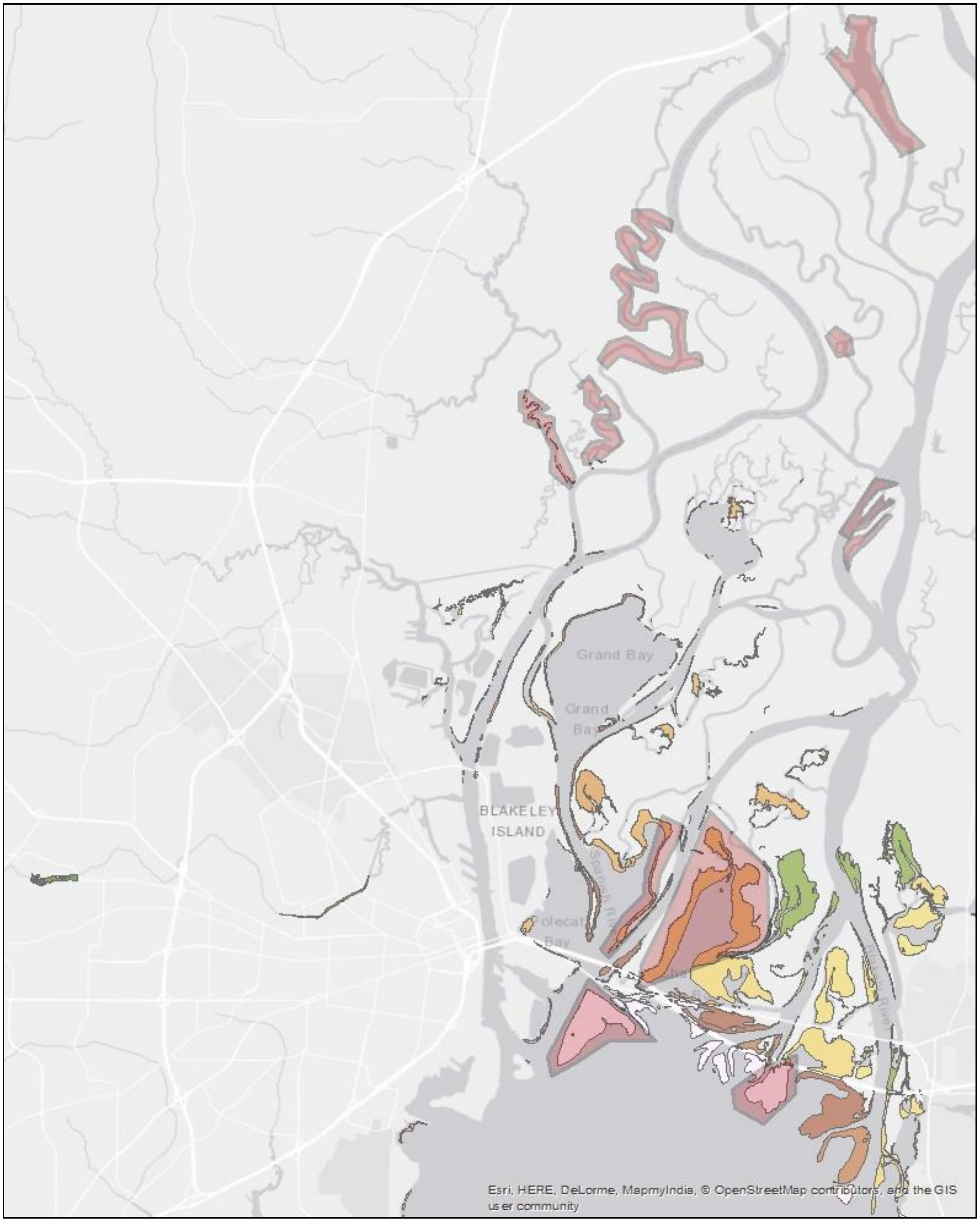


Figure 2-25. Fall 2016 Field verification sites (highlighted red polygons) and Fall 2015 SAV distribution within Mobile Bay as mapped by Vittor & Associates.

Table 2-7. Species legend for Figure 2-25

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*

Table 2-8. 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

Figure 2-26. Locations of the artificial inshore reef and gas platforms within and adjacent to the project area (ADCNR, Alabama Marine Resources Division, 2009).

2.6.5. Essential Fish Habitat (EFH)

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) 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,” as defined previously, 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 Fishery Management Council (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, extending 3 nautical miles in coastal Alabama.

The NMFS has identified EFH for the Gulf of Mexico in its FMP Amendments. These habitats include estuarine areas, such as estuarine emergent wetlands, seagrass beds, algal flats, mud, sand, shell, and rock substrates, and the estuarine water column. **Table 2-9** provides a list of the species that NMFS manages under the federally implemented FMP in the vicinity of the proposed action.

2.6.6. Plankton and Algae

2.6.6.1. Phytoplankton.

Diatoms and dinoflagellates are the dominant components of the phytoplankton community in the Gulf of Mexico, and the relative composition of these organisms depends on nutrient and silica availability in the water. Over 900 diatom species and 400 dinoflagellate species have been reported from the Gulf of Mexico. Within the Mobile Bay, phytoplankton communities are generally quite diverse, with occasional monotypic blooms. Salinity, nutrient concentrations, temperature, and wind conditions influence the distribution of phytoplankton. Population composition, abundance, and diversity also vary by season. The greatest diversity of phytoplankton has been reported in areas affected by river discharges where both riverine and marine species occur (USEPA, 1991).

Table 2-9 List of the species that NMFS manages under the federally implemented FMP in the vicinity of the proposed action.

Management Plan	Common Name	Scientific Name
Coastal Migratory Pelagic	King Mackerel	*Scomberomorus cavella*
	Spanish Mackerel	*Scomberomorus maculatus*
	Cobia	*Rachycentron canadum*
Red Drum	Red Drum	*Sciaenops ocellatus*
Reef Fish		

Snappers	Queen Snapper	*Etelis oculatus*
	Mutton Snapper	*Lutjanus analis*
	Blackfin Snapper	*Lutjanus buccanella*
	Red Snapper	*Lutjanus campechanus*
	Cubera Snapper	*Lutjanus cyanopterus*
	Gray (Mangrove) Snapper	*Lutjanus griseus*
	Lane Snapper	*Lutjanus synagris*
	Silk Snapper	*Lutjanus vivanus*
	Yellowtail Snapper	*Ocyurus chrysurus*
	Wenchman	*Pristipomoides aquilonaris*
	Vermillion Snapper	*Rhomboplites aurorubens*
Groupers	Speckled Hind	*Epinephelus drummondhayi*
	(Atlantic) Goliath Grouper	*Epinephelus itajara*
	Red Grouper	*Epinephelus morio*
	Yellowedge Grouper	*Hyporthudus flavolimbatus*
	Warsaw Grouper	*Hyporthudus nigritus*
	Snowy Grouper	*Hyporthudus niveatus*
	Black Grouper	*Mycteroperca bonaci*
	Yellowmouth Grouper	*Mycteroperca interstitialis*
	Gag	*Mycteroperca microlepis*
	Scamp	*Mycteroperca phenax*
	Yellowfin Grouper	*Mycteroperca venenosa*
Tilefishes	Goldface Tilefish	*Caulolatilus chrysops*
	Blueline Tilefish	*Caulolatilus microps*
	Tilefish	*Lopholatilus chamaeleonticeps*
Jacks	Greater Amberjack	*Seriola dumerili*
	Lesser Amberjack	*Seriola fasciata*
	Almaco Jack	*Seriola rivoliana*

	Banded Rudderfish	*Seriola zonata*
Triggerfishes	Gray Triggerfish	*Balistes capriscus*
Hogfish	Hogfish	*Lachnolaimus maximus*
Shrimp	Brown Shrimp	*Farfantepenaeus aztecus*
	White Shrimp	*Litopenaeus setiferus*
	Pink Shrimp	*Farfantepenaeus duorarum*
	Royal Red Shrimp	*Pleoticus robustus*
Spiny Lobster	Caribbean Spiny Lobster	*Panulirus argus*
Coral and Coral Reefs	Hydrozoa Corals (stinging and hydrocorals)	** There are over 140 species of corals listed in the Coral Fishery Management Plan. Taxonomy is undergoing review and will be updated in Coral Amendment 7.*
	Anthozoa (stony and black corals)	

Blue-green algae and diatoms are the dominant microflora in marshes and seagrass beds in the Mississippi Sound (Stout and de la Cruz, 1981; Daehnick et al., 1992). Red algae are the dominant filamentous algae in those systems and support coverings of epibenthic diatoms. Phytoplankton production in seagrass beds is highest in summer (August) and lowest in winter (January) (Moncreiff et al., 1992).

Seaward of the Mobile Bay along the shelf, both estuarine and Gulf species of plankton are present. Populations are greatest during the winter and spring and lowest during the late summer and fall.

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 2-10**). 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 2-11**). Generally, in estuaries along the Gulf, phytoplankton populations exhibit seasonal variations.

Table 2-10. Phytoplankton Collected from Mobile Bay

Blue-Green Algae		Green Algae
Anabaena sp.	*Actinastrum hantschii*	*Oocystis* spp.
Aphanizomenon sp.	*Ankistrodesmus convolutes*	*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*
Lyngbya 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 2-11. Phytoplankton Survey Data Collected in Mobile Bay, February 1986a

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

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

2.6.6.2. Zooplankton

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

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

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 enhanced 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).

2.6.7. 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.

In 1978, Vittor and Associates conducted a benthic macroinfauna survey of Garrows Bend. **Table 2-12** presents a summary of the major species that were identified during the survey. This has helped to fill the data gap by characterizing benthic community structure and diversity in those areas that could be subjected to dredging and placement for future actions.

Table 2-12. Taxa Identified from 1978 Benthic Macroinvertebrate Survey

Polychaeta-Capitellidae *Capitella capitate* *Mediomastus californiensis*	Polychaeta-Nereidae *Neanthes succinea*
Polychaeta-Spionidae *Streblospio benedicti*	Insecta-Diptera-Chironomidae Chrironomidae (Larvae)
Polychaeta-Pilargidae *Parandalia Americana*	Rhynchocoela *Nemertean sp*.
Polychaeta-Ampharetidae *Hypaniola florida*	Mollusca *Macoma mitchelli* *Malina pontchartrainensis*

Source: Vittor and Associates (1978)

The Vittor and Associates (1978) study represents benthic macroinfauna abundance and diversity at only one point in time. However, it is reasonable to assume that community structure during this time of year constitutes a worst-case condition. That is, estuarine species abundance and diversity are generally lowest during periods of high temperature and low stream discharge, as occurred during the 1978 characterization of Garrows Bend. The study suggested that minimum abundance and diversity occur in upper Mobile Bay in late summer. Polychaetous annelids dominated the fauna at each site, although nemerteans and mollusks were abundant in some areas. The most abundant polychaetes present, *Mediomastus californiensis* and *Streblospio benedicti*, are opportunistic species typical of high-stress estuarine habitats. Such forms are expected in waters subject to periodic oxygen depletion and/or salinity variations. At the time of the study both of these taxa dominated the Mobile Bay benthos (numerically) in the vicinity of the Theodore ship channel (Vittor and Associates, 1978).

A recent evaluation conducted for this study characterizes baseline benthic infaunal communities in estuarine, transitional, and freshwater habitats in the Mobile Bay watershed (Berkowitz et al., 2019). Specific details of the study conducted by ERDC (Berkowitz et al., 2019) can be accessed in Attachment A-1. 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 2-27.** 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 modifications. The empirical data were collected to document the distribution and abundance of benthic macroinvertebrates within the potential zone of influence of the harbor deepening project. Multivariate statistical techniques were used to determine the location(s) where the taxonomic composition of these benthic assemblages changed relative to bottom salinity concentrations. Water quality model results were assessed near benthic stations to determine whether projected salinity increases affected macroinvertebrate distributions.

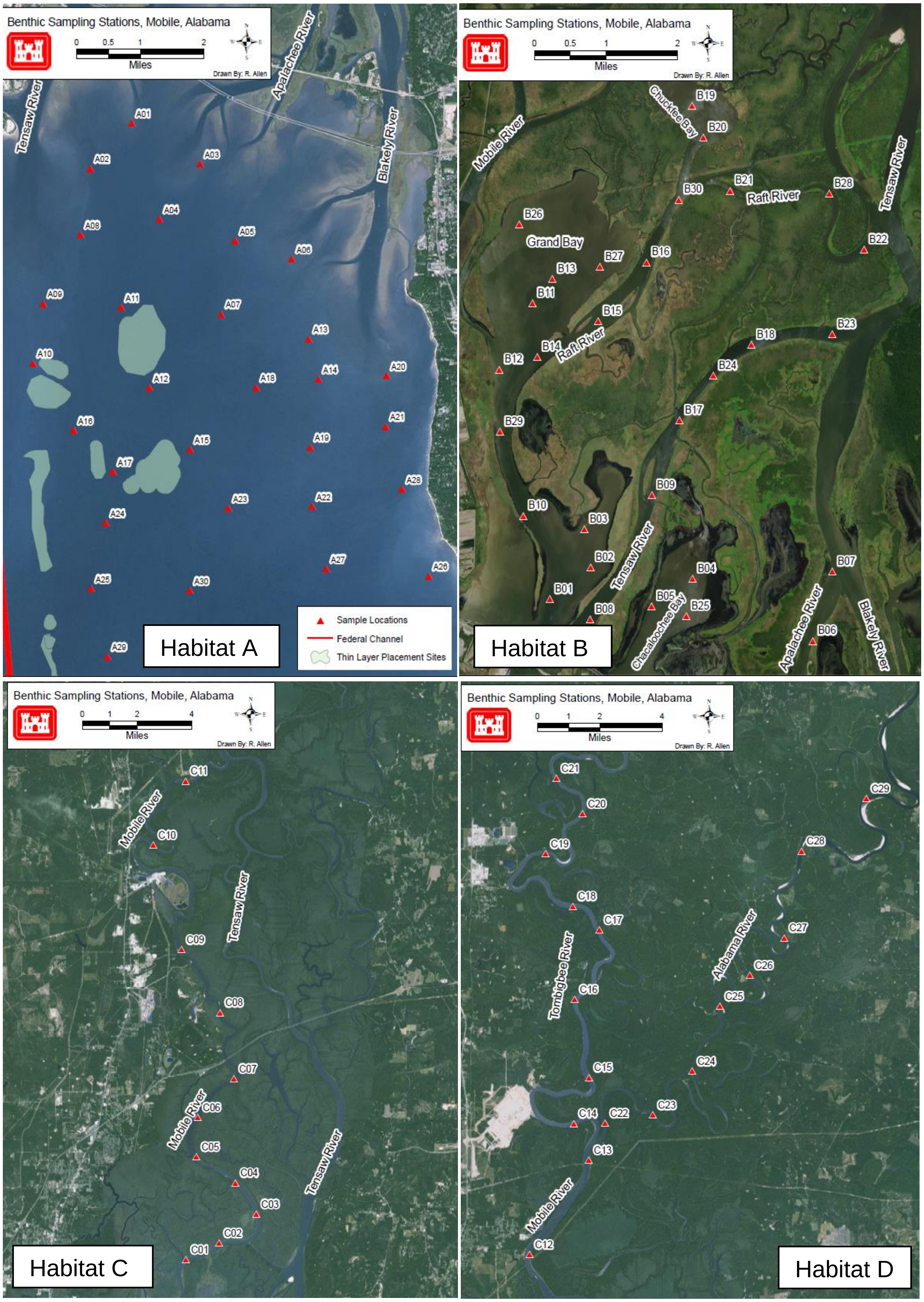


Figure 2-27. Benthic station locations for A-estuarine, B-transition, C-freshwater western zone, and D-freshwater eastern zone.

Potential impacts of the harbor channel modifications on biological resources in Mobile Bay are a concern to natural resource managers 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). An examination of the Environmental Monitoring and Assessment Program (EMAP) benthic data set collected by the EPA from (1991-1994) to assess the potential foraging value for Gulf sturgeon revealed the macrofaunal densities in Mobile Bay were greatest at water depths of 1.5 to 2.5m, with decreasing densities at greater depths. This benthic evaluation conducted by ERDC (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). **Table 2-13** and **Table 2-14** provide a summary of average abundances of benthic macroinvertebrates associated with the estuarine, transitional, and freshwater zones for each sampling period.

Table 2-13. Average abundances of benthic macroinvertebrates in each location within the Estuarine, Transitional, and Freshwater zones in October 2016.

Class	Family	Estuarine	Transitional					Freshwater		
		Estuarine	Raft River	Tensaw River	Chac. Bay	Apalachee River	Grand Bay	Mobile River	Tom. River	Alabama River
Arachnida	*Araneae*	0	0	0	0	0	0	0	0	0.33
Bivalvia	*Mactridae*	2.45	0	0	0	1	0	0	0	0
	Mysidae	0	0.21	0	0	0	0	0	0	0
	Sphaeriidae	0	0	0	0	0	0	0	0	0.44
	Unionidae	0	0	0	0	0	0	0	0	0.11
Crustacea	*Corophiidae*	0	0	0	0	0	0	0	0	0.22
	Harpacticoida	0	0	0	0	0	0	0	0.25	0
	Idoteidae	0.14	0.29	0	0	1	0	0.15	0	0
	Ogyridiae	0.07	0	0	0	0	0	0	0	0
Insecta	*Ceratopoginidae*	0	0	0	0	0	0	0	0.63	0.22
	Chaoberidae	0	0	0	0	0	0	0	0	0.22
	Chironomidae	0	0.29	0	4.67	0	6.5	0.38	4.25	5
	Ephemeridae	0	0	0	0	0	0	1.69	5	2.7
	Trichoptera	0	0	0	0	0	0	0	0	0.11
Nematoda	*Nematoda*	0	0	0	0	0	0	0	0	1.22
Nemertea	*Nemertea*	2.31	0.64	0.29	0.67	1	0	0.38	0	0

Table 2-13. Average abundances of benthic macroinvertebrates in each location within the Estuarine, Transitional, and Freshwater zones in October 2016.

Class	Family	Estuarine	Transitional					Freshwater		
		Estuarine	Raft River	Tensaw River	Chac. Bay	Apalachee River	Grand Bay	Mobile River	Tom. River	Alabama River
Oligochaeta	Tubificidae	0.21	0.21	0	0	0	0	1.23	6.63	13.9
Polychaeta	Ampharetidae	0.21	0	0.29	0	0	0	0.31	0	0
	Archiannelida	0	0	0	0	0	0	0	0	0.11
	Capitellidae	5.03	3.86	10.14	1.33	3	4.25	3.92	0	0.22
	Gonianidae	1.66	0.21	0	0	0	0	0	0	0
	Nereidae	0.62	0.14	0	0	0	0	0.46	0	0
	Nereididae	0.38	0	0.29	0	0	0	0	0	0
	Pilargiidae	4.45	4.07	2	0	0	0	6.08	0	0
	Spionidae	2.24	3.29	22.71	0	0	1.25	6.08	0	0

Table 2-14. Average abundances of benthic macroinvertebrates in each location within the Estuarine, Transitional, and Freshwater zones in May 2017.

Class	Family	Estuarine	Transitional					Freshwater		
			Raft River	Tensaw River	Chac. Bay	Apalachee River	Grand Bay	Mobile River	Tom. River	Alabama River
Arachnida	*Araneae*	0	0	0	0	0	0	0	0.17	0.13
Bivalvia	*Mactridae*	3.80	0.57	0.29	0	0.50	0	0.92	0.17	0
	Mytilidae	0	0	0	0	0	0	0.08	0	0
	Sphaeriidae	0	0	0	0	0	0	0.23	0	0.13
	Tellinidae	1.5	0.29	0	0.33	0.50	1.00	0	0	0
Crustacea	*Alpheidae*	0.03	0	0	0	0	0	0	0	0
	Aoridae	0	0.14	0	0	1.00	0	0.38	0	0
	Corophiidae	0	0	0.29	0	5.00	0	6.92	0.17	0.13
	Cumacea	0.1	0	0	0	0	0	0	0	0
	Gammaridae	0.03	0.07	0	0	0.50	0	0.23	0	0
	Harpacticoida	0	0.14	0.14	0	0	0	0	0	0
	Haustoriidae	0	0.07	0.43	0	0	0	0	0	0
	Idoteidae	0.23	0	0	0	0.50	0	0	0	0
	Melitidae	0	0.07	0	0	0	0	0	0	0
	Mysidacea	0	0	0	1.00	0.50	0.25	0	0	0
	Oedicerotidae	0.4	0	0	0	0	0	0	0	0
	Xanthidae	0.03	0	0	0	0	0	0	0	0

Table 2-14. Average abundances of benthic macroinvertebrates in each location within the Estuarine, Transitional, and Freshwater zones in May 2017.

Class	Family	Estuarine	Transitional					Freshwater		
			Raft River	Tensaw River	Chac. Bay	Apalachee River	Grand Bay	Mobile River	Tom. River	Alabama River
Gastropoda	*Cyclichnidae*	0.03	0	0	0	0	0	0	0	0
	Gastropoda	0	0	0	0	0	0	0.08	0	0
Insecta	*Chaoberidae*	0	0.36	0	0	0	0	0	0	0.13
	Chironomidae	0.63	5.29	1.71	21.33	4.50	6.75	4.00	4.00	17.75
	Coleoptera	0	0	0	0	0	0	0.08	0	2.00
	Ephemeridae	0	0	0.14	0	11.50	0	0.62	2.67	2.50
Nematoda	*Nematoda*	0.03	0.07	0	0	0	0.25	0.38	0.17	6.00
Nemertea	*Nemertea*	0.9	0.57	0.86	1.67	0	0.75	0.23	0	4.00
Oligochaeta	*Tubificidae*	0.87	2.14	1.29	0.67	0.50	0.50	2.00	9.00	3.63
Polychaeta	*Ampharetidae*	2.57	0.64	0	0.33	1.50	1.25	0.77	0	0
	Capitellidae	12.73	5.29	1.14	4.00	3.50	13.75	0.23	0.17	0
	Gonianidae	0.03	0	0	0	0	0	0	0	0
	Nereidae	0.13	0	0	0.67	0.50	0	0	0	0
	Orbiniidae	0.03	0	0	0	0	0	0	0	0
	Pilargiidae	3.10	6.36	1.00	0	3.00	2.75	1.31	0	0
	Spionidae	1.17	0.29	0.29	0.33	0	1.50	1.23	4.83	0

2.6.7.1. Relic Shell Mined Area

The mining of oyster shells in the middle of Mobile Bay substantially modified Bay bathymetry and benthic habitat quality. Fossil oyster shells were mined from Mobile Bay from 1946 to 1982 to manufacture cement-based products, poultry feed, and road materials (Schroeder et al. 1998). The shell mining area is shown in **Figure 2-28**. During this process, suction dredges removed overburdens of silt/clay material as thick as 20 ft at depths of 10 to 16 ft (May 1976). Usable shell was removed and slurried sediment was discharged overboard, forming a series of pits that extended up to 16 ft below the natural bay bottom. In addition, furrow-shaped excavations with elevated ridges that extended up to 5 ft above the bay bottom were created. The habitat quality in this area of the bay was detrimentally affected because excavated pits in Mobile Bay can experience periods of hypoxia and anoxia that are detrimental to fish and other estuarine biota (Reine et al. 2013; Reine et al. 2014). Underwater electrical resistivity tomography and continuous electrical resistivity profiling have since revealed that dredge holes persist in these areas and are filled with fine clayey silt sediments (Nwokebuihe et al. 2016).

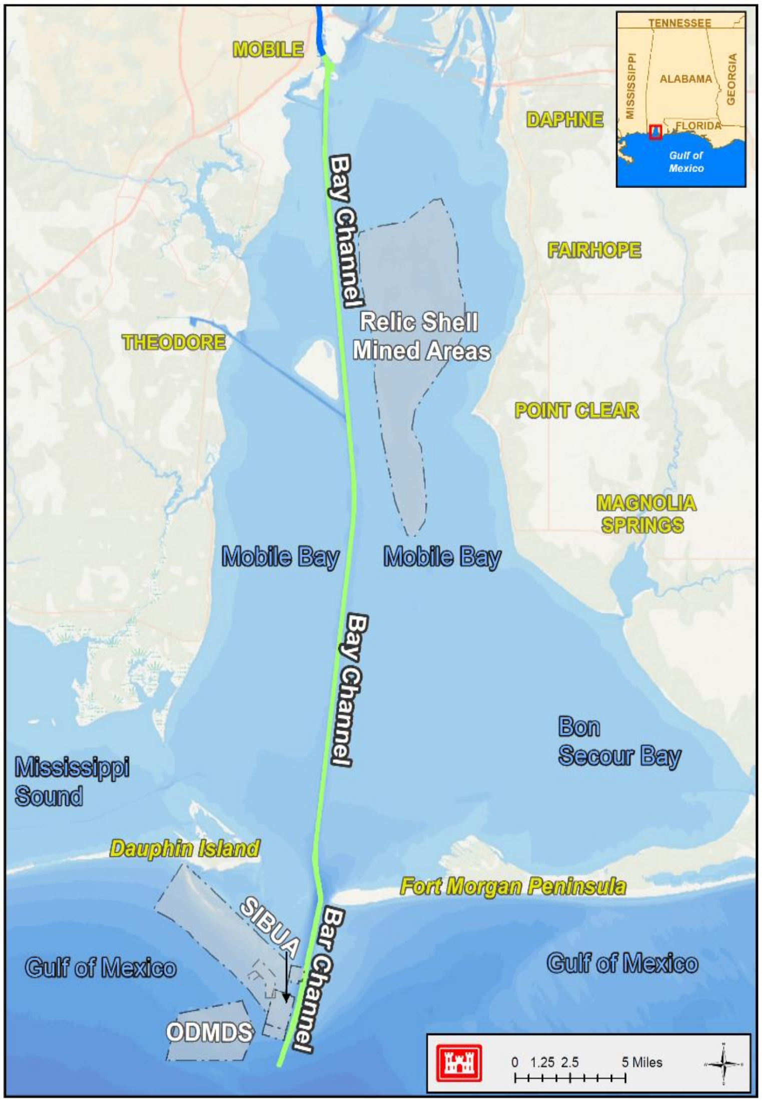


Figure 2-28. Location of Relic Shell Mined Area in the upper half of Mobile Bay

Because oyster holes in the Bay bottom and the associated environmental conditions still persist, the USACE, Mobile District at the recommendation of the cooperating agency beneficial use sub-group, tentatively selected this area as a site for beneficial use of dredged material from the Mobile Bay navigation channel. Subsequently, an investigation was conducted to assess the potential impacts to macrofauna and sediments at proposed beneficial use site (Reine, 2018). Benthic macrofauna are important prey items for demersal fish and crustaceans. Placement of new work dredged material from the proposed modification of the navigation channel into the Relic Shell Mined Area may restore the ecological function of these areas by reducing periods of hypoxia, increasing benthic productivity, and enhancing the forage base of higher trophic organisms in the Bay.

Sampling with 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.

The locations of the sampling stations are illustrated in **Figure 2-29.** Sediments at the Control, Placement, and Impact stations were comprised of roughly equal contributions of clay, fine silt, and coarse to medium silt. Coarser grain sizes were present at the Baseline stations, which were highly variable in sediment composition. In addition, higher total organic carbon (TOC) concentrations at the impact stations are consistent with degraded benthic habitat related to excavated pits that are periodically hypoxic or anoxic.

2.6.8. 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 MRD, 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 ERDC during September 2016 to evaluate recruitment and growth and May 2017 to evaluate the spawning period and young-of-year survival (Berkowitz et al., 2019)

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 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 depicting the sampling station distribution (overall map with two insets) was created (**Figure 2-30**) that illustrates the FAMP stations historically and currently sampled by 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. However, despite the broad geographic coverage represented by their database, only those stations that were located within the footprint of the model grid to be used as snapshots of modeled environmental parameters within the project area were included (**Figure 2-31**).

Outputs from the study provided for the fisheries assessment included baseline conditions, Without-Project conditions and the numerical difference (change) between baseline and With-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.

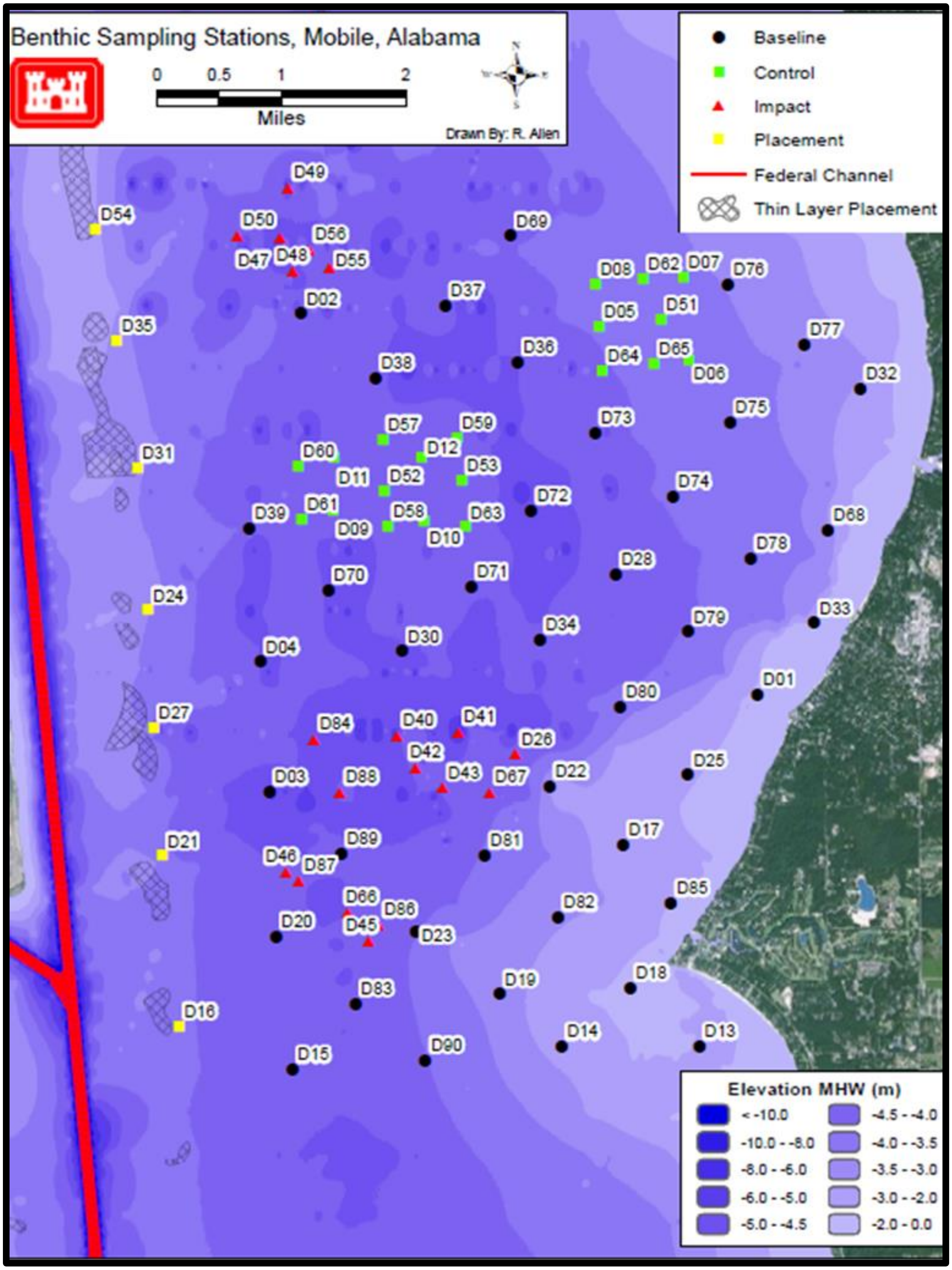
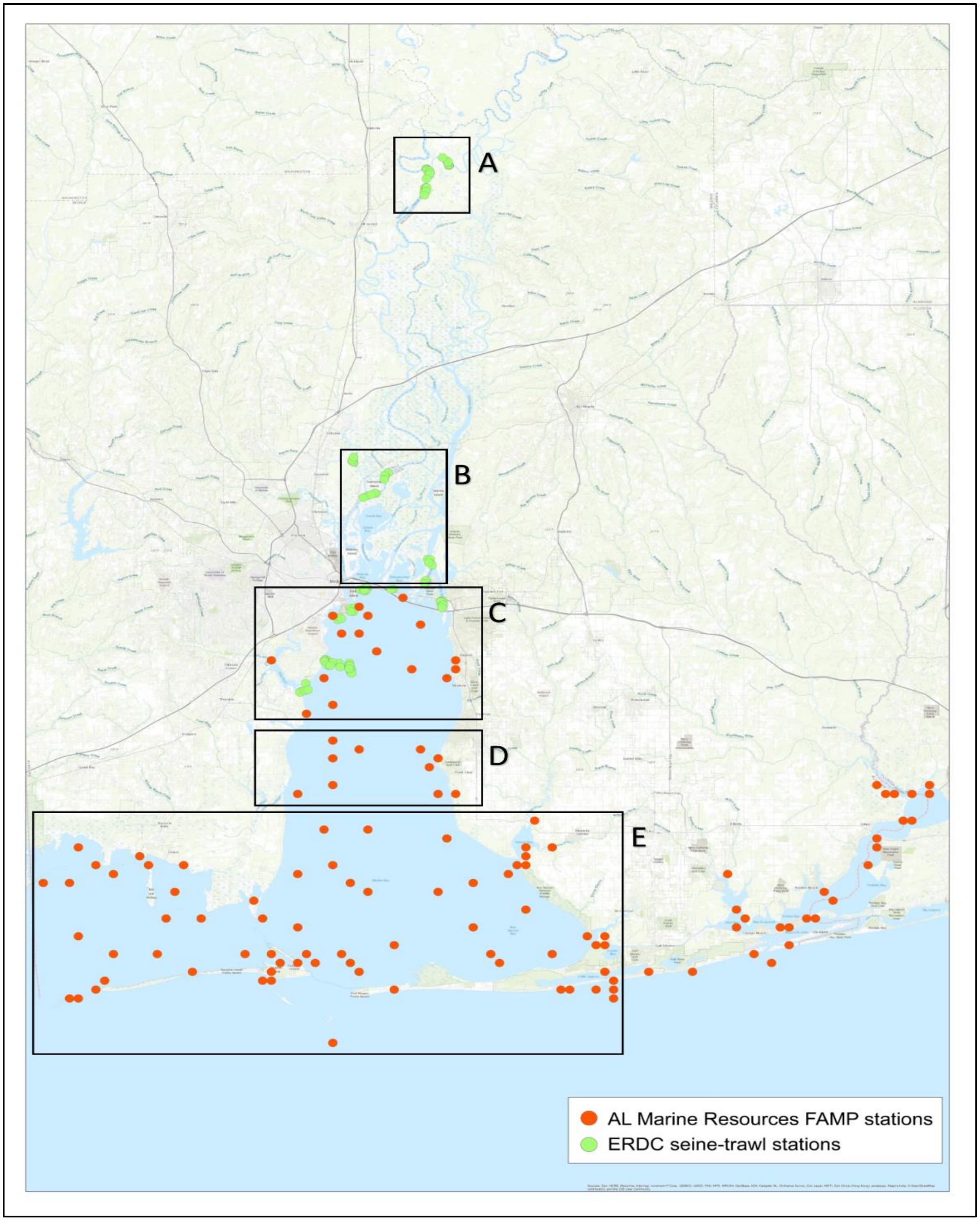
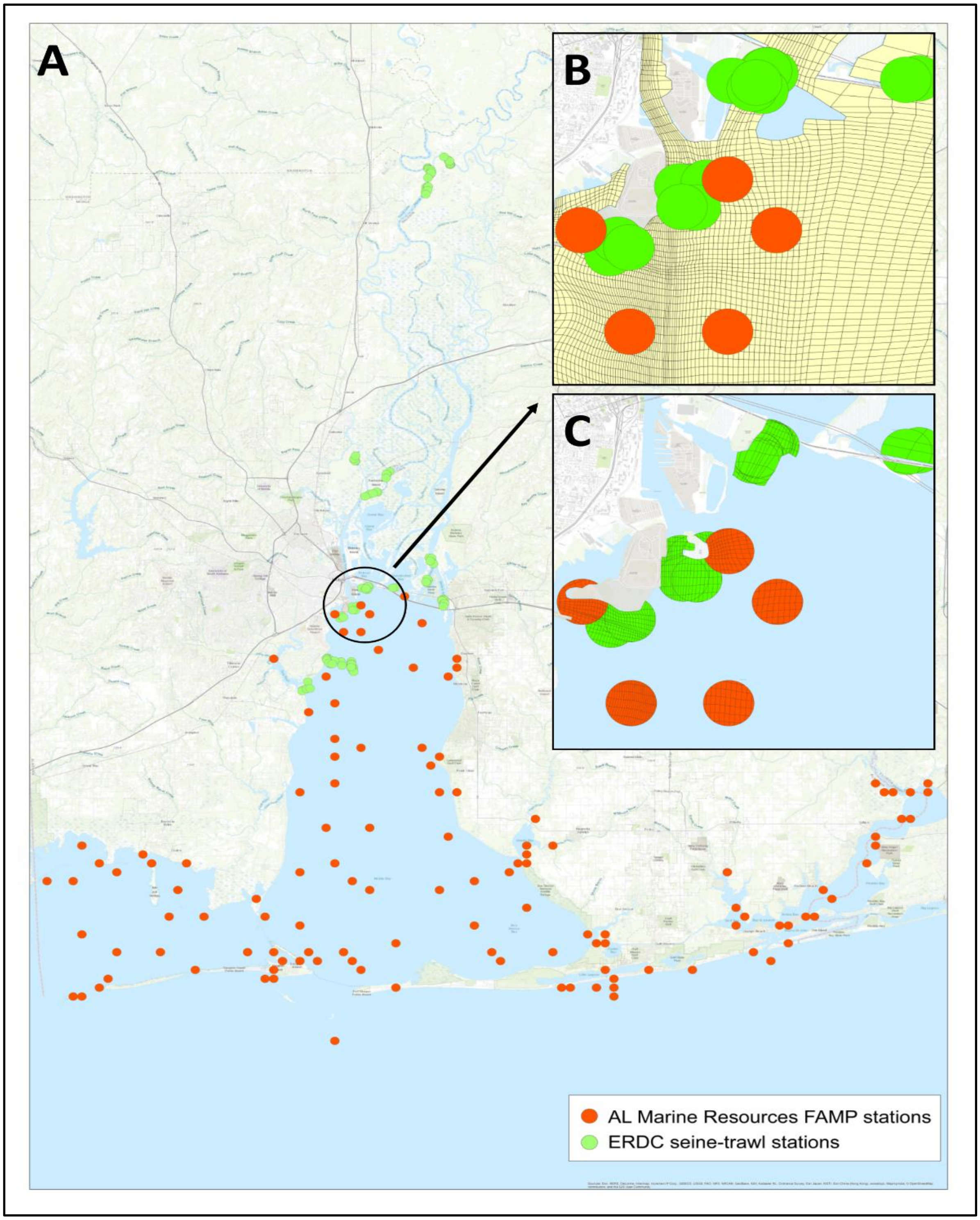


Figure 2-29. Station locations for benthic macrofaunal and sediment samples at the proposed Relic Shell Mined Area.



Zones within the project area are coded as freshwater (A), transition (B), estuarine-upper bay (C), middle bay (D) and lower bay (E).

Figure 2-30. Distribution of ERDC sample stations (green) and Alabama Marine Resources FAMP stations (red) utilized for fisheries assessment.



Panel B highlights a portion of the upper bay zone which depicts the station buffer layer and model grid. Panel C illustrates the extracted model grid cells for the corresponding sample stations.

Figure 2-31. Distribution of ERDC sample stations (green) and Alabama Marine Resources FAMP stations (red) utilized for fisheries assessment (A).

Fish were collected by trawling and seining. A two-seam, 16-foot otter trawl was used to sample benthic fish over a range of water depths. A total of 2-5 trawl samples were taken at each site. Trawling occurred in water depths ranging from 5 to over 30 ft. A GPS recorded average speed and distance travelled during a 10-minute trawl sample, which was the duration used for the FAMP data. The trawl was retrieved after completion of the sample and contents of the cod end was emptied into a sorting container. A 50 x 4 ft., 3/16-inch mesh knotless bag seine was used to sample shoreline fish and shellfish. One seine haul was taken per site, which was the same effort used for the FAMP data. Two people carried the seine out from the shoreline 60 ft, then moved parallel to the shore a short distance to avoid disrupting the sample area. All organisms collected by trawl and seine were identified to species or the lowest practical taxon, enumerated, and measured. Large-bodied fish and shellfish were released at the point of capture after processing. Smaller bodied fish, shellfish, and other invertebrates were preserved in 10% formaldehyde and processed in the laboratory. A label was placed in each sample container including location, date, and sample number. Total length was measured for all fish. Carapace or disc width were measured for crabs, anemone, and other shellfish. Mantle length was measured for squids.

Physical and water quality habitat measurements were taken in conjunction with fishery collections at each site. A GPS location was recorded at each sampling site. Surface and bottom water quality were measured using a calibrated YSI multi-parameter meter and included temperature, pH, conductivity, salinity, and dissolved oxygen. Depth was recorded from boat-mounted transducers, and surface velocity was measured using a Marsh-McBirney flow meter. Substrate type (i.e., sand or mud/silt) was visually assessed from otter boards or using a stadia rod to probe the bottom. 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 (**Table 2-15**). The most speciose assemblage was represented in the marine entering freshwater guild, indicating the importance of the Mobile Bay to this group of fishes. This guild was dominated by three species comprising 79% of the total number of individuals: Spot, Gulf Menhaden, and Atlantic Croaker. The freshwater estuarine guild was next in number of species (21) with a total of 10,315 individuals. Three species comprised 75% of the total number of individuals: Sailfin Molly, Threadfin Shad, and Blue Catfish. The resident estuarine guild had 20 species comprised of 891,773 individuals, but the Bay Anchovy was overwhelming dominate making up 94% of the total. The freshwater only guild had 13 species dominated by Silverside shiner comprising 94% of the total. However, small sample size at these locations contributed to fewer number of species. The marine only guild had nine species, with Red Snapper comprising 91% of the total.

Table 2-15. Species abundance in the Mobile Bay project area by salinity classification.

Common Name	Frequency	Percent	Cumulative Frequency	Cumulative Percent
CLASSIFICATION=Freshwater only				
Banded pygmy sunfish	1	0.05	1	0.05
Crystal darter	2	0.09	3	0.14
Emerald shiner	24	1.1	27	1.24
Flathead catfish	1	0.05	28	1.29
Fluvial shiner	9	0.41	37	1.7
Freshwater drum	40	1.84	77	3.54
Golden shiner	6	0.28	83	3.82
Green sunfish	4	0.18	87	4
Mississippi silvery minnow	8	0.37	95	4.37
Silver chub	17	0.78	112	5.15
Silverside shiner	2060	94.71	2172	99.86
Starhead topminnow	2	0.09	2174	99.95
Taillight shiner	1	0.05	2175	100
CLASSIFICATION=Freshwater entering estuary				
Alligator gar	1	0.01	1	0.01
Black crappie	133	1.25	134	1.26
Blue catfish	1932	18.17	2066	19.43
Bluegill	143	1.34	2209	20.77
Channel catfish	301	2.83	2510	23.6
Coastal shiner	1	0.01	2511	23.61
Gizzard shad	79	0.74	2590	24.35
Golden topminnow	1	0.01	2591	24.36
Largemouth bass	740	6.96	3331	31.32
Least killifish	6	0.06	3337	31.38
Longear sunfish	18	0.17	3355	31.55
Longnose gar	11	0.1	3366	31.65
Redear sunfish	460	4.33	3826	35.98
Redspotted sunfish	369	3.47	4195	39.45
River carpsucker	2	0.02	4197	39.46
Sailfin molly	3141	29.53	7338	69
Saltmarsh topminnow	14	0.13	7352	69.13
Skipjack herring	18	0.17	7370	69.3
Smallmouth buffalo	19	0.18	7389	69.48
Spotted gar	16	0.15	7405	69.63
Threadfin shad	2910	27.36	10315	96.99
Western mosquitofish	319	3	10634	99.99
White crappie	1	0.01	10635	100
CLASSIFICATION=Resident estuarine				
Bay anchovy	840659	94.27	840659	94.27

Table 2-15. Species abundance in the Mobile Bay project area by salinity classification.

Common Name	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Black drum	40	0	840699	94.27
Clown goby	954	0.11	841653	94.38
Code goby	5	0	841658	94.38
Diamond killifish	257	0.03	841915	94.41
Feather blenny	1	0	841916	94.41
Freckled blenny	9	0	841925	94.41
Green goby	145	0.02	842070	94.43
Gulf killifish	540	0.06	842610	94.49
Gulf toadfish	56	0.01	842666	94.49
Highfin goby	511	0.06	843177	94.55
Inland silverside	30448.1	3.41	873625.1	97.96
Naked goby	324	0.04	873949.1	98
Rainwater killifish	12137	1.36	886086.1	99.36
Sheepshead minnow	2551	0.29	888637.1	99.65
Speckled worm eel	1256	0.14	889893.1	99.79
Spotted seatrout	1024	0.11	890917.1	99.9
Striped blenny	1	0	890918.1	99.9
Striped killifish	852	0.1	891770.1	100
Twoscale goby	3	0	891773.1	100
CLASSIFICATION=Marine entering estuary				
Atlantic bumper	7215	0.6	7215	0.6
Atlantic croaker	172572	14.47	179787	15.07
Atlantic cutlassfish	757	0.06	180544	15.13
Atlantic midshipman	69	0.01	180613	15.14
Atlantic moonfish	579	0.05	181192	15.19
Atlantic needlefish	381	0.03	181573	15.22
Atlantic stingray	755	0.06	182328	15.28
Atlantic thread herring	64	0.01	182392	15.29
Atlantic threadfin	1	0	182393	15.29
Banded drum	1774	0.15	184167	15.44
Bandtail puffer	2	0	184169	15.44
Bay whiff	4357.667	0.37	188526.7	15.8
Bighead searobin	1628	0.14	190154.7	15.94
Blackcheek tonguefish	5753	0.48	195907.7	16.42
Blackwing searobin	39	0	195946.7	16.43
Blue runner	2	0	195948.7	16.43
Bluefish	19	0	195967.7	16.43
Bluespotted searobin	3	0	195970.7	16.43
Bluntnose jack	109	0.01	196079.7	16.44
Chain pipefish	252	0.02	196331.7	16.46

Table 2-15. Species abundance in the Mobile Bay project area by salinity classification.

Common Name	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Clearnose skate	6	0	196337.7	16.46
Cobia	6	0	196343.7	16.46
Cownose ray	1	0	196344.7	16.46
Crested blenny	10	0	196354.7	16.46
Crested cusk-eel	187	0.02	196541.7	16.48
Crevalle jack	204	0.02	196745.7	16.49
Dusky anchovy	12567	1.05	209312.7	17.55
Dwarf sand perch	142	0.01	209454.7	17.56
Emerald sleeper	10	0	209464.7	17.56
Fat sleeper	23	0	209487.7	17.56
Florida blenny	1	0	209488.7	17.56
Florida pompano	31	0	209519.7	17.56
Frillfin goby	1	0	209520.7	17.56
Fringed flounder	1921	0.16	211441.7	17.72
Gafftopsail catfish	2868	0.24	214309.7	17.96
Gray snapper	130	0.01	214439.7	17.98
Great barracuda	1	0	214440.7	17.98
Guaguanche	71	0.01	214511.7	17.98
Gulf butterfish	2852	0.24	217363.7	18.22
Gulf flounder	93	0.01	217456.7	18.23
Gulf kingfish	9	0	217465.7	18.23
Gulf menhaden	238228	19.97	455693.7	38.2
Gulf pipefish	389	0.03	456082.7	38.23
Hardhead catfish	14575	1.22	470657.7	39.45
Harvestfish	436	0.04	471093.7	39.49
Inshore lizardfish	1934	0.16	473027.7	39.65
Ladyfish	149	0.01	473176.7	39.66
Lane snapper	341	0.03	473517.7	39.69
Least puffer	2184	0.18	475701.7	39.88
Leatherjacket	194	0.02	475895.7	39.89
Leopard searobin	133	0.01	476028.7	39.9
Lined seahorse	23	0	476051.7	39.91
Lined sole	10	0	476061.7	39.91
Longspine porgy	67	0.01	476128.7	39.91
Lookdown	270	0.02	476398.7	39.93
Lyre goby	2	0	476400.7	39.94
Marsh killifish	647	0.05	477047.7	39.99
Northern kingfish	19	0	477066.7	39.99
Northern sennet	8	0	477074.7	39.99
Pigfish	994	0.08	478068.7	40.07
Pinfish	46220	3.87	524288.7	43.95

Table 2-15. Species abundance in the Mobile Bay project area by salinity classification.

Common Name	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Pygmy sea bass	5	0	524293.7	43.95
Red drum	288	0.02	524581.7	43.97
Rock sea bass	250	0.02	524831.7	43.99
Rough silverside	6076	0.51	530907.7	44.5
Round scad	11	0	530918.7	44.51
Roundel skate	1	0	530919.7	44.51
Sand seatrout	28855	2.42	559774.7	46.92
Scaled sardine	1022	0.09	560796.7	47.01
Scrawled cowfish	3	0	560799.7	47.01
Sharksucker	4	0	560803.7	47.01
Sheepshead	127	0.01	560930.7	47.02
Shortnose batfish	1	0	560931.7	47.02
Silver jenny	689	0.06	561620.7	47.08
Silver perch	5174	0.43	566794.7	47.51
Silver seatrout	1160	0.1	567954.7	47.61
Singlespot frogfish	10	0	567964.7	47.61
Skilletfish	38	0	568002.7	47.61
Smooth butterfly ray	44	0	568046.7	47.62
Smooth puffer	3	0	568049.7	47.62
Southern flounder	444	0.04	568493.7	47.65
Southern hake	1113	0.09	569606.7	47.75
Southern kingfish	1484	0.12	571090.7	47.87
Southern puffer	6	0	571096.7	47.87
Southern stargazer	40	0	571136.7	47.88
Southern stingray	6	0	571142.7	47.88
Spadefish	399	0.03	571541.7	47.91
Spanish mackerel	47	0	571588.7	47.91
Spot	531328	44.54	1102917	92.45
Spotfin mojarra	38045	3.19	1140962	95.64
Spotted hake	754	0.06	1141716	95.71
Spotted whiff	62	0.01	1141778	95.71
Star drum	11950	1	1153728	96.71
Striped anchovy	8794.9	0.74	1162523	97.45
Striped mullet	28125.8	2.36	1190648	99.81
Tripletail	2	0	1190650	99.81
White mullet	2281	0.19	1192931	100
Yellowfin menhaden	7	0	1192938	100
CLASSIFICATION=Marine only				
Blackedge cusk-eel	8	2.54	8	2.54
Broad flounder	9	2.86	17	5.4

Table 2-15. Species abundance in the Mobile Bay project area by salinity classification.

Common Name	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Dusky flounder	2	0.63	19	6.03
Mexican searobin	1	0.32	20	6.35
Red snapper	288	91.43	308	97.78
Rough scad	3	0.95	311	98.73
Round herring	1	0.32	312	99.05
Smoothhead scorpionfish	1	0.32	313	99.37
Spotted batfish	2	0.63	315	100

2.6.9. 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, Mobile Bay, 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 Mobile Bay and Mississippi Sound include various gastropods (snails, limpets, nudibranchs, and sea slugs) and cephalopods (octopods and squids).

2.6.9.1. Oysters in Mobile Bay

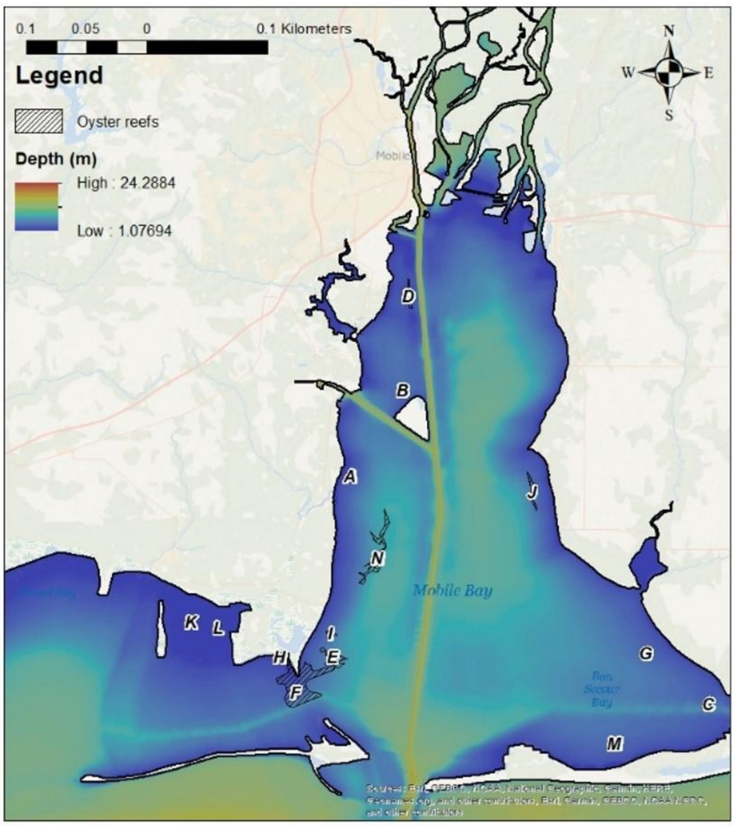
Oysters inhabit shallow estuarine waters during all lifestages. Eastern oyster (Crassostrea virginica) recruitment is the key driver for maintaining oyster population over time. However, this process is poorly understood due to the difficulty in tracking oyster larvae over time. Recruitment occurs through 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., 2019). Specific details of the study conducted by ERDC (Berkowitz et al., 2019) can be accessed in Attachment A-1.

Using information provided by the MRD, 18 adult oyster reefs were assessed (>3,200 acres) for salinity and DO potential impacts based on juvenile and adult oyster tolerance thresholds. The locations of the known reefs used in this assessment for Mobile Bay are indicated in

Note: Cedar Point reef encompasses all five Cedar Point reef areas.

Figure 2-32. 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, local oyster recruitment within the Mobile Bay area could be negatively impacted if a higher percentage of oyster larvae are flushed out of the bay due to hydrodynamic changes caused by alterations to the navigation channel (ERDC, 2018). The potential impacts of the proposed channel modifications are addressed in Section 3.

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).



Label	Reef name
A	Area VI Natural
B	Bender-Austal Reef
C	Bon Secour Reef
D	Brookley Reef
E	Buoy Reef A
F	Cedar Point - all
G	Fish River Reef
H	Heron Bay Pass-aux-Bar
I	Kings Bayou Reef
J	Klondike Reef
K	Portersville Bay Hard Reef
L	Portersville Bay Middle Ground
M	Shell Banks Reef
N	Whitehouse/Denton Reef

Note: Cedar Point reef encompasses all five Cedar Point reef areas.

Figure 2-32. Known reefs used for modeling oyster larval dispersion in Mobile Bay

2.6.10. 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 (*Farfantepenaeus aztecus*), the pink shrimp (*Farfantepenaeus duorarum*), the white shrimp (*Litopenaeus 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 estuaries along the northern Gulf of Mexico in large numbers during the spring, with a smaller wave of migration in the fall. White and pink shrimp post-larvae arrive during the summer and fall, with white post-larvae being more abundant. Of the three species, white shrimp spawn closest to the shore and brown shrimp spawn the farthest from shore (Perry, 2010*).* Brown shrimp inhabit offshore waters ranging from 45–360 ft in depth and adults are most abundant from June to October (Pattillo et al., 1997).

Mature pink shrimp inhabit deep offshore waters, and the highest concentrations occur in depths of 33 to 145 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 to 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. White shrimp, found in shallower waters over mud bottoms, are caught mostly during daylight hours during the fall months. Pink shrimp are usually found in higher-salinity waters and are generally caught at night. These shrimp are most abundant in winter and early spring. Water temperatures, salinity, available food, and habitat area affect the size of the shrimp harvest. The most productive seasons are those when water conditions are warm and brackish, i.e., in the spring.

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 1 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).

2.7. Threatened and/or Endangered Species

Several species of threatened and endangered marine mammals, turtles, 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 2-16** includes 12 species that NMFS, 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 2-16**).

Table 2-16. Federally Listed Threatened and Endangered Species in Mobile and Baldwin Counties, Alabama, and Offshore Waters of Alabama

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).

Table 2-16. Federally Listed Threatened and Endangered Species in Mobile and Baldwin Counties, Alabama, and Offshore Waters of Alabama

Common Name	Scientific Name	Status[a]	Area of Potential Occurrence	Habitat
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 NMFS)	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).

Table 2-16. Federally Listed Threatened and Endangered Species in Mobile and Baldwin Counties, Alabama, and Offshore Waters of Alabama

Common Name	Scientific Name	Status[a]	Area of Potential Occurrence	Habitat
Kemp's Ridley Sea Turtle [b]	*Lepidochelys kempii*	LE (USFWS and NMFS)	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 (NMFS)	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 NMFS)	Mobile and Baldwin Counties, and offshore waters	Rivers, estuaries, and Gulf of Mexico waters (USFWS and NOAA Fisheries, 2009).
Alabama (=inflated) heelsplitter	<u>*Potamilus inflatus*</u>	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 (NMFS)	Offshore waters	Offshore waters.
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 NMFS)	Offshore waters	Offshore waters.

Table 2-16. Federally Listed Threatened and Endangered Species in Mobile and Baldwin Counties, Alabama, and Offshore Waters of Alabama

Common Name	Scientific Name	Status[a]	Area of Potential Occurrence	Habitat
Giant manta ray	*Manta birostris*	LT (NMFS)	Offshore waters	Offshore waters.
Bryde's whale	*Balaenoptera edeni*	Proposed endangered (NMFS)	Offshore waters	Offshore waters.
Sei Whale	*Balaenoptera borealis*	LE (NMFS)	Offshore waters	Offshore waters.
Sperm Whale	*Physeter macrocephalus*	LE (NMFS)	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.

<u>Species Not Discussed Further</u>

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
- 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 NMFS, under the 2003 Gulf Regional Biological Opinion (GRBO) (amended 2005 and 2007) has resulted in 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.

2.7.1. Gulf Sturgeon and Gulf Sturgeon Critical Habitat

The Gulf sturgeon is a subspecies of the Atlantic sturgeon. Subadult and adult Gulf Sturgeon spend six to nine months each year in rivers and three to six of the coolest months (September-March) in estuaries and/or the adjacent Gulf of Mexico. Gulf Sturgeon less than two years old typically reside in lower reaches of riverine habitats and estuaries throughout the year. In general, subadult and adult Gulf Sturgeon begin to migrate into rivers from the Gulf of Mexico as river temperatures increase to about 16 to 23° C (60.8 to 75.0° F). They continue to immigrate through early May, but most arrive when temperatures reach 21° C. Most Gulf Sturgeon return to estuaries or the Gulf of Mexico by mid-November to early December. Adults migrate up the river and other streams during the period of March through September to spawn. Juvenile Gulf Sturgeon use the bay primarily from September through June, although they may be found in the bay or adjacent estuaries during any month of the year. The proposed project area may be used by Gulf sturgeon for foraging during their migration periods.

NMFS and USFWS (2003) jointly designated Gulf Sturgeon Critical Habitat on April 18, 2003 (68 *Federal Register* [Fed. Reg.] 13370, March 19, 2003). The primary constituent elements essential for the conservation of the Gulf sturgeon are those habitat components that support foraging, water quality, sediment quality, and safe unobstructed migratory pathways. However, Mobile Bay and the project waters are not within designated Gulf Sturgeon critical habitat.

2.7.2. Green Sea Turtle

The breeding populations of the green sea turtle off Florida and off the Pacific coast of Mexico are listed as endangered. All other breeding populations are listed as threatened (USFWS, 2010f). Although green sea turtles are found worldwide, this species is concentrated primarily between the 3º North and 35º South latitudes. Green sea turtles tend to occur in waters that remain warmer than 68ºF; however, there is evidence that they may be buried under mud in a torpid state in waters to 50ºF (Ehrhart, 1977; Carr et al., 1979). In the southeastern U.S., nesting season is approximately June through September. Nesting occurs nocturnally at 2-, 3-, or 4-year intervals. Nesting has been known to occur in Alabama.

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

2.7.3. Kemp's Ridley Sea Turtle

The Kemp's ridley sea turtle is listed as endangered under the ESA (USFWS, 2010g). The Kemp's ridley occurs mainly in coastal areas of the Gulf of Mexico and the northwestern Atlantic

Ocean, with occasional individuals reaching European waters. Immature turtles have been found along the eastern seaboard of the U.S. and in the Gulf of Mexico. In the Gulf, studies suggest that immature turtles stay in shallow, warm, nearshore waters in the northern Gulf until cooling waters force them offshore or south along the Florida coast (Renaud, 1995). Little is known of the movements of the post-hatching stage (pelagic stage) within the Gulf. Studies have indicated that this stage varies from 1–4 or more years and the immature stage lasts about 7–9 years (Schmid and Witzell, 1997). The maturity age of this species is estimated to be 7–15 years.

Kemp’s ridley sea turtles are regularly seen in Alabama coastal waters and could potentially nest on the Alabama coastal beaches. Immature Kemp’s ridley turtles have been incidentally captured by recreational fishermen at Mississippi fishing piers. In 2012, almost 200 Kemp’s ridley turtles were captured and rehabilitated (Coleman, personal comm., 2012). Nests have been documented on Santa Rosa Island in the Florida District of the Gulf Islands National Seashore (GUIS) along the Gulf coast. In addition, nesting is being reestablished in Texas through conservation programs; however, its primary nesting area is near Rancho Nuevo in Tamaulipas, Mexico (Rothschild, 2004).

2.7.4. Loggerhead Sea Turtle

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

Nesting in the northern Gulf outside of Florida occurs primarily on the Chandeleur Islands in Louisiana and to a lesser extent on adjacent Ship, Horn, and Petit Bois Islands in Mississippi (Ogren, 1977). Ogren (1977) reported a historical reproductive assemblage of sea turtles, which nested seasonally on remote barrier beaches of eastern Louisiana, Mississippi, and Alabama. These sea turtles have historically nested on Alabama’s beaches and barrier islands.

There currently is designated nearshore reproductive (NMFS) and nesting critical habitat (USFWS) for the loggerhead sea turtle in the project area. The USFWS has identified coastal beach habitat that is important for the recovery of the northwest Atlantic population of the loggerhead sea turtle. The agency has identified portions of islands and mainland coastal beaches in six states, including Alabama, as critical habitat. The areas in Alabama include Little Lagoon Pass, Gulf State Park, and Perdido Pass. NMFS has designated nearshore reproductive critical habitat along the Fort Morgan penninsula along coast Alabama to the Florida State line, which is located in the proposed project vicinity.

2.7.5. Hawksbill Sea Turtle

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

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

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

2.7.6. Leatherback Sea Turtle

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

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

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

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

Adult leatherbacks have been documented by strandings and are regular visitors to our coast as they follow eruptions of jellyfish in the Gulf of Mexico. The possibility of a leatherback nest in Alabama exists each season due to the proximity of a confirmed nest in nearby Gulf Islands National Seashore, Florida, in 2000 (USFWS, 2008).

2.7.7. Piping Plover and Piping Plover Critical Habitat

Different distinct population segments of the piping plover are listed as endangered or threatened under the ESA (USFWS, 2010h). Approximately 35 percent of the piping plover's total breeding population winters on the Gulf coast between Florida and Texas (NatureServe, 2007). The USFWS has designated the Gulf of Mexico coastline, Horn Island, Petit Bois Island, and Round Island as critical habitat for the wintering piping plovers (USFWS, 2001). Piping plovers occur along the Gulf Coast and also may occur on Dauphin Island or other nearby land forms. The final rule designating critical habitat for the wintering population of the piping plover was published in the Fed. Reg. on July 10, 2001. The primary constituent elements for the piping plover wintering habitat are those habitat components that are essential for the primary biological needs of foraging, sheltering, and roosting, and only those areas containing these primary constituent elements within the designated boundaries are considered critical habitat. The primary constituent elements are found in geologically dynamic coastal areas that support or have the potential to support the species, such as intertidal beaches and flats and the sparsely vegetated back beach areas. Important components of intertidal flats include sand and/or mud flats with no or sparse emergent vegetation. Critical habitat for the Alabama extends to the MLLW. During their migration, these areas serve as refueling spots on the long migratory journey. Within the project area, piping plovers are known to congregate primarily along the tidal flats and beaches. Although the piping plover does not nest in Alabama, stopover and foraging habitat could be found near the Mobile Harbor Bar Channel along the shores of Dauphin Island and the Fort Morgan peninsula.

2.7.8. Red Knot

The red knot (*Calidris cantus rufa*) is a sandpiper shorebird species of concern that has been observed wintering on the majority of the Gulf of Mexico barrier islands, including Dauphin Island, in few numbers. The USFWS recently listed the subspecies, the rufa red knot (*Calidris canutus rufa*), as a threatened species under the ESA (USFWS, 2013). *C. canutus rufa* breed in the central Canadian Arctic and most winter in Tierra del Fuego, Maranhão, or Florida (New Jersey Dept. of Env. Protection, 2007). The USFWS lists Mississippi and Alabama as states where *C. canutus rufa* are known or believed to occur. However, a county-level range has not been defined for Mississippi or Alabama. Although red knots are not known to nest in Alabama, stopover and foraging habitat could be found near the Mobile Harbor entrance channel along the shores of Dauphin Island and the Morgan peninsula.

2.7.9. Alabama Red-bellied Turtle

The Alabama red-bellied turtle is listed as endangered under the Endangered Species Act (ESA) (USFWS, 2010e). The Alabama red-bellied turtle is a freshwater, herbivorous turtle that (USFWS, 1990a) is most common in sluggish bays and bayous in brackish marshes adjacent to the main channels of large coastal rivers (USACE, 2009a, USFWS, 1990a). This species is listed as endangered due to habitat degradation in the form of water pollution and siltation from mining, forestry, agriculture and industrial and municipal sewage effluents. Listed on June 16, 1987, the species is a large (carapace length reaching 13 inches) freshwater, herbivorous, diurnal, and non-migratory turtle. It inhabits streams, lakes, and sloughs associated with the lower part of the Mobile-Tensaw Delta and streams adjacent to Mobile Bay. Extensive beds of submerged and emergent aquatic vegetation are considered to be the principal habitats of the species. Destruction of nesting habitat, sand banks and beaches, is the primary cause for the decline in species numbers. Other threats are from disturbances from human activities, loss of aquatic vegetation, and collection for food and pets.

2.8. Marine Mammals

All marine mammals are covered 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 **Table 2-17**, including the West Indian manatee, have been, or are known to occur, in the Gulf of Mexico. Based on NMFS 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 Endangered Species Act (50 CFR Part 224, Federal Register 2016-29412). However, it is currently protected under the Marine Mammals Protection Act. 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.

Table 2-17. 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.

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.

2.9. Other Wildlife Communities

2.9.1. 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. 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 about 620 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, it is likely that some migratory waterfowl use the area for foraging and loafing. 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).

The following bird species are known to use the project area for roosting and foraging: great blue heron, belted kingfisher (*Ceryle alcyon*), ring-billed gull (*Larus delawarensis*), herring gull (*Larus argentatus*), Forester's tern (*Sterna forsteri*), white ibis (*Eudocimus albus*), brown pelican (*Pelecanus occidentalis)*, white pelican (*Pelecanus erythrorhynchos*), snowy egret, great egret, and double-crested cormorant (*Phalacrocorax auritus*). No bird rookeries were observed along the project area shore line.

2.9.2. 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).

2.9.3. Reptiles/Amphibians

The Mobile Bay and 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.

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.

2.10. 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 (Mobile Bay NEP, 2001). Fisheries numbers are astounding. The Mobile Bay NEP (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.

2.10.1. 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 and adjacent areas during part or all of their life cycle. In 1996, the American Sportfishing Association (ASA) reported that recreational fishing in Alabama as a major industry. Historically, the top-producing commercial species are shrimp, blue crab, oysters, and finfish (NMFS, 2002).

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 and topographic highs such as the various artificial reefs and gas rig features located in and around the Bay and nearshore areas.

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.

2.10.2. Red Drum

The red drum is common in the Mobile Bay area (Nelson, 1992). 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 (4 to 12 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 0.1 to 0.2 inches 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 main ship 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 to 88^{o}F, and that early juveniles were captured primarily in March.

2.10.3. Shrimp Fishery

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. Historically, commercial shrimp catches in Alabama have been composed of 87 percent brown, 10% white, and 3% pink and royal red (Swingle, 1971). 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 Intracoastal Waterway, 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.

2.10.4. 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.

2.10.5. 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 Alabama 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.

2.10.6. Oysters

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 Alabama 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.

2.10.7. 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 66 to 84°F 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 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.

2.10.8. 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 0.6 to 1.3 inches 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.

2.11. 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 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 United States 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 ups 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 objection able 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 zebra mussel (*Dreissena polymorpha*), bighead carp (*Hypophthalmichthys nobilis*) and spotted jellyfish (*Phyllorhiza punctata*) (EPA, 2000).

2.12. 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 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 Attachment C-3. 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. The full and detailed Air Quality Report that was prepared for this study is included in Attachment C-3.

2.12.1. NAAQS Attainment Status & CAA General Conformity Rule Applicability

Areas in compliance with the NAAQS are designated "attainment" areas. Areas in violation of the NAAQS are designated as "nonattainment" areas, and new sources being located in or near these areas may be subject to more stringent air permitting requirements. Nonattainment areas are usually defined by county. National standards, other than annual standards, are not to be exceeded more than once per year (except where noted). Areas that cannot be classified on the basis of available information for a particular pollutant are designated as "unclassifiable" and are treated as attainment areas unless proven otherwise.

The CAA, as amended in 1990, also expands the scope and content of the act's conformity provisions in terms of their relationship to the State Implementation Plan. Under Section 176(c) of the CAA, a project is in "conformity" if it corresponds to State Implementation Plans' purpose of eliminating or reducing the severity and number of violations of the NAAQS and achieving their expeditious attainment.

The EPA published final rules on general conformity (40 CFR Parts 51 and 93) in the Federal Register on November 30, 1993 and subsequently revised the rules on March 24, 2010. The rules apply to federal actions in nonattainment or maintenance areas for any of the applicable criteria pollutants. The rules specify *de minimis* emission levels by pollutant to determine the applicability of conformity requirements for a project on a local level. However, the ROI area (Mobile and Baldwin Counties) where the Proposed Action is located is in attainment for all criteria pollutants; therefore, the rules do not apply to the implementation of the Proposed Action and a general conformity applicability analysis is not required.

2.12.2. Navigation Channel Existing Air Quality

Existing air quality conditions in the Study Area can be reflected through the current status of NAAQS attainment and the recent ambient air monitoring data collected by ADEM and published by EPA.

Mobile and Baldwin Counties, within which the project area lies, have been designated as attainment areas for all criteria pollutant standards. The most recent available measured ambient air concentrations closest to the project area as shown in **Table 2-18** are consistent with the above designation. Therefore, the project area is located in an area with good air quality.

Table 2-18. 2016 Air Quality in Mobile AL Metropolitan Area

Pollutant		Concentration	NAAQS	Metric
Carbon Monoxide (CO)		NM (1)	35 ppm	2nd highest 1-hour measurement in the year
		NM (1)	9 ppm	2nd highest non-overlapping 8-hour average in the year
Lead (Pb)		NM (1)	0.15 μg/m^3	Maximum of all rolling 3-month averages in the year
Nitrogen Dioxide (NO_2)		NM (1)	100 ppb	98th percentile of the daily max 1-hour measurements in the year
		NM (1)	53 ppb	Annual mean of all the 1-hour measurements in the year
Ozone (O_3)[2]		0.06 ppm	0.07 ppm	4th highest daily max 8-hour average in the year
Particulate Matter (PM)[2]	$PM_{2.5}$	16.0 μg/m^3	35 μg/m^3	98th percentile of the daily average measurements in the year
		8.1 μg/m^3	12 μg/m^3	Weighted Annual Mean (mean weighted by calendar quarter) for the year
	PM_{10}	NM (1)	150 μg/m^3	2nd highest 24-hour average measurement in the year
Sulfur Dioxide (SO_2)[2]		13.0 ppb	75 ppb	99th percentile of the daily max 1-hour measurements in the year
		NM (1)	0.5 ppm	Secondary 3-hour Average Standard

Notes:

(1) Not Monitored. The Alabama Department of Environmental Management does not monitor this pollutant because the Mobile CBSA does not meet the minimum monitoring requirements. Minimum monitoring requirements vary for each pollutant and can be based on a combination of factors such as population, level of traffic on nearby major roads, the level of monitored pollutants, and Core Based Statistical Area boundaries as defined in the latest US Census information.

(2) In the Mobile MSA there are 2 O_3 monitors (located at Bay Road, and in Chickasaw), 1 $PM_{2.5}$ monitor (Chickasaw), and 1 SO_2 monitor (Chickasaw) (2017 Ambient Air Plan.docx)

Source: https://www.epa.gov/outdoor-air-quality-data/air-quality-statistics-report

2.12.3. Baseline Conditions

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.

Because the Port of Mobile (the port) 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 Draft GRR/SEIS purpose estimates emissions that occur on-port 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 the port boundary such as:

- Stationary sources: terminal exhaust stacks and coal handling 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
- Locomotives and rail yard

The areas around the port 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.

Under the CAA general conformity rule applicable to nonattainment areas, the EPA uses the major stationary source definition under the New Source Review program as the de minimis levels to separate presumably exempt actions from those requiring a positive conformity determination on a project level. Because the project occurs in an area that is in attainment for all criteria pollutants, the major stationary source definition of 250 tons under the PSD program was selected as a comparable project-level significant impact threshold for this Draft GRR/SEIS.

The baseline 2011 emissions estimate was made essentially based on the levels established by EPA using the C-TOOLs modeling system. Supplemental emission source elements such as emissions from on-port truck running and coal storage piles were further considered using additional EPA-developed analysis tools or documents and their emissions were added to the C-TOOLs predicted 2011 baseline emissions. The 2011 baseline emission inventory is presented in **Table 2-19** and details on emission estimates can be found in Attachment C-3.

2.13. Hazardous and Toxic Materials

Hazardous materials, including hazardous substances and 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.

Table 2-19. Predicted 2011 Baseline Annual Port-wide Operational Emissions

Source Category	NO_x (tons)	CO (tons)	SO_2 (tons)	$PM_{2.5}$ (tons)	PM_{10} (tons)
Ships and Harbor Craft along Channels (line sources)	1151.6	448.1	107.2	35.5	38.7
Terminal Areas and Railyards (area and point sources)	2122.5	411.1	69.5	67.0	73.0
Railways (line sources)	45.5	6.3	0.4	1.4	1.5
On-Port Trucks	21.8	10.8	0.0	1.8	2.5
Coal Pile	--	--	--	0.7	4.6
Total	3,341.4	876.3	177.1	106.4	120.3

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 the State Emergency Response Commission, local emergency planning committee, 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.

The federal law regulating hazardous wastes is RCRA, and RCRA regulations define what constitutes a hazardous waste and establish a “cradle to grave” system for management and disposal of such wastes. Subtitle C of RCRA also includes separate, less stringent regulations for certain potentially hazardous wastes. Used oil, for example, is regulated differently depending on whether it is disposed of or recycled. Specific requirements are provided under RCRA for generators, transporters, processors, and burners of used oil that are recycled.

Universal wastes may be managed in accordance with the RCRA requirements for hazardous wastes or by special, less stringent provisions.

In considering Hazardous, Toxic, and Radioactive Waste (HTRW), according to 40 CFR Section 261.4(g), dredged material from navigation projects is exempt from solid and hazardous waste consideration. The document states that dredging large volumes of sediment from U.S. waters is a common practice used to maintain navigable waterways, ports and marinas. Excavated dredged material is currently disposed in the ocean at designated sites in accordance with Marine Protection, Research, and Sanctuaries Act (MPRSA). Additional options for disposing of dredged material exist under the Clean Water Act (CWA), including discharge into open waters of the U.S., discharge to confined placement facilities located in the U.S., and the beneficial use of dredged material. Prior to the promulgation of this exclusion, if dredged material proposed for placement in the aquatic environment was contaminated or suspected of being contaminated with hazardous waste, the potential application of both the RCRA Subtitle C regulations and the dredged material regulations under CWA or MPRSA complicated efficient assessment and management of dredged material. In order to avoid duplicative regulation, dredged material produced as a result of maintenance or project-related dredging is subject to a permit issuance under Section 103 of MPRSA, or Section 404 of CWA , and is excluded from the definition of hazardous waste (63 FR 65874, 65921; November 30, 1998).

The Mobile Harbor Federal Navigation Channel, itself, does not generate hazardous materials. However, approximately 10 terminals currently handle coal, petroleum products, e 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.

Vehicles transporting hazardous waste, including radioactive materials, flammable, corrosive and explosive materials are currently prohibited from traveling through the I-10 Wallace tunnels. This was decreed in a Federal Register Notice on December 2, 2000 by the Federal Motor Carrier Safety Administration because of the potential for accidents in a confined space. Currently, these trucks are re-routed through the Mobile 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 2010, and a projected 396 trucks by 2030 (FHWA and ALDOT 2014).

2.14. Noise

This section provides an overview of the existing airborne and underwater ambient sound environment in the project area.

2.14.1. Airborne Noise

Noise is unwanted or unwelcome sound usually caused by human activity and added to the natural acoustic setting of a locale. It is further defined as sound that disrupts normal activities and diminishes the quality of the environment. Community response to noise is dependent on the intensity of the sound source, its duration, the proximity of noise-sensitive land uses, and the time of day the noise occurs (i.e., higher sensitivities would be expected during the quieter overnight periods).

Noise in terms of air pressure is the force experienced by an object immersed in air divided by the area on which the force acts. The typical unit of measurement used to evaluate air pressure is pounds per square inch. However, when dealing with sound pressure levels, an international unit, the Pascal (Pa), is what is commonly used. One pound per square inch is equal to 6,890 Pa. The loudest sounds that can be detected comfortably by the human ear have intensities that are a trillion times higher than those of sounds that can barely be detected. Because of this vast range, using a linear scale to represent the intensity of sound becomes very unwieldy. As a result, a logarithmic unit known as the decibel (dB) is used to represent the intensity of a sound. Such a representation is called a sound level. The dB unit expresses the ratio of sound pressure to a reference standard. Specifically, the sound pressure level in dB is defined as 20 times the common logarithm of the ratio of sound pressure in Pa to the reference pressure (0.00002 Pa or 20µPa for airborne sound). Some typical levels of sound in dB are shown in **Table 2-20**.

Table 2-20. Common Sounds in Air and Water

Amplitude of Example Sounds	In Air (dB re 20µPa at 1 meter)	In Water (dB re 1µPa at 1 meter)
Threshold of hearing	0 dB	--
Whisper at 1 meter	20 dB	--
Normal conversation	60 dB	--
Painful to human ear	130 dB	--
Jet engine	140 dB	--
Blue whale	--	165 dB
Earthquake	--	210 dB
Supertanker	128 dB	190 dB

Source: NOAA 2003

Since sound is measured in units of decibels (dB) on a logarithmic scale; increasing the noise level by 5 dB results in a noise level perceived by the human ear to be twice as loud as the original source. The “pitch” (high or low) of the sound is a description of frequency, which is measured in Hertz (Hz). Most common environmental sounds are a composite of sound energy at various frequencies. A normal human ear can usually detect sounds that fall within the frequencies from 20 Hz to 20,000 Hz. However, humans are most sensitive to frequencies between 500 Hz to 4,000 Hz.

Given that the human ear cannot perceive all pitches or frequencies in the sound range, 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.

2.14.1.1. Regulations

The Noise Control Act of 1972, along with its subsequent amendments, delegates authority to the states to regulate environmental noise and directs government agencies to comply with local community noise statutes and regulations. Although there are no regulations for community noise in Mobile or Baldwin Counties, the City of Mobile has noise ordinances for public places and in residential areas. Noise-restricted activities include construction, amplified music and domestic power equipment. According to the ordinance, excessive noise is prohibited during the daytime (6 am to 10 pm) within a residential community when it is plainly audible at a distance of fifty (50) ft or more from any property line or upon any public street or right-of-way. Additionally, any activity which creates noise in a residential area that exceeds eighty-five (85) dBa at any property line or upon any public street or right-of-way is prohibited. During the nighttime (10 pm to 6 am), the distance is reduced to 25 ft and the sound level is reduced to 50 dB (City of Mobile 2018). Residential areas do not occur within 50 ft of the proposed project areas.

For on-road traffic-related noise, Alabama Department of Transportation (ADOT) developed Highway Traffic Noise Analysis and Abatement Policy and Guidance (ADOT, July13, 2016). According to the ADOT policy, a 15-dBA increase over the existing condition as a result of a highway project is considered a substantial increase in traffic noise and the project would require noise abatement. EPA guidelines recommend that day and night average sound levels (Ldn) do not exceed 55 dBA for outdoor residential areas. The EPA noise guideline is considered to be sufficient to protect the public from the effect of broadband environmental noise in typical outdoor and residential areas. These levels are not regulatory goals but are "intentionally conservative to protect the most sensitive portion of the American population" with "an additional margin of safety" (EPA 1974). The U.S. Department of Housing and Urban Development (HUD) considers an Ldn of 65 dBA or less to be compatible with residential areas (HUD 1985).

2.14.1.2. Background Noise Levels

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.

Community noise refers to outdoor noise near a community. A continuous source of noise is rare for long periods and is typically not a characteristic of community noise. Typical background day/night noise levels for rural areas range between 35 and 50 dB whereas higher-density residential and urban areas background noise levels range from 43 dB to 72 dB (EPA 1974). Background noise levels greater than 65 dBA can interfere with normal conversation, watching television, using a telephone, listening to the radio, and sleeping.

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 modification project. 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).

Existing noise levels in the project area where sensitive receptors are located are already relatively high ranging from 56 to 85 dBA (USACE 2003, FHA and ADOT 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 EIS.

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 (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).

2.14.2. 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).

2.14.2.1. Regulations

Marine mammals are protected under the MMPA, enacted on October 21, 1972. Under this regulation, noise induced hearing loss (NIHL) can be considered a ‘taking’ of marine mammals. In 2016, the NMFS published technical guidance regarding impacts to marine life due to noise exposure. The guidance identifies the received levels, or acoustic thresholds, at which individual marine mammals are predicted to experience changes in their hearing sensitivity (either temporary or permanent) for acute, incidental exposure to underwater anthropogenic sound sources. It provides thresholds for the onset of temporary threshold shifts (TTS) and permanent threshold shifts (PTS) in marine mammal hearing (NOAA NMFS 2016).

No direct measurements of marine mammal PTS have been published; PTS onset acoustic thresholds have been extrapolated from marine mammal TTS measurements. PTS onset acoustic thresholds for all sound sources are divided into two broad categories: 1) impulsive (airguns, impact pile drivers) and 2) non-impulsive (tactical sonar, vibratory pile drivers) as listed in **Table 2-21** and **Table 2-22**. Acoustic thresholds are also presented as dual metric acoustic thresholds using cumulative sound exposure level (SEL_{cum},) and peak sound pressure (PK) metrics for impulsive sounds. For non-impulsive sounds that are relevant to the sources in port channels such as dredges and vessels, thresholds are provided using the SEL_{cum} metric. Additionally, to account for the fact that different species groups use and hear sound differently, marine mammals are sub-divided into five broad hearing groups – low frequency (LF), mid frequency (MF), high frequency (HF), Phocids (earless seals) in water (PW), and Otariids (eared seals) in water (OW).

Table 2-21. TTS Onset Auditory Acoustic Thresholds for Non-impulsive Sounds.

Hearing Group	Weighted TTS Onset Acoustic Thresholds (SEL_{cum} in dB)
Low-frequency Cetaceans (baleen whales)	179
Mid-frequency Cetaceans (dolphins, toothed whales, beaked whales, bottlenose whales)	178
High-frequency Cetaceans (true porpoises, Kogia, river dolphins, cephalorhynchid, etc.)	153
Phocid Pinnipeds (true seals)	181
Otariid Pinnipeds (sea lions and fur seals)	199

Table 2-22. PTS acoustic levels for both impulsive and non-impulsive sounds

	PTS Onset Acoustic Thresholds * (Received Level)	
Hearing Group	**Impulsive**	**Non-impulsive**
Low Frequescy (LF) Cetaceans	*Cell 1* $L_{pk,flat}$: 219 dB $L_{E,LF,24h}$: 183 dB	*Cell 2* $L_{E,LF,24h}$: 199 dB
Mid Frequency (MF) Cetaceans	*Cell 3* $L_{pk,flat}$: 230 dB LE,MF,24h: 185 dB	*Cell 4* $L_{E,MF,24h}$: 198 dB
High Frequency (HF) Cetaceans	*Cell 5* $L_{pk,flat}$: 202 dB $L_{E,HF,24h}$: 155 dB	*Cell 6* $L_{E,HF,24h}$: 173 dB
Phocid Pinnipeds (PW) (Underwater)	*Cell 7* $L_{pk,flat}$: 218 dB $L_{E,PW,24h}$: 185 dB	*Cell 8* $L_{E,PW,24h}$: 201 dB
Otariid Pinnipeds (OW) (Underwater)	*Cell 9* $L_{pk,flat}$: 232 dB $L_{E,OW,24h}$: 203 dB	*Cell 10* $L_{E,OW,24h}$: 219 dB

* Dual metric acoustic thresholds for impulsive sounds: Use whichever results in the largest isopleth for calculating PTS onset. If a non-impulsive sound has the potential of exceeding the peak sound pressure level thresholds associated with impulsive sounds, these thresholds should also be considered.

Note: Peak sound pressure (L_{pk}) has a reference value of 1 µPa, and cumulative sound exposure level (L_E) has a reference value of 1µPa2s. In this Table, thresholds are abbreviated to reflect American National Standards Institute standards (ANSI 2013). However, peak sound pressure is defined by ANSI as incorporating frequency weighting, which is not the intent for this Technical Guidance. Hence, the subscript "flat" is being included to indicate peak sound pressure should be flat weighted or unweighted within the generalized hearing range. The subscript associated with cumulative sound exposure level thresholds indicates the designated marine mammal auditory weighting function (LF, MF, and HF cetaceans, and PW and OW pinnipeds) and that the recommended accumulation period is 24 hours. The cumulative sound exposure level thresholds could be exceeded in a multitude of ways (i.e., varying exposure levels and durations, duty cycle). When possible, it is valuable for action proponents to indicate the conditions under which these acoustic thresholds will be exceeded. Source: 7. NOAA NMFS 2016.

Table 2-21 presents weighted TTS and PTS levels for the hearing groups, respectively. (NOAA NMFS 2016).

The SEL_{cum} metric takes into account both received level and duration of exposure, both factors that contribute to NIHL. Often this metric is normalized to a single sound exposure of one second. NMFS intends for the SEL_{cum} metric to account for the accumulated exposure. This metric should be applied to individual activities, not exposure to multiple activities over time. Accumulation time must be established for this metric, NMFS recommends using 24 hours unless specific shorter or longer time periods are predicted. The peak sound level metric (PK) is also used by the NMFS to determine acoustic PTS levels. These are considered the point at which permanent damage would occur due to exposure to an impulsive sound. The PK thresholds are therefore un-weighted, as they represent noise levels which results in direct mechanical damage.

2.14.2.2. Background Levels

Underwater noises in the project area consist of natural background sounds (e.g., the ocean, coastal winds, and fauna) and anthropogenic noise sources (e.g., fishing/shrimp boats, pleasure craft, dredges, shipping traffic, oil/natural gas rigs, and aircraft from airports. Shipping traffic throughout the Gulf Intracoastal Waterway (GIWW) exceeds 232,000 vessel trips per year (USACE, 2008). Marine shipping activities produce underwater noise, typically low-frequency sounds in the range of 20-500 hertz (Hz), resulting from operation of engines and propellers. Low-frequency sound travels farther underwater than higher-frequency sound (University of Rhode Island, 2003). Vessel propulsion type and horsepower are important factors in the intensity of underwater sound emitted by powered vessels. Source levels for hopper dredges generally range from 161 dB to 177 dB re 1 µPa at 3.3 ft (8 Reine et al., 2014). Source levels for cutterhead dredges range from 151dB to 157dB re 1 µPa at 3.3 ft (Reine et al., 2014). Underwater noise levels of marine vessels range from 157 to 182 dB re 1 µPa at a distance of 3 fee (Kipple and Gabriele, 2004). Although source running time and frequency are factors, these levels are essentially below the range of PTS and TTS thresholds developed by the NMFS.

2.15. Coastal Barrier Resources

The Coastal Barrier Resources Act (CBRA) of 1982 (PL 97-348) restricts Federal expenditures and financial assistance within designated CBRA zones in the Gulf and Atlantic Coasts. The navigation channel and associated disposal areas are not located within designated CBRA zones. Therefore, CBRA will not be considered further under this study.

2.16. Cultural and Historic Resources

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 that is included in, or eligible for inclusion in, the National Register of Historic Places maintained by the Secretary of the Interior. Several Federal laws and regulations protect these properties, 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.

The history of Mobile Bay is rich and evidence of prehistoric and historic human activity is common along its shores and within its waters. Sediments within the bay are known for preserving shipwrecks and their contents. In addition to submerged sites, there are a number of terrestrial archaeological sites and historic buildings and structures in Mobile Bay or along the shoreline such as Forts Morgan and Gaines (both listed on the National Register), and structures in the bay including Middle Bay Lighthouse (listed on the National Register) and Sand Island Lighthouse (currently unevaluated for National Register eligibility).

Section 106 of the NHPA and its implementing regulations, 36 CFR Part 800, requires an assessment of the potential impact of an undertaking on historic properties that are within the proposed project's Area of Potential Effect (APE), which is defined as the geographic area(s) "within which an undertaking that may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist." The APE for the direct impacts for the proposed project includes the areas where dredging activities and the placement of dredged material would occur. This includes the Choctaw Pass Turning Basin, Bay Channel, and Bar Channel of Mobile Harbor and Dredging placement areas including the Relic Shell Mining Area, SIBUA, and ODMDS as shown below in **Figure 3-6**.

2.16.1. Prehistory of Mobile Bay Area

Paleoindian Period

While there is much debate on when Paleoindian peoples first populated the Americas, it is generally agreed upon that between 20,000 - 10,000 years before present (YBP) people occupied the northern Gulf Coast. This period falls at the end of the Pleistocene and the beginning of the Holocene and marks the transitrion from the “ice age” to warmer more seasonal and temperate weather patterns. This warming trend casued sea level to rise as large volumes of water were released form melting glaciers. During the Late Pliestocen prior to the arrival of people on the Gulf Coast when sea levels were lowest, large areas of the continental shelf were exposed and the Gulf’s shoreline was 100 km south of its present position. By the time Paleoindian peoples first occupied the Gulf, global sea levels were approximately 65 ft lower than today. The shoreline during this period, a focal point for Paleoindian exploitation of maritime resources, would have been situated several miles south of Mobile Bay.

The earliest Paleoindian occupants of the northern Gulf Coast were nomadic hunter/gatherers and evidence for their presence is limited to fluted projectile points. While evidence for Paleoindian occupation is widely believed to be located in the now-submerged bottomlands in Mobile Bay and surrounding offshore areas (Mistovich and Knight 1983, Lydecker et al. 2015), no Paleoindian sites or artifacts have been found within the project area. This is supported by the presence of Paleoindian sites located in nearby Covington County Alabama, Escambia County, Florida, and in submerged contexts along Florida’s Gulf Coast.

Archaic Period

The earliest known occupants in the immediate vicinity of the project area date to the Early Archaic Period. This period is also characterized projectile points, specifically Dalton, Hardaway, and Big Sandy type points (Trickey and Holmes 1971:124). These point types can be used to accurately date the initial human settlement of the Mobile area at 9,000 - 10,000 YBP. Sea levels continued to rise steadily throughout this period and submerged Early Archaic sites could be present in the project’s APE. The rate of sea level rise slowed between 6,000 - 7,000 YBP, but, continued to steadily inundate lands that potentially contained Archaic Period archaeological sites.

While various Early Archaic sites have been identified within the Coastal Plain region of the gulf, Early and Middle Archaic sites are relatively rare within the Mobile Bay area (Trickey and Holmes 1971:124). This apperent lack of archaeological evidence regarding the Archaic period of Mobile Bay could be due to a general lack of published archaeological research on the area or because most of the sites dating to this period are inundated (Mistovich and Knight 1983:9, Lydecker et al. 2015:11).

Between 6,000 - 3,000 YBP the Fort Morgan Peninsula began to form. The relic oyster beds in the upper bay also formed at this time and may have been exploited by archaic peoples

(Mistovich and Knight 1983:23). By about 3,000 YBP, the present coastal environmental conditions were established and a relatively sedentary human population occupied the lower part of Mobile Bay and harvested the area's abundant oyster beds. This trend continued throughout the prehistoric period (Lydecker et al. 2015:11).

Between 3,200-2,700 YBP, fiber tempered ceramics appear in the Mobile River Delta and on the present day margins of Mississippi Sound and Mobile Bay (Mistovich and Knight 1983:23). These ceramics are more commonly found in archaeological sites associated with estuarine environments rather than those associated with riverine or inland environments. This suggests that the archaic inhabitants of the Mobile Bay area were primarily focused upon estuarine resources for subsistence (Mistovich and Knight 1983:9).

Woodland Period

From 2,700–2,000 YBP the Bayou La Batre ceramic series is established in the area, and there is documented cultural exchange with the lower Mississippi Valley. Bayou La Batre ceramics are characterized by coarse grit temper, tetrapodal or tripodal bases, scallop shell impressions and shell rocker stamping (Trickey and Holmes 1971:124). This is also the earliest human occupation of Dauphin Island suggesting that watercraft were in use at that time. The next 450 years (2,000–1,550 YBP) sees the development of the Porter ceramic series. During this time people continue the estuarine centered hunting and gathering of the Bayou La Batre culture (Mistovich and Knight 1983:23). The Porter phase shows some cultural continuity with the earlier Bayou La Batre ceramic series, but, was also influenced by the Santa Rosa Island culture to the east (James et al. 2015:13; Walthall 1980:156; Wimberly 1960).

From 1,550–850 YBP estuarine hunting and gathering continues with the Tates-Hammock Phase replacing the Bayou La Batre cultural system. Tates-Hammock is a regional variant of the broader Weeden Island culture (Mistovich and Knight 1983:23). Weeden Island is generally defined as a Late Woodland culture that began making ceremonial as well as functional ceramic types. Functional types were for daily use and are often found in middens and house sites, while cremonial types were found primarily in mounds (Milanich et al. 1997:19-22). The Tates-Hammock ceramics were similar to the earlier sand tempered Santa Rosa ceramics and other earlier types found in the area. Abundant and reliable aquatic food resources available in the Mobile Bay area also fueled the development of more elaborate mortuary practices, more intensive and centralized settlement patterns, and increased social hierarchy during this period (James et al. 2015:13).

Mississippian Period

A dramatic cultural shift occurred with the transition from the Late Woodland period to the Mississippian period between 1,100 - 900 YBP. Primarily, the Mississippian Period is characterized by increased sedentism afforded by an increased reliance upon agriculture. Increased social hierarchy, warfare, ceremonialism, and the establishment of large mound complexes are also typical markers of Mississippian culture. This has been demonstrated by archaeological evidence for increased long-distance trade, complex artistry, and ceremonial iconography unique to the Mississippian period (Walthall 1980:185).

Bottle Creek ceremonial mound complex in the center of the Mobile River Delta dates to the Missippian Period. The Bottle Creek type site is specifically associated with the Pensacola culture, a coastal variant of the Mississippian culture and the later Bear Point complex. It is believed that the unique Pensacola culture, while still heavily reliant on estuarine resources, also practiced a form of delta adapted horticulture. Dietary analyses of a Bear Point-aged archaeological materials, which also included some early European artifacts, revealed a diverse diet of fish, shellfish, terrestrial animals, and agricultural products (Mistovich and Knight 1983:11).

Prehistoric Considerations

Rising sea levels stabilized at the modern shoreline sometime after 4,000 YBP and much of what is now Moblile Bay was inundated between 6,000–4,000 YBP. Human occupation of the now inundated project APE was, therefore, limited to the Early Archaic and Paleoindian periods. While landforms known to contain sites form these early time periods have been identified in Mobile Bay, the potential for the present project to impact inundated Paleoindian or Early Archaic period resources is extremely limited. This is because, sites dating to these early periods genrally consist of isolated artifacts or small scatters of artifacts with limited distributions. Significant advances are being made in finding these earfly sites and the submerged landforms that contain them within the Gulf. Several models for the Mobile Bay area have also been published that show submerged relic river channels and other areas that could contain evidence for early prehistoric occupation (**Figure 2-33**).

2.16.2. History of the Mobile Bay Area

The following historical context was complied by Wes Hall (2007:4-16) for the maritime Phase I survey for the expansion of the turning basin at Choctaw Pass, under contract with the USACE. It provides important historical information on the turning basing survey area and the Mobile Harbor GRR APE. Most of this information has been reprinted from Hall (2007) with some edits for clarity and updates based on recent investigations conducted by Grinnan et al. (2018).

European Settlement and Colonialism to American Annexation

Spanish ships under the command of Alonso Alvarez De Pineda first sailed into Mobile Bay in 1519 during the age of discovery. The French continued to investigate the gulf coast in the 17th century, including locating the mouth of the Mississippi River and setting up Fort Maurepas, or Old Biloxi in 1699. However, the first successful attempt at European settlement on the gulf coast was at Pensacola in 1698 by the Spanish. The initial French attempt to settle the Mobile area, Fort Louis, or “Old Mobile” was at 27 Mile Bluff−upstream from modern-day Mobile on the

Mobile River in 1702. The bar at the entrance to the bay at this time was 12 to 13 ft deep at low tide making the bay inaccessible to the largest ships. With the unpredictable and constant threat of shoaling and no convienient and safe place along the shoreline to unload cargo, large vessels were moored at “Port Dauphine,” at modern-day Pelican Bay on the south side of Dauphin Island. From Port Dauphine, cargos were unloaded onto smaller vessels which then lightered goods 30 miles up the bay and Mobile River to the Fort Lewis. Fort Lewis was only occupied for a decade before a month-long flood forced the French to move to Choctaw Point, the site of present day Mobile.

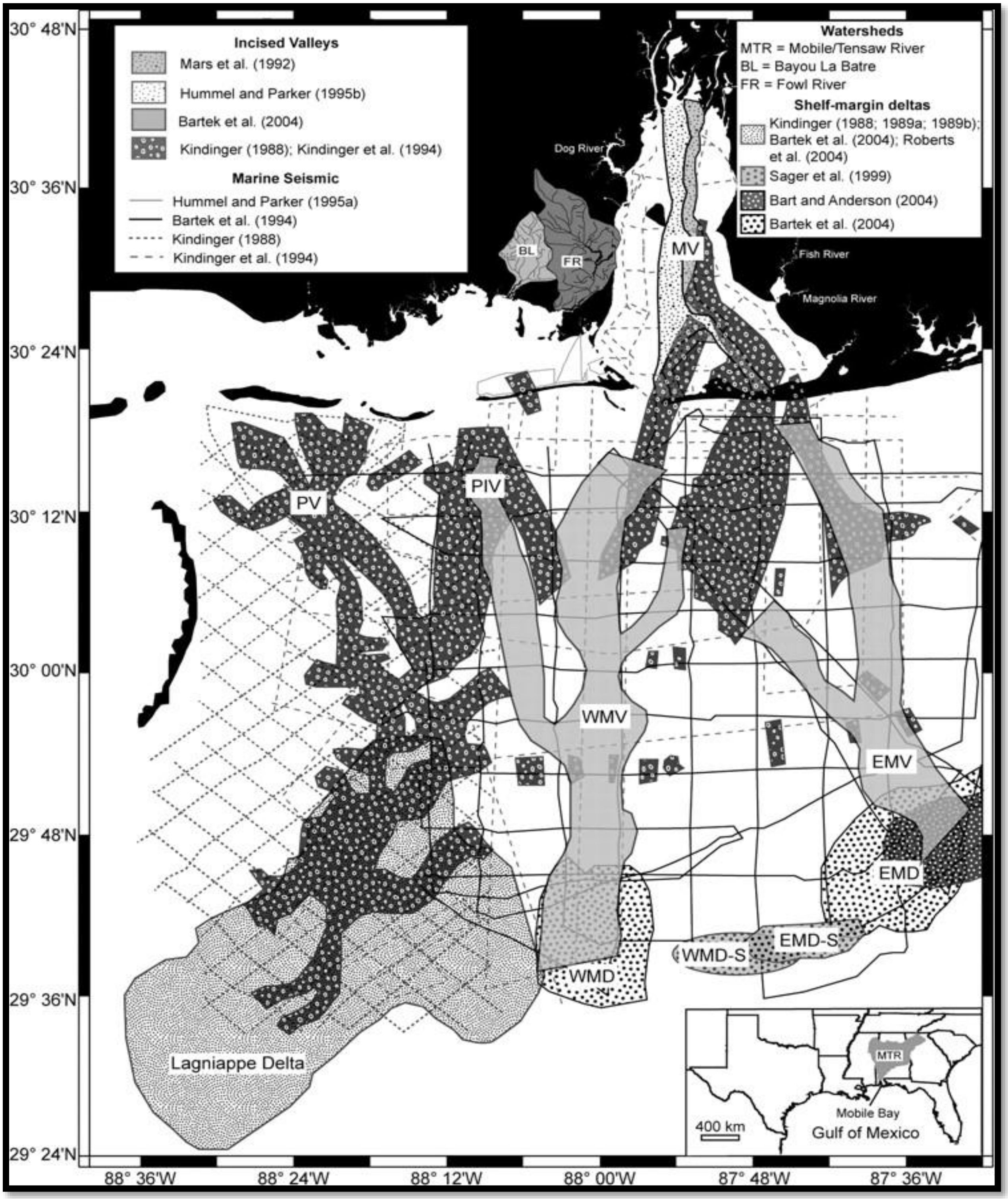


Figure 2-33. Composite paleographic map showing paleo river valleys and landforms (Greene et al. 2007:140).

Shifting sands from a hurricane further limited access to the bay and Port Dauphine. By 1717 ships could not access the sheltered Port Dauphine and had to unload cargo out in the Gulf of Mexico. This rendered Port Dauphine useless and the outpost was abandoned in 1719. Shortly after the War of the Quadruple Alliance in 1720, the capitol of Louisiana was transferred from Mobile to Biloxi (Mistovich and Knight 1983).

Mobile was still occupied during the early to mid-eighteenth century despite relatively dismal conditions. With relatively little available in the way of trade goods and raw materials, Mobile provided meager economic gains for the French. Through the persistence of the local inhabitants and primarily through a trade monopoly established by the John Law's "Company of the West," commerce in the area expanded between 1717 and 1731. Ships carrying supplies called more frequently and the population increased from the arival of both colonists and slaves. Exports included rice, corn, beans, indigo, tobacco, cotton, and naval stores such as pitch, tar, and lumber. Mobile continued on as a French colony until the end of the French and Indian War. Through complex land exchanges among the belligerents in this war, Mobile, along with the rest of West Florida, was ceded to the British in 1763.

The British made accurate maps and charts of the area in the interest of both commerce and military security. These charts allowed the British to safely bring larger vessels into the lower bay. It was once said that the entire British fleet could, if necessary, anchor within the confines of the bay (Delaney 1962; Mistovich and Knight 1983). Exports during the British period included indigo, hides, timber, naval stores, cattle, corn, tallow, bear oil, rice, tobacco, myrtle wax, salted wild beef, salted fish, pecans, sassafras, and oranges (Mistovich and Knight 1983).

As an ally to the United States during the American Revolution, the Spanish Governor of Louisiana, Don Bernardo de Galvez, captured Mobile from the British in 1781, stranding four of his ships on Mobile Bar in the process. During this second period of Spanish rule, commerce continued to focus upon trade with Native Americans. As the Spanish did not trade with Native Americans in the area, companies, such as Panton, Leslie and Co. (later Forbes and Co.), that were already established in East Florida, were able to eventually dominate trade in West Florida, which at that time included Mobile.

In 1803, through the Louisiana Purchase, Napoleon sold France's territory including New Orleans, the largest port in the Gulf, to the the United States. Spain claimed that Mobile was not part of the Louisiana Purchase and insisted that it was part of Spanish controlled West Florida. Despite this claim and that Spain and the United States were at peace, General Wilkinson captured Mobile in 1812. The American occupation of Mobile in 1813 ended more than 100 years of European control.

<u>American Control</u>

American control of the Mobile erased the international boarder to the north and opened the entire Alabama River system to American trade. The Native American cession of the lands encompassing present day Alabama to the United States through treaties such as the Mount Dexter and Fort Jackson settlement opportunites were created for Americans from the established states. In contrast to the French, Spanish, and British practice of granting large tracts of land to applicants, the American system granted small tracts of land to individuals. This attracted large numbers of settlers, spured economic growth in Mobile and expedited the rapid development of the surrounding countryside (Hamilton 1913). Within 3 years, the towns of Tuscaloosa, Cahawa, Demopolis, Montgomery, Selma, and Claiborne were built. These cities became collection points for cotton as a plantation system was developed by slaveholders transplanted from older planatations from the east. Cotton was easily brought downriver by keelboats and flatboats, however, upriver travel was difficult for these vessels. In 1818, with the introduction of the steamboat, reliable packet service began. Mobile began to enjoy success as the central distribution point for cotton grown in the Alabama-Tombigbee-Warrior River agricultural region, and became the second largest international seaport on the Gulf Coast between 1815 and 1861 (Mistovich and Knight 1989). In 1860, $150,000,000 worth of cotton was reportedly exported through Mobile (Owsly 1989).

The rapid influx of settlers, American land claims, and rising tensions between the United States and Britian were a source of conflict for the new American Territory. Men in the area were organized into militia that were as active as the regular army whom regularly fought with Native American Tribes supplied by the British in Pensecola. While the militias engaged Tribes in the inland frontier, General Claiborne, who commanded the territorial troops, was tasked with the defense of Mobile. In 1814, Andrew Jackson assumed command at Mobile, which was under threat by the British fleet operating in the Gulf. In September 1814, the British conducted a combined land and sea attack of Fort Bowyer at Mobile Point. During the attack the H.M.S. *Hermes* ran aground and was set on fire by her crew and abandoned. In a massive show of force with 38 vessels and 5,000 men General Lawrence surrendered Fort Bowyer on Febuary 12, 1815 after minor fighting. This happened after the signing of the Ghent Peace Treaty on December 24, 1814, by which all property captured by the British was returned (Hamilton 1913).

Like the large deep draught vessels of the British and Spanish occupation that used Mobile Harbor, American brigs, barks, and schooners were required to anchor in lower Mobile Bay and unload cargo onto smaller boats for transport ashore. Navigational hazards such as Choctaw Point Spit and the Dog River Bar precluded direct access of ships with moderate drafts to Mobile Harbor. In 1826 congress appropriated funds to improve to the harbor. Beginning in 1839, a 5-foot channel was created through present-day Grants Pass allowing vessels to travel between New Orleans and Mobile through the sheltered waters to the Mississippi Sound (Bond 1983). Obstacles were cleared and dredging of Mobile Harbor’s channels and tunning basin were conducted in 1857 (Mistovich, Knight 1983).

<u>Civil War</u>

Mobile became a Confederate port in 1861, with the succession of Alabama from the Union. Mobile’s strategic location on the Gulf became even more important after the fall of New Orleans and Pensacola in 1862, leaving Mobile as the only port able to receive supplies from Europe (by way of Cuba). For this reason, Mobile was heavily defended by Confederate forces during the war. Important defensive features in Mobile Bay included Fort Morgan on Mobile Point and Fort Gains across the entrance channel on Dauphin Island. Fort Morgan, commanded by Col. William L. Powell, CSA, housed 700 men and was equipped with 79 guns comprising parapet guns, mostly 32-pound smoothbores with limited range and unreliable accuracy and smaller casemate guns, mostly 24-pound smoothbores. In contrast, Fort Gains had a total of 30 guns.

During the war, romurs spread that confederate forces were building an ironclad in Mobile. In one instance Union Commander, Rear Admiral David Farragut received news that a new ironclad, the Tennessee, “a ram more formidable than the Merrimack” would be launched. Rear Admiral Farragut was also warned that the confederates had five such rams ready and waiting at Mobile (Hearn 1993:63). In truth, the Tennessee could not pass over the Dog River Bar, the ironclads Huntsville and Tuscaloosa were not ready for battle, the Nashville was in Montgomery awaiting armor, and the Baltic was available for service, but, was very slow. Only three small gunboats, the Selma, the Gaines, and the Morgan actually protected Mobile Bay (Hearn 1993).

During the time of the Civil War, wealthy local sugar broker Horace L. Hunley was busy trying to perfect his submarine. His first attempt, the Pioneer, had not yet been refined enough during Farragut’s attack on New Orleans in 1862. And, although the the subsequent vessel, Hunley, showed promise in Mobile, unsuccessful test runs kept the submersibles from seeing any action in Mobile Bay. The Hunley, however, would be the first submarine to sink a war ship, USS Husatonic, off Fort Sumter, in Charleston, on 17 February 1874.

Rumor of its “impenetrable defenses” might have been the reason that Mobile was not attacked until the very end of the Civil War. However, the Union did maintain blockades at Mobile Bay in an attempted to prevent the delivery of much-needed Confederate supplies (arms, ammunitions, medicine, and blankets) and the export of trade goods.

Mobile had enjoyed a reputation as a cultural center, during the antebellum period. The prosperous cotton trade had created great wealth among many of the citizens, and they yearned for the finer things. Little affected personally by the Civil War, blockade running became a profitable business, and many ship captains were willing to take the risk. By one count, there were at least 208 successful blockade runs to the port, a number which does not take into account the smaller vessels that took more discreet routes (Hearn 1953). The success of blockade running was good for the Mobile economy, as exports (namely cotton) continued to make their way to Europe and other trade ports. And, with the Alabama interior protected, cotton production was uninterrupted despite the war.

Rear Admiral Farragut often complained that his vessels – often in need of fuel and repair, were ineffective at stopping the blockade runners. In defense of this, the incident in which the unarmed *CSS Florida* (or *Oreto*) easily steamed through four gunboat stations off Fort Morgan in broad daylight reaching Mobile with minimum damage and then returning to sea with the same ease four months later was readily recounted (Hearn 1993). Only a few blockade runners could not evade capture, such as the *Clara*, *Elias Beckwith*, and side-wheeler *Eugenie*. The prize *Eugenie* was outfitted with two small guns, renamed *USS Glasgow*, and used in the Battle of Mobile Bay as a dispatch boat (Hearn 1993).

In the spring of 1862, the Confederate forces under the direction of Captain Charles Liernur implemented a harbor defense plan. This plan included the deployment of floating mines called torpedoes, and placing solid obstructions that consisted of piles and sunken vessels at various points in the bay. Some of the obstruction points were also guarded by shore batteries like the channel through Dog River Bar in the Upper Bay (Irion 1985).

On August 5, 1864, a fleet led by Rear Admiral Farragut launched an attack against Mobile. Farragut's fleet included various ironclads and a contingent of 5,000 troops. The lead vessel, Tecumseh, struck a torpedo and immediately sank. Rear Admiral Farragut exclaimed "Damn the torpedoes! Four bells. Captain, go ahead! Jouett, full speed," and passed into the bay beyond the reach of shore based guns with the bulk of his warships intact. The Confederate fleet was reduced to one ironclad vessel, the CSS Tennessee. Greatly outnumbered, the heavily armoured Tennessee single handedly attacked the Federal fleet. Several union vessels attempted to ram the Tennessee, but suffered more damage than they could inflict. The Tennessee's thick armor easily deflected shots from the Union fleet, but, inferior powder, misfires, jammed gun port shuters, broken rudder chains, and a destroyed smokestack left her defenseless and unable to move. Two Union ironclads took up position next to the crippled Tennessee and pummeled her with 15 inch guns until she surrendered. Without navel support, Fort Gaines was captured the following day and Fort Morgan on Dauphin Island surrendered on August 22, 1864. With the lower Mobile Bay under Union control the blockade, of the south was complete. Forts Morgan and Gaines was repared by the Union from which attacks on Spanish Fort and Blakely on the eastern shore were launched (Wheat 2008). Mobile was besieged by the Union Army from March 25, 1865 until the city capitulated on April 12, 1865. Confederate forces surrendered that same month ending the war.

<u>Nineteenth Century to Present</u>

Following the Civil War, Mobile, along with most of the south struggled to recover. Mobile, however, was still well positioned for international trade. During the last half of the nineteenth century, after the Civil War, entrepeneurs in Mobile devised new means of importing and exporting goods, the Mobile Board of Trade was established in 1868 to bolster local and state economies, and the Federal government provided funding to dredge the harbor (Kirkland 2012; Lewis 2007).

In 1879 the Alabama Legislature established a commission for harbor improvements that removed Civil War obstructions and modified channels. From 1876 to 1934 the U.S. Army Corps of Engineers conducted a series of dredging projects to deepen and widen a 32-foot ship channel from the Mobile Bar entrance to the city, boosting seagoing trade. Grant's Pass was also opened, enabling steamship access between Mobile Bay and Mississippi Sound (Mistovich and Knight 1983). In 1914, the Upper Bay channel was straightened, establishing its current configuration, to remove a dangerous bend. With all of these navigational improvements complete, seagoing vessels could sail directly to the city wharves for the first time (See Mistovich and Knight 1983 for a detailed chronology of harbor improvements from 1826 to 1943).

At the turn of the nineteenth century, local maritime traffic had grown considerably as the number of fishing, oystering, and recreational vessels also increased. Small local shipyards were established to build both small fishing and recreational vessels and large steam boats. The bay steamers, such as the Mobile-built Baldwin, were often used to ferry passengers between Mobile and excursion points on the eastern shore such as Fairhope, Daphne, and Point Clear (Mistovich and Knight 1983).

Early in the twentieth century, the cotton trade waned as other industries gained prominence. An increase in iron and coal industries, particularly in Birmingham, contributed to the prominence of Mobile as a Gulf port. World War I prompted the need for shipbuilding and companies such the Alabama Dry Dock and Shipbuilding, operating since the 1880s, became Mobile's largest industrial employer. By 1917, five major shipbuilding operations were active in the Bay area (McLaurin and Thomas 1981).

During World War II, Mobile's shipbuilding industry proved invaluable to the Allied war effort. During the military buildup prior to the war Mobile's population exploded with workers to meet the increased demand fro shipbuilding. The Alabama Dry Dock and Shipbuilding Company alone, built 20 Liberty Ships between 1941 and 1945. Shipbuilding continues today as an important commercial activity in Mobile.

POTENTIAL FOR SUBMERGED CULTURAL RESOURCES

Paleoindian and Archaic Resources

By the end of the Pleistocene, the Southeast underwent several climatic oscillations (Grimm et al. 2006). During the Paleoindian period (14,550-10,000 YBP), the Southeast was much drier than it is now. Many of the lakes, rivers, and springs within the region were not filled or flowing until the Early Holocene (Faure et al. 2002).

In parts of the Southeast U.S. 50 percent of all Paleoindian sites have been identified within 1.2 km (0.7 mi) of a paleo-freshwater source (Duggins 2012). This includes Paleoindina artifats in association with Pleistocene fauna within relic and extant springs and streambeds (Neill 1964). With more aride conditions during the Early Holocene, humans and animals would have been dependant upon these sources of water. Some settlement models have proposed that Paleoindian peoples were highly mobile, yet groups may have adopted a semi-sedentary lifestyle with prolonged occupations around permenant freshwater sources (Neill 1964; Thulman 2006). Paleoindian peoples would be drawn to locations such as currently inundated portions of the Mobile River as a dependable source of water.

The association of Early Archaic sites with major rivers is even more apparent. Sixty-six percent of Early Archaic sites are located within 2.0 km (1.2 mi) of a major river (Duggins 2012). The earliest known shell middens within the Gulf Region date to this period (8200 - 8050 YBP) (Saunders and Russo 2011) and were established as sea-level rise began to slow and resources rich estuaries such as Mobile Bay began to form. During the Middle and Late Archaic subsistence patterns increasingly focus on estuarine resources. Subsequently, during the Late Archaic and Woodland Periods, the exploitation estuarine continues to intensify resulting in an increase in number of large shell midden sites (Saunders and Russo 2011).

The Paleo-channels of the Mobile and Tensaw Rivers and associated estuaries were likely rich in aquatic resources and served as an important source of fresh water for Paleoindian and Archaic peoples. Additionally, the Mobile-Tensaw River valley would have been frequented by Pleistocene fauna frequently utilized by Paleoindian groups and the banks of the river may have been an excellent location for semi-sedentary Paleoindian camps sites.

By about 7,500 YBP, the area currently known as Mobile Bay, was likely a productive estuary representing a rich source of fish, shellfish, and water fowl for Archaic

Period peoples. Therefore, Mobile Bay could contain submerged historic properties dating to the Paleoindian and Archaic periods. The most likely location of these properties would be along the margins of the submerged Paleo river and stream channels.

Historic Resources

The earliest shipwrecks in Mobile Bay that are readily detectable with modern remote-sensing technologies date to the sixteenth century. During this period Spanish explorers increasingly navigated the Gulf of Mexico and were the first to Record Mobile Bay. The first European settlement in Mobile Bay was established on Dauphin Island in 1702 and later moved to the mouth of the Mobile River in 1711. Through time, Mobile Bay was continually used as a center for commerce due to the presence of a deep-water port and the sheltered nature of the bay. Activity increased in the seventeenth and eighteenth centuries as fledgling settlements and towns became important anchorages and ports. The establishment of protective batteries at the entrances to Mobile Bay on Dauphin Island protected a growing domestic and international commercial trade. Mobile Bay became an important maritime artery between the Gulf of Mexico and the bay's hinterlands. Smaller craft also increasingly crisscrossed the bay, ferrying passengers between smaller coastal communities, as well as between the military outposts.

With the pronounced increase in European maritime traffic in the region between the seventeenth and eighteenth centuries, NRHP eligible shipwrecks of both large vessels and small locally build craft associated with the colony could be present within the APE. An increase in the occurrence of vessel casualties would likely coincide with increased maritime traffic as a growing number of vessels of all sizes fell victim to hurricanes, sand bars, military action, and shoals through time.

A prime example is la Bellone, a French merchant ship that sank unexpectedly in April 1725. Although there is contradicting information regarding the fate of La Ballone, an account of the event written by a monk reported that the vessel sank at the mouth of Mobile Bay, off Dauphin Island (Krivor et al. 2011). Despite frenzied searches to recover reportedly valuable cargo the final resting place of la Bellone remains unknown.

As commerce flourished in the Gulf of Mexico, tensions between various colonies increased to the point of war. In the late eighteenth and early nineteenth centuries during the War of 1812, Mobile changed hands various times. Activity from vessels associated with commerce and local industries was suspended during these conflicts. This likely lessened the potential for the presence of NRHP eligible shipwrecks dating to this period within the APE.

Following these conflicts, maritime commerce throughout the Gulf of Mexico expanded. Steam vessels became a regular sight within Mobile Bay, which were well suited to exploit the region's transportation needs. However, the Federal blockade of southern ports during the American Civil War, restricted maritime trade activities. As with previous wars, the potential presence of NRHP eligible shipwrecks of non-military vessels within the APE from this period has also been lessened. Blockade running became a briefly profitable and dangerous industry during the Civil War and the Battle of Mobile resulted in a dramatic Confederate ship losses. Therefor, there is potential that NRHP shipwrecks from the Civil

War era are present in the APE especially at the southern terminus of the Channel where the Battle of Mobile was fought.

Mobile increased in importance as a commercial hub with the steady recovery during Reconstruction and the late nineteenth century. Locally built vessels of all types supported the well-established industries and commerce of Mobile Bay. Therefore there is potential for the presence of NRHP eligible shipwrecks dating to this period of increased maritime activity within the APE.

Mobile became a major military shipbuilding and shipping center as the Mobile Bay region boomed in the twentieth century. However, the potential for maritime casualties during this time period significantly decreases. Factors decreasing shipwrecks include harbor improvements implemented by the Army Corps of Engineers, which created safe navigation corridors and the development of ship navigation technologies that reduced the chance of human error. There is a corresponding increase in the potential for historic navigation aids along the margins of shipping channels, however, as well as transportation related jetsam.

Mobile Bay's main Navigation Channel has been extensively dredged and the deposition of dredging material could have buried submerged historic properties. Therefore, unknown historic properties may exist within the project APE.

Previously recorded Cultural Resources

Cartographic images, secondary sources (Gaines 2008; Shomette 1973), and databases of reported shipwrecks were reviewed to identify reported submerged cultural resources within or adjacent to the project APE. Several desktop reviews, cultural resources reconnaissance studies, and environmental assessments have addressed the potential for submerged historic resources in the vicinity of the mouth of Mobile Bay, including Mistovich and Knight (1983) and Krivor (2004). The database sources include the following

- Bureau of Ocean Energy Management (BOEM) Archaeological Resource Information Database
- Global GIS Data Services, LLC, Global Maritime Wrecks Database (GMWD)
- National Oceanic and Atmospheric Administration (NOAA)
- Automated Wreck and Obstruction Information System (AWOIS)
- NOAA electronic navigation charts (ENC)
- USACE, Mobile District, shipwreck map

Table 2-23 lists shipwrecks that have been reported within 1.6 km (1.0 mi) of the APE. The accuracy of locational data for historic shipwrecks is tentative in most instances. Historic shipwrecks generally are plotted based on contemporary records, maps, or oral histories. Many shipwreck databases provide a range of position accuracy or an accuracy reliability scale. It must be assumed, therefore, that **Table 2-23** does not constitute an exhaustive list of reported shipwrecks potentially within the 1.6-km (1.0-mi) zone surrounding the APE, nor can it be assumed that every shipwreck truly resides where it is depicted.

Table 2-23. Shipwrecks Reported Within 1.6 km (1.0 mi) of APE

Map ID	Name	IDNumber	Date Sunk	Source	Location
1	Alphonsine	USACE 45	1889	USACE	Mobile Bay
2	Bellone	USACE 3	Unknown ·	USACE	Pelican Island
3	Bonne Fortune	USACE 31	Unknown	USACE	West Bank
4	Bunge 401	AWOIS 3524	Unknown	AWOIS, GMWD	Mobile Bay
5	Elvolante	USACE 24	Unknown	USACE	Gulf of Mexico
6	HMS Herman	USACE 33	Unknown	USACE	Mobile Point
7	Indian Chief	USACE 17	1916	USACE	Mobile Bar Channel
8	Liberian Freighter	USACE 23	Unknown	AWOIS, ENC, GMWD, USACE	Gulf of Mexico
9	Magnolia	GMWD 23082	1945	AWOIS, ENC, GMWD, USACE	Adjacent Mobile Bar Channel
10	Philipi	USACE 27	1864	USACE	West Bank
11	Raymond Lee	USACE 41	Unknown	USACE	Mobile Bay
12	Rosario	USACE 30	Unknown	USACE	Mobile Point
13	Sun #2	USACE 20	1906	USACE	Gulf of Mexico
14	USS Tecumseh	ENC 9800	1864	AWOIS, ENC, GMWD	Mobile Point
15	Terry Lee	BOEM 799	1957	BOEM, ENC, GMWD, USACE	Gulf of Mexico
16	Barge CBC-21	AWOIS 3533	1979	AWOIS, USACE	Mobile Bay
17	Barge	USACE 40	Unknown	USACE	Mobile Bay
18	Barge	USACE 42	Unknown	USACE	Lower Bay Channel
19	Unknown	AWOIS 7336	Unknown	AWOIS, ENC, GMWD	Gulf of Mexico
20	Unknown	ENC 2814	Unknown	ENC	Adjacent Mobile Bar Channel
21	Unknown	GMWD 38769	1980	AWOIS, ENC, GMWD, USACE	Mobile Point
22	Unknown	GMWD 38769	1980	GMWD	Northside Mobile Point
23	Unknown	AWOIS 12361	Unknown	AWOIS, ENC, GMWD	Northside Mobile Point
24	Unknown	ENC 233	Unknown	ENC	Mobile Bay
25	Unknown	USACE 35	Unknown	USACE	Mobile Bay
26	Unknown	USACE 39	Unknown	USACE	Lower Bay Channel
27	Unknown	AWOIS 3531	Unknown	AWOIS, GMWD, USACE	Mobile Bay

A large number of shipwrecks are reported in Mobile Bay and adjacent to Dauphin Island by secondary sources, but lack locational data. It has been estimated that, due to the high commercial traffic throughout Mobile Bay, that more than 300 vessels have sunk in the area (Mitchell 1983). **Table 2-24** includes shipwrecks with general information regarding location (e.g., "east of Dauphin Island") reported to be present in the southern portion of Mobile Bay and Dauphin Island. The interpretation of suspect magnetic anomalies and acoustic contacts must consider the numerous shipwrecks reported in and around Mobile Bay and the accuracy of associated locational data and information.

Table 2-24. Shipwrecks Reported in Vicinity of APE

Name	Date Sunk	Location	Source
CSS *Gaines*	1864	Mobile Bay	Shomette (1973)
CSS *Nelms*	1862	Mobile Bay	Shomette (1973); Gaines (2008)
CSS *Pioneer II*	1863	Mobile Bay	Gaines (2008)
Daniel Huger	1974	Mobile Bay	Jaffee (2004)
El Volante	1780	Gulf of Mexico	Mistovich and Knight Jr. (1983)
Hermes	1814	Mobile Bay	Colledge and Warlow (2006)
Isabel	1863	Fort Morgan	Gaines (2008)
Josephine	1863	Gulf of Mexico	Gaines (2008)
La Bellone	1725	Dauphin Island	Krivor et al. (2011)
Monticello	1862	Gulf of Mexico	Gaines (2008)
Noah Webster	1976	Unknown	Jaffee (2004)
Oran M Roberts	1974	Unknown	Jaffee (2004)
Philippi	1864	Mobile Bay-Entrance W Bank Shoals	Shomette (1973)
RB Hamilton	1865	Mobile Bay	Gaines (2008)
Robert Mills	1975	Unknown	Jaffee (2004)
Rosaria	1780	Mobile Bay	Mistovich and Knight Jr. (1983)
Unknown	1780	Gulf of Mexico	Mistovich and Knight Jr. (1983)
Unknown	1780	Gulf of Mexico	Mistovich and Knight Jr. (1983)
Unknown	1862	Mobile Bay	Shomette (1973)
Unknown	1862	Mobile Bay	Shomette (1973)
Unknown	1862	Mobile Bay	Shomette (1973)
Unknown	1862	Gulf of Mexico	Gaines (2008)
Unknown	1862	Gulf of Mexico	Gaines (2008)
USS *Glasgow*	1865	Mobile Bay	Gaines (2008)
USS *Ida*	1865	Mobile Bay-Main Channel	Gaines (2008)
USS *Magnolia*	1945	Gulf of Mexico-Off Mobile Bay	Naval History and Heritage Command (2009)
USS *Pink*	1865	Mobile Bay	Gaines (2008)
USS *Sciota*	1865	Mobile Bay	Gaines (2008)
USS *Tecumseh*	1864	Mobile Bay	Shomette (1973); Gaines (2008)
Warrior	1906	Mobile Bay	Mistovich and KnightJr. (1983)
Wave	1862	Mobile Bay	Gaines (2008)
William T Barry	1975	Unknown	Jaffee {2004)

PREVIOUS MARITIME INVESTIGATIONS

Numerous maritime investigations considered pertinent to the APE were consulted to determine the potential for the presence of previously unidentified submerged cultural resources witin the APE (**Table 2-25**). Currently, the Alabama State Historic Preservation Officer (SHPO) does not offer spatial data for previous maritime survey location; therefore, the following surveys were identified as pertinent to the APE upon review of in-text survey maps.

Table 2-25. Previous Maritime Cultural Resources Surveys in the Vicinity of the APE

Survey	Reference
Environmental Inventory and Assessment of Lower Mobile Bay Complex in Light of Drilling Four Exploratory Wells by Mobil Oil Corporation	Parker (1979)
Geologic Hazards and Cultural Resources Surveys for Proposed Mobile Bay Project	Dames & Moore, Inc. (1981)
A Multi-Sensor Engineering Survey of Offshore Alabama, Mobile Bay Area Northwest Gulf Blocks 111and 112.	Racal-Decca, Inc. (1981)
Magnetometer and Electronic Positioning Survey, Mobile Harbor Ship Channel, Alabama	Irion (1983)
Cultural Resources Survey of Mobile Harbor, Alabama	Mistovich and Knight (1983)
Archaeological, Engineering, and Hazard Study for Proposed 30-inch Gas Pipeline Route from a Point in Block 113 Mobile Bay Area to a Proposed Junction Platform in Block 955 Mobile Bay Area	John E. Chance & Associates (1991)
A Magnetic and Acoustic Remote Sensing Survey and Target Assessment Investigation of Shipwreck Sites in the Vicinity of the Entrance to Mobile Bay, Alabama	Watts (1992)
Archaeological and Hazard survey of Block 94 (L.L.-0349) Northwest Gulf Area Offshore, Alabama	John E. Chance & Associates (1993)
Underwater Archaeological Investigations, Gulf of Mexico, Alabama Coastal Waters	H&E Marine Enterprises, Inc. {1995)
Archaeological, Engineering, and Hazard Study, Proposed 10-inch Sour Gas Pipeline Route from OCS-G5064 "B" Structure Block 864, Mobile Area to SL-0521 "A" Structure Block 113, Northwest Gulf Area	John E. Chance & Associates, Inc. (1996)
USS Tecumseh Shipwreck Management Plan	West Jr. (1997)
Literature Search Sand Island Beneficial Use Area Mobile Harbor, Alabama	Pecorelli (1997)
Fort Morgan Submerged Cultural Resource Remote Sensing, Survey, Mobile Bay, Alabama	Institute for International Maritime Research (2001)
Fort Morgan Point Submerged Cultural Resource Target Identification and Remote Sensing Survey, Mobile Bay, Alabama 2001	Institute for International Maritime Research (2002)
Search for American Diver	Wilbanks (2002)
Archaeological and Hazard Site Specific Survey Block 77 Mobile Bay Area	Landry (2005)
Cultural Resources Remote Sensing Survey Sand Island Beneficial Use Disposal Area Proposed Southern Expansion Site	Giliberti and Birchett (2009)
Phase I Archaeology Maritime Survey of a Beneficial Use Areas for Mobile Bay Sediment Placement Project	Enright and Linville {2013)
Phase I Marine Survey of Borrow Areas for Camille Cut Fill Project, Harrison and Jackson Counties, Mississippi, and Mobile County, Alabama	Hanks et al. (2014)
Maritime Disposal Areas	Panamerican (2015)
Marine Remote-Sensing Survey for the Sand Island Benificial Use Area West Extension and Mobile Harbor General Reevaluation Report Bend Easing and Channel Widener Areas off Dauphin Island, Mobile County, Alabama	Grinnan et al. (2018)

The lower portion of Mobile Bay has been subjected to many submerged cultural resource surveys. A majority of these surveys are not accompanied by full archaeological reports or the report does not offer detailed information; however, survey results are mentioned in H&E Marine Enterprises, Inc. (1995) and Giliberti and Birchett (2009). The H&E Marine Enterprises, Inc. 1995 survey identified 49 anomalies, 8 of which are described as possible shipwreck sites in the vicinity to the SIBUA APE. The Giliberti and Birchett 2009 survey identified two magnetic anomalies in the SIBUA APE; neither are indicative of a shipwreck and are located outside the current APE. In 2013, SEARCH identified 17 magnetic anomalies potentially representing submerged cultural resources and were recommended for avoidance (Enright and Linville 2013). These anomalies included NRHP-nominated Civil War obstructions and shipwrecks, however none of these 17 anomalies are located within the the current APE. Also outside of the current APE, SEARCH's 2014 Phase I marine survey identified 10 remote-sensing targets potentially representing submerged cultural resources recommended for avoidance (Hanks et al. 2014). Most recently, SEARCH conducted a Phase I Remote-Sensing survey of previously unsurveyed portions of the APE. This included a 3 mile section of the Bay Channel beginning at the upper end of the bend area that will be widened, two bend easing sections of the channel at the upper end of the bar channel, and the SIBUA expansion area south of Dauphin Island. This Phase I survey resulted in the identification of 2 magnetic anomolies or acoustic reflectors that could represent potential historic properties and a natural landform sensitive for inundated Native American sites within the Channel widening portion of the APE and 6 magnetic anomolies or acoustic reflectors within the SIBUA portion of the APE. However, as these are all submerged within the offshore APE, the integrity and NRHP eligibility of these resources are currently unknown. A Phase II investigation is therefore required to determine if the 2 magnetic anomolies or acoustic reflectors, and the sensitive natural landform identified within the APE represent historic properties. If the aforementioned resources are found to be historic properties eligible for NRHP listing, consultation with the SHPO, Tribes and other interested parties will be required to develop mitigation measures to resolve any adverse affects to these properties due to the implementation of the Project. A Programmatic Agreement (PA) is currently being developed through consultation with SHPO, Tribes, and other interested parties that will ensure the Phase II investigation is completed and guide post Section 106 review processes during the engineering and design phase of the Project. This will include the stipulations regarding the assessment and mitigation of historic properties, the process for developing mitigation measures, Tribal involvement, and the treatment of any post review discoveries.

2.17. 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. Along the coastal areas of Baldwin and Mobile Counties, Alabama's protected lands and resources encompass the beaches and estuaries of the Gulf Coast 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.

2.17.1. 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 Highway 59 and State Highway 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.

2.17.2. Weeks Bay National Estuarine Research 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 198 square miles watershed into the portion of Mobile Bay via a narrow opening. This sub-estuary of Mobile Bay averages just 4.8 ft deep that provides rich and diverse habitats for a variety of fish, crustaceans and shellfish, as well as many unique and rare plants is fringed with marsh (*Spartina, Juncus*) and swamp (pine, oak, magnolia, maple, cypress, bayberry, tupelo and others). The reserve lands also include upland and bottomland hardwood forests, freshwater marsh (*Typha, Cladium*), SAV (*Ruppia, Valisneria*) and unique bog habitats (*Sarracenia, Drosera*). 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.

2.17.3. Grand Bay National Wildlife Refuge (NWR)

This refuge falls with the borders of both Alabama and neighboring Mississippi along the Gulf coast. The 10,188-acre reserve is part of the Federal Gulf Coast 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 brown pelican, which has recently been delisted from the endangered species list in Alabama.

2.17.4. 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 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.

2.17.5. Maeher 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 Battleship Parkway, known locally as the "Causeway," and is managed by ADCNR.

2.17.6. Historic Blakeley State Park

Located on the site of the former town of Blakeley, Historic Blakeley State Park is a on the Tensaw River delta. 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.

2.18. 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 to the ADCNR, the State contains 47 reservoirs larger than 500 acres (2.0 km^2) that cover 551,220 acres (2,230.7 km^2), 23 Alabama State Public Fishing Lakes, and 77,000 miles (124,000 km) of perennial rivers, streams and the Mobile Delta as well as over 60 miles (97 km) 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 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. The beaches of the coastal towns of Orange Beach, Gulf Shores, and Dauphin Island are popular instate vacation destinations and 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% 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 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.

2.19. Socioeconomics

This section describes an overview of the existing socioeconomic conditions within the project area and the potential impacts that would be associated with the and No Action Alternative and RP. 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 ROI with more than 10,000 residents are Prichard, Saraland, Foley, Daphne, and Fairhope (TWT 2017).

2.19.1. Regional Economic Activity

Port of Mobile

Mobile is home to the only deep-water seaport in Alabama. The economic contribution of the Port of Mobile to the regional economy is widespread and supports a variety of industries and businesses. Mobile's maritime industries (cargo and vessel activity, shipbuilding, and the cruise industry) play a key role in the region's economic health. Adding diversity to the region's economy are growing industry sectors in aerospace, chemicals and manufacturing, healthcare, logistics and transportation, oil and gas and technology (Chamber of Commerce 2018). These industries and businesses ship and consign products from Alabama's steel manufacturing, coal mining, and utility production industries, paper/pulp manufacturing industries, and chemical industries as well as regional auto manufacturers and local and regional retail and wholesale businesses. Containerized cargo exports include pulp and forest products, paper products, and frozen poultry.

In 2014, the total economic value of the marine cargo and vessel activity at the Port of Mobile 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. Public terminals (managed by Alabama State Port Authority) supported $20.9 billion of the total economic value. 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 the Port of Mobile. Of these jobs, the cargo activity moving via the ASPA marine terminals supported 124,328 total jobs. Activity at the public and private marine terminals generated $289.4 million of state, county and local taxes. The state of Alabama received $182.3 million of the tax revenue while local governments received $107.1 million (Martin and Associates 2016).

From an operational perspective, in 2014 total tonnage grew by about 5.5 million tons, and the tonnage at the ASPA public terminals increased by 5.3 million tons as compared to 2011. The overall growth in tonnage for the period 2011 to 2014 was driven by the growth in coal, steel slab, dry bulk, and containerized cargo tonnage. At the ASPA terminals, the key growth in tonnage was recorded for coal, steel slab, pig iron, containerized cargo and steel products. Total economic value of the Mobile Harbor increased from $22.3 billion to nearly $24.8 billion since 2011, while total jobs supported by cargo and vessel activity at the public and private terminals grew 8,400 jobs since 2011. State, county and local taxes increased $10.0 million over the same period (Martin and Associates 2016).

Since 2005, ASPA and its partners have invested $535 million in shore-side and channel improvements to support the larger container ships calling the Port of Mobile, maintain its ranking, and to position the Port for global trade (APM Terminals 2017). In the last five years, the ASPA has added two new facilities 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 (USACE 2018).

Seafood Industry

Alabama's seafood industry has great economic impact. Commercial species harvests provide a valuable source of revenue for the state contributing approximately $461 million in revenue annually and 10,000 jobs. The most common commercial species obtained from Alabama waters are shrimp, blue crabs, oysters, and numerous species of fish.

2.19.2. Population

Table 2-26 show population statistics, trends and projections within Baldwin and Mobile Counties, the State of Alabama, and the United States (U.S.).

The 2016 estimated population of Baldwin County, AL is 199,510 (USCB 2016). Population in the county exhibits strong growth. As shown in **Table 2-26**, between 1990 and 2016, the population increased by 103.0 percent, yielding an average annual growth rate of 6.4 percent. This trend of strong growth is expected to continue. As shown in **Table 2-26**, the projected population is approximately 300,899 in 2040, a 65.1 percent increase over the 30 year period between 2010 and 2040. Population is projected to increase by 46.7 percent to 441,497 by 2070, indicating slower growth over the period between 2040 and 2070 (USCB 2010, CBER 2017, CBER 2108).

The 2016 estimated population of Mobile County, AL is 414,291 (USCB 2016). Population in the county is stable. As shown in **Table 2-26**, between 1990 and 2016, the population increased by 9.4 percent, yielding an average annual growth rate of 0.6 percent. This trend of relatively slow growth is expected to continue. As shown in **Table 2-26**, the projected population is approximately 431,909 in 2040, a 4.6 percent increase over the 30 year period between 2010 and 2040. Population is projected to increase by 3.8 percent to 448,527 in 2070, indicating slower growth over the period between 2040 and 2070 (USCB 2010, CBER 2017, CBER 2018).

Table 2-26 indicates that the population in the state of Alabama increased by 19.8 percent between 1990 and 2016. Alabama's average annual growth rate during this period was 1.2 percent. **Table 2-26** projects population growth in Alabama to be 11.3 percent between 2010 and 2040, and 10.4 percent between 2040 and 2070. Similar to Baldwin and Mobile Counties, Alabama's projected population growth decreases over the furthest projected time periods. The population of Alabama is expected to grow at a slower rate than that of the U.S., which is expected to grow 23.1 percent between 2010 and 2040.

Table 2-26. 1990–2016 Population Data

	1990	2000	2010	2016 estimated	Percent Increase 1990-2000	Percent Increase 2000-2010	Percent Increase 2010-2016	Percent Increase 1990 - 2016	Average Annual Rate of Increase
Baldwin County	98,280	140,415	182,265	199,510	42.9%	29.8%	9.5%	103.0%	6.4%
Mobile County	378,643	399,843	412,999	414,291	5.6%	3.3%	0.3%	9.4%	0.6%
Alabama	4,040,587	4,447,100	4,779,753	4,841,164	10.1%	7.5%	1.3%	19.8%	1.2%
United States	248,709,873	281,421,906	308,746,065	318,558,162	13.2%	9.7%	3.2%	28.1%	1.8%

Sources: U.S. Census Bureau – USCB1990a, USCB1990b, USCB2000, USCB2010, and USCB2016

Table 2-26. 2020 - 2070 Population Projections

	Census 2010	Projection 2020	Projection 2030	Projection 2040	Projection 2050	Projection 2060	Projection 2070	Percent Increase 2010 - 2040	Percent Increase 2040 - 2070
Baldwin County	182,265	222,554	261,777	300,899	342,631	389,229	441,497	65.1%	46.7%
Mobile County	412,992	417,652	423,579	431,909	438,560	444,086	448,527	4.6%	3.8%
Alabama	4,779,736	4,941,485	5,124,710	5,319,305	5,502,279	5,691,011	5,873,912	11.3%	10.4%
United States	308,746,065	334,503,000	359,402,000	380,219,000	398,328,000	416,795,000	N/A	23.1%	not available

Sources: U.S. Census Bureau – USCB2010; CBER2017; CBER2018

2.19.3. Employment and Income

Table 2-27 shows employment data for Baldwin and Mobile Counties, Alabama and the U.S. Baldwin County had a total employment of approximately 107,334 in 2016. Retail trade provided the greatest number of jobs followed by accommodation and food services, government and government enterprises, health care and social assistance, construction, and manufacturing. The farm employment sector employed the least amount of people.

In the more populous and urban Mobile County, government and government enterprises provided the greatest number of jobs, followed by health care and social assistance, retail trade, manufacturing, accommodation and food services, and construction. The farm employment sector employed the least amount of people.

While employment in Baldwin and Mobile Counties varies somewhat from that of Alabama and the U.S., proportionally, employment is similar. The biggest differences are: 1) Mobile County, which has lower farm employment than all three of the other populations, and 2) retail trade and accommodation and food services in Baldwin County, which is higher than all three other populations. Manufacturing shows the greatest diversity across all populations (BEA 2017a, BEA 2017b, BEA 2017c).

The 2016 unemployment rates of Baldwin and Mobile Counties, Alabama and the U.S. declined sharply from 2010, as shown in **Table 2-28**. This illustrates recovery from the nation's last recession which began in 2008. Mobile County's unemployment rate was the highest in 2010, and remains the highest in comparison to Baldwin County, Alabama and the U.S. In all cases, the unemployment rates declined from the prior year. The 2016 U.S. unemployment rate of 4.9 percent is less than the counties and the state, indicating that Alabama has greater unemployment compared to the national levels (BLS 2018c).

Table 2-27. 2016 Employment Data

Employment Sector	Baldwin County	Mobile County	Alabama	United States
Total employment (number of jobs)	107,334	236,901	2,625,468	193,668,400
Farm employment	1.1%	0.4%	1.8%	1.4%
Construction	6.5%	6.5%	5.3%	5.2%
Manufacturing	4.3%	8.5%	10.3%	6.8%
Retail trade	15.3%	10.5%	10.9%	10.0%
Health care and social assistance	9.5%	11.6%	9.4%	11.3%
Accommodation and food services	13.1%	7.3%	7.3%	7.4%
Other services (except public administration)	7.0%	7.9%	6.7%	5.9%
Government and government enterprises	9.6%	11.9%	15.2%	12.5%

Source: Bureau of Economic Analysis BEA2017a, BEA2017b & BEA2017c

Table 2-28. 2016 Unemployment Rate

	2010 Unemployment Rate	2015 Unemployment Rate	2016 Unemployment Rate
Baldwin County	10.0%	5.6%	5.4%
Mobile County	11.3%	7.0%	6.9%
Alabama	10.3%	6.0%	5.7%
United States	9.6%	5.3%	4.9%

Sources: ADL 2018, BLS 2016a, BLS 2016b, BLS 2010

As shown in **Table 2-29**, per capita personal income in Baldwin County in 2016 was $41,286, 83.8 percent of the national average of $49,246 and more than the state average of $38,896. Per capita income increased 14.4 percent from 2010 (BEA 2017d, BEA 2010a, and BEA 2010b).

Also shown in **Table 2-29**, per capita personal income in Mobile County in 2016 was $35,951, 73.0 percent of the national average of $49,246 and more than the state average of $38,896.

Table 2-29. 2015 and 2016 per Capita Personal Income Data

	2010	2016	Percent Increase 2010 - 2016	Average Annual Rate of Increase
Baldwin County	36,089	41,286	14.4%	0.9%
Mobile County	31,782	35,951	13.1%	0.8%
Alabama	33,697	38,896	15.4%	1.0%
United States	40,277	49,246	22.3%	1.4%

Sources: BEA2017d, BEA 2010a, BEA 2010b

Per capita income increased 13.1 percent per year from 2010 (BEA 2017d, BEA 2010a and BEA 2010b).

2.20. Transportation

This section describes an overview of existing transportation resources within the project area, and the potential impacts on these transportation resources that would be associated with the Proposed Action and No Action alternative. Components of transportation resources that are analyzed include roads, traffic, railroads and airports. A detailed transportation analysis can be found in Attachment C-5.

2.20.1. Highways and Roadways

2.20.1.1. Interstate Highways

Interstate (I-) 10 is the most southern major highway connector in the United States; it travels in an east-west direction, linking Florida to California. In the southeastern United States, 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 the 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 Cochran-Africatown USA 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). I-10 continues east to Florida.

The I-10 tunnels cross the proposed activities at Mobile Harbor and are in close proximity to the northern portion of the proposed channel activities. The three closest interchanges on the west side of the harbor are located at Broad Street, Virginia Street, and Texas Street. In 2016, the average daily traffic count was 71,940 on I-10 between Broad Street and Texas Street (Alabama Department of Transportation [ALDOT] 2016). The closest interchange to the harbor on the east side is at Battleship Parkway/US-90. The ALDOT reports that in 2016, 75,320 vehicles travelled through the George C Wallace tunnel crossing the channel daily (ALDOT 2016).

In Mobile, about 5 miles west of the proposed Mobile Harbor and Channel activities, I-10 has a major interchange with I-65 providing easy access to the north. I-65 is routed north to Montgomery, where it intersects with I-85 northeast to Atlanta, Georgia; continuing to Birmingham, I-65 intersects with I-59 and I-20; and then to Huntsville and major cities to the north in the Midwest region of the United States. I-165 connects downtown Mobile with I-65 approximately 5 miles northwest of where the I-10 tunnels cross the Mobile River (Google Earth 2018a, FHA and ALDOT 2014). Currently, trucks carrying hazardous materials are detoured off the I-10 at either the I-65 or I-165 interchanges, or along surface streets. Trucks then travel north to cross the Mobile River on the Cochrane-Africatown Bridge (FHA and ALDOT 2014).

The I-10 Wallace Tunnels are currently nearing their capacity and have congestion during peak hours of use. However, a project to increase capacity for the I-10 corridor crossing of the Mobile River and Mobile Bay is currently proposed. The project is designated as the I-10 Mobile River Bridge and Bayway Widening (Project DPI-0030(005)). The Proposed Action includes eleven miles of improvements to the I-10 corridor from Broad Street in Mobile County to just east of the US 98 interchange in Daphne, Baldwin County, Alabama. The proposed improvements consist of: the widening of I-10 from Broad Street eastward to the proposed bridge; deletion of the existing Texas Street interchange; modification of the existing Virginia Street interchange; construction of a six-lane, cable-stayed bridge with 190 ft of vertical clearance over the Mobile River navigation channel; widening the I-10 Bayway by two lanes to the inside (resulting in a total of eight lanes); and tapering the eight lanes from the Bayway into the existing I-10 corridor in the vicinity of the existing US 98 interchange in Daphne (ALDOT/FHWA 2003). The proposed Mobile River I-10 Bridge will provide for additional capacity with acceptable level of service through the design year 2025. Additionally, a detour to the Cochrane-Africatown Bridge for hazardous truck cargoes will no longer be required. The Wallace Tunnels will remain as a "business" connector to the downtown area. Traffic studies and modelling associated with the I-10 bridge and bayway project revealed that by the year 2030, most of the interchanges in the Mobile Harbor area would be operating at level of service (LOS) D or F during peak hours (FHA and ALDOT 2014).

2.20.1.2. Surface Streets

Direct access for the 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.

2.20.1.3. Harbor-Related Truck Traffic

Traffic patterns for cargo at the North End of Mobile Harbor are different from the Lower End of Mobile Harbor. The North End of the Mobile Harbor moves petroleum, asphalt, metals, forest products and poultry. For terminals located on Blakeley Island off of Old Spanish Trail, freight will either travel south to I-10 or north to I-165 using the Cochran Africatown USA Bridge and

New Bay Bridge Road. Terminals located off of Telegraph Road travel south to Beauregard Street and then to I-165 or north to Conception Street, New Bay Bridge Road and then to I-165. A map of the north end truck routes is shown in **Figure 2-34** (AECOM 2018).

Lower Mobile Harbor consists of three terminals:

- Container Terminal
- McDuffie Coal Terminal
- Pinto Terminal

The Container Terminal is served by ship, truck and rail. The McDuffie Coal Terminal and Pinto Terminal only move cargo through ship, rail or barge. Only service vehicles and employees utilize the roadway system from these two terminals. There is terminal to terminal movement for vehicles along Baker Street and terminal to I-10 movement along Ezra Trice Boulevard to Virginia Street. A Map of the lower harbor truck routes is shown in **Figure 2-34** (AECOM 2018).

2.20.1.4. Annual Average Daily Traffic Counts

Annual average daily traffic counts (AADT) were collected by ALDOT in 2016 and are presented in **Table 2-30**. Generally, traffic levels are highly variable in the vicinity of the port, depending on which roads are examined. Overall, the freeways (I-10, I-65, and I-165) are more travelled than the smaller surface roads and State Highways (ALDOT 2016). **Figure 2-35** shows a map of the AADT traffic counts for 2016.

ALDOT does not analyze LOS unless a particular project calls for a traffic study. The FHA and ALDOT completed a Draft EIS for the construction of a bridge over the Mobile River and the widening of the I-10 Bayway. A traffic study was completed during this analysis. Part of this study was a projection of LOS in 2030 on portions of the existing I-10.

Table 2-31 presents the conclusions from this analysis. The predictions reveal that by 2030, most of the I-10 in the vicinity of Mobile Harbor would be operating at an LOS of D or worse during peak conditions (FHA and ALDOT 2014). LOS is calculated in different ways for different road types. Generally, for a typical freeway segment, LOS F occurs when there are more than 28 vehicles per lane per kilometer (Mathew and Rao 2006).

The Florida Department of Transportation (FDOT) developed LOS tables for future roadway planning purposes by looking at travel lanes available, AADT, and speed limit within urbanized or rural areas. These tables were utilized to estimate the existing and future roadway capacity in the area of the Mobile Port. A LOS “D” which consists of a high density but stable traffic flow is considered an acceptable level for urban design purposes. **Table 2-32** summarizes the vehicle capacity of the existing roadway system (AECOM 2018).

2.20.2. Air Transportation

2.20.2.1. Mobile Downtown Airport

Mobile Downtown Airport, previously and locally known as Brookley Field, is located approximately 2.75 miles southwest of the Choctaw Pass 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).

Airport services include the availability of 100LL JET-A fuel, hangars, tiedowns, major airframe repair, and major power plant service and repair. Other services available include air cargo, charter flights, flight instruction, aircraft rental, and aircraft sales (SkyVector 2018).

Table 2-30. AADT in the vicinity of Mobile Harbor

Intersection/Segment	2016 AADT
Bay Bridge Road/Peter Lee Street	19,370
Cochrane-Africatown Bridge - West	15,830
Cochrane-Africatown Bridge -East	16,650
Baybridge Road/US-90	18,320
US-90/Beauregard Street	27,690
Beauregard Street/US-90	11,410
US-98/St. Emanuel Street	23,290
I-10 between Texas and Canal Streets	64,890
I-10 at Baltimore Street	71,940
I-10 Bayway - West	76,030
US-90 Bayway - West	16,990
US-90 north of I-10 - West	17,160
Telegraph Road/Edwards Street	8110
Telegraph Road/Traffic Street	3110

Source: ALDOT 2016

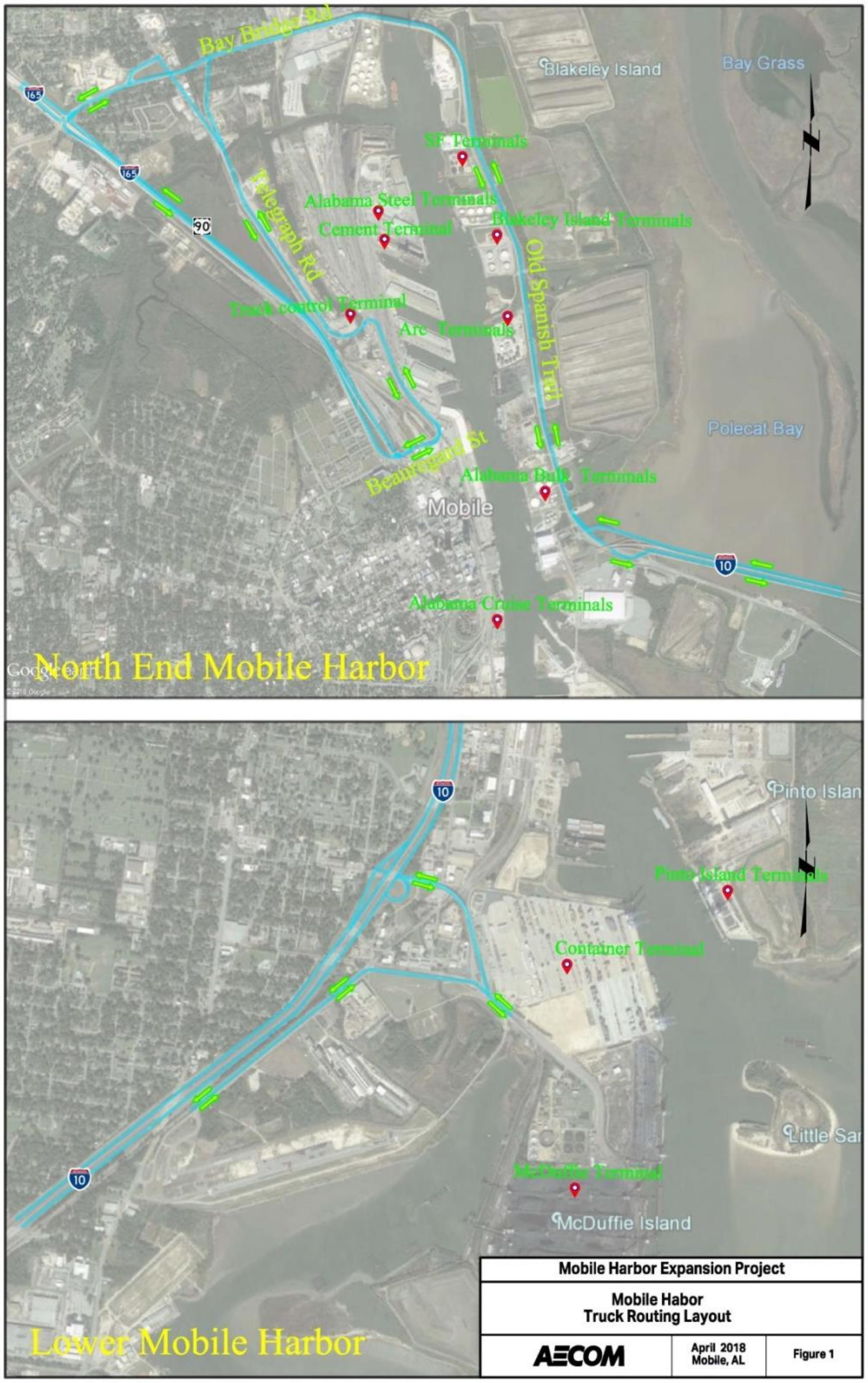


Figure 2-34. Mobile Harbor Truck Routes

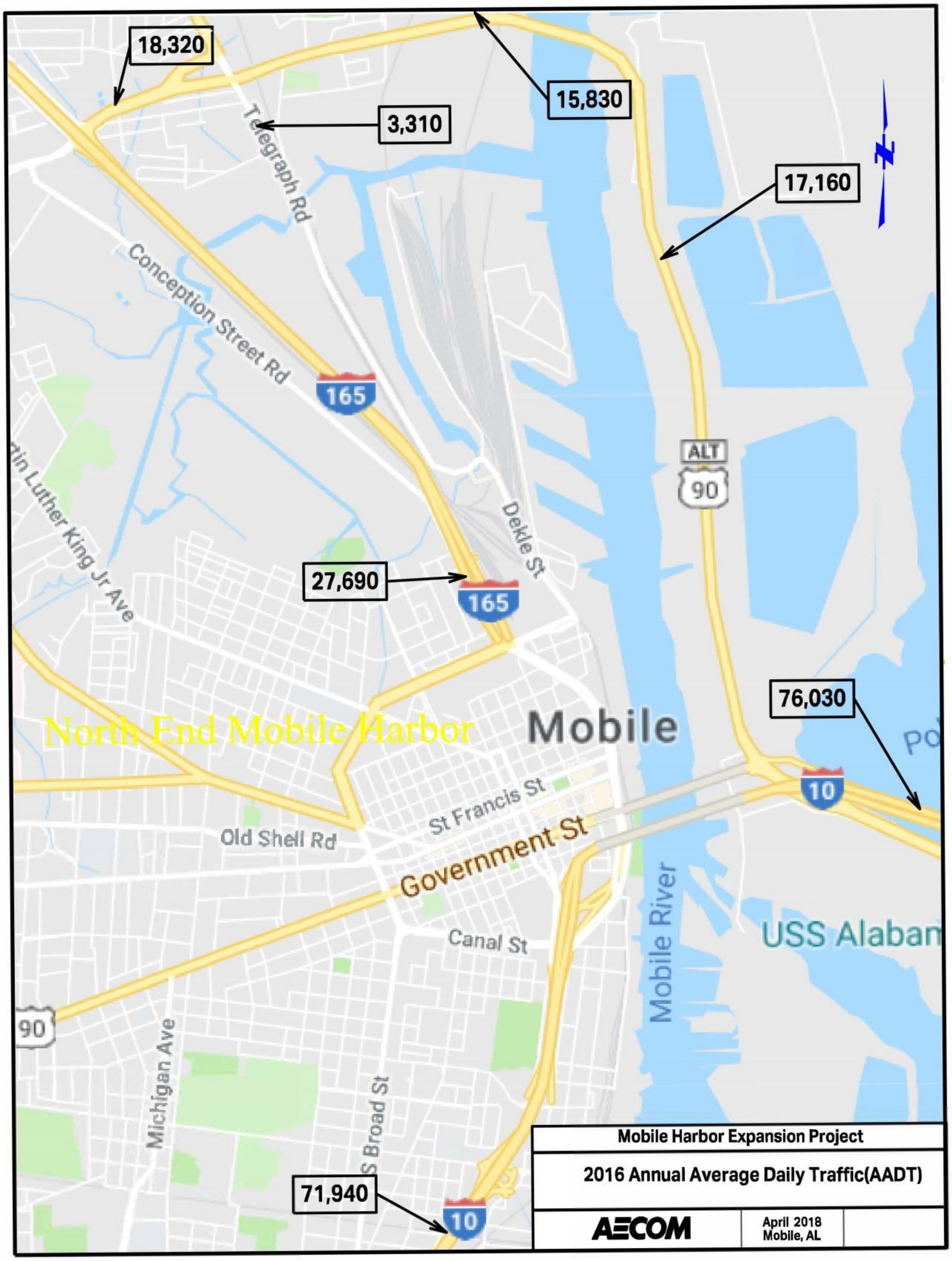


Figure 2-35. ***ALDOT Traffic counts for 2016 near the Port of Mobile.***

Table 2-31. Predicted 2030 LOS in the vicinity of Mobile Harbor

Roadway	Location	Direction	2030 Peak Hour LOS
I-10 West of Project	West of Duval Street	Eastbound	D
		Westbound	D
I-10 Mobile	Between Broad St. and Virginia St.	Eastbound	E
		Westbound	E
I-10 Wallace Tunnels	Under Mobile River	Eastbound	F
		Westbound	F
I-10 Bayway	Between Mid-Bay Interchange and US 90/98	Eastbound	F
		Westbound	F
I-10 East of Project	East of US 98	Eastbound (2 lanes)	F
		Eastbound (3 lanes)*	D
		Westbound (2 lanes)	F
		Westbound (3 lanes)*	D
Cochrane Africatown Bridge	Over Mobile River	Eastbound	D
		Westbound	D
Bankhead Tunnel	Under Mobile River	Eastbound	F
		Westbound	F

*ALDOT has an approved project to widen I-10 to three lanes, to the east in both directions, between the I-10/US 98 interchange and SR 181.
Source: FHA and ALDOT 2014

Table 2-32. Existing Roadway Capacity

Route	Roadway Laneage	Existing Capacity (LOS D)	2016 ADT	Under Capacity	% Trucks	Speed Limit
Al 13 (Telegraph Rd)	4 lane undivided	24,300	3,310	yes	18%	30
AL 16 (Old Spanish Trail)	4 lane undivided	29,850	17,160	yes	13%	55
AL 16 (Baybridge Rd)	4 lane divided	39,800	15,830	yes	14%	45
AL 16 (New Baybridge Rd)	4 lane divided	39,800	18,320	yes	16%	40
I-10	4 lane Interstate	77,900	76,030	yes	15%	65
I-10	8 Lane Interstate	154,300	71,940	yes	13%	65
I-165	6 lane Interstate	116,600	27,690	yes	8%	65

The Mobile Downtown Airport has two major runways as follows:

- Runway 14/32 – 9618x150 ft with precision instrument and high-intensity edge and approach lighting, and
- Runway 18/36 – 7800x150 ft with medium intensity edge lighting (SkyVector 2018).

Currently, there are 31 aircraft based at the field with a breakdown as shown in **Table 2-33**.

In 2017, there were 1,774 commercial aircraft operations, 42,095 military operations, 2,792 air taxi operations, 4,710 local operations, and 10,451 itinerant operations (SkyVector 2018).

Table 2-33. Aircraft based in the Mobile Downtown Airport

Classification	Number
Single engine airplanes	21
Multi-engine airplanes	4
Jet airplanes	5
Helicopters	1

Source: SkyVector 2018

Sufficient additional capacity for flights at the field is available to support additional intermodal transfer of containerized cargo if needed. Space is also available for development of support facilities for such shipping. In addition, the Mobile Downtown Airport is very accessible to transfer containerized cargo from the Alabama State Port Authority (ASPA) Choctaw Point Terminal by truck using I-10 or surface streets or, if necessary, by rail (USACE 2003).

2.20.2.2. Mobile Regional Airport

Mobile Regional Airport is the primary commercial passenger airport serving the Mobile area. It is located approximately 11 miles west of the Choctaw Pass 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).

2.20.3. Water Transportation

The ASPA has a total of 41 berths; the channel depth is 45 ft to the tunnels and 40 ft in the River Harbor. The facilities include the main complex, McDuffie Island, Choctaw Point and other sites. 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.

2.20.4. Public Transportation

The Wave Transit System, funded by the City of Mobile, is the largest fixed-route transit system in the region. It provides service within Mobile limits, limited service into Prichard to the north, and paratransit service, in accordance with the Federal Transit Authority mandated 3/4 of a mile 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. According to the Mobile Transit Development Plan, all fixed-route services operate Monday through Saturday, with weekday operations beginning between 5 a.m. and 6 a.m. Nine weekday routes in the Wave Transit system end at 7:25 p.m. or earlier, with the remaining weekday routes ending between 9:55 p.m. and 10:25 p.m. Weekend service routes begin between 6 a.m. and 7 a.m., ending around the same time as weekday service routes. All fixed-route services operate on a 60-minute frequency with the exception being *moda!*, a fare-free downtown circulator that arrives every 10 to 20 minutes (SARCOR et al. 2014).

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 the Port of Mobile.

Less than 1% 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. Even though the majority of the jobs are located within the city, many workers do not use public transportation. This could be attributed to living outside of the public transportation service area, the commute is during hours when transit is out of service, or the frequency of the transit is not sufficient for adequate travel times (SARCOR et al. 2014).

Most bus routes converge on the CBD which is immediately west of the Port of Mobile. The routes traveling along the active port area include 5, 9, 11, and 16 (SARCOR et al. 2014).

2.21. Utilities and Infrastructure

This section describes an overview of existing infrastructure and utilities within the vicinity of the project area and the potential impacts on these utilities that would be associated with the Proposed Action and No Action alternatives. Infrastructure and utilities include roads, rail lines, airports, ports, electrical power sources, gas lines, water and sewer lines, and communications lines. Transportation infrastructure is discussed in above in Section 2.20, navigation and port conditions are discussed in section 2.20.1.3.

2.21.1. Utilities or Energy Resources

2.21.1.1. Electrical System

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 (Google Earth 2018a). 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 line (Alabama Power 2018).

2.21.1.2. Natural Gas

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

2.21.1.3. Water

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 (Google Earth 2018b).

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).

2.21.1.4. Communication Lines

BellSouth Telecommunications 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).

2.21.1.5. Oil and Natural Gas

Mobile Harbor and the other ports in and around Mobile Bay provide significant oil and gas infrastructure. **Figure 2-36** shows Oil and Natural Gas wells and platforms located in Mobile Bay and in the Gulf of Mexico south of Dauphine Island. The figure also shows petroleum refineries, natural gas processing plants, petroleum and natural gas pipelines, import/export terminals, electrical transmission lines and power plants in the Mobile area.

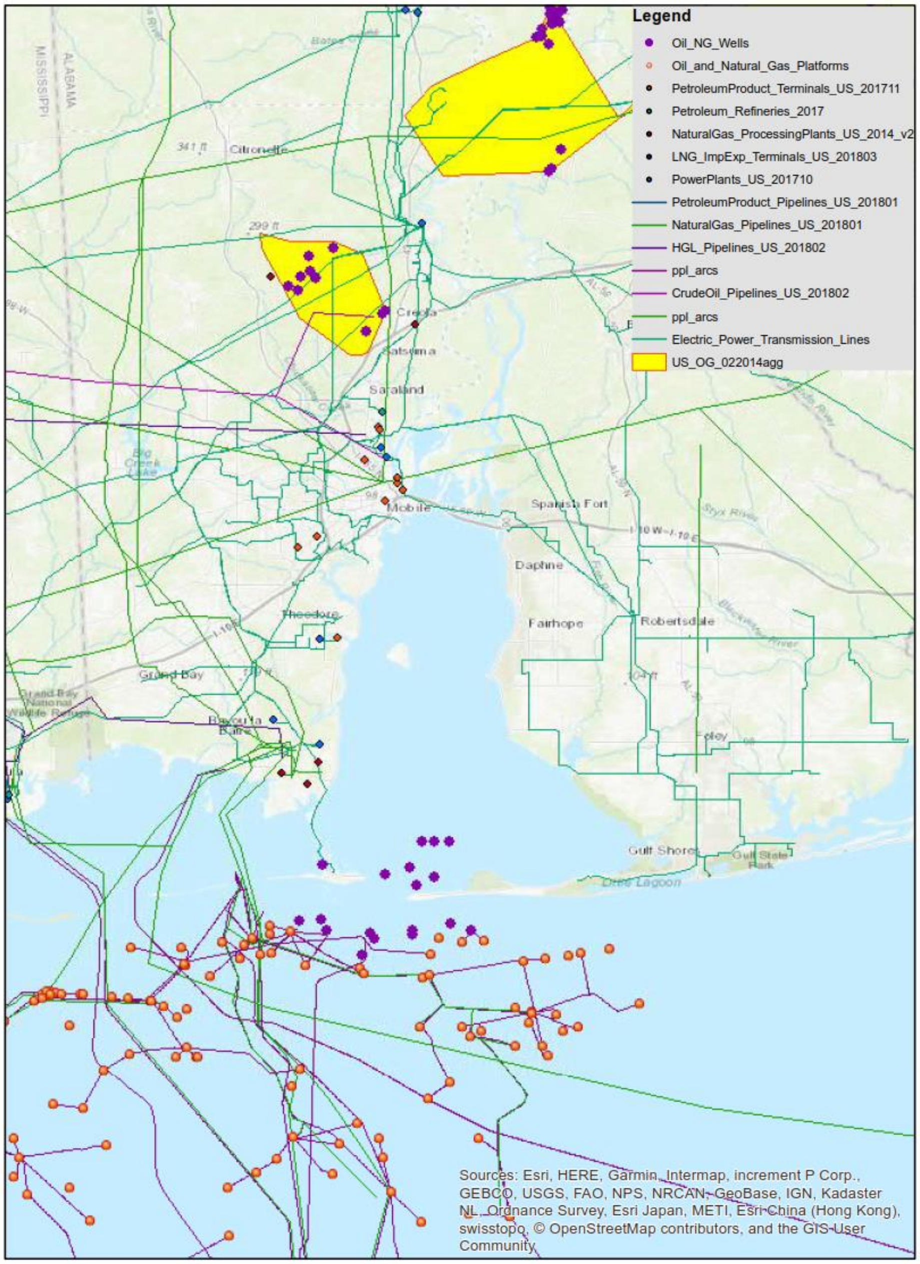


Figure 2-36. Oil, natural gas and power infrastructure and resources in the Mobile area.

2.22. Environmental Justice

This section describes an overview of environmental justice considerations within the project area and the potential environmental justice impacts that would be associated with the Proposed Action and No Action Alternative. Components of environmental justice that are analyzed include minority and low-income populations.

EO 12898 (59 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 percent 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 percent 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 percent low-income based on the Census data or (2) the percentage of low-income population in the affected area is greater than 20 percent 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 to consideration of 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 surrounded by Mobile and Baldwin Counties. 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 percent or more aggregate minority or low-income population (the "Fifty Percent" analysis), or 20 percent 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.

2.22.1. Minority Populations

The analysis for minority populations in the ROI followed the CEQ guidance for identifying minority populations. **Table 2-34** presents the results of the minority population analysis for Baldwin and Mobile Counties. Information regarding the racial composition was derived from the 2012-2016 American Community Survey (ACS) 5-Year Estimates. The proportion of minority individuals has also been compared to the State (Alabama) and National levels.

As shown in **Table 2-34**, the vast majority (83.2%) of people in Baldwin County are white. Minorities constituted 16.8% of the total population in Baldwin County in 2016, less than Alabama (33.8%) and National levels (38.0%t). Black or African Americans were the predominant minority in the study area representing 9.2% of the population, followed by Hispanics or Latinos, representing 4.4% of the population. Of the 94 block groups in Baldwin County, 3 block groups met the “Fifty Percent” analysis and 10 block groups met the “meaningfully greater” analysis. The three block groups that met the “Fifty Percent” threshold also met the “meaningfully greater” threshold, yielding a total of 10 minority block groups. These results were compared to an analysis of the 2010 Census using the same methodology, which yielded a substantially similar outcome. In 2010, 4 block groups met the “Fifty Percent” analysis and 7 block groups met the “meaningfully greater” analysis. Therefore, because of the similarity of the data, the 2012-2016 ACS 5-Year Estimates were used for the current analysis because these estimates are likely more similar to the current population estimates given the amount of time that has passed since the 2010 Census. Using the ACS estimates, it was determined that there were 10 minority block groups in Baldwin County in 2016.

As shown in **Table 2-34**, the majority (57.9%) of people in Mobile County are white. Minorities constituted 42.1% of the total population in Mobile County in 2016, more than that of Alabama and National levels. Black or African Americans were the predominant minority in the study area representing 35.2% of the population, followed by Hispanics or Latinos, representing 2.6% of the population. Of the 269 block groups in Mobile County, 118 block groups met the “Fifty Percent” analysis and 99 block groups met the “meaningfully greater” analysis. The 99 block groups that met the “meaningfully greater” threshold also met the “Fifty Percent” threshold, yielding a total of 118 minority block groups. These results were compared to an analysis of the 2010 Census using the same methodology, which yielded a substantially similar outcome. In 2010, 120 block groups met the “Fifty Percent” analysis and 103 block groups met the “meaningfully greater” analysis. As described previously, because of the similarity of the data, the 2012-2016 ACS 5-Year Estimates were used for the current analysis because these estimates are likely more similar to the current population estimates given the amount of time that has passed since the 2010 Census. Therefore, it was determined that there were 118 minority block groups in Mobile County in 2016. The locations of the minority block groups are displayed in **Figure 2-37**.

The entire project site is located in the water. A majority of the minority block groups are located land-side adjacent to the project site along both sides of the navigation channel, and within the city of Mobile along the riverfront, and along Interstate 165.

Environmental justice issues are identified by determining whether minority or low-income populations are present in the ROI. If such populations are present, disproportionate effects on these populations should be considered. As described above, a total of 128 block groups in the ROI (10 block groups in Baldwin County and 118 block groups in Mobile County) met the criteria for having minority populations, and therefore, should be considered Environmental Justice communities, subject to environmental justice considerations.

Table 2-34. 2016 Minority and Low-Income Population Data

	Baldwin County	**Mobile County**	**Alabama**	**United States**
Total Population	199,510	414,291	4,841,164	318,558,162
Minority Population	33,560	174,620	1,636,829	121,195,490
Percent White, Not Hispanic or Latino Population	83.2%	57.9%	66.2%	62.0%
Percent Minority Population	16.8%	42.1%	33.8%	38.0%
Black or African American	9.2%	35.2%	26.4%	12.3%
American Indian and Alaska Native	0.6%	0.6%	0.5%	0.7%
Asian	0.7%	1.9%	1.2%	5.2%
Native Hawaiian and Other Pacific Islander	0.0%	0.0%	0.0%	0.2%
Other Race	0.2%	0.1%	0.1%	0.2%
Two or More races	1.8%	1.6%	1.6%	2.3%
Hispanic or Latino	4.4%	2.6%	4.0%	17.3%
Total Number of Block Groups	94	269	N/A	N/A
Total Blockgroups with Total Aggregate Minority >=50%	3	118	N/A	N/A
Total Blockgroups with Total Aggregate Minority that is 20% higher than the County Aggregate Minority Percentage	10	99	N/A	N/A
Percent Low-income Population	13.0%	19.5%	18.4%	15.1%
Total Blockgroups with Total Aggregate Low-income Population >=50%	1	21	N/A	N/A
Total Blockgroups with Total Aggregate Minority that is 20% higher than the County Aggregate Low-income Percentage	**5**	**46**	N/A	N/A

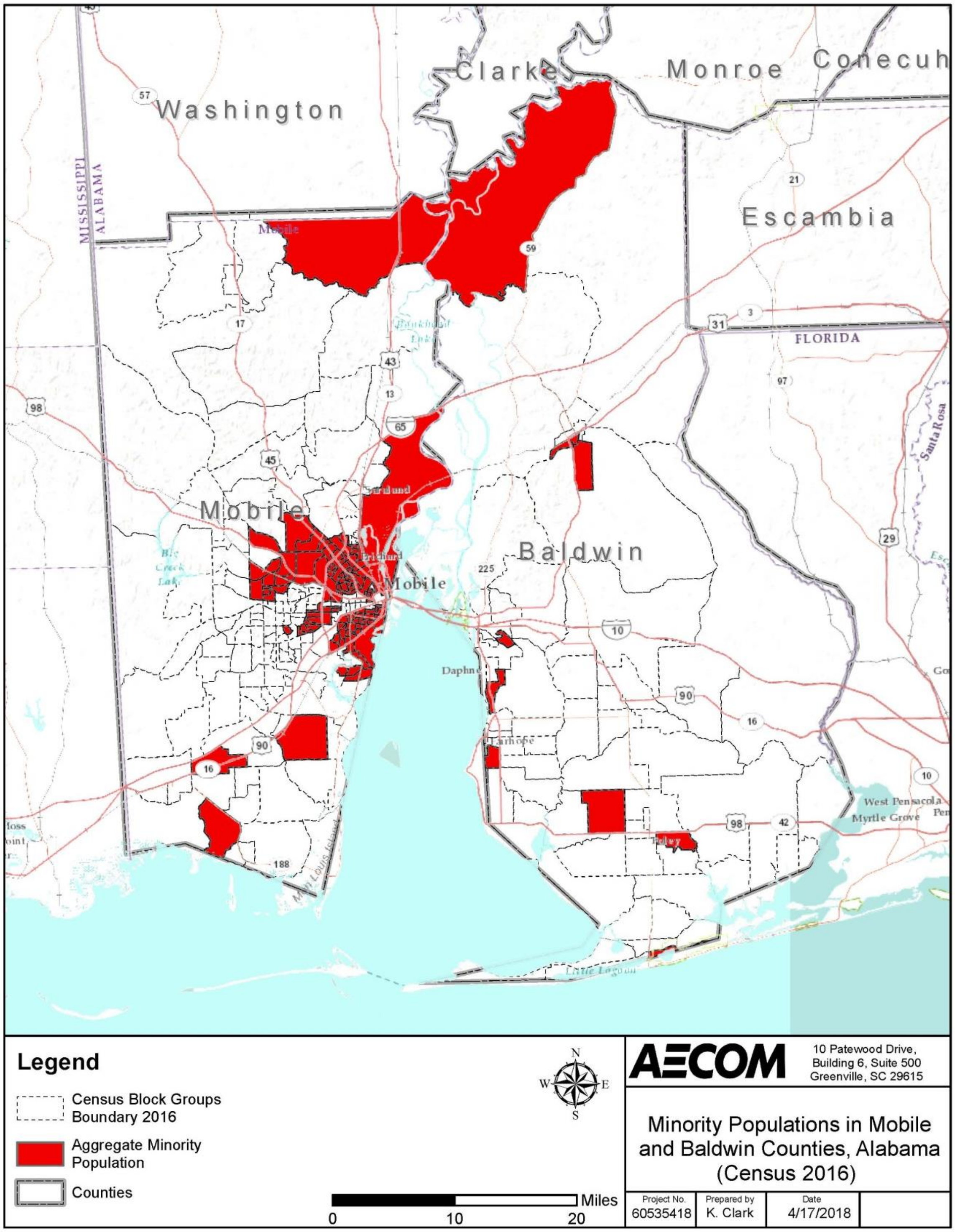


Figure 2-37. 2016 Minority Populations in the ROI

2.22.2. Low-income Populations

The analysis for low-income populations in the ROI followed the CEQ guidance for identifying low-income populations. **Table 2-34** shows the percentage of low-income individuals residing in

Baldwin and Mobile Counties. Information was derived from the 2012-2016 American Community Survey 5-Year Estimates.

Low-income populations constitute 13.0% of the total population in Baldwin County, less than Alabama (18.4%) and National levels (15.1%). Of the 94 block groups in Baldwin County, one block group met the “Fifty Percent” analysis and five block groups met the “meaningfully greater” analysis. The one block group that met the “Fifty Percent” threshold also met the “meaningfully greater” threshold, yielding a total of five low-income block groups. The most conservative metric was used in the analysis for each block group. The distribution of the five identified low-income block groups in Baldwin County is displayed in **Figure 2-37**.

Low-income populations constitute 19.5% of the total population in Mobile County, less than Alabama and National levels. Of the 269 block groups in Mobile County, 21 block groups met the ”Fifty Percent” analysis, and 46 block groups met the “meaningfully greater” analysis for population of low-income residents. The most conservative metric was used in the analysis for each block group. The distribution of 46 low-income block groups in Mobile County is displayed in **Figure 2-38**.

A majority of the low-income block groups are located land-side adjacent to the project site along the riverfront south of the city of Mobile, in the city’s downtown central business district, and along the Interstate 165 transportation corridor. The town of Bayou La Batre which lies along the Mississippi Sound on the Gulf of Mexico in south *Alabama* also has several low-income block groups.

As described above, a total of 51 block groups in the ROI (5 block groups in Baldwin County and 46 block groups in Mobile County) met the criteria for having low-income populations, and therefore, should be considered Environmental Justice communities, subject to environmental justice considerations.

2.22.3. Neighborhood Populations

In Mobile, communities are often congregated in very recognizable, and in certain situations historic, neighborhoods. Therefore, for this analysis, the USACE elected to consider the presence of environmental justice communities within specific neighborhoods for thoroughness. **Figure 2-39** shows minority and low-income communities of concern in the city of Mobile juxtaposed on a map delineating 168 neighborhoods (Mobile 2018). The list of neighborhoods with minority populations includes Africatown (Plateau), Orange Grove, Mayville, Maryvale, and several neighborhoods in the area known as “Down the Bay” (which comprises Oakdale, Texas Street and the Riverfront Industrial area). Low income population block groups include Orange Grove, Three Mile Trace, Toulminville, Oakdale, Arlington, Maysville, Maryville, Ricarby and portions of Riverside, and Rosedale, among others. Minority and low-income population block

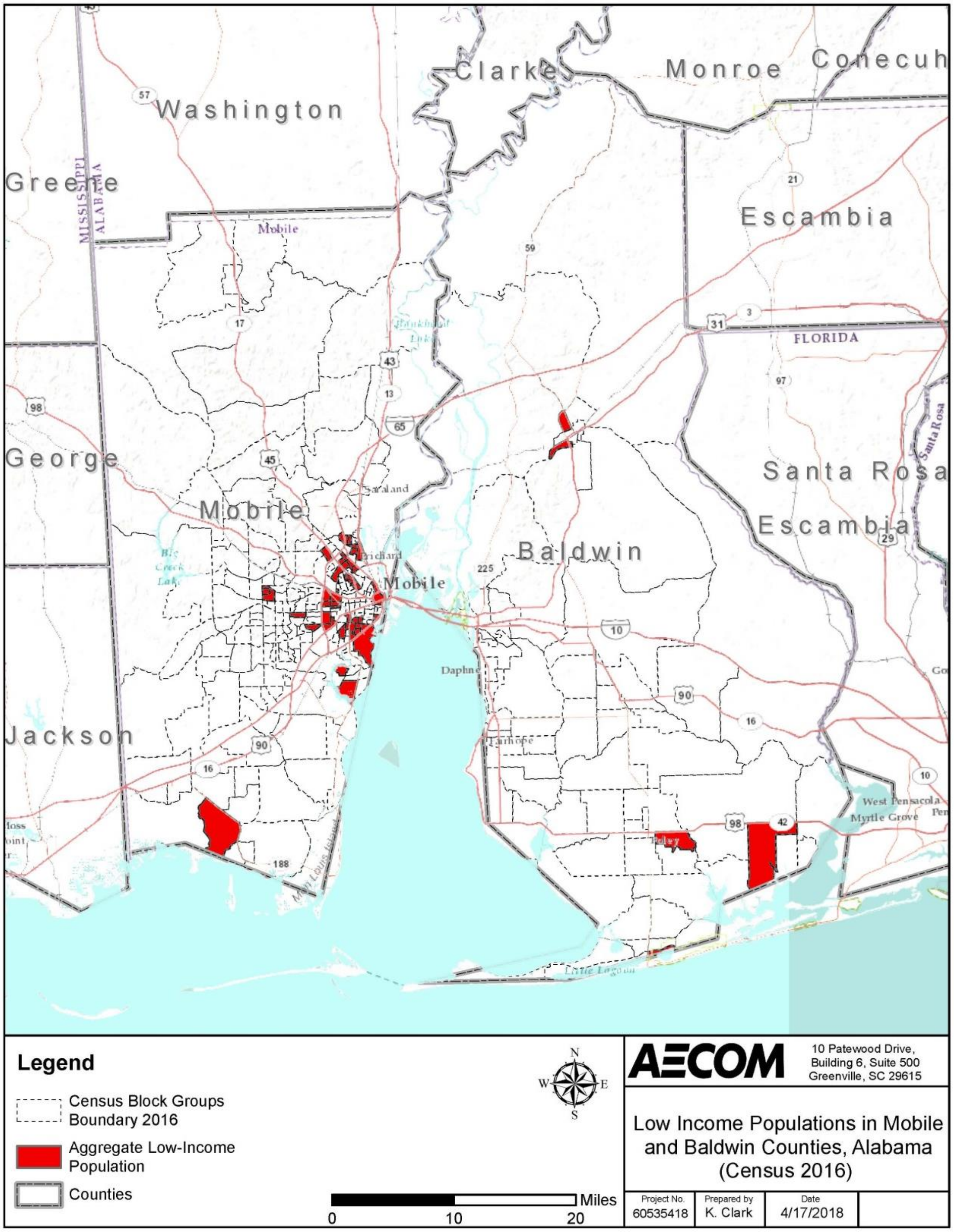


Figure 2-38. 2016 Low-income Populations in the ROI.

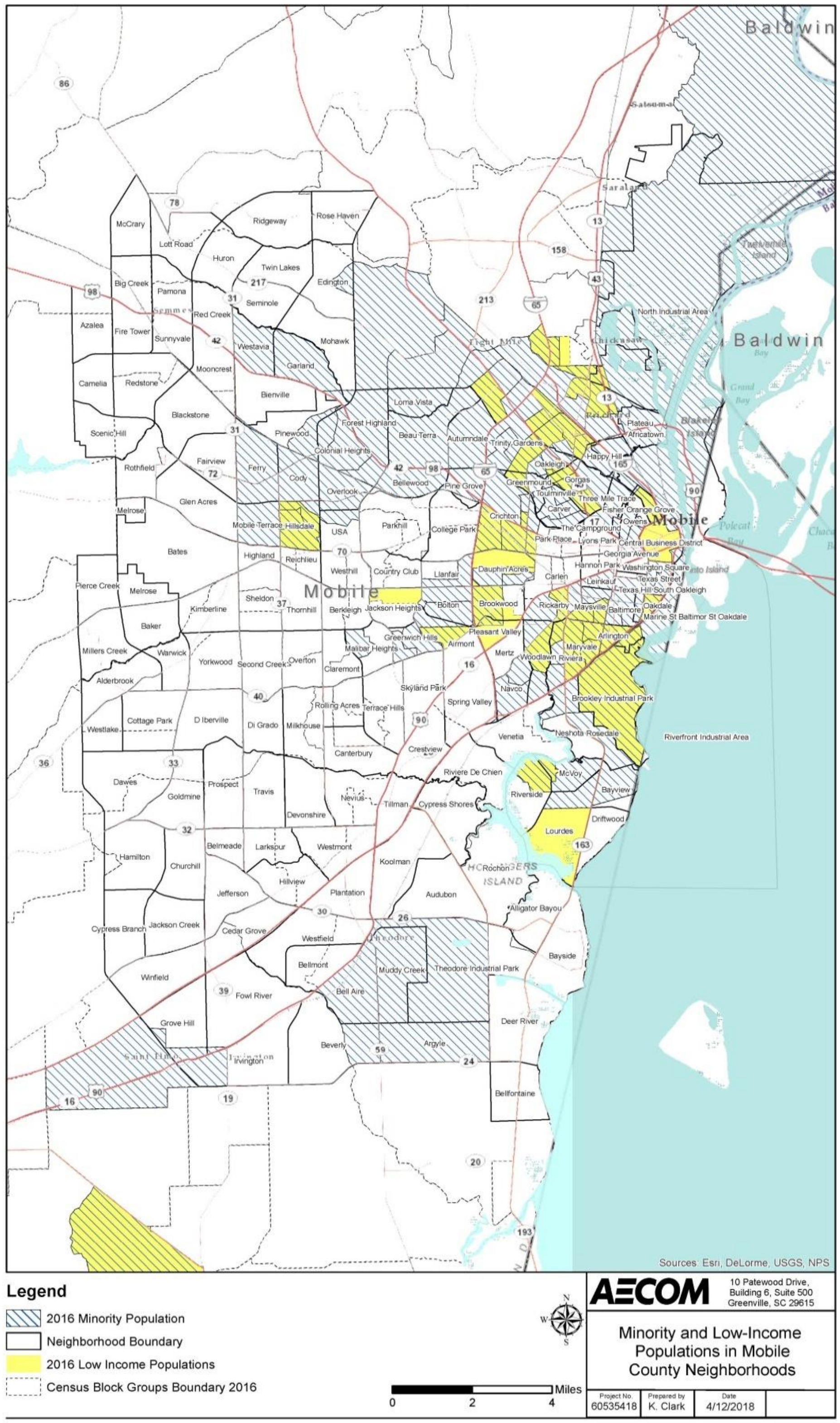


Figure 2-39. Minority and Low-income Populations in the neighborhoods in the city of Mobile

groups overlap in several neighborhoods including Orange Grove, Three Mile Trace, Trinity Gardens, Crichton, Maysville, Maryvale, Arlington, and Brookley Industrial Park among others.

Early in the study, the USACE coordinated with the Alabama State Port Authority to help identify specific neighborhood groups with potential environmental justice concerns and develop an outreach strategy to address environmental justice issues and concerns.

Special notices of public meetings were mailed (and emailed) to various neighborhood associations, City Planners, Municipalities, Churches, Community Centers, Chapters of the National Association for the Advancement of Colored People, etc. to obtain feedback from groups and individuals with environmental justice-related concerns.

In an effort to assure opportunities for environmental justice populations to provide input to the NEPA process, workshop meetings were held at the James Seals Community Center located in the Africatown Neighborhood and other communities. Workshops provide a forum to explain the project and its implications, answer questions, listen to concerns, and gain an understanding of neighborhood issues.

Additional public involvement tools and activities for the Draft GRR/SEIS include focus-group meetings, agency briefings, public meetings, a project website, listserve, social media, news media releases and quarterly bulletins and all community groups have access to these resources and activities.

2.22.4. Subsistence Consumption of Fish and Wildlife

EO 12898 provides for agencies to collect, maintain, and analyze information on patterns of subsistence consumption of fish, vegetation, or wildlife. Where an agency action may affect fish, vegetation, or wildlife, that agency action may also affect subsistence patterns of consumption and indicate the potential for disproportionately high and adverse human health or environmental effects on low-income populations, minority populations, and Indian tribes (CEQ 1997).

Alabama has one of the highest rates of subsistence fishing in the country (Alabama Rivers Alliance 2018). If the proposed project significantly impacts fish and animal populations, then subsistence fishermen and hunters may be disproportionately and adversely impacted by the proposed project. USACE queried staff, government organizations, and social welfare organizations to identify the existence of subpopulations near the project area that engage in a subsistence-like lifestyle. This would include groups in which hunting, gathering, fishing, and gardening constituted a larger fraction of the subpopulations food sources than those of the general population.

More than a dozen telephone calls and emails were made and sent to local agencies and organizations within Mobile and Baldwin counties, Alabama as well as to Gulf Coast regional organizations. The persons contacted were asked if they were aware of any concentration of minority or low-income populations who obtain or supplement their food supply through hunting, fishing, gathering or gardening. The telephone survey yielded anecdotal evidence from the representatives of several organizations who indicated their awareness of people living along the Gulf Coast who fished to eat, or trade for other fish, as a supplement to their family’s food source and/or income. The number and location of subsistence fishermen, or the existence of a defined subpopulation, were unknown to the organizations polled.

Definitions of “subsistence” vary from organization to organization. The CEQ defines subsistence consumption pattern to be a dependence on fish or wildlife by a minority population, low-income population, Indian tribe or subgroup of such populations on indigenous fish, vegetation and/or wildlife, as the principal portion of their diet (EJ 1997). British Petroleum (BP), in paying out claims to subsistence fishermen harmed by the 2010 Deep water Drilling Disaster, defined subsistence more broadly as “a natural person who fishes or hunts to harvest, catch, barter, consume, or trade natural resources in a traditional manner in order to sustain his or her basic personal or family dietary, economic, shelter, tool, or clothing needs”. Approximately 10,857 claims were paid out to subsistence fishermen affected by the oil spill in Alabama. The claimants included commercial fishermen and seafood crew. Recreational fishermen who fish for pleasure or sport were not eligible claimants (DHES 2018: DWHS 2012).

A representative from Alabama Department of Conservation and Natural Resources (ADCNR) stated that a fishing license is required in Alabama. In 2017, 755 recreational shrimp and 568 recreational gill net licenses were sold. ADCNR is aware of the presence of subsistence fishermen but does not track their number and location. The difficulty in distinguishing between subsistence, recreational and commercial fishermen was noted by the representative because fishing that results in personal consumption may be done using hook and line from the shore, or from a commercial vessel that retains fish from a catch for personal consumption; oftentimes species that would not be commercially viable (ADCNR 2018).

Wilma Subra of the Louisiana Environmental Action Network (LEAN) stated that despite the contamination of waterways due to Hurricane Katrina, industrial waste from the Theodore Industrial Canal, and the Deepwater Horizon oil spill, people are still selling (to a larger extent) and eating (to a lesser extent) what they catch every day in Mobile Bay in order to supplement their family’s food supply or income.

As indicated above, the organizations polled did not have any information about the existence of any defined subsistence subpopulation. Further research was done in an attempt to identify subpopulations from other sources. According to a 2010 article, Southeast Asian and African-American communities are dependent on the Gulf for their livelihood. Southeast Asian fishermen, for example, make up one-third of the 13,000 fishing vessels registered along the Gulf Coast. Among the approximately 40,000 Southeast Asian individuals living in the gulf coast region, one in five individuals work in the seafood processing industry (Honda 2010).

NOAA identified 29 communities in Baldwin and Mobile counties as “fishing communities” in a 2006 report (NOAA 2006). The term ‘fishing community' was defined as a community that is substantially dependent on or substantially engaged in the harvest or processing of fishery resources to meet social and economic needs, and includes fishing vessel owners, operators, and crew, and fish processors that are based in such communities.

NOAA identified the following 17 fishing communities in Baldwin County (NOAA 2006): Bay Minette, Bon Secour, Daphne, Elberta, Fairhope, Foley, Gulf Shores, Lillian, Loxley, Magnolia Springs, Orange Beach, Perdido Beach, Robertsdale, Silverhill, Spanish Fort, Stapleton, and Summerdale. Of the 17 fishing villages listed in Baldwin County, Bay Minette is the only one having minority and low income populations according to the 2016 American Community Survey (USCB 2016a; USCB 2016b). Therefore, subsistence subpopulations may be present at that location.

NOAA identified 12 fishing communities in Mobile County (NOAA 2006): Axis, Bayou La Batre, Coden, Dauphin Island, Eight Mile, Grand Bay, Irvington, Mobile, Saraland, Semmes, St. Elmo and Theodore.   Of these 12 communities, the following seven contain minority populations according to the 2016 American Community Survey: Bayou La Batre, Eight Mile (Pritchard), Irvington, Mobile, Saraland, Semmes, St. Elmo and Theodore. According to the 2016 population survey, Bayou La Batre had a Vietnamese population of 19.4% (491 people). Eight Mile (Pritchard) had an African American population of 87.3% (19,501 people) (USCB 2016a; USCB 2016b). Therefore, subsistence subpopulations comprised of Southeast Asians or African-Americans may be present at those locations.

A challenge for the survey is the lack of data as no organization formally tracks subsistence populations. Another challenge is that information on related topics is scarce and outdated, such as the 2006 NOAA report on fishing villages discussed above. The information gathered from the NOAA report was helpful in identifying possible locations of subpopulations, but not conclusive because the topic of the report was the identification of fishing villages, not subsistence populations. There is also a semantic challenge of defining the elements of a subsistence life style. In spite of these challenges, anecdotal evidence suggests the presence of subsistence fishing by individuals in the Mobile Harbor area, which appears to be confirmed by the Deepwater Horizon claim payments to area fishermen. Furthermore, NOAA’s study on fishing communities, coupled with American Community Survey demographic information, yields indications of the possible locations of groups or subpopulations that fish for their family’s consumption.

2.23. Public and Occupational Health and 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 RP. 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 Occupational Safety and Health Administration (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. 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) Public Law 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); and
- Emergency Evacuation Plan.

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

The general project area considered in this evaluation of public and occupational safety includes 37 nautical miles of channel and the area surrounding the 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 RP 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 miles) 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 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 the Port of Mobile is located approximately 2 miles west of the port. 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 USACE 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 Alabama State Port Authority (ASPA); additionally, hazardous materials would not be used during dredging operations. Limited quantities of petroleum products would be associated with dredging operations.

The ASPA now 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 Port Authority'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 can be programmed with security messages and instructions (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 new 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. ENVIRONMENTAL EFFECTS - INTRODUCTION

This section describes the environmental effects of alternative actions for the proposed Mobile Harbor channel modifications. 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 (1.6 ft) (from here on referred to simply as the No-Action alternative) to the modeled channel improvement dimensions as described in Section 4.1 of the GRR/SEIS. A 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 three to five nautical mile lengths for each deepening alternative. The selected RP consists of: deepening the existing channel an additional 5 ft (existing 45 ft deep channel in the bay to 50 ft and existing 47 ft deep in the Bar Channel to 52 ft); adding an additional 100 ft of widening for a distance of three 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. Extensive modeling of a "maximum potential impacts" scenario was conducted representing the potential environmental effects equal to or no greater than the RP (i.e. dredging to a depth of 50 ft with widening of a five-nautical mile channel section by 100 ft). It should be noted that the actual RP represents conditions less than the modeled maximum channel dimensions. Therefore, impacts associated with all alternatives considered in the final array of alternatives were considered that would be less than or no greater than the modeled scenario.

3.1. Geographic Setting

Neither the future Without-Project condition (FWOP) /No Action Alternative nor the proposed project or any Future Maintenance 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 the Port of Mobile and the project itself would have no effect on the conversion of additional natural area.

With the exception of Little Sand Island that will be affected by the widening of the Choctaw Pass Turning Basin, 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 upland placement areas which include upland confined areas, open water in-bay sites, SIBUA, and the ODMDS such that there would be no additional affects associated with land use. The effects to Little Sand Island and widening of the Choctaw Pass Turning Basin is addressed in Section 3.7.2.1 below.

3.2. Climate, Tides, and Gulf Circulation

Generally, the scale and type of activities associated with the No Action Alternative, RP, or Future Maintenance 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.

3.3. 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 of the Appendix A.

3.3.1. Waves

As covered in greater detail in the 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 the 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.

3.3.1.1. Alternative 1 – No Action

Under the No Action Alternative, current channel and harbor maintenance operations would continue. Generally, dredging and placement 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. When the expansion dimensions have been determined, the necessary coordination actions will be conducted to modify the Water Quality Certification under the O&M program. Under this scenario, waves conditions in and around the project are expected to be negligible.

3.3.1.2. Alternative 2 – RP

3.3.1.2.1. Project Construction

General Wave Climate. The model results indicate that implementation of the RP 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 of the 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 the port. The investigation included field data collection using a suite of 5 pressure sensors located north of Gaillard Island and a validation deployment using similar techniques in the southern part of the bay. 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 (Allen, 2018). Vessel speed was obtained from a statistical summary of 2016 AIS 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 the port to meet that demand if the project is implemented. In other words, fewer vessels will call at the port in the future if the channel is deepened/widened than if it’s not. This reduced number of vessels anticipated to call at the port 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 D to Appendix A.

3.3.1.3. Future Maintenance

Future maintenance placement practices 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.

3.3.2. Currents

The modeling conducted ERDC as described in Section 6.1.2 of the 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. The boundary-fitted coordinate feature of the model provides grid resolution enhancement necessary to adequately represent the deep navigation channels (i.e. Bar, Bay, and River Channels) and irregular shoreline configurations of the flow system.

3.3.2.1. Alternative 1 – No Action

Under the No Action Alternative, current channel and harbor maintenance operations would continue. Generally, dredging and placement 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. At that time, the necessary coordination actions will be conducted under the O&M program. Under this scenario, it is expected that the currents in and around the project area would be negligible.

3.3.2.2. Alternative 2 – RP

3.3.2.2.1. Project Construction

The model results indicate implementation of the RP 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 of Appendix A.

3.3.2.3. Future Maintenance and Operations

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

3.3.3. 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 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) *Draft Mobile Harbor Study Quantifying Sediment Characteristics and Discharges into Mobile Bay*. These stations were equipped with physical samplers, optical turbidity sensors, and acoustic instruments for measuring water velocity, acoustic backscatter. Long-term datasets were augmented with local and 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 which was built upon previous Modeling conducted in 2012 to evaluate thin-layer placement of maintenance dredged material as described in the Section 2.9, Appendix A. The results from this effort indicated a minimum difference range of no greater than +/- 0.3 ft of erosion when compared to the existing conditions and indicates no discernable net erosion or net deposition. Additional details of the estuarine sediment transport modeling effort are provided in Section 6.3.1 of 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 as described in Section 6.3.2 if the Appendix A. 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 of Appendix A.

3.3.3.1. Alternative 1 – No Action

Under the No Action Alternative, current channel and harbor maintenance operations would continue. Generally, dredging and placement 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 expansion 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. At that time, 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.

3.3.3.2. Alternative 2 – RP

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 of channel modifications within the bay which was 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 minimum difference range of no greater than +/- 0.3 ft of erosion when compared to the existing conditions and indicates no discernable net erosion or net deposition. Additional details of the estuarine sediment transport modeling effort are provided in Section 6.3.1 of Appendix A.

3.3.3.2.1. Project Construction

Estuarine/Mobile Bay. Channel modifications may change sedimentation rates and patterns, which directly impact future maintenance dredging requirements. The purpose of the sediment transport modeling was to assess the relative changes in sedimentation rates within the navigation channel, dredged material placement sites, and surrounding areas as a result of the proposed RP. The modeling conducted was built upon previous Regional Sediment Management data collection and modeling efforts conducted in 2012, which evaluated thin layer placement of dredged material in Mobile Bay associated with the Federal navigation project. 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 measured 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 RP 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 SLR. 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 RP. Additional details of the estuarine sediment transport modeling effort are provided in Attachment A-1 of Appendix A.

<u>Ebb Tidal Delta</u>. 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. 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. Relevant field experiments conducted as part of the NFWF study included bathymetric, current, wave and sediment measurements. 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 Appendix A-2 of Appendix A.

The model domain was expanded to include probable effects on shoreline changes with the minimal extents 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 dredge material placement in the SIBUA as part of the 10-year simulations. The modeling results indicate minimal difference in bed level changes between the RP 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 SLR).

Results of the modeling conducted by 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.

3.3.3.3. Future Maintenance

Future maintenance and placement practices 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.

3.3.4. Sea Level Change

Based on an extrapolation of the high curve values, SLR in the project area would be approximately 5 ft in the year 2115 relative to North American Vertical Datum 1988. The NOAA Digital Coast SLR Viewer (NOAA Office for Coastal Management, 2011) was utilized to visualize the first estimate of the vertical and horizontal extents of the potential SLR impacts.

A detailed description on the effects of SLR in relation to the navigation project can be found Section 2.10.1 of the Engineering Appendix. Generally, neither the No Action Alternative nor the RP or Future Maintenance activities would have an effect on the rates of SLR.

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 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 RP.

3.4. 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.

3.4.1. Geologic Setting

There would be no permanent changes to the underlying sediment and supporting geologic structure that would result in impacts to sedimentation or sediment transport processes associated with the project. No activities from project construction, sediment placement, or Future Maintenance will have an impact on the underlying geological framework.

3.4.2. Soils

3.4.2.1. 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 placement areas. A copy of the Draft 404(b)(1) is included in Attachment C-2.

3.4.2.2. Alternative 2 – RP

3.4.2.2.1. Project Construction

The sediment profile in the new work dredging areas would be altered as the sediment would be removed and placed in the placement 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.

3.4.2.3. 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.

3.4.3. Geotechnical Conditions

3.4.3.1. 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, there would be no change to the subsurface geotechnical properties and conditions associated with the existing navigation channel.

3.4.3.2. Alternative 2 – RP

3.4.3.2.1. 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 placement 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 excavating the new slide slopes would have an effect on soil types or underlying stratigraphy. However, additional slope stability analyses will be performed during PED Phase of this project. Flatter slopes will be considered at that time in a suite of slope stability analyses.

3.4.3.3. Future Maintenance

Other than the effects of the dredging operations, future maintenance and placement 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.

3.4.4. Sediment Quality

3.4.4.1. 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.

3.4.4.2. Alternative 2 – RP

3.4.4.2.1. 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. O&M, along with proposed new work dredged material suitability must comply with guidelines in accordance with the MPRSA of 1972, CWA, and the ocean dumping criteria (40 Code of Federal Regulation (CFR) §227) under the jurisdiction of the EPA.

Sediment sampling will be required to obtain an MPRSA Section 103 concurrence from the EPA of material suitability 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).

The new work testing will consist of sediment core samples taken at 14 locations in the Mobile Bay (-54 ft mean lower low water (MLLW)) and Mobile Bar and Entrance channels (-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 and Entrance channels will be new locations not previously tested during past O&M sampling. One additional sample will be taken in the Choctaw Pass Turning Basin (-54 ft MLLW).

The results of new work sediment testing in both the upper and lower portions of the project discussed in Section 2.3.4 indicated that the sediments met the requirements for placement in the ODMDS. Based on these results the USACE, Mobile District has determined that there is an acceptable risk that levels of contamination would not be encountered above the levels exhibited in the previously tested new work material located between these locations. Therefore, the determination was made that there is an acceptable risk that contaminants would not be encountered and that sediment testing during PED should proceed. Should levels of contamination be encountered within specific reaches of the channel that would result in limitations for placement of that new work material in the ODMDS, contingency plans will be developed for the specific new work areas.

The upper northeastern quadrant of the bay contains a relic shell mined area (highly hypoxic micro-environments) which was 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 RP. To that end, grab samples from within the Relic Shell Mined Area 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 Area.

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. The final determination on whether the new work material meets the ODMDS placement criteria will be the responsibility of the EPA in accordance with Section 103 of the MPRSA.

3.4.4.3. 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. The sediment testing and evaluation requirements will continue as required for all future maintenance material as described above.

3.5. 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.

3.5.1. Dissolved Oxygen (DO)

3.5.1.1. Alternative 1 – No Action

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

3.5.1.2. Alternative 2 - RP

3.5.1.2.1. Project Construction

Hydrographic and water quality modeling performed by the ERDC is documented in the Appendix A. Results of simulations comparing Without and With-Project conditions of the bay and river were assessed for changes in DO. 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.

Figure 3-1 and **Figure 3-2** show a time series of the daily average surface and bottom DO concentrations for the Without and With-Project conditions. As the figures indicate, 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 existing conditions are represented by red curve compared to

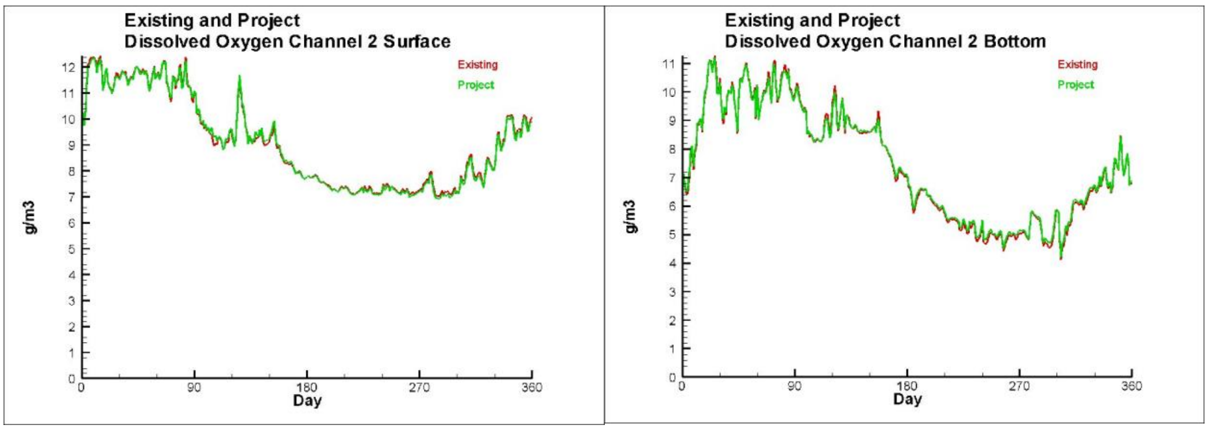


Figure 3-1. Existing daily average surface and bottom DO conditions for middle Mobile Bay.

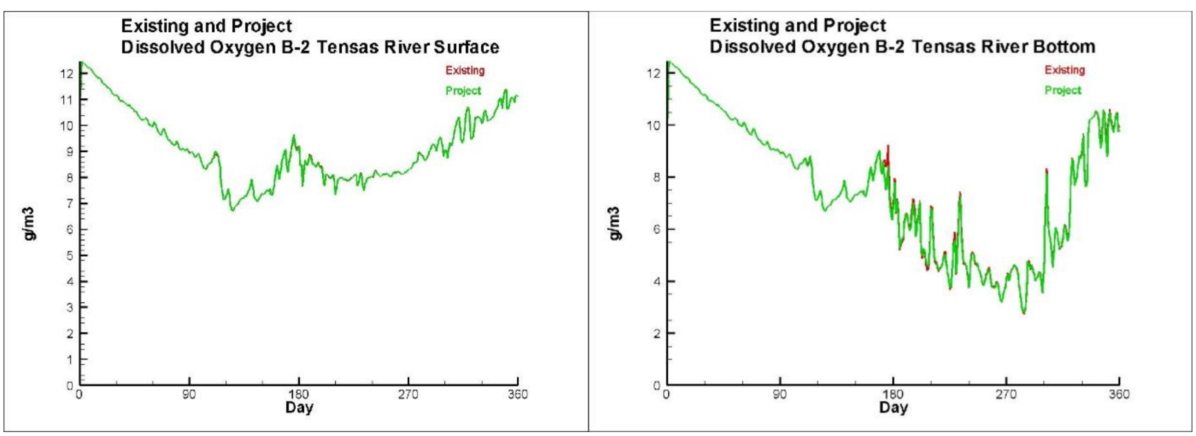


Figure 3-2. Existing daily average surface and bottom DO conditions for the Tensas River.

the predicted project conditions illustrated by the green curve. As clearly seen, the simulated results for the existing and project condition are nearly identical, indicating very little change in DO resulting from implementation of the RP. 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 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 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 SLR.

As presented below in Section 3.8.8, 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.

3.5.1.3. Future Maintenance

Other than the effects of implementing the RP, future maintenance and placement 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.

3.5.2. Nutrients

3.5.2.1. 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.

3.5.2.2. Alternative 2 – RP

3.5.2.2.1. Project Construction

Model predictions for ammonium and nitrate were conducted in the water quality simulations 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 RP.

3.5.2.3. Future Maintenance.

Other than the effects of implementing the RP, dredging operations, future maintenance and placement 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.

3.5.3. Salinity

3.5.3.1. Alternative 1 – No Action

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

3.5.3.2. Alternative 2 – RP

3.5.3.2.1. Project Construction

Hydrographic and water quality modeling performed by ERDC is documented in Appendix A. Results of simulations comparing the Without- and With-Project conditions of the bay and river 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 show 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.

Figure 2-17 and **Figure 2-18** presented in Section 2.4.3 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 allow for more salt intrusion through the navigation channel to Mobile River than wet conditions of the winter months. As shown in **Figure 3-3** and **Figure 3-4** 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, SAV, benthic communities, oysters, and fish can be found in Attachment C-1 and presented later in this report.

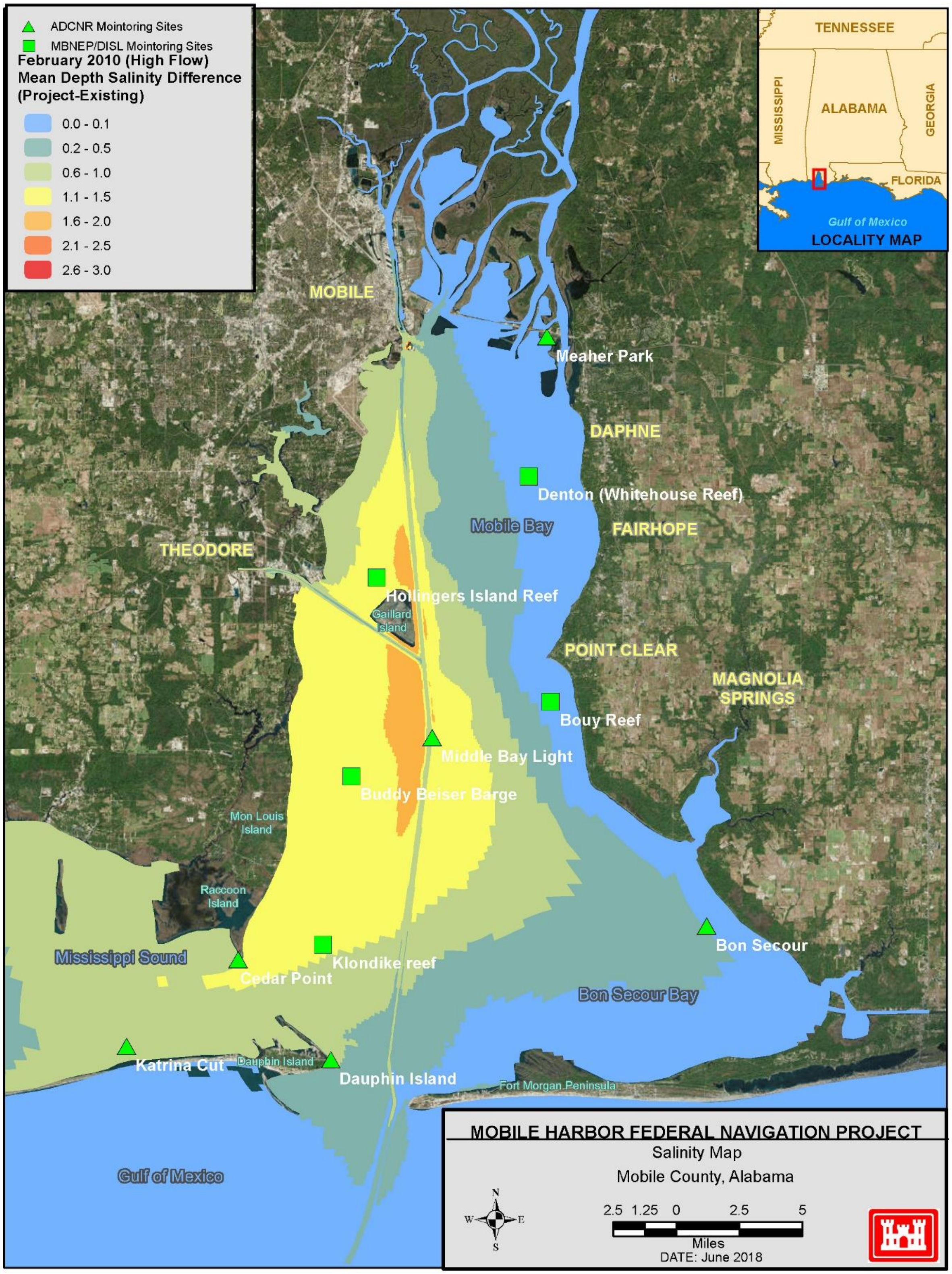


Figure 3-3. Distribution of differences in monthly mean depth salinity (ppt) With and Without-Project for February (high flow/wet)

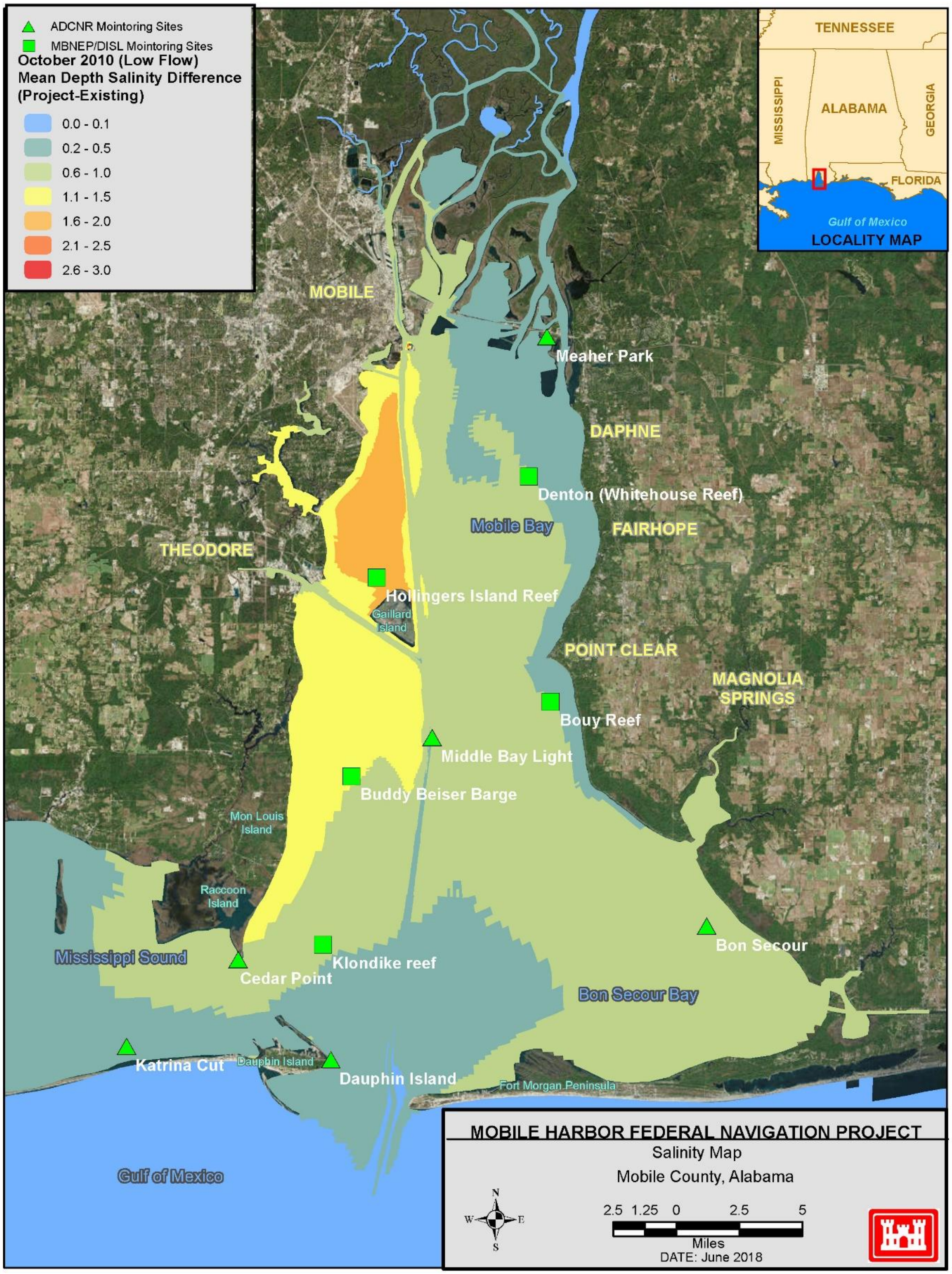


Figure 3-4. Distribution of differences in monthly mean depth salinity (ppt) With and Without-Project for October (low flow/dry)

3.5.3.3. 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.

3.5.4. Turbidity and Suspended Solids

3.5.4.1. 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.

3.5.4.2. Alternative 2 – RP

3.5.4.2.1. 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 filling, fine sediments (primarily silt, clays, and fine sands) may be 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) in the UK (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 500 ft 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 RP. The USACE, Mobile District 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, 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 400 ft 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, Mobile District 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.

3.5.4.3. Future Maintenance

Future maintenance activities will be much as they exist currently. Turbidity in the Mobile Bay and surrounding water bodies 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. 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.

3.5.5. Water Temperature

3.5.5.1. Alternative 1 – No Action

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

3.5.5.2. Alternative 2 – RP

3.5.5.2.1. Project Construction

Hydrographic and water quality modeling performed by the ERDC is documented in Appendix A. Results of simulations compared the Without- and With-Project conditions of the bay to characterize Mobile Bay's water temperatures. **Figure 3-5** illustrates the comparison between the simulated Without- 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 Without-Project conditions are represented by red curve compared to the predicted With-Project conditions illustrated by the green curve. 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 RP.

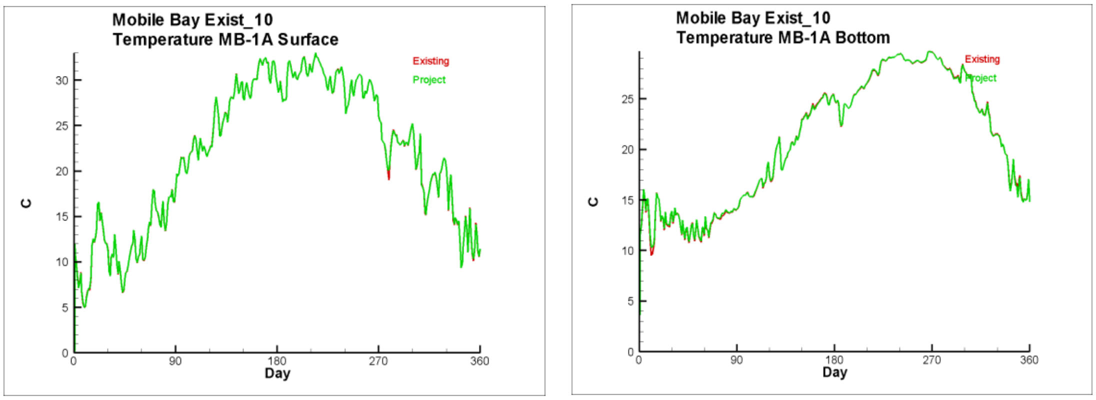


Figure 3-5. Existing daily average surface and bottom water temperatures for Mobile Bay

3.5.5.3. Future Maintenance

Other than the effects of implementing the RP, dredging operations, future maintenance and placement 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 temperature conditions in the bay and river systems.

3.6. 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.

There are communities within Mobile and Baldwin Counties which rely on the Miocene-Pliocene Aquifer for drinking water. Gillet et al. (2000) mentions 113 public groundwater wells within their well survey. Of these wells, 15 derive water from the Watercourse Aquifer, and the rest derive water from the Miocene-Pliocene Aquifer. If the new work dredging were to remove the confining layers between the Watercourse and Miocene-Pliocene aquifers within the channel's footprint, it is possible that brackish and salt water intrusion rates of the bay and bar areas could be affected, and in turn, affect the quality of water at the well locations.

3.6.1. 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 and therefore, the No Action Alternative would have no additional impacts to the local groundwater supplies.

3.6.2. Alternative 2 – RP

3.6.2.1. Project Construction

As previously mentioned, brackish and salt water intrusion rates of the bay and bar areas could be affected resulting from project construction. The water wells on Dauphin Island are the most likely to be affected as they are closest to the new work dredging, located approximately 4.5 miles away from the shipping channel at its closest point. A three dimensional (3-D) groundwater model was developed to understand the impact that new work dredging may have on the drinking water supply wells at Dauphin Island. The model explains how the change in the shipping channel, due to new work dredging, may affect the water supply to the Dauphin Island water wells. Additionally, the model seeks to quantify changes in travel time of groundwater from the channel to the island. A detailed report discussing the model development, calibration, and findings is in Attachment A – 7, Appendix A.

The analyses incorporated regional geologic data and current water well withdrawal rates for Dauphin Island into a series of steady state models. Particle tracks were then run in the models to assess the flow of water under certain variables (i.e. channel deepening, varying hydraulic conductivity, sea level rise, and increased withdrawal). Models were compared by looking at the particle tracks around the well capture zones, mainly within a 1000-year timeframe. A conservative approach was used to model the confining clay layer within the channel, assuming that it is currently present and uniform, and that the new work dredging completely cuts through it. Results show that the new work dredging may have a minor influence on the drinking water source at Dauphin Island. However, variables such as drought, sea-level rise, or increased demand have considerably more effect on increases in salinity. Additionally, the model shows that the minor effects of salinity change caused by the new work dredging may not be realized for thousands of years. The models show minor differences in the 1000-year capture zone for the existing conditions versus the cut through the channel condition. Based on the modeling results, the new work dredging minimally impacts the groundwater source to the Dauphin Island water wells and any negative effect could take thousands of years to be realized. Considering these conclusions from the aquifer modeling and analysis, it is not anticipated that the deepening of the channel would result in adverse impacts to the aquifer or associated groundwater used by Dauphin Island. A more detailed discussion of the aquifer modeling results are included in Section 6.6, Appendix A.

3.6.3. Future Maintenance

Future maintenance and placement practices will be 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.

3.7. 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 RP, are as follows:

- Deepen the existing Bar, Bay, and River Channels (below 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 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 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 RP 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 RP. These included six locations in a relic shell mined area, the ODMDS, and the SIBUA (if new work sand sources are found within the Bar Channel) as illustrated in **Figure 3-6**. Details of these areas are provided in Section 4.11 of Appendix A.

<u>Relic Shell Mined Area</u>. 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 3-6**. 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 oyster dredging operations were conducted prior to 1982. These operations resulted in an overall deepening of the bay bottom which has been filled in by very fine grained sediment believed to be the cause of degraded bay bottom characteristics and decreased ecological productivity resulting from hypoxia during certain times of the year.

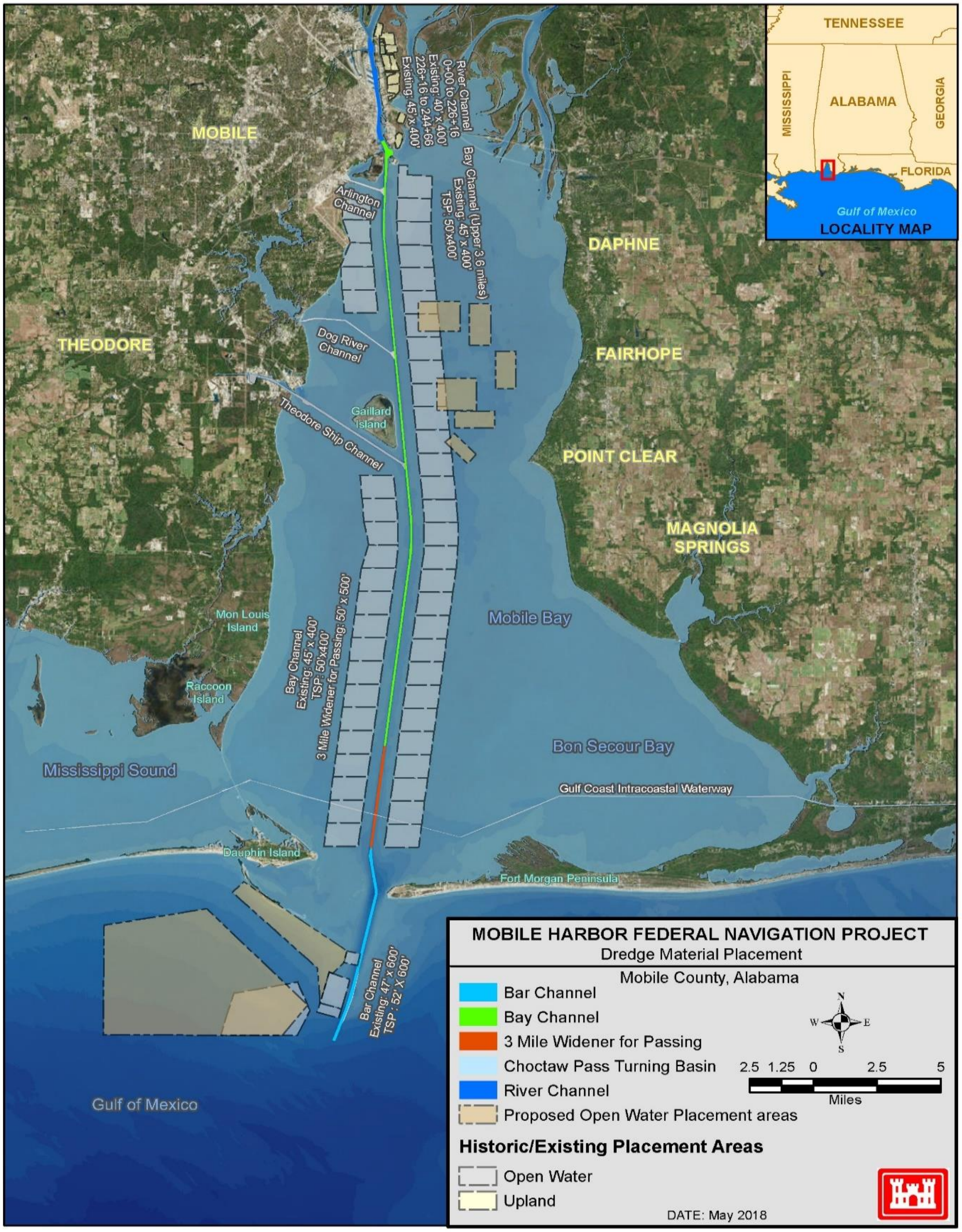


Figure 3-6. Dredge Material Placement Site Overview

Approximately 5.5 mcy of new work material are anticipated to be placed in the Relic Shell Mined Area. Site selection and volume estimates for the locations in this area were based on NOAA compiled bathymetric surveys within the area between 1960 to 1961 and 1984 to 1987. More recent assessments conducted by the USACE, Mobile District revealed that the deeper holes filled with unconsolidated fine grained sediments. 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 encompas s 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 un-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 this site is detailed in Section 4.11.1.1, Appendix A.

<u>SIBUA</u>. The WRDA 1996 authorized practices for beneficial use of dredge material from the ODMDS. The USACE then coordinated with the ADEM to designate an area on the western side of the Bar Channel in which suitable material could be placed when any opportunity arose. Designation of the SIBUA was completed in 1998 and placement of the sandy bar channel maintenance material at this site became the preferred placement option 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 as part of the RP. 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 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.

<u>ODMDS</u>. 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 million total volume minus the 5.5 mcy going in the Relic Shell Mined Area) are anticipated to be placed in the expanded ODMDS. EPA Region 4 is pursuing the proposed ODMDS expansion pursuant to Section 102 of the MPRSA. 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 RP. The boundaries of the current and expanded area is described in detail in Section 4.11.1.2 of Appendix A.

3.7.1. 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.

3.7.2. Alternative 2 – RP

3.7.2.1. 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 Nephelometric Turbidity Units (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 ft 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, Mobile District 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.

<u>Channel Deepening</u>. Adverse impacts to wetlands, oyster reefs, or SAVs from dredging activities associated with the implementation of the RP 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 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 respectively.

Widener and Bend Easing. As with the proposed channel deepening activities, adverse impacts to wetlands, oyster reefs, or SAV from dredging activities associated with the implementation of the RP 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, especially in those areas where natural bay bottom is being removed in the widening 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, impacts to existing resources would be temporary and localized in nature associated with the dredging and would be no more than the maintenance dredging operations regularly occurring within the navigation channel. Based on the extent of the 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 respectively.

Choctaw Pass Turning Basin. As shown in **Figure 4.5,** Section 4.1 of the GRR/SEIS, 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., (2019) mapped the existing wetlands as described in Section 2.6.2. **Figure 2-20 and Figure 2-21** show the wetland communities that exist on and around Little Sand Island. Berkowitz et al. (2019) indicates these wetlands are typical of those found in disturbed areas. Additionally, the study conducted by Berkowitz et al., (2019) conducted mapping of existing SAV in the area which includes Little Sand Island. The distribution of SAV are shown by **Figure 2-25** in Section 2.6.3 and shows that there are no existing SAVs in the area where material is to be excavated for the widening of the turning basin. Based on the study results conducted by Berkowitz et al., (2019) that presents baseline conditions on and around Little Sand Island, there would be no significant losses to wetland communities and SAVs from the proposed widening of the Choctaw Pass Turning Basin.

When conducting dredging activities, the USACE takes extensive steps to reduce and avoid potential impacts to aquatic habitats such as wetlands, SAV, oysters, benthic communities, and fish as well as other significant area resources. Adverse impacts to wetlands, oyster reefs, or SAVs from dredging activities associated with the implementation of the RP would 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 dredging activities will be taking place in the vicinity where maintenance dredging operations of the existing turning basin 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 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 limited abundance of aquatic resources within and around the turning basin and the localized 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 respectively.

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. Some fish may use the deeper portions of the Relic Shell Mined Area as refuge during winter conditions. As shown above, the entire area will not be used for placement of material, allowing much of the area to still be utilized as refuge under these conditions.

An example used to exhibit the effects of placement in the Relic Shell Mined 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 the concept of using dredged material to fill holes created by past dredging and borrow actions. Brookley Hole is a 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**. Baseline surveys indicate that the deepest portion of Brookley Hole, at approximately 23 ft, 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

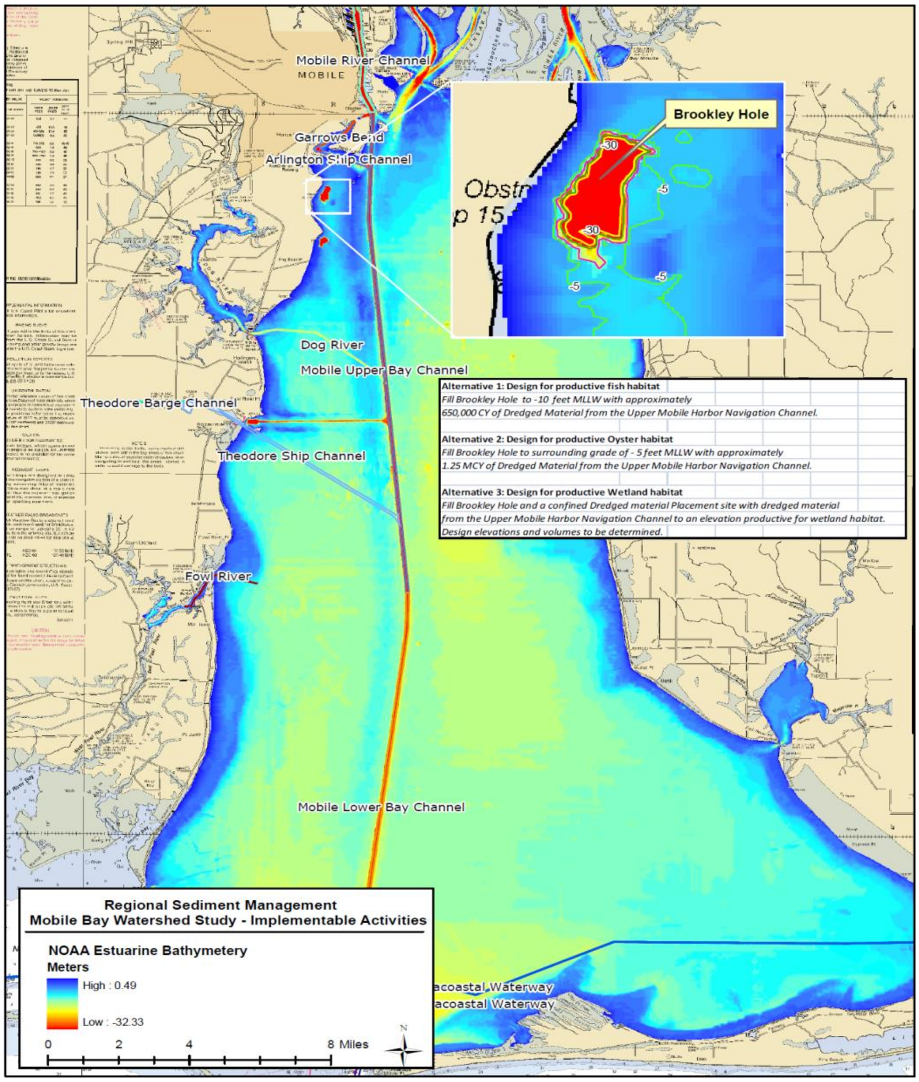


Figure 3-7. Location of Brookley Hole in the upper Mobile Bay

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 in Section 3.3.3, 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 Section 6.3, Appendix A.   The modeling conducted specifically for the open water thin-layer placement 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.

<u>SIBUA</u>. 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 RP. 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.

<u>ODMDS</u>. The implementation of the RP 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 RP, 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 placement 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). Furthermore, given the small area (percentage wise) that will be affected in the Gulf of Mexico at a given point in time, no significant long-term impacts to the benthos, motile invertebrates, and fishes are expected to occur as a result of the proposed action. Therefore, no long-term adverse impacts are expected to the aquatic community from the continued use of the Mobile ODMDS.

3.7.3. Future Maintenance

Future maintenance and placement practices will be consistent with the current O&M placement 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.

A Joint Public Notice between the USACE, Mobile District and the EPA was published September 27, 2018 stating that the EPA proposes to modify the ODMDS pursuant to Section 102 of the MPRSA. The public notice stated that the modification is an administrative change and required to accommodate future and additional dredged material placement needs within the area. The modification expands the boundary from the current configuration of 4.75 square nautical miles (nmi^2) to approximately 24 nmi^2. An Environmental Assessment (EA), which includes a draft Site Management Monitoring Plan (SMMP), for this modification was prepared and made available for agency and public comment. A copy of the EA is available on-line at the USACE, Mobile District Office, Planning and Environmental Division web site located at

http://www.sam.usace.army.mil/Missions/PlanningEnvironmental.aspx.

The proposed modification is currently awaiting the EPA final approval process and anticipated to be completed prior the release of the Final GRR. Once the modification is approved by the EPA, the ODMDS will provide the capacity necessary for the channel modification. The status of the ODMDS will be included in the GRR Main Report.

Material dredged as part of the routine maintenance of the Bar Channel (primarily sandy sediments) is placed in the SIBUA. The SIBUA, located west of the channel on the ebb tidal shoal (see **Figure 3-6**), was evaluated to determine whether capacity exists to accommodate projected increases in maintenance dredged material associated with implementation of the RP. In an effort to ensure adequate placement capacity for maintenance dredging of the Bar Channel, the USACE, Mobile District has completed modifications to extend the SIBUA beyond its existing boundaries expanding the site to the northwest, following the shoal and pathway of sediment transport towards Dauphin Island. A water quality certification (WQC) and coastal zone consistency (CZC) determination was received from ADEM on November 15, 2018. No adverse impacts to Dauphin Island resulting from the SIBUA expansion are expected. Details of the ODMDS and the SIBUA are provided in Section 4.11.2 of Appendix A.

Future O&M dredging and placement of material in the placement sites will result in temporary increases of suspended sediments, 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.

3.8. Biological Resources

3.8.1. Upland Communities

3.8.1.1. 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.

3.8.1.2. Alternative 2- RP

With the exception of the Little Sand Island, the actions associated with constructing and placement of new work sediments will be conducted totally within the open waters of the Gulf of Mexico and Mobile Bay. Impacts to Little Sand Island are addressed in Section 3.7.2.1.

3.8.1.3. Future Maintenance

Future Maintenance of the project, will utilize already existing and certified 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.

3.8.2. Wetlands

This discussion of potential impacts on tidal wetlands resulting from implementation of the RP is a summary of the wetland impacts assessment conducted by Berkowitz et al. (2019). The detailed report is included in Section 3 of Attachment C-1.

In order to determine potential effects of the proposed project modifications on the wetland environments 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 were conducted (Berkowitz et al., 2019). 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 Interstate 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 temporary salinity fluctuations resulted in the development of diverse and resilient wetland community types within Mobile Bay. However, potential changes in water quality resulting from the implementation of the proposed Navigation Channel expansion were evaluated to determine if post-project water quality conditions will impact wetland resources. The analysis also considered the effects of SLR 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 deepening 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 3-1**. The salinity mortality thresholds are documented in the United States Department of Agriculture (USDA) PLANTS database (https://plants.usda.gov).

Table 3-1. Salinity tolerance ranges for each wetland plant community.

Note: 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		

Hydrodynamic and water quality model results conducted by ERDC (see Attachment A-1 of 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 representativewhen the full cohort of species has undergone the annual growth cycle (USDA-NRCS 2006). During that period, data from 802 distinct locations within Mobile Bay were evaluated to enable development of a comprehensive map of wetland features within the study area as described in Section 2.6.2. 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 (31000 ha) 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.

Salinity tolerance thresholds for each wetland community type were obtained from peer reviewed journal publications and salinity classes documented within the United States Department of Agriculture (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 (USDA; **Table 3-2**) 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 of Attachment C-1.

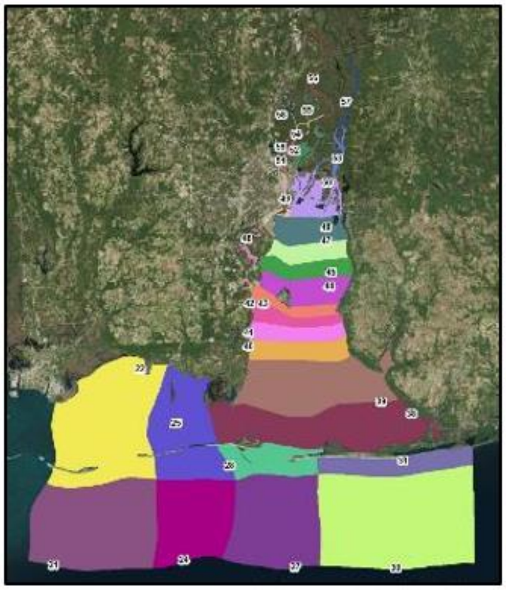
Extensive water quality and hydrodynamic data was generated to evaluate both present day (i.e., existing) conditions within Mobile Bay as well as estimated post-project conditions. Available water quality parameters included salinity, DO, and other factors (e.g., nutrients). For the assessment of wetland resources, only potential changes in salinity were evaluated due to the fact that wetlands are adapted to saturated and anaerobic soil conditions (Vepraskas and Craft 2016). Additionally, the river systems flowing into Mobile Bay are rich in both nutrients and sediment resulting in fertile substrate within the Bay (AWF 2018), suggesting that change to the navigation channel would have little effect on other water quality parameters. All hydrodynamic and water quality data was generated using a combination of approaches including 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 US Army Corps of Engineers Engineer Research and Development Center (Cerco and Cole 1995).

The water quality data included baseline condition and estimated post product conditions for > 48,000 individual cells organized into 30 blocks (or groups of cells) encompassing the entire area of Mobile Bay (**Figure 3-8**). 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 US Army Corps of Engineer's 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.

Table 3-2. Salinity tolerance ranges for each wetland plant community. Salinity thresholds are absolute values based upon ideal growth conditions and do not reflect mortality (USDA plants database)

Species	Salinity (ppt)	Duration (d)	Citation
Baldcypress	10	14	Conner et al. (1997)
Chinese tallow	10	42	Conner and Askew (1993)
Green ash	10	14	Conner et al. (1997)
Red maple	20-27	<5	Conner and Askew (1993)
Saltmeadow cordgrass	>60	14	Crain et al. (2004)
Smooth cordgrass	>33	Long term	USDA (2000)
Southern cattail	15	68	Glenn et al. (1995)
Water tupelo	10	14	Conner et al. (1997)
Wax myrtle	>8.7	35	Sande and Young (1992)

Note: Salinity and exposure (duration) based upon values available in published literature.



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 3-8. 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 Without-Project and estimated 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 RP condition, and the post project condition plus 0.5 m sea level 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 ft, water quality data is generated in 33-foot increments. Similarly, if the water depth is 3.3 ft, 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.

3.8.2.1. 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 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.

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.

3.8.2.2. Alternative 2 – RP

3.8.2.2.1. 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 ac study area. As a result, the With-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** and **Table 3-4**; and **Figure 3-9**, **Figure 3-10**, and **Figure 3-11** below provide data on the post project salinity conditions of wetland communities within the potential impact area, evaluating potential exceedance of mortality and productivity thresholds.

Table 3-3. Vegetation mortality analysis comparing the maximum estimated salinity increase with published salinity thresholds. Note that the maximum increases remain < 20% of increases required to induce mortality.

Species	Salinity mortality threshold (ppt)	Maximum estimated salinity increase (ppt)
Baldcypress	10	2.0
Chinese tallow	10	1.9
Green ash	10	1.5
Red maple	20-27	1.2
Saltmeadow cordgrass	>60	2.1
Smooth cordgrass	>33	2.1
Southern cattail	15	1.9
Water tupelo	10	2.0
Wax myrtle	>8.7	1.5

<u>Wetland Mortality Analysis</u>. The study conducted by Berkowitz et al. (2019) evaluated wetland features using mortality threshold data available in the published literature as can be seen in Attachment C-1. 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).

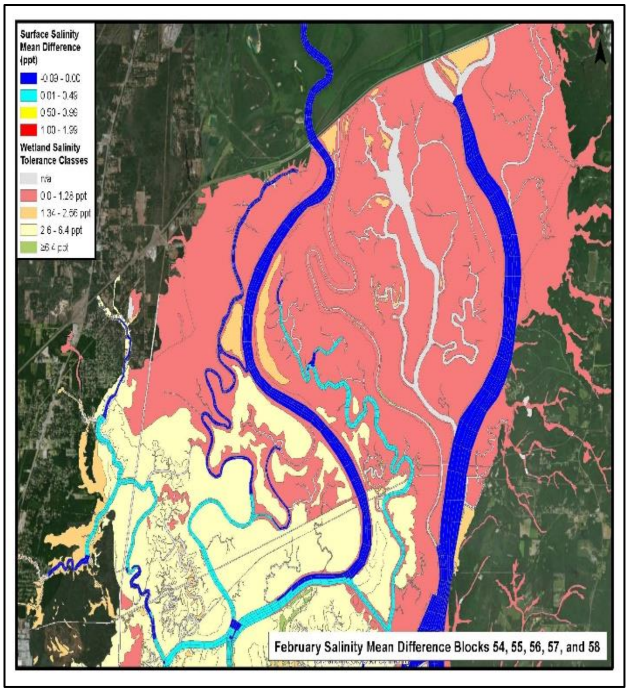
The analysis linked each wetland feature with an adjacent water quality cell as described above to determine if the estimated changes in salinity between Without and With-Project conditions would exceed published mortality thresholds. To provide a conservative approach the mortality analysis utilized the maximum estimated increase in salinity for each vegetative community. Results indicate that maximum estimated increases in salinity would not exceed salinity thresholds for the vegetation communities examined (i.e., those with available mortality data; **Table 3-2**). 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 (**Table 3-3**). 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 of 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.

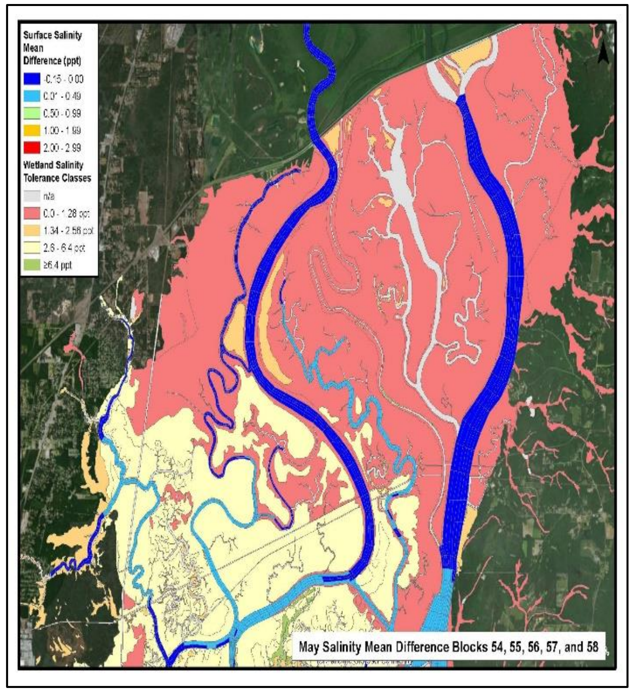
<u>Wetland Productivity Assessment</u>. In addition to the mortality threshold study presented above, an analysis was conducted utilizing the ideal growth tolerances developed by USDA (2000). Ideal growth tolerances are available for all wetland community types occurring within the potential impact area, 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 (**Table 3-4**). 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 that no impacts to wetland productivity will result under the With-Project conditions. To emphasize these findings **Figure 3-9**, **Figure 3-10,** and **Figure 3-11** illustrates the salinity changes for each season within the upper, central, and southern portions of the study area and provide seasonal visual representations of post project conditions representing predominantly fresh, intermediate, and estuarine wetland plant community assemblages. Note that within each figure, the estimated changes in salinity remain below the salinity tolerance thresholds identified for individual wetland features. Note that estimated salinity increases in the upper portion of the study areas (Figure 3-9) are limited to 0.0, or <0.5 ppt. In areas where salinity increases may occur in the upper Bay, wetland communities are adapted to predicted conditions. Within the central (transitional) portion of the study area (Figure 3-10), areas containing wetlands display estimated 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 (see bottom left portion of winter and spring periods in Figure 3-10). Similarly, within the lower (estuarine) portion of the study area (**Figure 3-11**), areas containing wetlands exhibit estimated salinity increases of <1.0 ppt (winter and fall), <0.5 or <1.0 ppt (spring), or <1.0 or <2.0 ppt (summer). 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 (see far right portion fall period in **Figure 3-11**).

Table 3-4. Mean estimated post-project seasonal change in salinity, standard deviation for each vegetation community. Note: All units are in part per thousand (ppt). Salinity tolerances (absolute values) for optimal growth are also provided.

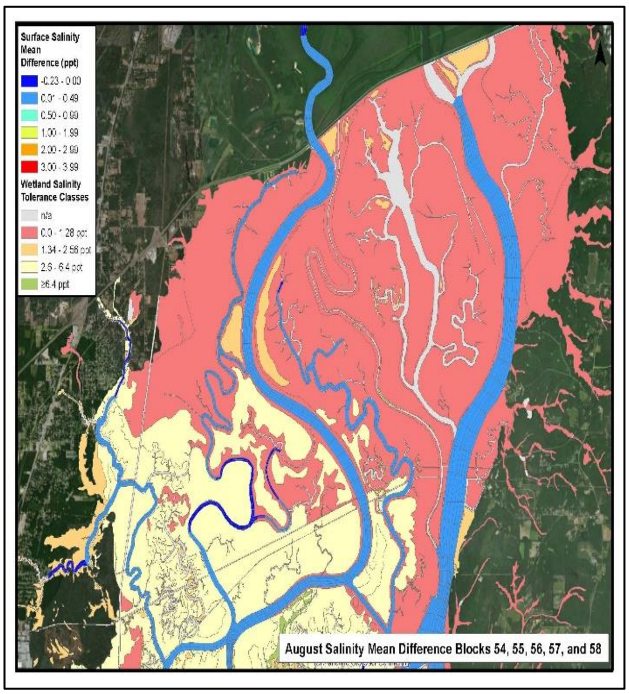
Wetland community	Salinity tolerance	Winter	Spring	Summer	Fall
Baldcypress - Black Willow - Chinese Tallow	2.6-6.4	0.11, 0.2	0, 0	0.25, 0.18	0.44, 0.14
Baldcypress - Tupelo	1.31-2.59	1.09, 0.23	0.78, 0.21	0.98, 0.17	1.29, 0.12
Baldcypress - Tupelo - Slash pine	1.31-2.59	0.8, 0.35	0.61, 0.07	0.8, 0.11	1.19, 0.01
Baldcypress - Tupelo - Swamp bay - Palmetto - shrub mix	2.6-6.4	0.68, 0.42	0.57, 0.01	0.7, 0.05	1.05, 0.06
Big cordgrass	>6.4	0.66, 0.43	0.39, 0.1	0.86, 0.32	1.21, 0.1
Big cordgrass - Switchgrass	2.6-6.4	0.17, 0.22	0.04, 0.01	0.32, 0.19	0.53, 0.09
Big cordgrass - Switchgrass - Sawgrass	2.6-6.4	0.29, 0.27	0.16, 0.01	0.41, 0.16	0.64, 0.02
Black needlerush	>6.4	0.84, 0.26	0.61, 0.16	0.87, 0.2	1.22, 0.05
Black needlerush - Big cordgrass	>6.4	0.94, 0.35	0.65, 0.16	0.97, 0.23	1.37, 0.04
Black needlerush - Big cordgrass - Switchgrass	>6.4	0.71, 0.33	0.47, 0.11	0.84, 0.29	1.21, 0.07
Bottomland mix	0-1.30	0.63, 0.38	0.53, 0.03	0.65, 0.06	0.98, 0.05
Bulrush	1.31-2.59	0.56, 0.36	0.45, 0.01	0.56, 0.06	0.88, 0.05
Chinese tallow - Black willow - tidal shrub mix	2.6-6.4	0.6, 0.35	0.35, 0.1	0.76, 0.28	1.01, 0.09
Giant cutgrass	1.31-2.59	0.72, 0.39	0.61, 0.01	0.7, 0.07	1.05, 0.06
Live oak - Magnolia - Pine (Hammock)	0-1.30	1.13, 0.3	0.82, 0.28	1.03, 0.19	1.41, 0.13
Mexican water-lily	1.31-2.59	1.14, 0.17	0.82, 0.27	1.02, 0.21	1.27, 0.12
Phragmites	>6.4	0.48, 0.3	0.26, 0.08	0.6, 0.23	0.88, 0.06
Pine flatwoods	0-1.30	0.27, 0.09	0.2, 0.04	0.45, 0.2	0.6, 0.12
Sawgrass	2.6-6.4	0.54, 0.27	0.38, 0.04	0.59, 0.13	0.88, 0.03
Sawgrass - tidal shrub mix	2.6-6.4	0.41, 0.23	0.27, 0.03	0.49, 0.16	0.73, 0.05
Slash pine - Live oak - tidal shrub mix	1.31-2.59	0.97, 0.3	0.7, 0.18	0.99, 0.22	1.36, 0.04
Smooth cordgrass	>6.4	0.53, 0.4	0.27, 0.07	0.66, 0.25	0.99, 0.09
Sweetbay - swampbay - yellow-poplar - netted chainfern	0-1.30	0.08, 0.07	0.03, 0.03	0.32, 0.28	0.39, 0.17
Tidal shrub mix	2.6-6.4	0.68, 0.29	0.47, 0.11	0.76, 0.2	1.09, 0.03
Torpedo grass	2.6-6.4	1.14, 0.17	0.82, 0.27	1.02, 0.21	1.27, 0.12
Typha	1.31-2.59	0.53, 0.38	0.37, 0.03	0.6, 0.13	0.91, 0.03
Typha - Bulltongue	1.31-2.59	0.42, 0.32	0.31, 0.01	0.49, 0.1	0.75, 0
Typha - Bulltongue - Three square - Alligatorweed	1.31-2.59	0.13, 0.21	0.01, 0.01	0.24, 0.16	0.46, 0.07
Typha – Bulrush	1.31-2.59	0.84, 0.54	0.47, 0.15	1.08, 0.43	1.64, 0.27



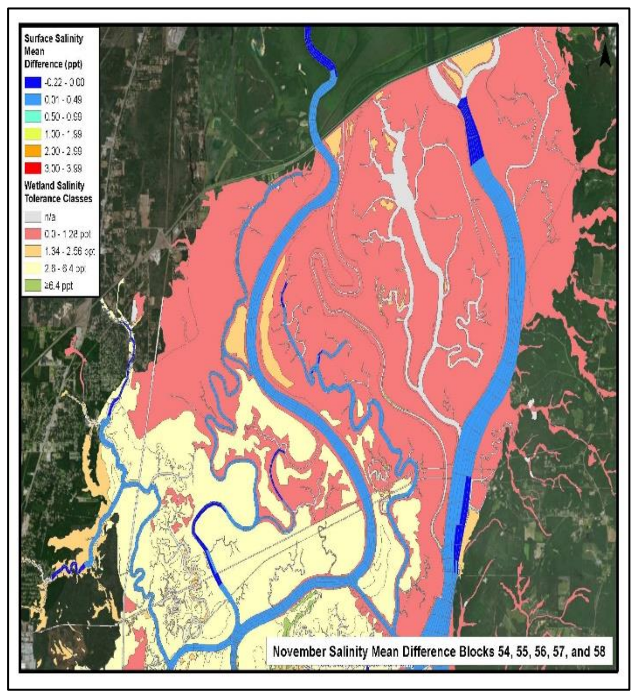
Winter Period



Spring Period



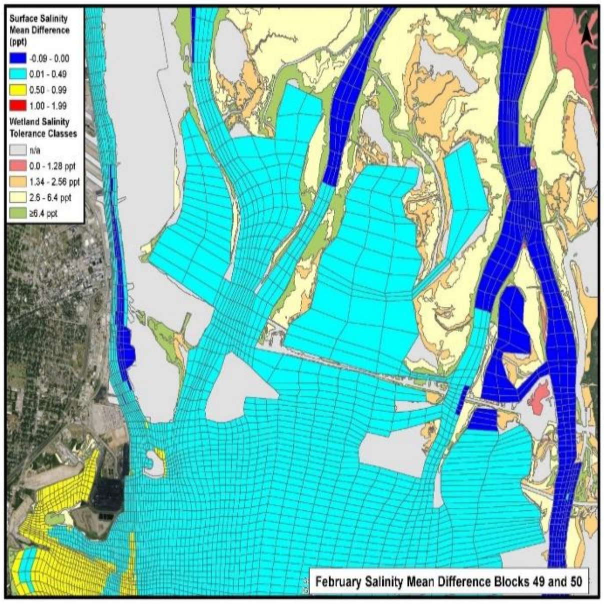
Summer Period



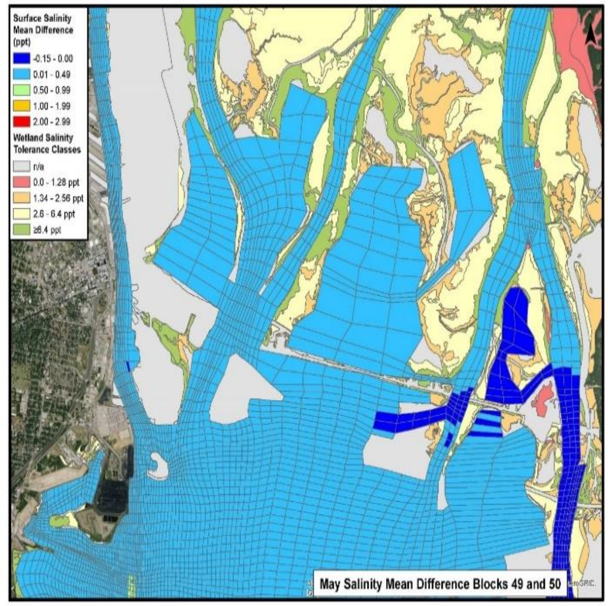
Fall Period

Note that estimated salinity increases are limited to 0.0, or <0.5 ppt. In areas where salinity increases may occur, wetland communities are adapted to predicted conditions.

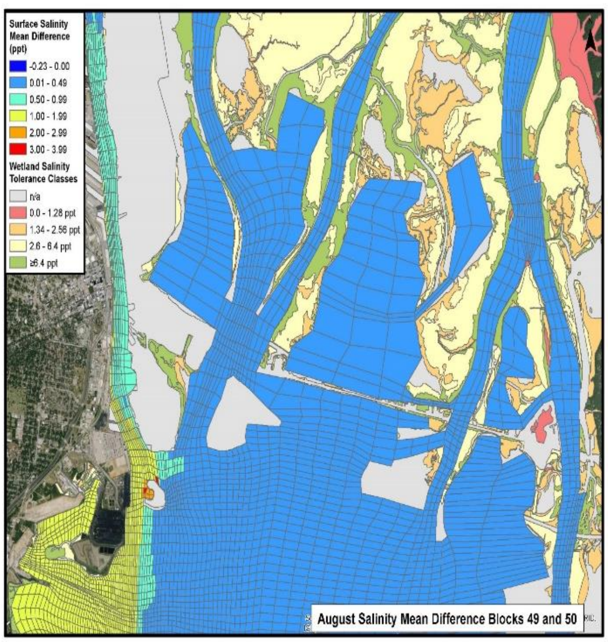
Figure 3-9. Estimated seasonal increase in salinity (February data shown for example) within the upper (freshwater) portion of the study area.



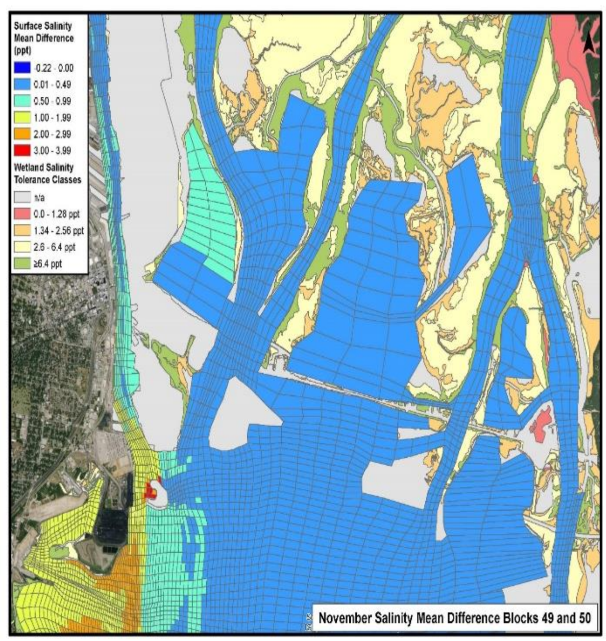
Winter Period



Spring Period



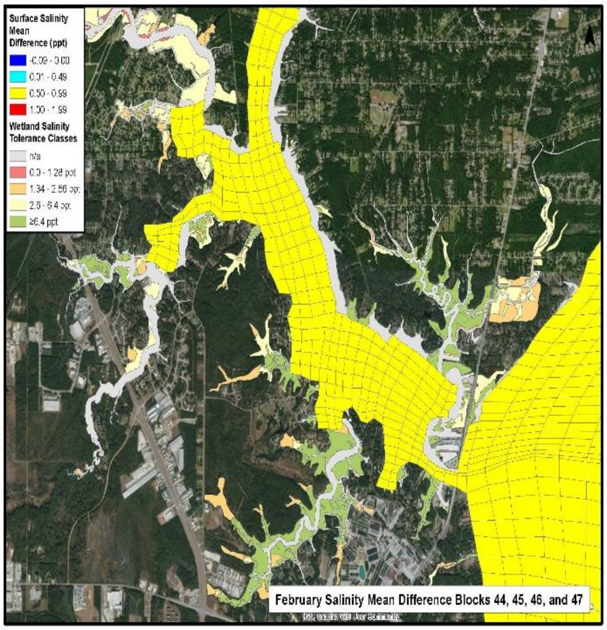
Summer Period



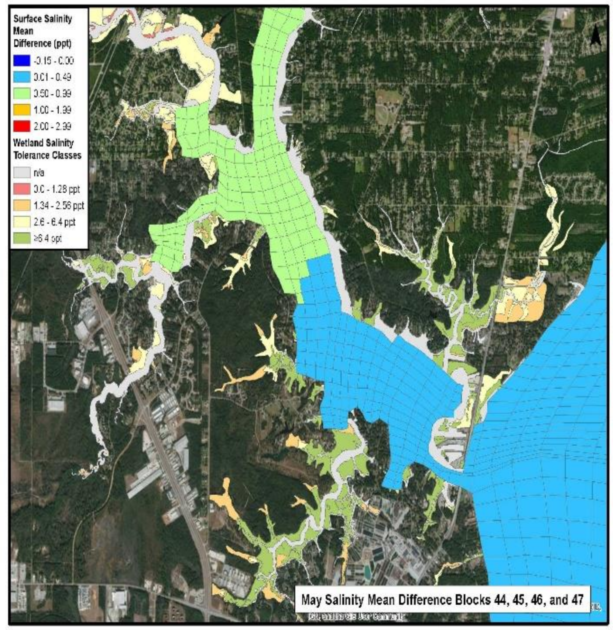
Fall Period

Note that estimated salinity increases are limited to 0.0, <0.5, or <1.0 ppt. In areas where salinity increases may occur, wetland communities are adapted to predicted conditions.

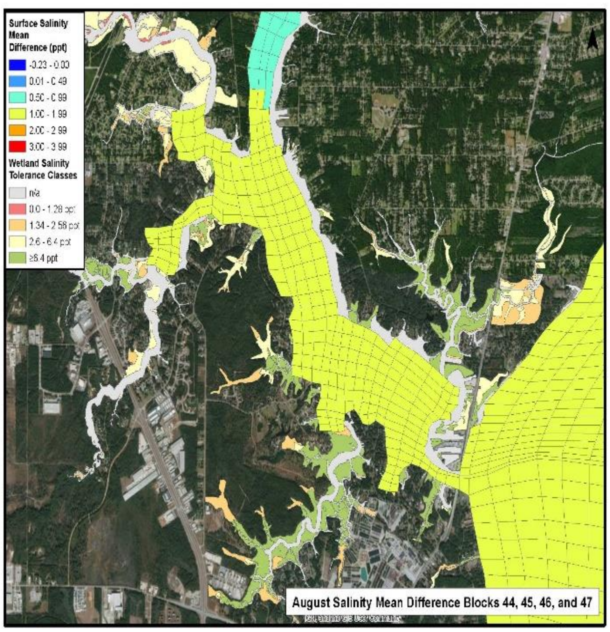
Figure 3-10. Estimated seasonal increase in salinity within the central (transitional) portion of the study area.



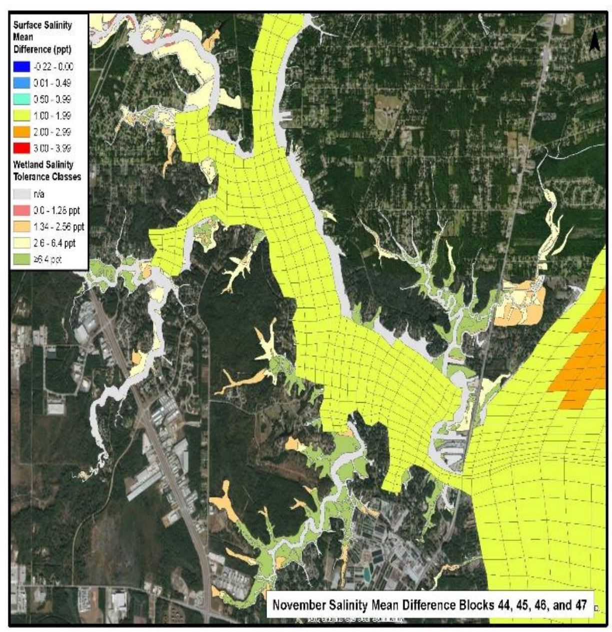
Winter Period



Spring Period



Summer Period



Fall Period

Note that in areas containing wetlands estimated salinity increases are limited to <1.0 ppt. In areas where increases may occur, wetland communities are adapted to predicted conditions.

Figure 3-11. Estimated seasonal increase in salinity within the lower (estuarine) portion of the study area.

<u>SLR</u>. 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 cause 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 ac) in the context of much larger potential SLR implications (>8,000 ac) occurring over a 50 year interval suggests that any wetland impacts related to implementation of the project remain negligible within the larger SLR 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.

3.8.2.3. 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. However, these temporary and local conditions will be far removed from existing wetlands and no long term impacts are expected.

3.8.3. Submerged Aquatic Vegetation

This discussion of potential impacts on SAV communities resulting from implementation of the RP is a summary of the SAV assessment conducted by ERDC (2018). The detailed report is included in Section 4 of Attachment C-1.

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 temporary variation in order to establish baseline distribution, within Mobile Bay as described in Section 2.6.3. 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 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 RP.

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, as compiled from published reports and peer reviewed literature is presented in **Table 3-5**. As is expected in a geographic region that encompasses fresh water, brackish, and estuarine conditions, SAV species in the region have tolerance ranges that vary considerably on whether the plant is adapted to variable salinity exposure or not. For example, Water Stargrass, *Heteranthera dubia*, is a predominantly freshwater species with a limited salinity tolerance of 0-3.5 ppt. In contrast, Widgeon grass, *Halodule wrightii*, has a very broad salinity tolerance of 0-60+ ppt. These species specific differences provide critical information for evaluating potential impacts of increased salinity due to projects implementation. Spatial alignment of project related salinity increases with SAV species occurrence makes it possible to evaluate impacts. For example, an increase in salinity from 2 ppt to 10 ppt would not indicate potential impacts if this increase occurred in an SAV bed made up of Widgeon grass. If the bed were composed of Water Stargrass, this same increase in salinity would likely have negative effects on the species.

3.8.3.1. 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 impact to SAV communities and distributions as the SLR occurs (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.

Table 3-5. Reported Salinity tolerance thresholds and ranges for local SAV species.
Note: Where threshold information was not available, published salinity range in known locations is reported and designated as 'Range'.

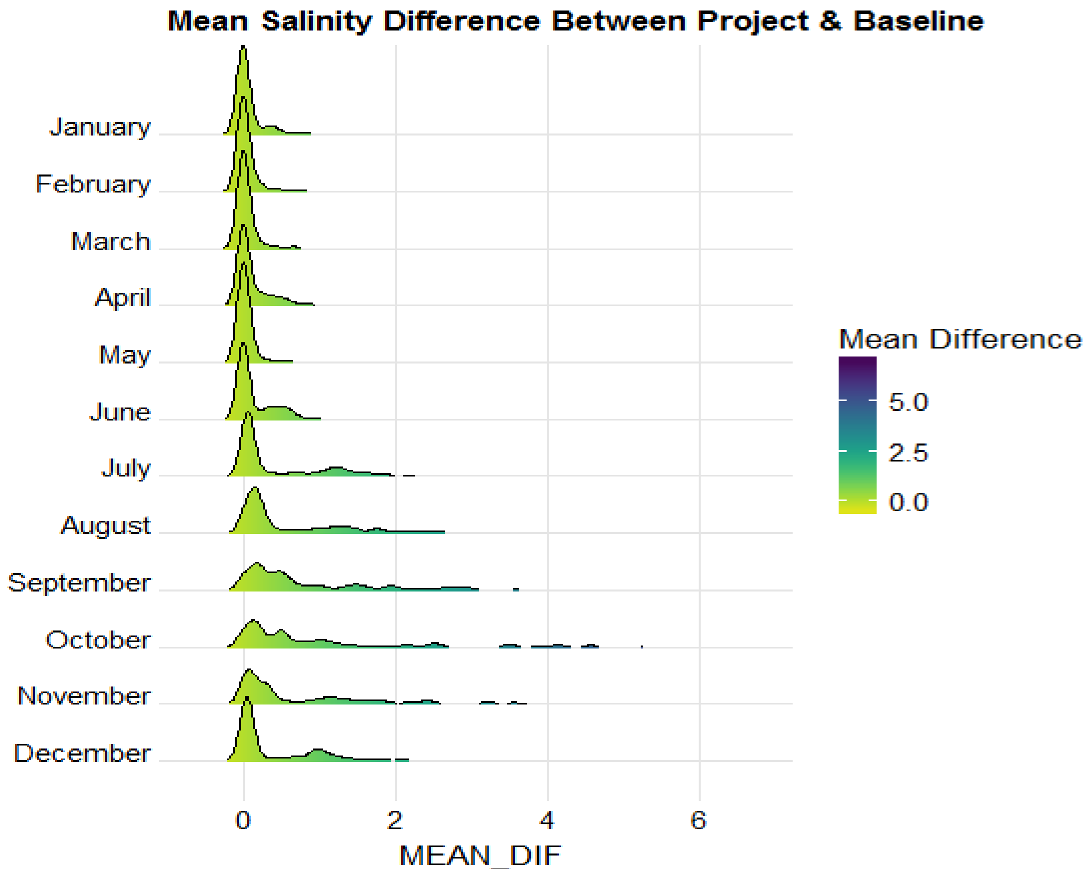
Species	Abbreviation	Common Name	Reported Salinity Tolerance or Range (ppt)	Citations	Notes
Cabomba caroliniana	*CC*	carolina fanwort	0-0.5	Poirrer et al. 2010	Rare in study area, mostly in the side creeks
Ceratophyllum demersum	*CD*	coon's tail	0-0.7	Poirrer et al. 2010	Present throughout the delta, very abundant
			0-5	Izzati 2015	
Halodule wrightii	*HW*	shoal grass	0-60	Texas Parks and Wildlife 1999	All along the Gulf of Mexico, likely not affected by project
			0-70	Kock et al. 2007	
			5-80	McMahan 1968, McMillian 1974	
Heteranthera dubia	*HD*	water stargrass	0-3.5	Poirrer et al. 2010	Very abundant on the east side of the delta
			0-5	Izzati 2015	
Hydrilla verticillata	*HV*	hydrilla	0-6.6	Haller et al. 1974	invasive, only at 5 points up creeks in the right side of the delta
			0-10	Poirrer et al. 2010	
			0-12	Twilley et al. 1990	
			0-13	Steward and Van 1987	
Myriophyllum aquaticum	*MA*	parrot's feather	0-10	Haller et al. 1974	Very rare in study area, in upland areas, invasive
Myriophyllum heterophyllum	*MH*	southern watermilfoil	0-5 (Range)	Sivaci et al. 2008	Very rare in study area, one patch far up a creek
			~6 (Range)	Eggleston et al. 2008	
Myriophyllum spicatum	*MS*	Eurasian watermilfoil	0-13	Haller et al. 1974	Present throughout the delta, invasive
			0-15	Aiken et al 1979	
			0-15	Izzati 2015	
			0-20	Poirrer et al. 2010	
Najas guadalupensis	*NG*	southern naiad	0-3.5	Poirrer et al. 2010	Present throughout the delta, very abundant
			0-10	Texas Parks and Wildlife 1999	
			0-10	Haller et al. 1974	
Potamogeton crispus	*PC*	curly pondweed	0-8 (Range)	Vincent 2001	Rare but spread throughout the delta, invasive
Potamogeton diversifolius	*PD*	water thread pondweed	0 (Range)	USDA, NRCS 2018	Present in the bay far downstream of areas of salinity change
Potamogeton nodosus	*PN*	longleaf pondweed	0 (Range)	USDA, NRCS 2018	Present in the bay far downstream of areas of salinity change
			0-1.3 (Mean, Range)	Castellanos and Rozas 2001	
Potamogeton pusillus	*PP*	small pondweed	0-3.5	Poirrer et al. 2010	Present in the bay far downstream of areas of salinity change
Ruppia maritima	*RM*	widgeon grass	0-60	Phillips 1960	Present throughout the entire study region
			0-70	Kock et al. 2007	
			0-100	Kantrud 1991	
Stuckenia pectinata	*SP*	sago pondweed	0-15, can likely handle above 20	Borgnis and Boyer 2014	Present only in lower part of the delta, not likely to be affected by project
Thalassia testudinum	*TT*	turtle grass	5-45	Lirman and Cropper 2003	One patch by the Gulf of Mexico, out of project area
			20-40	Zieman 1982	
			36-70	Kock et al. 2007	
Utricularia foliosa	*UF*	leafy bladderwort	0-5 (Range)	Camargo and Florentino 2000	A few patches up the creeks on the east side of the lower delta
			1-3.5 (Range)	Ross et al. 2000	
Utricularia inflata	*UI*	floating bladderwort	0-0.02 (Range)	de Roa et al. 2002	Rare, one patch miles away from the lower delta
Vallisneria neotropicalis	*VN*	wild celery	0-18	Doering et al. 2001	Widespread, species observed in areas higher than 18 ppt
			0-18	Kraemer et al. 1999	
			0-18	Boustany et al. 2010	
			0-18	Lauer et al. 2011	
Zannichellia palustris	*ZP*	horned pondweed	0-6	Greenwood and DuBowy 2005	A few patches present up creeks at the mouth of the Bay, not likely to be affected by the project

3.8.3.2. Alternative 2 – RP

3.8.3.2.1. Project Construction

This section provides the predicted impact assessment based on the results of hydrodynamic and water quality modeling.

Salinity. Results of the hydrodynamic model indicate that predicted depth averaged salinity changes due to project implementation are less than 2 ppt during the months of January-June (**Figure 3-12**). There is an increased range in predicted depth averaged mean salinity starting in

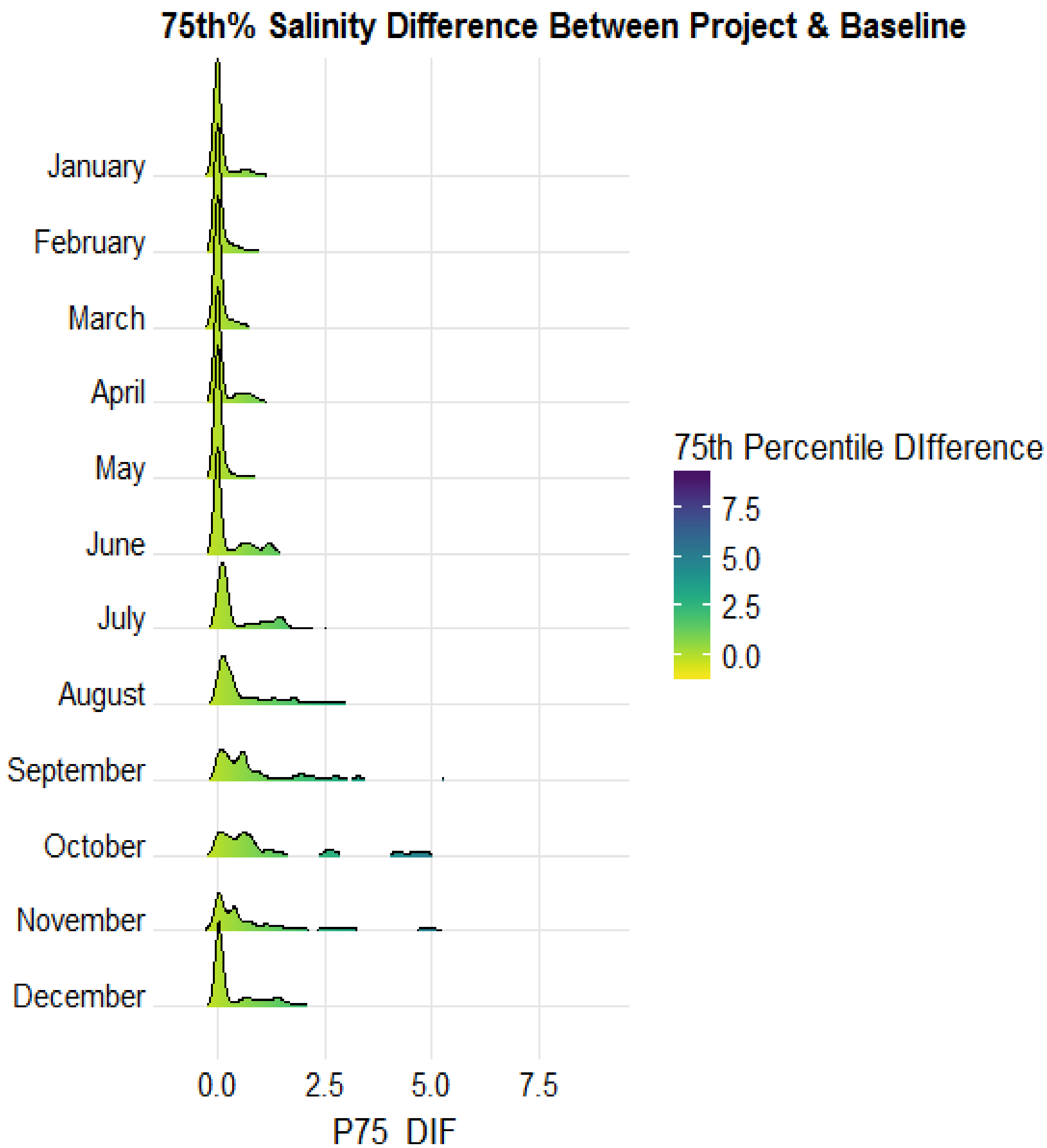


Note largest range is in October.

Figure 3-12. Mean depth averaged salinity differences resulting from project implementation as predicted by the hydrodynamic model (CH3D).

July, and peaking in October, with a range above 5 ppt (**Figure 3-13**). Summaries of the 75th percentile results show similar trends, with a larger range of increased predicted salinity in October and November (**Figure 3-14**). October is the most critical month to examine in terms of potential impact of salinity increases on SAV distribution and coverage. Therefore, the impact analysis was focused on the month of October.

When predicted increases in salinity above the species-specific SAV threshold values were evaluated, it was found that the majority of SAV habitat was not predicted to experience an increased salinity regime or be impacted by salinity changes due to the channel deepening project (**Figure 3-14**). Over 94% of the mapped fall 2015 SAV habitat is predicted to experience a negligible (≤0 ppt) monthly mean change in salinity (**Table 3-6**). The range in mean salinity threshold increases were from 0-5 ppt. Similar patterns were seen when evaluating the monthly 75th percentile hydrodynamic model output. In this case, post-project impacts were predicted to be ≤0 ppt for 93.3% of all mapped SAV and increases in salinity thresholds were from 0-9 ppt. There was a total of 421 (mean) and 510 (75th percentile) acres of SAV habitat that showed any predicted increase in October salinity threshold values following project implementation (**Table 3-6**). 50% of this potentially impacted SAV acreage was exposed to



Note largest ranges are in October and November.

Figure 3-13. Seventy fifth percentile depth averaged salinity differences resulting from project implementation as predicted by the hydrodynamic model (CH3D).

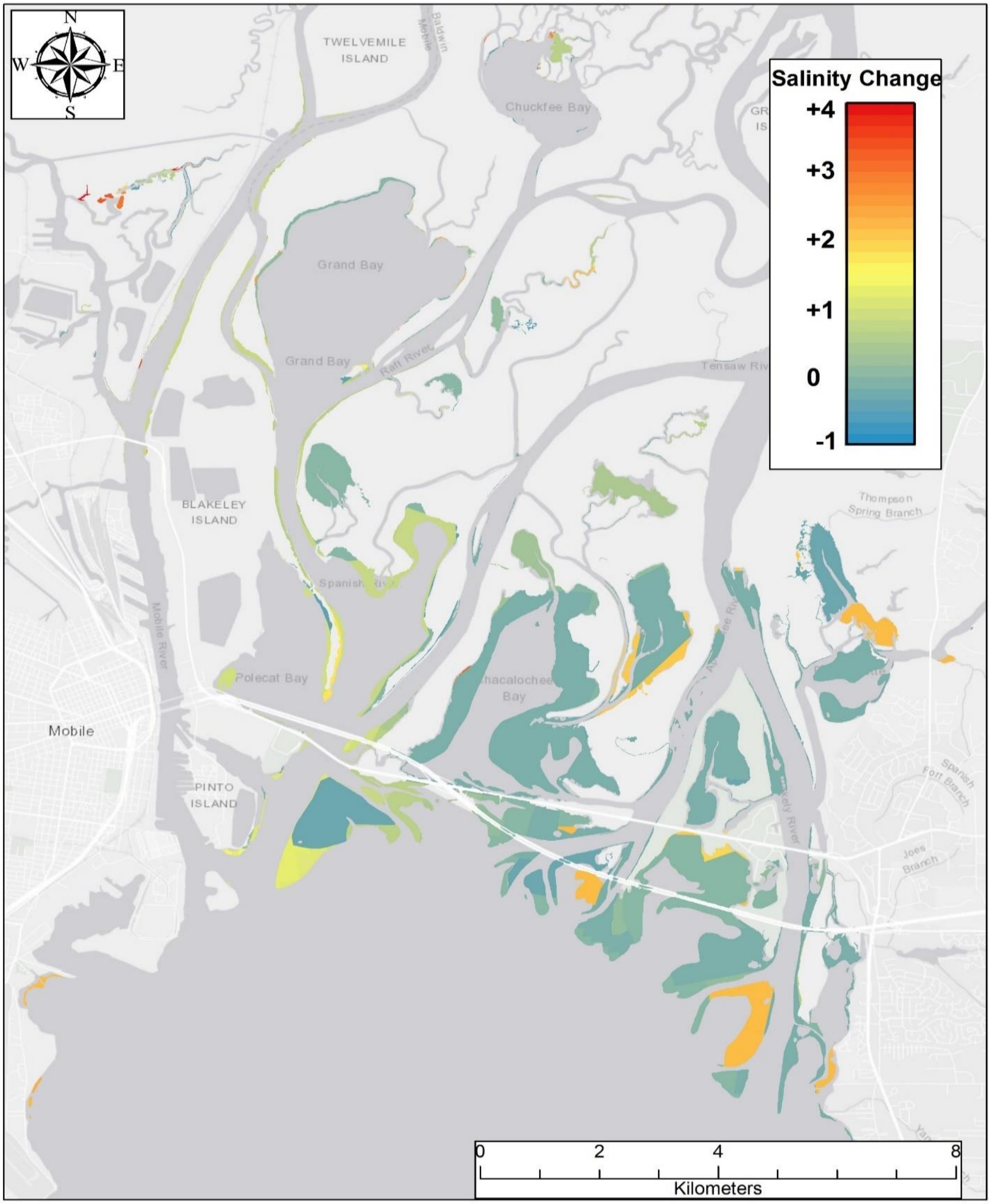


Figure 3-14. Increase in salinity (ppt) above relative species specific thresholds values due to project implementation (i.e., post-project – baseline salinity).

Table 3-6. Number of SAV acres predicted to experience a change in salinity exposure, displayed by range of predicted salinity change.

Post-Project Salinity (ppt) above SAV tolerance threshold		
Range	Mean Acres	75th Percentile Acres
<0	7207	7118
0-1	212	0
1-2	47	54
2-3	116	217
3-4	35	76
4-5	11	22
5-6		101
6-7		33
7-8		0
8-9		7

salinities 1-2ppt (mean) or 2-3ppt (75th percentile) above threshold values **(Table 3-6)**

To get a better understanding and evaluate these potential impacts further, a species specific analysis for potentially impacted 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 (**Table 3-7** and **Table 3-8**).

Table 3-7. Number of SAV acres, by most vulnerable species, predicted to experience a change in mean monthly salinity exposure, displayed by range of predicted salinity change.

	Species within SAV Bed with lowest Salinity Tolerance						
Post-Project Monthly Mean Salinity (ppt) above SAV tolerance threshold	Water Star Grass	Eurasian Watermilfoil	Southern Naiad	Widgeon Grass	Wild Celery	Carolina Fanwort	Coon's Tail
<0							
0-0.25	3288	561	284	5	401	82	41
0.25-0.5	18	257	60	12	106	15	
0.5-0.75		313	164		412		25
0.75-1.0		1		1	9		
1-1.25		3	21	20	2		
1.25-1.5				2			

Table 3-8. Number of SAV acres, by most vulnerable species, predicted to experience a change in monthly 75th percentile salinity exposure, displayed by range of predicted salinity change.

	Species within SAV Bed with lowest Salinity Tolerance						
Post-Project Monthly 75th Percentile Salinity (ppt) above SAV tolerance threshold	Water Star Grass	Eurasian Watermilfoil	Southern Naiad	Widgeon Grass	Wild Celery	Carolina Fanwort	Coon's Tail
<0							
0-0.25	3285	557	281	16	386	82	41
0.25-0.5		171	185	4	62	15	
0.5-0.75	25	380	52	14	66		25
0.75-1.0		32	11	3	309		
1-1.25		4	21	3	25		
1.25-1.5					1		

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 100ppt, so an increase in salinity of 1.5 ppt of up to 22 acres of Widgeon Grass does not a 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.

Two to twenty-six acres of Wild Celery were also predicted to experience elevated salinities 1-1.5 ppt above threshold values (mean, 75th percentile, respectively) due to project implementation (**Table 3-7 and Table 3-8**). At a maximum reported salinity threshold of 18 ppt, post-project estimates suggest salinity exposure to increase to 20.5 ppt. These results do not contain duration information, despite the importance of exposure time to elevated salinity. A short exposure (< 4hrs) to elevated salinity will likely have a smaller impact than a long (>24 or 48 hrs) exposure time. The extent of the impact is due to both magnitude of salinity increase, duration of exposure, and the specific species of interest. For many SAV species, duration data are not reported. Fortunately, studies have been conducted using Wild Celery, showing that this species can survive salinity up to 25 ppt in pulses of less than 7 days (Frazer et al. 2006). As the predicted salinity impact due to project implementation are lower than this, we expect that the predicted salinity increases should have a minimal impact Wild Celery, if any.

Eurasian Watermilfoil represents the majority of the potentially impacted SAV habitat. Eurasian watermilfoil, a non-native aquatic invasive species native to Europe, Asia and North Africa. This species was introduced to the U.S. and first sighted in the early 1940s. The species is now observed nationwide. Eurasian watermilfoil reproduces through fragmentation, grows quickly and outcompetes native species. Due to its invasive status, impacts to this species are unlikely to require mitigation or may even be considered beneficial, however, it appears that none of the predicted salinity range increases would reach severe productivity restriction or mortality levels.

Sea Level Rise and Salinity. 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 sea lever rise 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, increases in salinity from SLR coupled with project implementation would not exceed that expected for baseline SLR conditions and would not cause additional impacts to SAV species in the project area.

DO. 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.

3.8.3.3. 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.

3.8.4. Hardbottom and Structural Habitats

3.8.4.1. 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.

3.8.4.2. Alternative 2 – RP

3.8.4.2.1. Project Construction

Indirect impacts to the manmade hardbottom habitats, as described in Section 2.6.4, 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 RP.

3.8.4.3. 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.

3.8.5. Plankton and Algae

3.8.5.1. 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.

3.8.5.2. Alternative 2 – RP.

3.8.5.2.1. 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.

3.8.5.3. Future Maintenance

Future maintenance would be conducted similar to existing O&M activities. Thus, no negative impact on plankton in the area is anticipated.

3.8.6. Benthic Invertebrates

This discussion of potential impacts on benthic communities resulting from implementation of the RP is a summary of a study on the predictive analysis of potential impacts on benthic invertebrates resulting from salt water intrusion conducted by Berkowitz et al. (2019). The detailed report is included in Attachment 1 of this Environmental Appendix.

Potential impacts of the harbor deepening project on biological resources in Mobile Bay are a concern to natural resource managers because the navigation channel has an influence on water circulation, estuarine mixing, and sedimentation patterns in the Bay (Osterman and Smith 2012). To assess potential impacts to benthic communities that may be associated with the proposed navigation channel modifications, an evaluation was conducted by Berkowitz et al. (2019) that 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 Bay (Zhu et al. 2014), and Lake Pontchartrain (Junot et al. 1983) following dredging. Other factors affect habitat quality and the salinity balance within an estuary, including severe storms, sediment changes, and development; therefore, understanding the influence of a single factor, such as channel dredging, is challenging. Alterations to inputs of freshwater (e.g., droughts, floods, flood control levees) or saltwater (e.g., channel modificatgion) 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. Their abundances and distributions, therefore, can serve as an indicator of environmental conditions in an area.

Benthic invertebrates are important prey items for bottom feeding fishes and crustaceans, therefore, changes to invertebrate distributions and abundances could affect these higher trophic organisms. The widening and deepening of the Navigation Channel 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.

This section characterizes baseline benthic infaunal communities in estuarine, transitional, and freshwater habitats in the Mobile Bay watershed. 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. Empirical data were collected to document the distribution and abundance of benthic macroinvertebrates within the potential zone of influence of the harbor deepening project. Multivariate statistical techniques were used to determine the location(s) where the taxonomic composition of these benthic assemblages changed relative to bottom salinity concentrations. Water quality model results were assessed near benthic stations to determine whether projected salinity increases affected macroinvertebrate distributions.

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 (**Figure 3-15**) (Freshwater, Brackish and Estuarine (upper bay) by ponar grab as discussed in Section 2.6.7. The field data collection procedures and the statistical approach used to analyze the data are described in detail in Section 2 of Attachment C-1.

Water quality parameters were collected and recorded during both the fall (October 2016) and spring (May 2017 field data collection efforts. A total of 1,789 individual benthic macrofauna from 54 taxa was collected during baseline (October 2016) sampling 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) sampling, 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 Section 2 of Attachment C-1.

3.8.6.1. 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.

3.8.6.2. Alternative 2 – RP

3.8.6.2.1. Project Construction

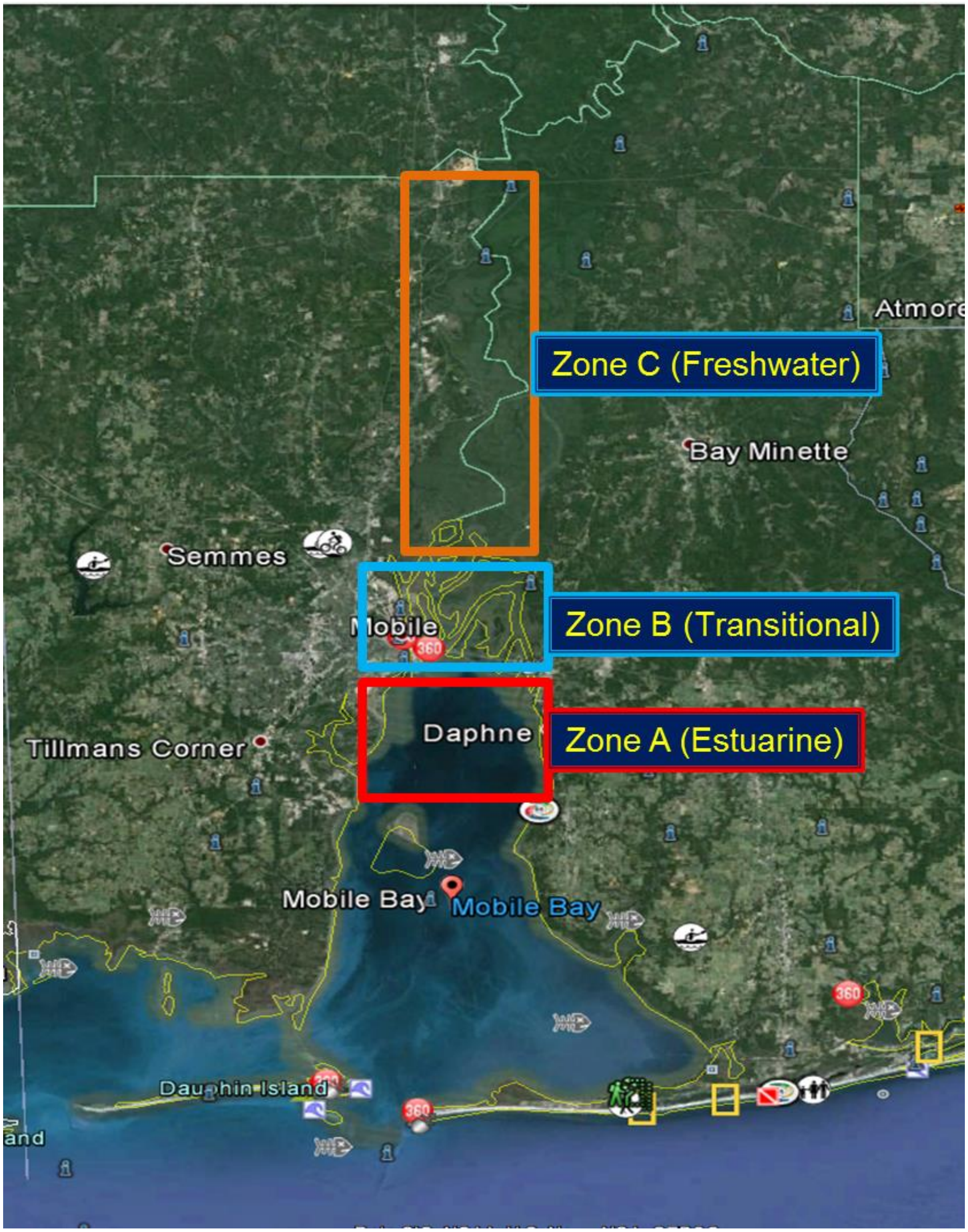


Figure 3-15. Habitat zones indicating estuarine, transitional, and freshwater habitats in the Mobile Bay watershed

In the fall, when salinities were relatively high, the extent of influence of saltwater on benthic macroinvertebrates was evident as far upstream as station C9, which is located south of Bucks, Alabama. At this location, immediately upstream from C9, the Mobile River takes two sharp 90 degree bends, first east, then north, which may contribute to the abrupt salinity decline between stations C9 (5 ppt) and C10 (<1 ppt) 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 one 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 three strata to characterize projected salinities following harbor deepening. Projected salinities for cells within a 100 m of each benthic station were evaluated for the mean project salinity. To evaluate a worst case scenario, the maximum difference in salinity projected by from the implementation of the RP was considered for each month for cells within the buffer. In the fall, maximum projected differences in salinity ranged from 1.9 to 3.6 ppt and the greatest changes in salinity were projected for the estuarine habitat where benthic macrofauna are well adapted to salinity fluctuations of this magnitude. In the winter, maximum changes to salinity 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 changes in salinity 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 harbor deepening project. Impacts to higher trophic levels, such as fish, will be negligible because prey availability and distributions are unlikely to be affected.

Sea Level Rise. 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.

DO. Estuarine organisms respond to decreasing DO in variable 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 habitat with DO concentrations below 2 mg/L. Less mobile benthic invertebrates, such as burrowing species, exhibit stress behaviors (e.g., emerging from sediments) at DO 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 harbor deepening project impacts on DO concentrations was evaluated by determining the minimum concentrations predicted under project conditions in the summer. High temperatures combine with low DO concentrations to 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 Areas. The Relic Shell Mined Area is one of the proposed placement areas for new work material, presumably from the upper Bay Channel. As discussed in Section 2.6.7, 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.

The locations of the sampling stations are illustrated in Section 2.6.7 (**Figure 2-19** of Section 2). Sediments at the Control, Placement, and Impact stations were comprised of roughly equal contributions of clay, fine silt, and coarse to medium silt. Coarser grain sizes were present at the Baseline stations, which were highly variable in sediment composition. In addition, higher total organic carbon (TOC) concentrations at the impact stations are consistent with degraded benthic habitat related to excavated pits that are periodically hypoxic or anoxic. A full copy of this study report can be accessed in Attachment C-1.

Benthic 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. The excavation of these oyster holes created depressions in the bay bottom that were associated with poor water quality conditions, such as high organic content and low DO concentrations. The Mobile Harbor GRR/SEIS cooperating agencies and the USACE, Mobile District recognized the potential for a beneficial use of dredged material from the Mobile Bay navigation channel to restore these areas to the pre-mining bathymetry. Sampling was conducted in the fall of 2016 and spring of 2017 at 90 stations. "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. 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. The benthic organisms that occur in the bay bottom sediments may be destroyed or severely impacted by the physical placement of sediment. However, it is believed that affected areas are small in relation to surrounding areas and would rapidly recover within 12 to 18 months back 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). Responses of benthic infauna to large scale disturbance by dredged material placement were studied at areas in Corpus Christi Bay, Texas. The study looked at biological responses to dredged material disturbance that were linked to both pre-disturbance conditions and differences between disturbed and neighboring undisturbed areas. The impacts of the dredged material placement were evident for less than one year. 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 that adults re-colonized the newly deposited sediments either through vertical migration or lateral immigration from adjacent areas within a period of 3 to 10 months. A related study conducted in Mississippi Sound associated with the Gulfport Federal Navigation Project indicated benthic recovery rates to pre-placement conditions occurred within 12 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.

3.8.6.3. 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.

3.8.7. Fish

This discussion of the fisheries assessment and potential impacts resulting from implementation of the RP is a summary of the study conducted by Berkowitz et al. (2019). The detailed fisheries assessment report is included in Section 6, Attachment C-1.

Outputs from the study 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. A description of the existing or baseline conditions for the fishery is included in Section 2.6.1. As discussed previously and described in detail in Section 6 of Attachment C-1, all organisms collected by trawl and seine were identified to species or the lowest practical taxon, enumerated, and measured. 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 from 2000-2005 (from ADCNR, DMR) and the ERDC from 2016-17, 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. Mean abundance by guild was calculated prior to curve fitting techniques in SAS 9.4 (SAS 2013. Abundance was log transformed ($\log_{10}$ +1) to account for outliers and skewed data to approximate normality. Details concerning the field data analysis are presented in Section 6 of Attachment C-1.

3.8.7.1. 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 which may result in impacts to the benthic invertebrate communities and distributions as well the fish communities that prey upon them as the SLR occurs. 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.

3.8.7.2. Alternative 2 – RP

3.8.7.2.1. Project Construction

Seasonal variability in modeled output at each sample station for mean salinity and DO without sea level are discussed in detail in Section 6 of Attachment C-1. As shown by the analyses, 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) with few stations exceeding the 3 ppt salinity threshold. Salinity changes evaluated under the “with SLR” condition exhibited a narrower range in MAX-DIFF 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 of Attachment C-1).

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 MAX-DIFF values occurring between -0.5 and 0.5 indicating little projected change in DO levels for benthic oriented fishes. In contrast, 70% of the MAX-DIFF values for mean water conditions occurred between -0.5 and 0.5. Nearly 29% of the values exceeded the 0.05 mg/L MAX-DIFF condition with 1% exceeding the 2.0 mg/L MAX-DIFF condition. These results suggest overall changes in DO are likely to occur, but the extent of change will likely be minimal and expressed in reduced spatial and/or temporary basis.

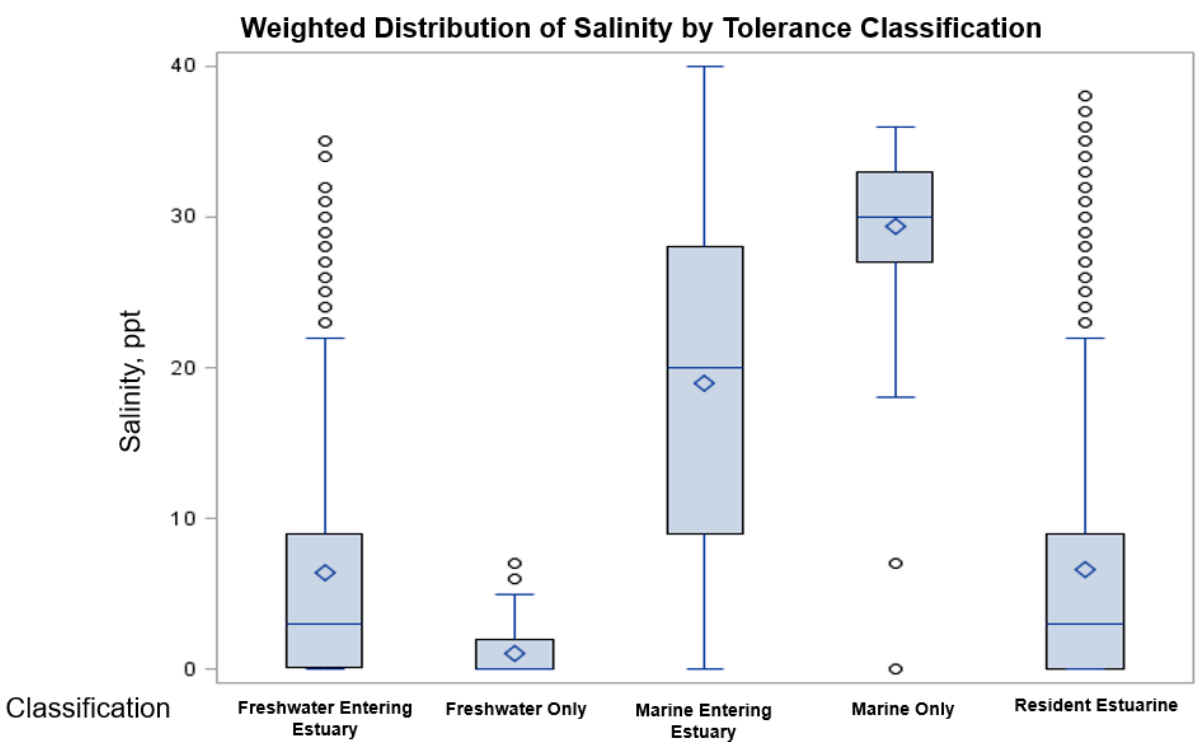
Almost 1200 measurements of salinity and DO were taken during fish collections by both ADCNR, MRD and the ERDC (**Table 3-9**). A salinity gradient occurred among zones with the lower bay averaging 23 ppt, the middle bay at 12 ppt, upper bay at 8.9 ppt, transition zone at 3.7 ppt, and the freshwater sites at 0.1 ppt. 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.

Table 3-9. Mean values of Salinity (ppt) and DO (mg/l) by zone in Mobile Bay project area.

ZONE	Variable	N	Mean	Std Dev	Minimum	Maximum
Lower Bay	Salinity	864	23.1	8.4	0.5	37.3
	DO	863	6.6	1.7	0.4	12.2
Middle Bay	Salinity	272	12.0	7.3	0.5	30.5
	DO	272	6.8	2.0	0.5	12.0
Upper Bay	Salinity	199	8.9	6.3	0.3	24.5
	DO	198	6.5	2.1	1.7	13.0
Transition	Salinity	12	3.7	3.7	0.1	9.7
	DO	12	7.0	1.3	5.0	8.8
Freshwater	Salinity	4	0.1	0.0	0.1	0.2
	DO	4	7.4	0.6	6.7	8.0

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 and presented in **Table 2-11** in Section 2.6.6.1. The relationship between guild abundance and salinity is portrayed as a box and whisker plot in **Figure 3-16**. To avoid a dominance biased analysis, the following species were not used in the evaluation of salinity: Bay anchovy, Spot, Gulf Menhaden, Atlantic Croaker, Pinfish, Spotfin Mojarra, and Inland Silverside. 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.

Quantile regression models were developed seasonally for each guild further supporting the wide tolerance range of most species that occur in Mobile Bay (Section 6 of Attachment C-1). 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 previously, 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.



Note: Data based on FAMP and ERDC collections from 2000-2017. Each box includes mean weighted abundance (diamond), median (horizontal line inside box), first and third quartile (lower and upper edge of box, respectively) and minimum and maximum values (endpoint of lower and upper whisker, respectively). Circles represent extreme values outside of the normal distribution.

Figure 3-16. Plots of the weighted distribution of fish and shellfish by salinity tolerance classification in the Mobile Bay project area.

3.8.7.3. 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.

3.8.8. 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. 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.

3.8.8.1. 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 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.

3.8.8.2. Alternative 2 – RP

3.8.8.2.1. Project Construction

In general, the mollusks require conditions similar to that of the oysters which is described in detail in Section 3.8.10 below. These organisms live within the sediments and in the water column. Berkowitz et al. (2019) 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.

3.8.8.3. 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.

3.8.9. Oysters

This discussion of potential impacts on oysters and the effects on larval distribution resulting from implementation of the RP is a summary of the oyster impacts assessment conducted by Berkowitz et al., (2019). The detailed report is included in Section 5 of Attachment C-1.

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 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.

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 two to three mm/s (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. Specifically, local oyster recruitment within the Mobile Bay area could be negatively impacted if a higher percentage of oyster larvae are flushed out of the bay due to hydrodynamic changes caused by alterations to the navigation channel (Berkowitz et al., 2019).

Oysters, as filter feeders, play an important role in reducing turbidity in natural systems by removing suspended materials from the water column. Most studies on adult estuarine and marine bivalves have indicated that, except for individuals directly buried by the disposal operation, the mortality rate among populations adjacent to dredging and disposal areas is low. By contrast, laboratory studies indicate that the percentage of normally developing eggs and larvae usually decreases as the concentration of suspended solids increases in the range of concentrations normally resulting from dredging and disposal. (U.S. Army Engineer Waterways Experiment Station 1978). Due to the ambient turbidity within Mobile Bay, adverse effects to developing eggs and larvae are not expected.

Using information provided by the ADCNR-DMR, 18 reefs were assessed (>3,200 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 indicated in **Figure 2-32** of Section 2.6.9.1.

The complexity of the oyster life cycle, coupled with the difficulty in tracking oyster larvae in the field, facilitates an integrated ecological modeling approach for understanding system dynamics. As described in Section 5 of Attachment C-1, Eulerian-Lagrangian particle tracking models developed for visualizing flow fields, estimating contaminant transport paths, or estimating sediment transport can be adapted for tracking biological particles by applying behavior rules that can supersede physical rules (e.g., Tate et al. (2012) successfully modified it to simulate various fish egg behaviors in the Mississippi River Gulf Outlet). A detailed description of the model used in this analysis is included in Section 5 of Attachment C-1.

The main objectives of this evaluation were to assess oyster larvae movement and survival under four different scenarios for Mobile Bay, including: 1) a baseline scenario of future-without-project and without projected SLR (SLR), 2) a project involving the implementation of deepening Mobile Harbor via dredging the navigation channel within Mobile Bay and without projected SLR conditions, 3) a scenario of future Without-Project with projected SLR, and 4) a project involving the implementation of harbor deepening with projected SLR conditions. Oyster modeling occurred in two phases (A) an initial phase that included simulating oyster larval releases from the Brookley Reef under all conditions and (B) a detailed analysis of the spatial distribution of oyster larvae that was specifically designed to address public comments; this analysis simulated larval releases from 18 reefs (the Brookley reef and 17 additional reefs, see **Figure 2-32**) under future-without-project and the implementation of deepening Mobile Harbor via dredging the navigation channel within Mobile Bay.

3.8.9.1. 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. 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 the 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.

3.8.9.2. Alternative 2 – RP

3.8.9.2.1. Project Construction

Initial assessments for analyzing differences in larval transport and survival, were conducted using release locations at the Brookley reef in upper Mobile Bay. Under the assumptions used for this model parameterization, settlement locations of simulated larvae were all within the boundaries of Mobile Bay.

The scenarios with SLR (i.e., Scenarios 3 & 4) 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. The model results specific to Brookley Reef did not project an increase in larvae flushing out of Mobile Bay under the with channel modification project scenarios (i.e., Scenarios 2 & 4), however, this analysis is limited to a small number of particles being released from the Brookley Reef. A detailed description of the analysis performed for the oyster larvae particle tracking specific to Brookley Reef is presented in Section 5 of Attachment C-1.

3.8.9.2.1.1. Additional Oyster Larvae Tracking Assessment

Based on public comments received in response to the published draft report in July 2018, it was determined that additional analysis was warranted to assess potential impacts on the spatial distribution of larval settlement that included other reefs that are considered contributors of larvae within Mobile Bay and eastern Mississippi Sound. In addition to the analysis conducted for Brookley Reef, a total of 18 reef locations (including the Brookley reef) were used as larval sources in the additional modeling. A common particle tracker, PT123 (Cheng et al. 2011), uses water level and current estimates from two- and three-dimensional hydrodynamic models to predict where sediments or other discrete constituents are transported. The PT123 tracker was modified with biologically-based behaviors to simulate and track oyster larvae within the system.

The objectives for the additional modeling were to assess oyster larvae movement and survival under two different scenarios for Mobile Bay: 1) a baseline scenario of without-project and 2) a scenario of with-project involving the implementation of deepening Mobile harbor via dredging the navigation channel within Mobile Bay.

The model simulated the responses of oyster larvae to physical processes and biological behavior. The model produces a veliger particle transport success rate, which must be combined with a veliger particle mortality rate dependent upon simulated local water quality conditions to provide an estimate of recruitment rates.

The model was added to PT123, an existing particle tracking/engineering model. Biological behaviors were parameterized defining rules governing growth, swimming ability, and fall velocity that represent the current state of knowledge of larval life history strategies (e.g., growth, settling rate) and how oyster larvae respond to the physical environment. Mortality was assessed in a separate analysis based on known larval response to environmental conditions such as salinity and dissolved oxygen (DO). The model and mortality analysis were based on models developed by North et al., (2008), Kim et al., (2010) and Kjelland et al., (2015).

<u>Model Evaluation and Application</u>

The final larval particle locations are shown in **Figure 3-17**. To better visualize the distribution of the larval particles, point density maps of the final larval positions were constructed to show the relative density of the particles across the model domain and are shown in **Figure 3-18**. The overall pattern between the Without and With project conditions are similar and agree well with the behavioral particle tracking results of Kim et al. (2010) despite the use of different hydrodynamic and particle tracking models as well as different parameterizations of oyster behavior. Most of the larvae end up in the Cedar Point and Eastern Mississippi Sound (southwestern portion of the model domain) with another concentrated area of particle settlement in Bon Secour Bay. Oyster larval tracking is probabilistic in nature; the vertical position of each particle is a function of how much time it spends actively swimming producing a more realistic representation of the natural variability of larval distribution. Consequently, the final positions of the larval particles are not the same between model runs so the point density map similarity was assessed using the Warren similarity index (Warren et al., 2008 and VanDerWal et al., 2014). The index is used to determine ecological niche model distribution overlap and has been used in a variety of habitats; 1 is the similarity index value if the spatial distributions are identical and 0 is the similarity index value if there is no overlap between the spatial distributions. Comparing the without and with project point density maps, the similarity index value is 0.977 and indicates the larval particle distributions are very similar.

To better ascertain whether the observed larval particle distributions are statistically significant, the particle final locations were analyzed using a spatial hot spot analysis using ArcMap 10.6.1. The hot spot analysis indicate if more particles end up in an area than would be expected due to chance. Since the distribution of larval particles is controlled by a combination of system hydrodynamics and swim behavior, some hot spots are expected. Comparison of the hot spot locations between without and with project conditions is used to analyze if the hot spots change due to the deepening of the channel. The overall pattern of hot spots, where more particles than expected by chance occur, are similar between without and with project conditions and show no discernible difference between the without and with project conditions.

To add more granularity to the analysis, the results of the hot spot analysis at each reef location were analyzed without and with project to see if the proposed channel deepening affected the likelihood of a reef being a hot spot or not. Note that since not all larval sources are simulated, there may be more hot spots within Mobile Bay that are not represented in these results. Of the

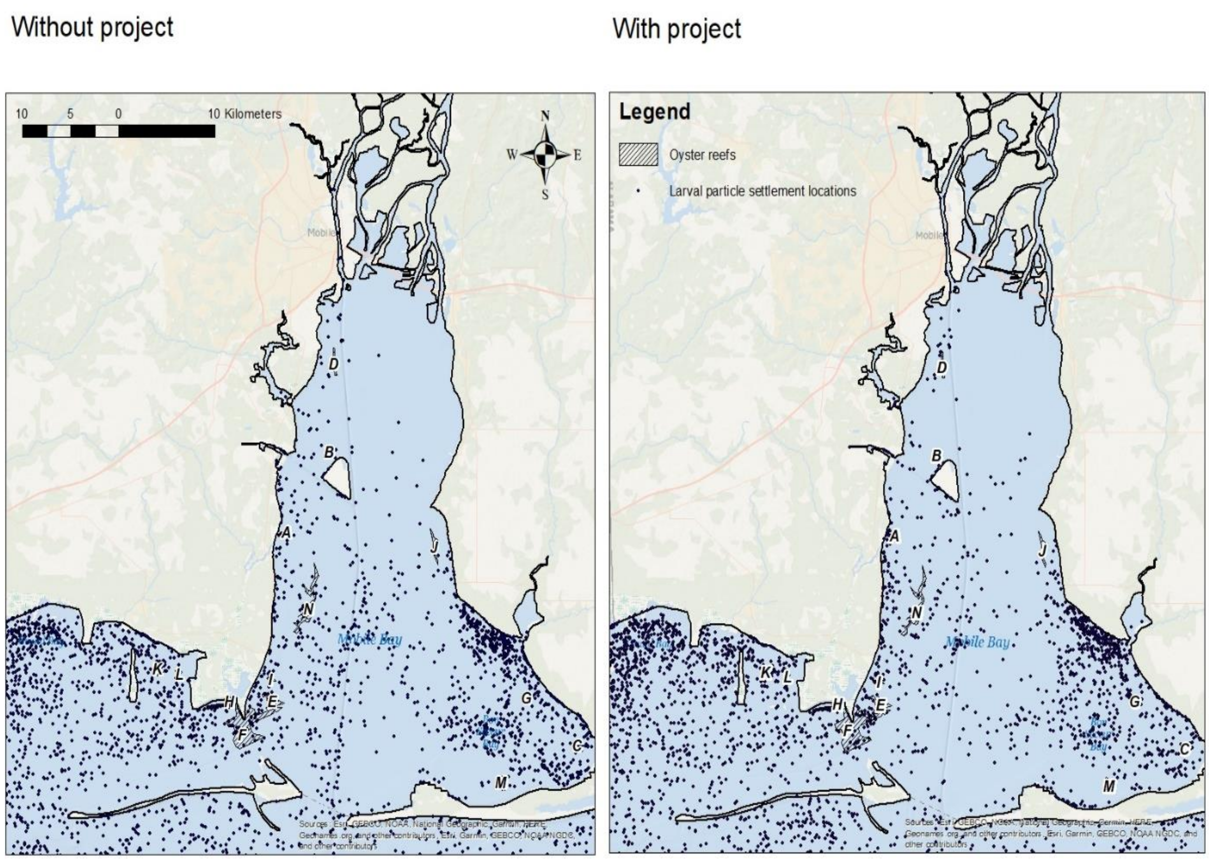


Figure 3-17. Final location of simulated oyster larvae for without (left) and with (right) project scenarios.

18 reefs that were included in the analysis, seven are predicted to be particle settlement hot spots (>50% of the area identified as a hot spot at $\alpha=0.05$) under without project conditions and 8 are predicted to be particle settlement hot spots with the deepening (**Table 3-10**). A greater proportion of Kings Bayou Reef and Whitehouse/Denton Reef were identified as hot spots for larval settlement in the with-project condition than the without-project condition. While Shell

Banks Reef was not identified as a hot spot based on the >50% of the total area criteria, 13.2% of the reef area was located in a hot spot region under without-project conditions. Under with project conditions the location of the hot spot in that region shifted so that Shell Banks reef was no longer in the hot spot. This is does not indicate that larvae are not settling on Shell Banks reef, but that the criteria for classifying it as a hot spot were not met. Of the 3262 acres of oyster reef included in the analysis, 2700 acres were identified as larval settlement hot spots under without project conditions and 2761 acres were identified as larval settlement hot sport with project conditions.

As the model did not explicitly account for particle settling, additional analysis of the larval trajectory data were used to determine if competent larvae passed over reef areas before finally settling. ArcMap 10.6.1 was used to visualize the particle trajectories 10 days from release to the end of the simulation and the line density of the trajectories was mapped. As with the final larval particle location point density maps, the overall pattern of line density was similar between Without and With project conditions, indicating that a similar density of competent larvae passed over reef areas (**Figure 3-19**). The Warren similarity index between the line density maps was 0.980, indicating a high degree of similarity between the two datasets.

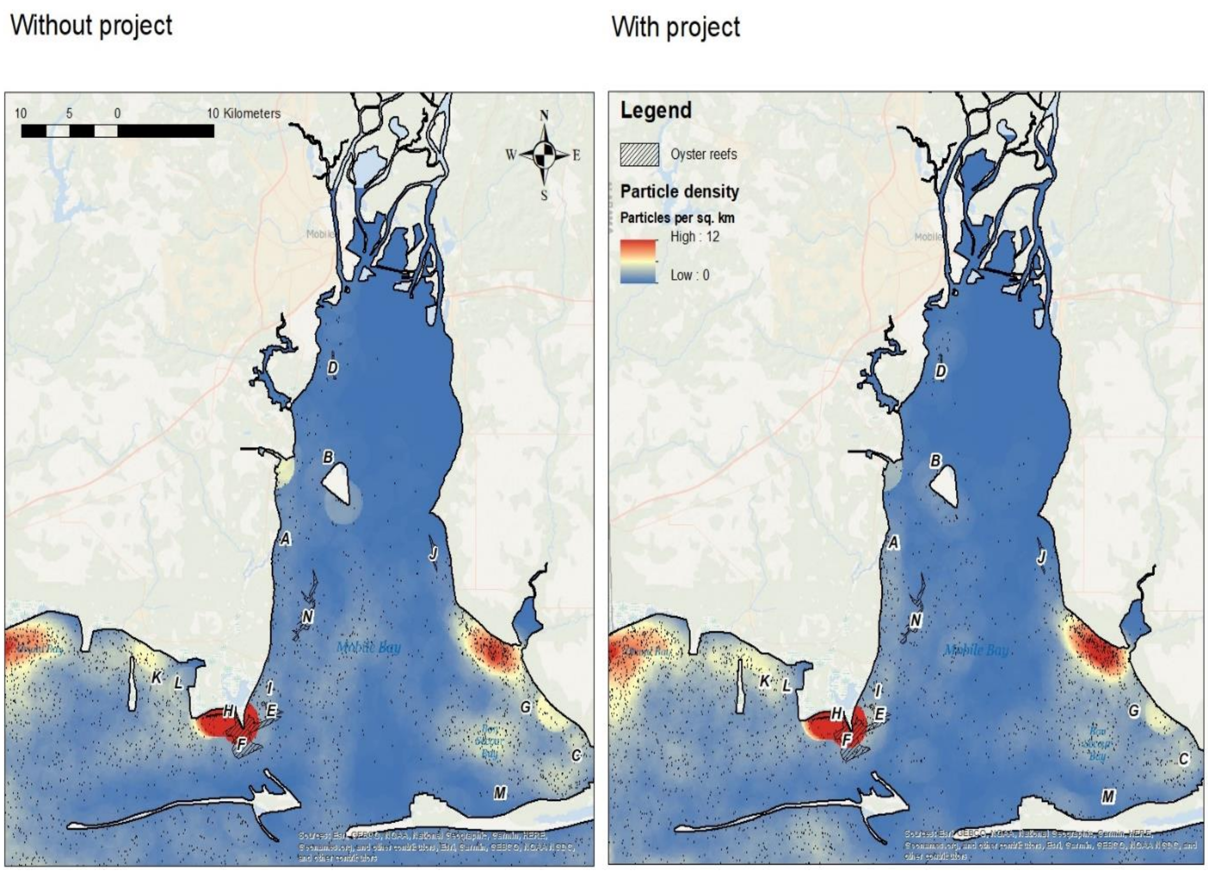


Figure 3-18. Point density heat map representing oyster densities of final locations of simulated oyster larvae for the without and with project scenarios.

Table 3-10. Results of the hot spot analysis at each reef location analyzed for without and with project.

Reef name	Label	Total Reef Area (acres)	Proportion of reef identified as hot spot		Area of reef identified as hot spot	
			Without	With	Without	With
Area VI Natural	A	17.9	0.0%	0.0%	0.0	0.0
Bender-Austal Reef	B	3.2	0.0%	0.0%	0.0	0.0
Bon Secour Reef	C	30.7	100.0%	100.0%	30.7	30.7
Brookley Reef	D	88.4	0.0%	0.0%	0.0	0.0
Buoy Reef A	E	212.0	99.4%	95.7%	210.7	203.0
Cedar Point - all	F	2009.2	97.9%	99.6%	1966.6	2001.8
Fish River Reef	G	109.1	100.0%	100.0%	109.1	109.1
Heron Bay Pass-aux-Bar	H	264.1	100.0%	100.0%	264.1	264.1
Kings Bayou Reef	I	66.1	43.4%	100.0%	28.7	66.1
Klondike Reef	J	166.2	0.0%	0.0%	0.0	0.0
Portersville Bay Hard Reef	K	35.4	100.0%	100.0%	35.4	35.4
Portersville Bay Middle Ground	L	33.5	100.0%	100.0%	33.5	33.5
Shell Banks Reef	M	155.6	13.2%	0.0%	20.5	0.0
Whitehouse/Denton Reef	N	70.6	0.7%	24.2%	0.5	17.1
Total		**3262**			**2700**	**2761**

Note: All Cedar Point reefs are combined for the purpose of this analysis.

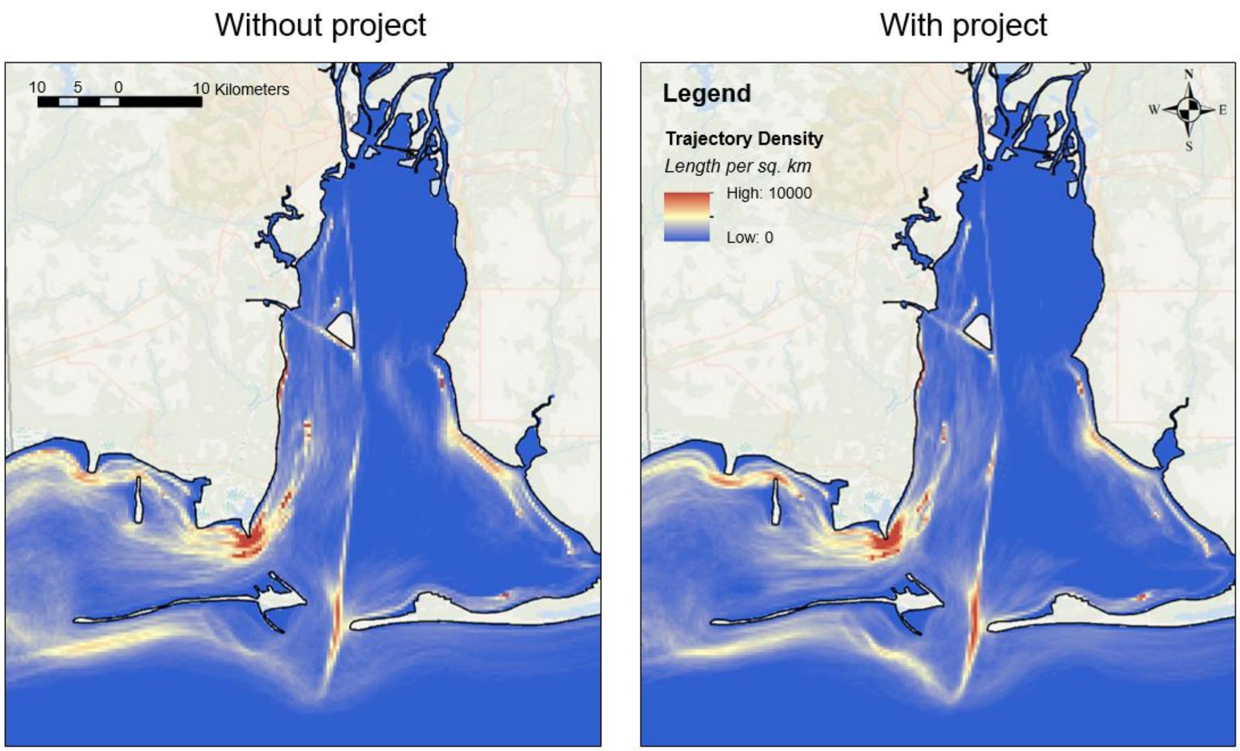


Figure 3-19. Line density heat map representing line densities of simulated oyster larvae trajectories for the without and with project scenarios.

Final particle locations were used to quantify the number of particles being flushed out of the system. Results indicate a similar number of particles were flushed from the Mobile Bay system with the project than without. Although fewer particles were flushed under with project conditions, the total number were similar and it is unclear if the difference was due to the project or the probabilistic nature of the model. Breaking down the number of particles flushed by the spawning reef produced similar results (**Table 3-11**).

The larval trajectories Without and With project were compared with monthly water quality model outputs at all water depths to determine if a simulated larval particle was exposed to adverse salinity or DO conditions before settling. As indicated in Chapter 5 of Berkowitz et al. (2019), no larvae were exposed to DO concentrations below the threshold value of < 2.4 mg/L at any time during the spawning season (**Figure 3-20**) so no mortality due to low DO was indicated. Although the water quality model results show minimum DO concentrations as low as 3.3-3.7 mg/L during some months (i.e., August through November), these conditions did not exceed the mortality threshold value of < 2.4 mg/L at any time during the simulated larval releases or the full spawning season. Consequently, no mortality due to low DO was indicated. The average differences between the With and Without project DO conditions across the model domain ranged from 0.02 to 0.06 mg/L with standard deviations ranging from 0.08 to 0.22 mg/L which is considered in within the range of modeling error. Given the small magnitude in DO differences attributable to the project, larval mortality during future instances when DO could exceed the mortality threshold should likewise be similar between without and with project conditions.

Some of the simulated salinity values were lower than the oyster larvae threshold of 6 ppt as described in Chapter 5 of Berkowitz et al., (2019) (**Figure 3-21**). Simulated oyster larvae experienced mortality due to spending more than 10,000 seconds in low salinity zones. Overall, there was a 33% loss in oyster larvae due to low salinity values in the Without project condition and a 28% loss in the with project scenario (**Figure 3-20**). Considering the results presented for the initial modeling of Brookley Reef and the additional modeling of the 18 reefs assessing oyster larvae movement and survival when considering implementation of the RP, there are no discernible differences between the Without and With project conditions. Additionally, there are minimal to no impacts to existing reefs and survival of the oyster larvae associated with changes in salinity or DO.

3.8.9.3. 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.

3.8.10. Crustaceans

The crustaceans of abundance in the Mobile Bay and vicinity being considered here 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 (*Farfantepenaeus aztecus*), the pink shrimp (*Farfantepenaeus duorarum*), the white shrimp (*Litopenaeus setiferus*), and the blue crab (Callinectes sapidus). The life histories of these important species are discussed in detail in Section 2.6.3 of this report.

Table 3-11. Number of particles flushed from the Mobile Bay system for without and with project scenarios for each reefs

	Without Project		With Project	
Reef Name	Particles flushed	% flushed	Particles flushed	% flushed
Area VI Natural	1	0%	1	0%
Bender-Austal Reef	40	13%	46	15%
Bon Secour Reef	85	28%	58	19%
Brookley Reef	26	9%	19	6%
Buoy Reef A	124	41%	129	43%
Cedar Point East 2014 Plant	86	29%	69	23%
Cedar Point East Bridge	103	34%	82	27%
Cedar Point Gullies	157	52%	111	37%
Cedar Point Pass-aux Huite	76	25%	79	26%
Fish River Reef	9	3%	1	0%
Heron Bay Cedar Point Beach	0	0%	0	0%
Heron Bay Pass-aux-Bar	0	0%	0	0%
King Bayou Reef	107	36%	108	36%
Klondike Reef	7	2%	12	4%
Portersville Bay Hard Reef	62	21%	27	9%
Portersville Bay Middle Ground	3	1%	0	0%
Shell Banks Reef	164	55%	170	57%
Whitehouse/Denton Reef	5	2%	62	21%
Total	1055	20%	974	18%

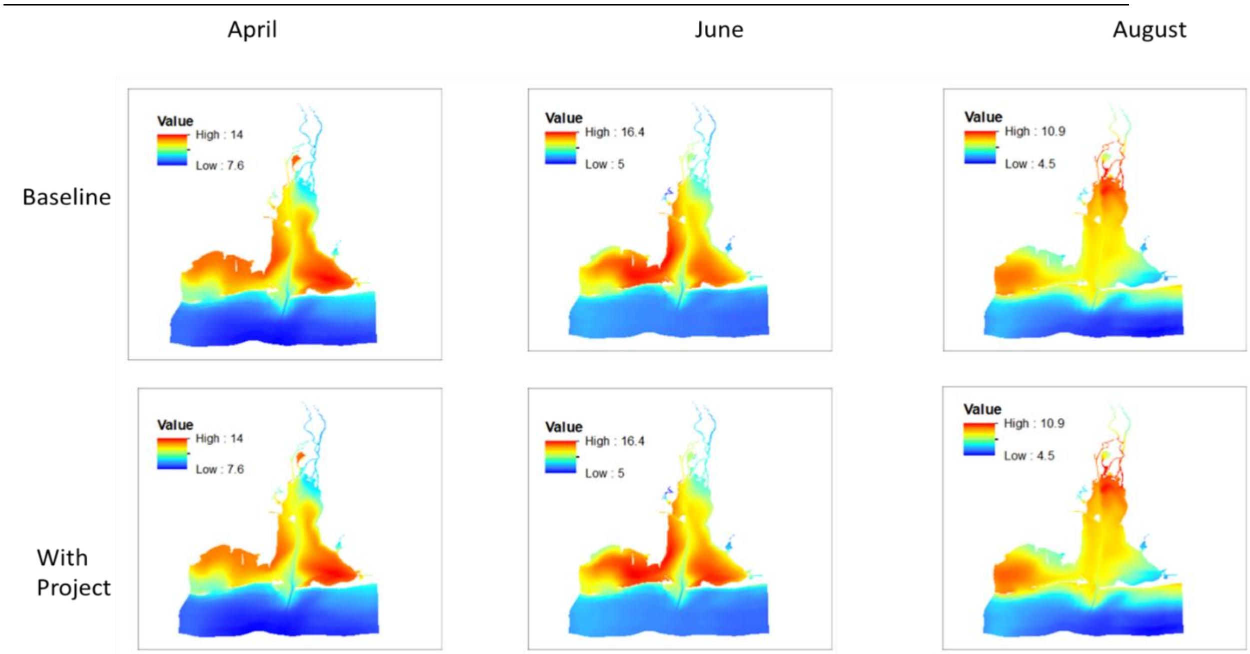


Figure 3-20. Simulated dissolved oxygen levels for Mobile Bay during the months of simulated oyster larval releases.

Table 3-12. Number of oyster larvae exposed to salinity values less than 6 ppt for 10,000 seconds.

	Without Project			With Project		
Release Date	April	June	August	April	June	August
# of Dead Particles	675	765	318	602	657	277
Total			1758			1536
Percentage of overall total released			33%			28%

3.8.10.1. 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 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 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 valuable crustacean resources in the project area.

3.8.10.2. Alternative 2 – RP

3.8.10.2.1. 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. (2019) 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.

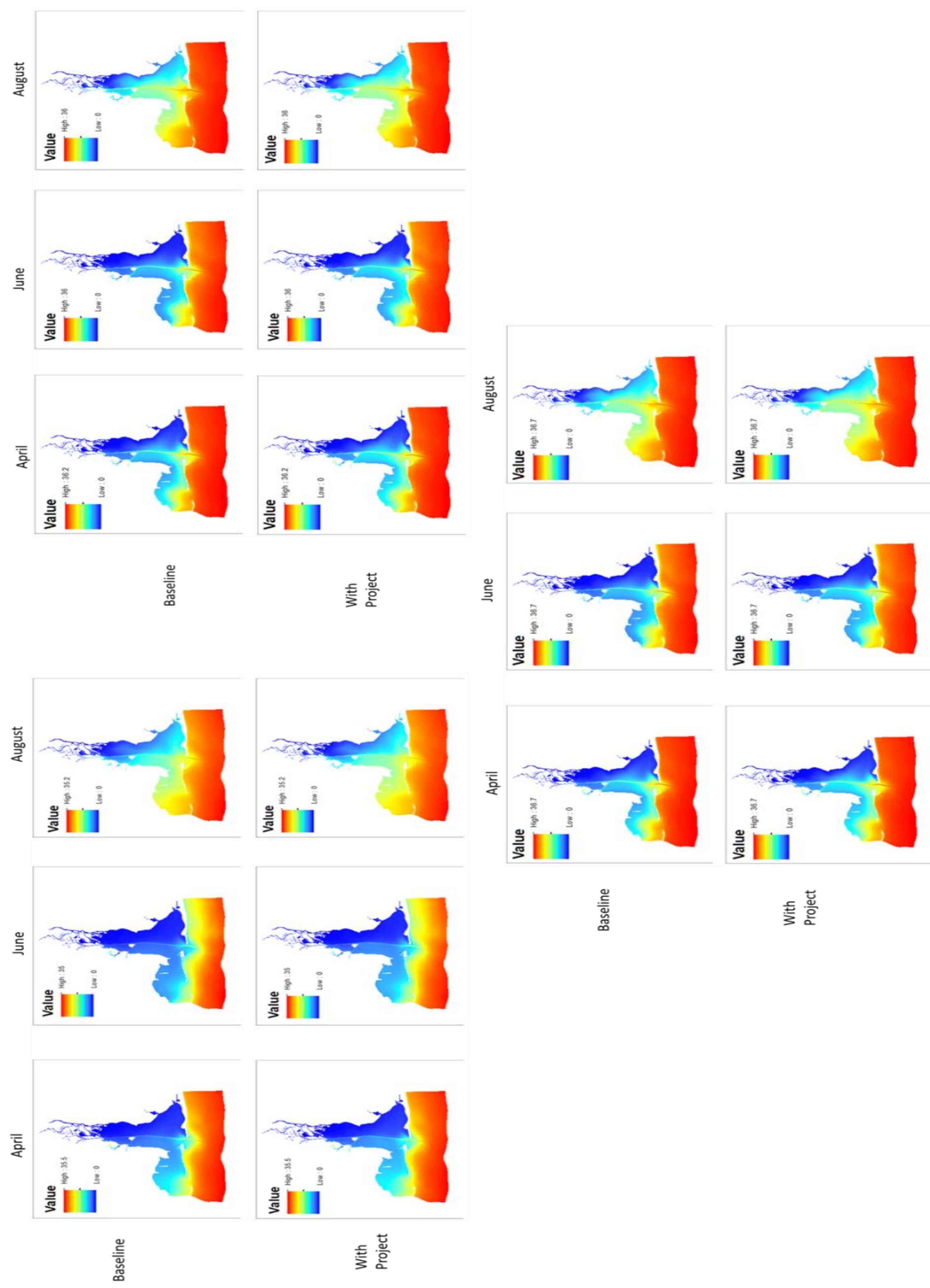


Figure 3-21. Simulated salinity values for the top third of layers, mean values, and bottom third of layers from the water quality modeling for each of the three months simulated for oyster larvae dispersal.

Occupying much of the same habitats as finfish, a fisheries assessment was conducted by Berkowitz et al., 2019 which consisted of a total of 2,097,836 individuals representing 162 species being recorded and used in the analysis, which include five salinity tolerance guilds ranging from freshwater to marine habitat conditions as discussed in Section 3.8.8. Additionally, shrimp and crabs generally prey on bottom detritus and benthic invertebrates. The benthic macroinvertebrate assessment results indicate that expected post 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 that 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 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 RP.

3.8.10.3. 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.

3.9. Essential Fish Habitat (EFH)

3.9.1. 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 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.

3.9.2. Alternative 2 – RP

3.9.2.1. 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 show that 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 RP 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 placed in the Relic Shell Mined Area. 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.

EFH consultation has been completed with NMFS, Habitat Conservation Division (HCD) as required under MSFCMA. The USACE, Mobile District has made the determination that the project would have no adverse effect to EFH. As a result of reviewing the Main Report and Appendix C, by letter dated September 27, 2018 (Attachment C-4), NMFS concurred with the USACE, Mobile District's determination that the project would not result in adverse effects to EFH.

3.9.3. Future Maintenance

Other than the impacts discussed above for the implementation of the RP, 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.

3.10. Threatened and Endangered Species

This section addresses potential impacts on species listed as threatened or endangered by the USFWS and NMFS, Protected Resources Division (PRD). Discussion of impacts is based on the presence of and potential changes in habitat within the project area resulting from implementation of the RP. 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.

3.10.1. 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 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.

3.10.2. Alternative 2 – RP

3.10.2.1. 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 Area, ODMDS, and if applicable, SIBUA). The USACE, Mobile District anticipates any impacts from constructing the RP 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.

Regional data such as the USFWS and NMFS species list and/or critical habitat designations, suitable habitat criteria, examination of possible routes of effects, and the GRBO was used to make a determination that the project may affect but is not likely to adversely affect threatened or endangered species. No designated critical habitat is found within the action area. Pursuant to Section 7 of the ESA, consultation with the USFWS and NMFS-HCD has been initiated and a request for concurrence with this determination has been sent by letter dated November 9, 2018. The USFWS in a letter dated December 21, 2018 concurred with the may affect but is not likely to adversely affect determination. In regards to the Migratory Bird Treaty Act (MBTA), it is noted that the project area is entirely within the open water and away from any landforms therefore it is highly unlikely that any impacts to the piping plover, red knot, or least tern would occur. In addition, by letter dated April 1, 2019, the USFWS provided the final Fish and Wildlife Coordination Act Report (FWCAR). This report stated that the USFWS did not oppose the implementation of the proposed project provided the listed conservation measures and recommendations were implemented. The USACE, Mobile District does not object to these conditions and consultation will continue until final resolution. Copies of the consultation letters with the USFWS and Coordination Act Report are included in Attachment C-4.

3.10.3. 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.

3.11. 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.

3.11.1. Alternative 1 – No Action

Under the No-Action Alternative, marine mammals would continue to utilize the area without additional disruption from localized temporary impacts.

3.11.2. Alternative 2 – RP

3.11.2.1. 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.

<u>West Indian Manatee</u>. 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.

3.11.3. 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 placement 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.

3.12. 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. 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. The only snake to habitually occupy the salt marsh habitat in Alabama is the Gulf salt marsh water snake.

3.12.1. 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 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.

3.12.2. Alternative 2 – RP

3.12.2.1. Project Construction

With the exception of Little Sand Island's highly disturbed shoreline, the RP 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. (2019), 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.

3.12.3. Future Maintenance

Future maintenance practices will be consistent with the current O&M dredging practices and would not be expected to cause any further 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.

3.13. 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 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.

3.13.1. 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 result in some effects to existing fisheries 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 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.

3.13.2. Alternative 2 – RP

3.13.2.1. 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. 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 RP as discussed in Sections 3.8.2 and 3.8.3. Considering that the habitats widely used by the shrimp and crabs considered in this section are unlikely to be affected by the implementation of RP, no negative impacts to these species due to changes in water quality would be expected by the implementation of the RP.

Placement Activities

Relic Shell Mined Area. 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 Area would result in a number of unavoidable but minor and temporary impacts to the immediate project area as previously described. The adverse impacts are temporary and localized 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 prior to shell mining operations 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 SIBUA placement. Should placement occur from deepening this reach of channel, temporary perturbations in water quality from placement activities would not 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 those that 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 those that already exists from normal maintenance operations.

3.13.3. 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.

3.14. 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).

3.14.1. 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 (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.

3.14.2. Alternative 2 – RP

3.14.2.1. Project Construction

As indicated in Section 3.8.3, Eurasian watermilfoil compose 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 Delta in local coastal drainages (USGS 2018b) and is typically found in freshwaters, wetlands, and marshes.

3.14.3. Future Maintenance

Future maintenance will not result in additional impacts greater than current O&M activities.

3.15. Air Quality

This section describes the potential impacts to air quality. The impact analysis is detailed in Attachment C-3.

3.15.1. 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 growth in vessel traffic was applied to the 2011 emissions inventory and predicted the 2035 No Action Alternative emission inventory as presented in **Table 3-13**. 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.

Table 3-13. Projected 2035 No Action Alternative Annual Emissions

Source Category	NO_x (tons)	CO (tons)	SO_2 (tons)	$PM_{2.5}$ (tons)	PM_{10} (tons)
All	5939.2	1557.6	314.8	189.1	213.8

3.15.2. *Alternative 2 – RP*

3.15.2.1. Project Construction

The proposed channel modifications 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 and localized resulting in less than significant air quality impacts to the community along the channel.

3.15.3. 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 VOC emissions 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 RP 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 RP 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. 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.

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 3-14** under the RP condition as compared to the No Action Alternative.

Table 3-14. 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
PSD Threshold	250	250	250	250	250

Reasonably foreseeable changes in emissions associated with the implementation of the RP 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 modified 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, marine vessels, heavy-duty diesel trucks, and private automobiles. The widening associated with the implementation of the RP 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 their 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. 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, as predicted by the DOE, 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, 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 the port 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 3-14** 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.

3.16. Hazardous and Toxic Materials

3.16.1. 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 the 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.

3.16.2. Alternative 2 – RP

3.16.2.1. Project Construction

Under the RP, 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 the 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 RP 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 RP, minor impacts associated with hazardous materials and petroleum products may occur.

3.16.3. Future Maintenance

With the widening associated with the implementation of the RP 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 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 2.20 - Transportation), in addition to the FHWA and ALDOT estimates proprietary hazardous materials truck counts provided by the tenants of the port terminals, approximately 1 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 1 percent of the hazardous materials traffic over the Cochrane-Africatown Bridge and the increase in total truck traffic associated with the RP is only 25 percent (as discussed in Section 2.20 - Transportation), the hazardous materials detoured over the Cochrane-Africatown Bridge as a result of implementation of the RP 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 RP.

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 dredgers 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.

3.17. Noise

This section describes the potential impacts to the airborne and underwater ambient sound environment.

3.17.1. 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.

3.17.2. Alternative 2 – RP

3.17.2.1. Project Construction

Airborne Noise. Under the RP, 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 temporarily increase in the Mobile Harbor area due to dredging and 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 the 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 RP 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.

3.17.3. 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 of the existing 2016 levels (see Section 3.22 below). 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 ADOT-adopted 15-dBA substantial traffic noise increase that requires noise abatement. The on-road traffic noise impacts under the RP would not be significant.

Underwater Noise. The underwater noise conditions around the port would essentially remain the same under the RP 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 1 yard (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.

3.18. Cultural and Historic Resources

3.18.1. Alternative 1 – No Action

Under the No Action Alternative, the proposed project would not be implemented. Dredging and placement 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.

3.18.2. Alternative 2 – RP

3.18.2.1. Project Construction

As referenced in Section 2.15 of Appendix C, the Area of Potential Effect (APE) of the RP has a very high potential for cultural resources, including prehistoric sites on now-submerged landforms as well as historic shipwrecks. Phase II evaluations may be necessary, based on recent Phase I findings (Grinnan et al. 2018). Continued Section 106 coordination and consultation with the Alabama SHPO and the USACE, Mobile District Tribal Partners will also be necessary. A Programmatic Agreement (PA) among the Alabama SHPO, USACE, Mobile District, and the Advisory Council on Historic Preservation (ACHP) is being developed to guide the Section 106 process and mitigateany adverse effects to potential historic properties. A draft of the PA is included in Attachment C-7. 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 for direct and indirect effects to the APE.

Direct Effects

Activities that would have direct effects upon cultural resources are dredging and placement of dredged material. Dredging is proposed in the Bay Channel (deepening), Choctaw Pass Turning Basin (widening and deepening), the portion of Bay Channel to be widened and deepened, and the Bar Channel (bend easing). Placement is proposed at the Relic Shell Mined Area, SIBUA, SIBUA Northwest Expansion, and ODMDS.

<u>Bay Channel</u>. The navigation channel was previously investigated for submerged resources with a Phase I survey (Mistovich and Knight, 1983). Underwater archaeologists subsequently investigated significant anomalies identified during the Phase I survey via diving (Phase II investigations) in 1986 and confirmed they all comprised modern debris (Irion 1986:27). 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 led to the recommendation of no additional investigations for this portion of the RP.

The areas to be widened have also been previously surveyed, resulting in the identification of 2 magnetic anomalies and acoustic contacts that could represent historic properties and an acoustical reflector of a natural feature sensitive for the presence of pre-Contact archaeological sites (Grinnan et al. 2018). The Corps will conduct a Phase II investigation of these anomalies via diving by underwater archaeologists to determine if they represent submerged historic properties prior to project construction.

<u>Choctaw Pass Turning Basin</u>. The Choctaw Pass Turning Basin as described in Section 1.1.3 of Appendix A, was not constructed with the other project improvements during the late 1980s/early 1990s at the request of the non-Federal sponsor (i.e., the Alabama State Port Authority). A General Reevaluation Report (GRR) was later prepared (in May 2007), per the sponsor'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 RP recommends expanding the Choctaw Pass Turning Basin to the southeast, adding an additional 250 ft of width to the turning basin and matching the depth of the larger part of the turning basin (50 ft 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.

<u>Bay Channel Widening</u>. A Phase I maritime survey has been performed for the proposed 3-nmi stretch of the lower bay channel included in the RP for channel widening. As referenced in Section 2.16 of Appendix C, the Bay Channel has a high potential of cultural resources. The areas to be widened have been previously surveyed (Mistovich and Knight 1983; SEARCH 2018) resulting in the identification of magnetic anomalies and acoustic contacts that could represent historic properties. Should a Phase II maritime survey be required, it will be completed

prior to the start of project construction at which time the results and recommendations will be reported.

Bar Channel. The proposed bar channel deepening and bend easing as described in Section 1.1.1 of Appendix A was investigated with a Phase I maritime survey (SEARCH 2018) and no potential submerged cultural resources were identified. No additional investigations are recommended.

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 existing SIBUA area was recently investigated for submerged resources. Some significant resources were identified and an avoidance zone has been establish for this site. No additional investigations are recommended.

SIBUA Northwest Expansion. An area northwest of the existing SIBUA was identified for expansion to accommodate future maintenance capacity of the RP. A Phase I survey of this area was completed in 2018. This survey identified 5 magnetic anomalies and acoustic contacts indicative of potential submerged cultural resources. These will be avoided during project construction and no additional investigations are recommended.

ODMDS. The USACE, Mobile District requested that the EPA, Region 4 modify the existing Mobile ODMDS in accordance with Section 102 of the MPRSA to ensure long-term ocean placement site capacity is available for suitable dredged material generated from new work (deepening and widening) and maintenance projects in support of the Mobile Harbor Federal Navigation Project and other local users. The existing 4.75 nmi^2 Mobile ODMDS was designated by the EPA in accordance with Section 102 of the MPRSA and is located between two and six miles south of Dauphin Island, Mobile County, Alabama. The USACE had previously selected two ocean sites for placement pursuant to Section 103 of the MPRSA. One of these sites, known as the Mobile North ODMDS, was approximately 46 nmi^2 and had been historically used for the placement of dredged material. The other site, the Mobile South ODMDS, has not been historically used as a placement site. EPA Region 4 has prepared an EA, *Modification of the Mobile ODMDS, Mobile, Alabama (2018)*, that will be available for public comment this fall to modify the existing EPA Section 102 Mobile ODMDS to include a portion of the previously selected USACE Section 103 Mobile North 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 (Alabama Historical Commission, 1978). The Union ironclad, U.S.S. Tecumseh, is under 30 ft 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 164-foot 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 was widened to 500-foot 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 46 nmi^2 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 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 prior to the start of project construction.

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 of 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. As channel modifications my 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 of 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 the Mobile Harbor navigable by larger, deeper draft vessels is a primary goal 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 of Appendix A. The modeling results indicate minimum difference between the With-Project and Existing Conditions in the bay and on the ebb tidal shoal. As such, no investigations are recommended.

3.18.3. Future Maintenance

Future maintenance and 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. Other than any impacts and recommendations that could result from pending Phase II maritime surveys and Section 106 consultation discussed above for the implementation of the RP, future maintenance and operations of the project, once constructed, will utilize already existing and certified placement sites. Therefore, there would be no additional disturbance from dredging and placement of sediments and no associated disturbance of cultural resources other than those that are already occurring during typical maintenance practices.

The existing upland and open water in bay O&M placement areas are certified for placement of material dredged for the O&M of the Mobile Harbor. That certification required Section 106 consultation and compliance. These areas will not be used for placement of dredged material originating from the harbor expansion. As these O&M placement areas would only be used for O&M dredging operations, there is no change in management practice. No investigations are recommended. Additional Section 106 review is recommended during the recertification of exiting upland and open water in bay O&M placement areas. Additional Section 106 review is recommended if any of these O&M placement areas require expansion.

3.19. 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 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. A summary of the Protected and Managed Lands considered in this report is provided in Section 2.17.

3.19.1. Under Alternative 1 – No Action

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 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).

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.

3.19.2. Alternative 2 – RP

3.19.2.1. 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. (2019) 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. 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.

3.19.3. Future Maintenance

Future maintenance of the navigation channel would be similar and 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.

3.20. Recreation/Aesthetics

As described in Section 2.18, 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.

3.20.1. 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 aesthetics association with maintaining the navigation project.

3.20.2. Alternative 2 – RP

3.20.2.1. 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 Mobile Harbor and 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.

3.20.3. 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 port 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.

3.21. Socioeconomics

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. 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.

3.21.1. 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. Over the long-term, the port may lose business to other ports with facilities that accommodate larger ships and allow ships to maximize capacity. As a result, international trade could be limited, which may hinder current 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.

3.21.2. Alternative 2 – RP

3.21.2.1. Project Construction

There is an initial capital cost of approximately $365.7 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 RP 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 National Ambient Air Quality Standards, 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 RP are anticipated to be positive and short-term during construction although small relative to the total economy of the counties.

3.21.3. Future Maintenance

The long-term socioeconomic impacts associated with implementation of the RP 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 on the Port would not increase based on implementation of the RP, but 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 RP 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 RP would have positive effects.

3.22. Transportation

This section provides a summary of the potential impacts to transportation should the Proposed Action or No Action Alternative be implemented.

3.22.1. 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 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.

3.22.2. Alternative 2 – RP

3.22.2.1. 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 RP 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.

3.22.3. 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 RP, 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 (LOS) 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.

3.23. Utilities and Infrastructure

Infrastructure and utilities include roads, rail lines, airports, ports, electrical power sources, gas lines, water and sewer lines, and communications lines as described in Section 2-21.

3.23.1. Alternative 1 – No Action

Under the No Action Alternative, the proposed project would not be implemented. Therefore, no project related impacts to utilities would occur.

3.23.2. Alternative 2 – RP

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 (MR) Reach area that are outside the area of impact of the RP. 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 RP, and Future Maintenance activities. Any possible future installation of utilities would require coordination with USACE Mobile District.

3.23.3. Future Maintenance

Future maintenance will be consistent with the current O&M dredging and placement practices. Maintenance activities for the future With-Project conditions will continue to place dredged material 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. Future maintenance of the project, once constructed, will be conducted within the navigation channel and utilize already existing and certified placement sites. Therefore, no additional impacts associated with utilities and infrastructure from future dredging and placement activities would be expected.

3.24. Environmental Justice

The environmental justice evaluation includes whether an alternative potentially results in significant adverse health or environmental impacts and if those impacts would be disproportionately experienced by a minority or low-income population.

3.24.1. Alternative 1 – No Action

Under the No Action Alternative, the RP 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 RP. As described in Section 2.5.13 (Hazardous Materials) the transportation of hazardous materials is subject to a variety of regulations. With the build-out 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 Mobile Central Business District (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 1 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 1 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 5.1.21., 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. 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). Furthermore, 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 is associated with the predominant east-west highway in this area.

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 and disproportionate 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.

3.24.2. Alternative 2 – RP

3.24.2.1. Project Construction

The adverse environmental impacts of implementation of the RP 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 RP project site is located in the water, and has no land-side construction staging areas. Therefore, fugitive dust emissions are anticipated to be minor and temporary during implementation of the RP, and during Future Maintenance 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.

3.24.3. Future Maintenance

The implementation of the RP 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 RP, 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 RP, 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 RP. With implementation of the RP, impacts associated with hazardous materials truck traffic over the Cochrane-Africatown Bridge would be minimal. 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 RP.

As discussed in Section 2.13, 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 RP 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 RP 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 No Action Alternative, there would minor disproportionate impacts to environmental justice communities from truck traffic transporting hazardous materials.

3.25. Public and Occupational Health and Safety

3.25.1. 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 basins 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 3-14 (Air Quality) 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 the port may not reach its 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.

3.25.2. Alternative 2 – RP

3.25.2.1. Project Construction

Under the RP, 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. 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.

3.25.3. Future Maintenance

With the widening associated with the implementation of the RP 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 their 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 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 3-14 (Air Quality) 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 the use of technology and staggered gate hours 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 RP on public and occupational health and safety would be minor.

3.26. 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 RP. 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, DO, Temperature, Nutrients, and Turbidity)

<u>Salinity</u>. 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, SAV, 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 0.5m SLR, however, increases and distribution of salinity under that scenario would be the same as those under the baseline conditions.

<u>DO</u>. 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 RP.

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 RP.

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 RP.

Waves

General Wave Climate. Model results indicate that implementing the RP 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 of the 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 RP, which results in less vessel generated wave energy affecting the study area.

Groundwater. The modeling suggests that it may take thousands of years for water that enters the aquifer system at the shipping channel or the aquifer ocean outcrop to make its way to the Dauphin Island wells and will likely have no impact on the water quality of the Dauphin Island wells over the 50-year design life of the project. Considering the results of the aquifer modeling and analysis, it is not anticipated that the deepening of the channel would result in adverse impacts to the aquifer or associated groundwater used by Dauphin Island.

Sediment Transport

Estuarine/Mobile Bay. Results from the one year model simulation with the RP 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 SLR. 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 RP. Additional details of the estuarine sediment transport modeling effort are provided in Attachment A-1 of the Appendix A.

Ebb-Tidal Delta. The sediment transport modeling as described in Attachment A-2 of the 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 RP 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 SLR). Additional details of the coastal sediment transport modeling effort are provided in Attachment A-2 of the Engineering Appendix.

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. (2019). 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 0.5m 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, additional impacts related to project implementation remain negligible under the 0.5 m SLR scenario.

Cultural Resources. The APE of the RP has a very high potential for the presence of historic properties, including prehistoric sites on now-submerged landforms as well as historic shipwrecks. Phase I maritime surveys have been completed for all of the RP’s APE and 2 magnetic anomolies or acoustic reflectors, and a natural landform sensitive for the presence of historic properties have been identified. A Phase II evaluation of these resources will be necessary to determine if they represent historic properties eligible for NRHP listing. Section 106 coordination and consultation with the Alabama SHPO and the USACE, Mobile District Tribal Partners may be necessary depending on the results of the Phase II survey. A PA is currently being developed to guide the completion of the Phase II survey and to mitigate any adverse effects to historic properties if impacts to listed, eligible, or potentially eligible cultural resources cannot be avoided.

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 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 in nature of the impact, the overall impact to fisheries resources is considered negligible. EFH consultation has been completed with NMFS-HCD as required under MSFCMA. The USACE, Mobile District has made the determination that the project would have no adverse effect to EFH. As a result of reviewing the Main Report and Appendix C, by letter dated September 27, 2018 (Attachment C-4), NMFS concurred with the Districts determination that the project would not result in adverse effects to EFH.

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. Pursuant to Section 7 of the ESA, consultation with the USFWS and NMFS-HCD has been initiated and a request for concurrence with this determination has been sent by letter dated November 9, 2018. The USFWS in a letter dated December 21, 2018 concurred with the may affect but is not likely to adversely affect determination. Under the terms and conditions of the GRBO as recognized by the NMFS-PRD, a determination was made that the project may affect but is not likely to adversely affect threatened or endangered species.

New Work Sediments. During the Pre-construction Engineering and Design (PED) phase of the Mobile Harbor GRR/SEIS, sediment testing and evaluation will be required for all material proposed for placement in the ODMDS. Maintenance material along with proposed new work dredged material suitability must comply with guidelines in accordance with the MPRSA) of 1972, and 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 project 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 RP. These included six locations in a relic shell mined area within the bay for the placement of mixed sand, silts, and clays dredged from the River and Bay Channels; the 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 placement areas. The USACE, 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 and placement 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 RP 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 harbor 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 and the subsequent ongoing activities would not have disproportionately high and adverse impacts to any communities, including environmental justice communities or children.

3.27. 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 WRDA 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 Engineer Regulation (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 Engineering Research and Development Center (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 as well as inputs from various public and focus group meetings to identify additional concerns.

Practicable avoidance and minimization measures were considered. Should impacts not be avoided and minimized, the Mobile Harbor project delivery team (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 expertise 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 improvement and placement alternative 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 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 these resources.

A characterization of baseline wetland community assemblages and distribution in estuarine, transitional, and freshwater habitats throughout Mobile Bay and the associated Delta region were conducted (Berkowitz et al., 2019). Salinity tolerance classes were established for each wetland community using existing literature sources; including thresholds for decrease productivity and mortality. The study area focused on the central and southern portions of the Mobile Bay and the Five 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 Berkowitz et al. (2019) covered a distance of 64 km 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 (Berkowitz et al., 2019). 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, Berkowitz et al. (2019) 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 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., 2019). Detail 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 are included in Section 3.25 above. Based on the minimal level of impacts determined for the implementation of the RP 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 RP 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) Comply with all coastal zone management conditions and adhere to any other protocols issued as part of the Coastal Zone Consistency determination.

3) Dredge practices will adhere to the GRBO (2003, and amended in 2005 and 2007).

4) Implement additional conservation measures required by NMFS and USWFS for ESA-listed species.

5) Beneficial placement strategies for new work material.

6) Continue working with cooperating agencies during the planning, PED, and construction phases.

3.27.1. Monitoring

It is understood that the analysis of environmental impacts relies heavily on a modeling approach, which can make it difficult to verify whether impacts will not actually occur after project construction. The extensive modeling approach was undertaken to ensure that the project would not increase salinity or degrade other water quality parameters within the project area to the point where wetland communities would be impacted. The USACE, Mobile District feels that based on the results of the modeling efforts, it is unlikely that the project would have significant impacts on fresh and brackish water wetlands and resources. However, there is an inherent assumption that the modeling conducted accurately represents the post-construction resources behavior and environmental conditions. The USACE, Mobile District feels that it would be appropriate and will be developing a monitoring plan during PED to ensure success of certain facets of the project in the event that unforeseen impacts are realized. The monitoring plan will be developed that will consist of seasonal monitoring for a minimum of 3 years but not to exceed 5 years. Should impacts be detected, contingency plans will be developed to mitigate any such impacts. The USACE, Mobile District will develop a post-construction monitoring plan for the project areas described below.

<u>Relic Shell Mined Area</u>. The following montoring will be conducted at the placement sites in the Relic Shell Mined Area on a seasonal basis. Sampling will be conducted at all the baseline sampling locations that were previously used when conducting benthic sampling. The monitoring will include but not necessarily limited to the following:

- Hydrographic surveys of the placement and surrounding areas to assess potential movement of the placed new work sediments.
- Collection and analysis of surface sediment samples at the same locations to assess physical sediment characteristics.
- Collection of water quality parameters at the bottom, mid-water, and surface (salinity, DO, nutrients)

<u>SIBUA</u>. The following montoring will be conducted at the placement sites on a seasonal basis and after tropical storm events to include but not necessarily limited to:

- Hydrographic surveys of placement site
- Sediment transport analysis

Monitoring of the SIBUA placement area is further discussed in Section 4.11, Appendix A.

<u>Mobile Bay and Delta</u>.

- Utilization of ADEM's existing water quality monitoring program to assess potential changes in post-construction bay-wide water quality conditions.
- The USACE, Mobile District will conduct supplemental sampling as deemed appropriate.

SECTION 4. CUMULATIVE IMPACTS - INTRODUCTION

4.1. Authority and Approach

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 United States (U.S.) Army Corps of Engineers (USACE), to consider cumulative impacts in rendering a decision on a federal action under its jurisdiction. Hence, this appendix to the Draft GRR/SEIS discusses potential impacts resulting 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. 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 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). However, 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).

Finally, 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 below Sections 4.2, 4.3 and 4.4. 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.). Section 4.3 lists past actions which have contributed to cumulative impacts on local resources, Section 4.3 lists current actions which continue to contribute to cumulative impacts and Section 4.4 describes proposed projects which could contribute to cumulative impacts if undertaken. These sections 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 the 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. Each of these sections details potential impacts to those resources that may be cumulatively affected, regardless of action (i.e., single or aggregate).

4.2. Spatial and Temporal Boundaries

4.2.1. Area of Influence

The geographic area of interest used for the scope of this analysis (the project impact zone) varies for each affected resource. Air quality is generally evaluated on a county by county basis by U.S. Environmental Protection Agency (EPA), so cumulative effects on air quality are based on impacts to the counties sharing the harbor and adjacent to the channel: Mobile and Baldwin. Water quality, however, may be affected in the harbor, upstream of the harbor (including the Mobile-Tensaw River Delta, the Mobile River, the Tensaw River, and several smaller rivers which empty into the bay: the Blakely, Spanish, Dog, Deer, Fowl, Middle, and Fish Rivers), downstream through the entrance channel, and at/near the proposed material placement area. Wetland habitats to be considered for cumulative impacts are generally located in riparian areas that are directly connected to the harbor and affected rivers and up to a certain elevation, but not necessarily throughout the nearby counties. Hardbottom marine habitats are assessed across the counties' offshore waters. Sediment dynamics are evaluated through the tributaries and into the harbor, while the shorelines evaluated are located in the harbor and on the coast. Aesthetics are considered relative to the harbor and surrounding lands.

4.2.2. Definition of Temporal Conditions

The temporal scope of this evaluation spans the initial dredging of the harbor to anticipated future actions within the projected 50-year life of the proposed action in the geographic areas identified above for the various evaluated resources. The time frames evaluated include the following:

- Pre-Water Resources Development Act (WRDA) 1986 Projects
- WRDA 86 Reauthorization
- Other Channel improvements
- Present Actions
- Foreseeable Future

4.3. Past Actions

4.3.1. Federal Navigation and Port Facilities

4.3.1.1. Harbor Construction, Reauthorizations, and Improvements

The navigation channel dredging in Mobile Bay and Mobile River began in 1826 with the 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 Hollingers 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-ft depth channel with a 400-ft width in Mobile Bay to the mouth of the Mobile River and a 40-ft depth in the Mobile River to the Africatown-Cochran Bridge with the width varying from 400 to 775 ft. Section 201 of the 1965 Flood Control Act, authorized a 40-ft by 400-ft channel, branching from the main 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. The improvements were reauthorized in Section 201 of the WRDA of 1986, and subsequently amended by Section 302 of the WRDA of 1996. The authorizations recommended the following improvements to the Federal project: deepening and widening the gulf entrance channel to 57 by 700 ft; deepening and widening the main channel to 55 by 550 ft in Mobile Bay, 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 Interstate 10 highway tunnels; and, constructing turning and anchorage basins near the upper end of the main channel.

4.3.1.2. Dredging and Placement Practices

Between 1870 and 2010, approximately 168.1 mcy of sediment were removed from the channel as a result of new work dredging and approximately 423.9 mcy for maintenance dredging. Since 1913, Mobile Bay Channel depths have been maintained at an average dredging rate of 4.1 mcy per year. **Table 4-1** shows a summarized history of dredging in the Mobile Bay Channel. **Figure 4-1** illustrates the cumulative dredging volumes in the channel with indicators showing widening and/or deepening dates. These volumes do not include the Theodore, Arlington, Garrows Bend, Dog River, Fowl River, Gulf Intracoastal Waterway, and Fly Creek channels. **Table 4-2** shows the placement areas for dredged material from Mobile Bay and Theodore ship channels between 1854 and 2010. **Table 4-3** shows the placement areas for the other channels in the Mobile Bay area (Byrnes et al. 2013).

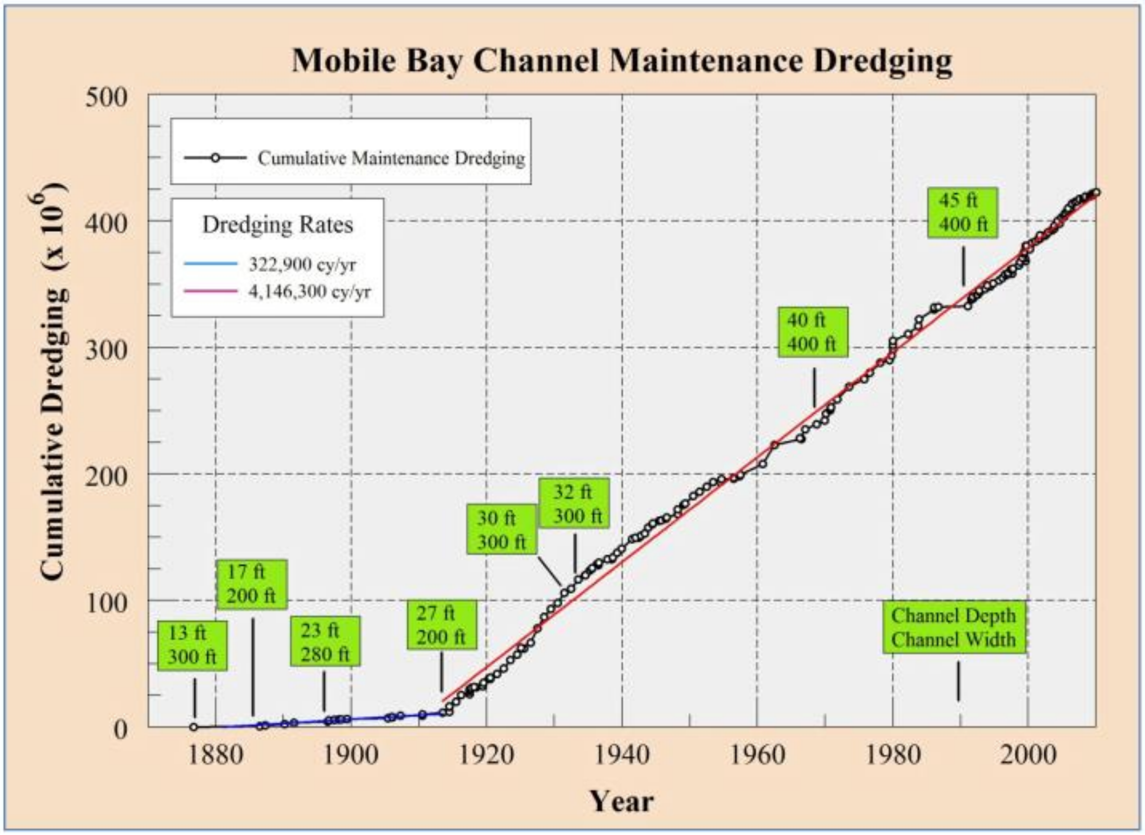
Table 4-1. Summary of dredging history for Mobile Bay Channel

Channel Dimensions (ft)	New Work Dredging Dates	New Work (CY)	Maintenance Dredging Dates	Maintenance (CY)	Dredging Rate (CY/year)
13 x 200	September 20, 1870 to September 1876	1,217,869	September 1876 to June 30, 1885	0	0
17 x 200	February 19, 1881 to June 30, 1885	4,724,704	June 30, 1885 to October 3, 1895	3,236,420	315,441
23 x 280	October 1888 to October 3, 1895	20,428,577	October 3, 1895 to July 12, 1909	5,717,644	415,225
23 x 100	June 26, 1899 to July 12, 1909	17,673,578	July 12, 1909 to August 15, 1913	2,264,298	557,709
27 x 200	January 6, 1911 to August 15, 1913	14,231,311	August 15, 1913 to July 25, 1926	66,700,043	5,150,582
30 x 300	September 10, 1918 to July 25, 1926	17,712,024	July 25, 1926 to July 19, 1933	38,607,404	5,531,147
32 x 300	FY 1932 to July 19, 1933	7,291,046	July 19, 1933 to November 10, 1964	106,628,266	3,405,566
40 x 400	January 27, 1956 to November 10, 1964	54,106,804	November 10, 1964 to July 3, 1989	108,945,745	4,419,706
45 x 400	October 24, 1987 to July 3, 1989	33,668,899	July 3, 1989 to October 3, 2010	91,821,071	4,320,922
Total		168,054,812		423,920,891	

Source: Byrnes et al 2013

Note: Totals do not include 100,000 CY new work prior to 1870 and 52,842 CY maintenance prior to 1876.

Historically, material dredged from the Mobile Bay Channel was disposed of inside the bay. Early methods of placement involved placement from a pipeline dredge at a distance of approximately 1,000 ft from the west bank of the channel. Later, dredging material was placed a minimum of 1,500 ft beyond the edge of the channel in order to minimize the possibility of shoaling. In 1953, an increase of the distance to 2,000 ft was proposed. However, the WRDA of November 17, 1986 stated that future dredged material from the project must be disposed of in open water in the Gulf of Mexico. Until 2012, most excavated material was placed in designated placement cells in the ODMDS in the Gulf, with the exception of occasional placement in designated placement areas within the bay during emergency dredging events, and on Gaillard Island. (Byrnes et al. 2013).



Source: Byrnes et al. 2013

Figure 4-1. Cumulative maintenance dredging volumes from Mobile Bay Channel between 1876 (the initiation of the -13 ft channel) and 2010.

Table 4-2. Placement areas for new work and maintenance material dredged from Mobile Bay and Theodore Ship Channels

	Mobile Bay Channel (1854 to 2010)		Theodore Ship Channel (1979 to 2010)		Total
	New Work (CY)	Maintenance (CY)	New Work (CY)	Maintenance (CY)	
Gaillard Island	0	4,991,735	33,534,235	23,393,449	61,919,419
Mobile Bay	134,485,913	341,820,397	0	5,121,877	481,428,187
Gulf of Mexico	33,668,899	77,161,601	0	652,521	111,483,021

Source: Byrnes et al. 2013

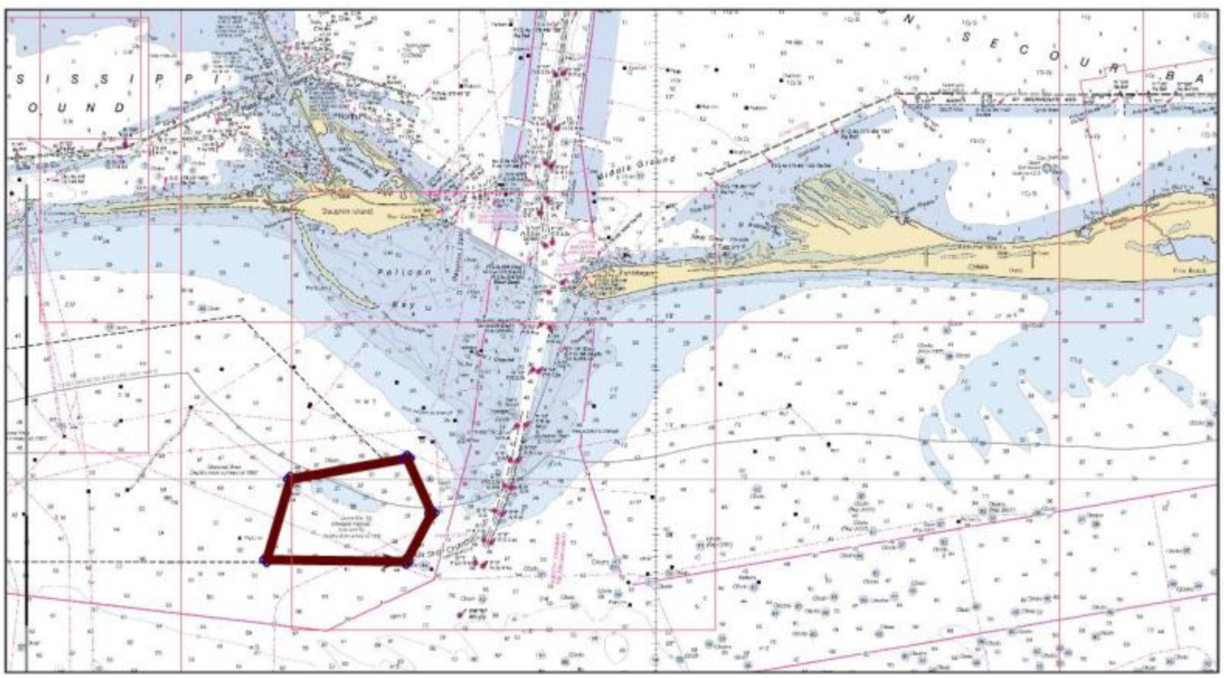
4.3.1.2.1. Ocean Dredged Material Disposal Site (ODMDS)

The ODMDS is a 4.75 square nautical mile (nmi^2) area. The site lies on the shallow continental shelf, 4 nautical miles (nmi) offshore of Mobile Point, Alabama with an average depth of 14 meters. Physical, chemical, and biological conditions at the ODMDS are described in, "Final Environmental Impact Statement for the Pensacola, FL, Mobile, AL, and Gulfport, MS Dredged Material Disposal Site Designation." (EPA and USACE 2015). **Figure 4-2** shows the location of the current ODMDS used for dredging operations in the Mobile Bay. This location is the same as those previously designated.

Table 4-3. Summary of other channels within Mobile Bay

Channel	Authorized Dimensions (ft)	Shoaling Rate (CY/year)	Primary Placement Areas Used	Source
Arlington Ship Channel	27x150	54,600	McDuffie Island, Mobile Bay OW	USACE O&M
Garrows Bend	27x150	7,700	McDuffie Island, Mobile Bay OW	USACE O&M
Dog River	7x100	5,000	Dog River Upland, Mobile Bay OW	USACE O&M
Fowl River	8x100	35,300	Fowl River OW (in Mobile Bay)	USACE O&M
Gulf Intracoastal Waterway	12x150	60,000	Gulf Intracoastal Waterway OW (in Mobile Bay)	USACE, 2008
Fly Creek	6x80	11,700	Upland (beach nourishment), Fly Creek OW (in Mobile Bay)	USACE O&M; USACE 2011b

Source: Byrnes et al. 2013



Source: EPA and USACE 2015

Figure 4-2. The location of the ODMDS for Mobile Bay

The Mobile ODMDS and the Mobile North ODMDS (selected by the USACE pursuant to Section 103 of the MPRSA) have been used for placement of 120 mcy since 1987 (USACE 2014). The composition of the dredged material is primarily silts and clays. The USACE has estimated the remaining capacity of the Mobile ODMDS at 15 mcy, based on projected volumes and the remaining capacity the ODMDS has an estimated life of four years (USACE 2014). EPA in cooperation with the USACE Mobile District is in the process of expanding the Mobile ODMDS to approximately 24 nmi^2 and expects to expand the site prior to construction of the proposed action.

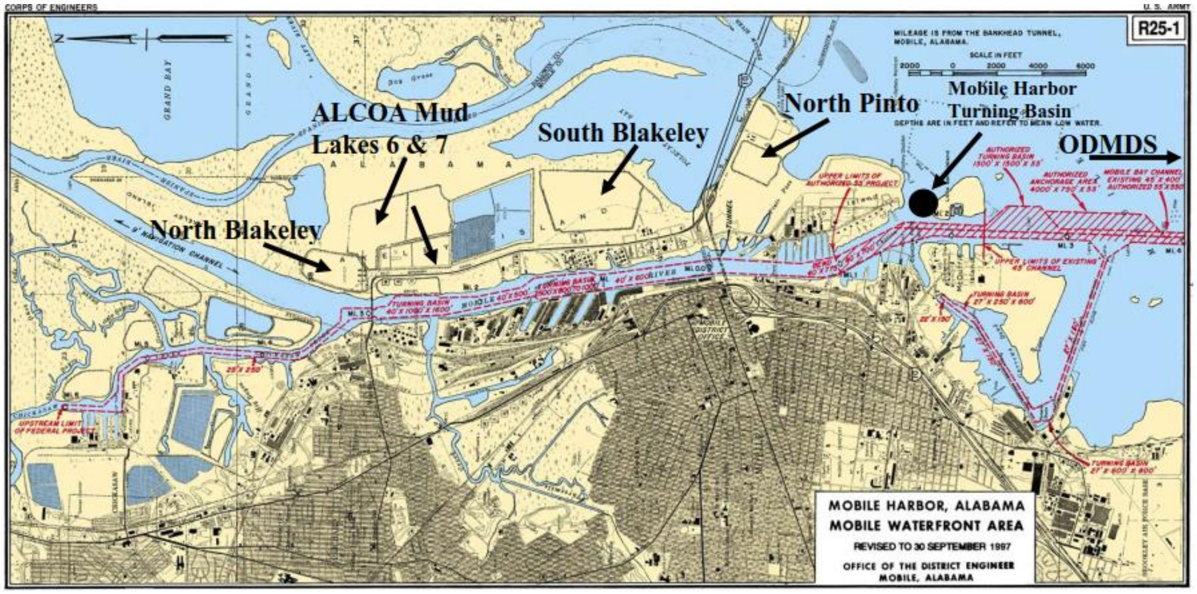
4.3.1.2.2. Upland Placement

Historically, dredge material has been placed in upland areas as well as in Mobile Bay and the ODMDS. Upland dredge placement sites include McDuffie Island, the Dog River upland area, Gaillard Island, the Fly Creek beach nourishment, Little Dauphin Island, and the approved placement areas near Mobile Harbor (Byrnes et al. 2013, USACE 2012). **Figure 4-3** shows the placement locations near Mobile Harbor.

Between 1849 and 1918, new land was created from material dredged from the Mobile Bay Channel. East of the city of Mobile, Pinto Island was enlarged by the placement of material dredged from the channel. South of Choctaw Point, McDuffie Island was built and just east of there, a narrow strip of land called Little Sand Island was established. From 1918 to 1934, the Mobile Harbor region was developed extensively. Dredged material from the channel was used to extend the shoreline of Garrows Bend into the bay, as well as to construct a strip of land known as Arlington Pier. McDuffie, Pinto, and Little Sand Islands were all enlarged with dredged sediment. During the years between 1934 and 1957, the Garrows Bend shoreline was further enlarged and, on the western shore of Mobile Bay, land was created for the development of Brookley Air Force Base. The placement of material dredged from Mobile Bay Channel continued, adding land area to McDuffie, Little Sand, Blakeley, and Pinto Islands. In 1970, a report recommended modification of the Federal navigation project for Mobile Harbor to include the Theodore Ship Channel based on the need for additional industrial sites and bulk handling facilities. Dredged material was originally to be deposited as five islands parallel to and 1,500 ft from the bay section of the channel. However, the project was modified in 1976 to include a barge channel extension connecting to a barge turning basin and dredged material was designated to be placed at Mobile Bay to create Gaillard Island. A total of 33,534,235 CY of material was placed to construct Gaillard Island. Maintenance dredging of the Theodore channel has been performed every one to three years since 1983 and has resulted in the removal of approximately 29,167,847 CY of sediment through February 2010 (Byrnes et al. 2013).

The 2012 USACE Environmental Assessment (EA) regarding Mobile Harbor operations and maintenance stated that approximately 1.2 mcy of dredged material would be removed from the main channel on an annual basis. This includes sediment collected in the sediment basins that would be periodically removed as necessary to restore their original dimensions and their sediment-trapping ability. Dredged material would be removed from the channels by dragline/clamshell, hydraulic pipeline and/or hopper dredge, and all material would be placed in previously-approved upland placement areas (i.e., North Blakeley, ALCOA Mud Lakes, South Blakeley and North Pinto; see **Figure 4-3** or the Mobile ODMDS. Dredging and material placement activities could occur at any time during the year, and in response to unforeseen shoaling (USACE 2012).

Included in the overall maintenance of the Mobile Harbor Project are activities necessary to maintain the longevity of the upland dredged material placement areas. At times, material from upland sites, i.e., Blakeley Island, may be transported to Gaillard Island for dike raising/construction or other purposes. Upland placement area restoration and material placement activities could occur at any time during the year. Material to be placed in Gaillard Island would only occur in accordance with the Migratory Bird Treaty Act and any associated regulatory agency agreements (USACE 2012).



Source: USACE 2012

Figure 4-3. Approved placement areas near Mobile Harbor

4.3.1.3. Placement Practice Changes

4.3.1.3.1. Regional Sediment Management/Beneficial Use

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". Several beneficial use options have been identified in the Mobile Bay area. These options include:

- Shoreline protection measures such as living shorelines
- Oyster reef restoration
- Creation of islands
- 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

4.3.1.3.2. Open-water and ODMDS Use Post WRDA 86

Historically, material dredged from the Mobile Bay Channel was disposed of inside the bay. The WRDA of 1986 stated that dredged material be disposed of in open water in the Gulf of Mexico. Until 2012, most excavated material was placed in designated placement cells in the Mobile

North ODMDS in the Gulf, with the exception of occasional placement in designated placement areas within the bay during emergency dredging events, and on Gaillard Island. According to a bathymetry study from 2013, the largest observable change in bay bottom morphology (between 1917 and 2010) was the continued increase in water depth in the southern portion of the bay adjacent to the channel. The apparent increase in water depth was speculated to be related to the shift in dredged material placement policy post WRDA (1986) that made offshore placement of dredged material mandatory. This policy resulted in the removal of dredged sediment from the estuarine system (Byrnes et al. 2013).

Since WRDA 1986, concerns were raised regarding whether removing dredged material from the Bay's sediment transport system is environmentally sound. The WRDA of 1996 provided the authority to consider alternatives to placement of dredged material for the Mobile Harbor Federal navigation project that include other environmentally acceptable alternatives, including beneficial uses and environmental restoration. As part of the 2012 recertification of the Mobile Harbor Federal navigation project, the use of open bay placement areas was authorized in the event of storm-related emergency dredging activities to provide safe navigation for returning the channels to their pre-storm dimensions and restoring full shipping capacity. Open bay placement utilizes pre-established historical placement areas that have been implemented during emergency procedures resulting from Hurricane Georges in 1998 and Hurricane Katrina in 2005. An EA completed in 2014 analyzed the potential impacts of using a proposed placement modification which would include a long term open bay thin-layer placement activity as defined in addition to the emergency storm-related action (USACE 2014).

In September of 2012, the USACE, Mobile District utilized a large pipeline dredge to clear the upper Bay channel. This action resulted in the placement of about 9 mcy of maintenance dredged sediment within the historically established open water sites (**Figure 4-4**). The placement utilized thin-layer techniques such that the thickness would be no greater than 12 inches. The proposed method for thin-layer placement included a spill barge outfitted with a continuous global positioning tracking system and a diffuser or baffle plate. The spill barge utilizes a system of winches, which constantly move the barge in a sweeping pattern to prevent material from exceeding the thin-layer tolerance. Placement of material in the open-water sites would occur at least 2,500 ft from the edge of the channel. The benefits associated with the thin layer placement method include allowing sufficient time for benthic recovery, permitting the bottom elevations to return to that of the adjacent bottom, remobilizing the sediment within the Bay's natural sediment transport system, and providing the ability to utilize both hopper and cutterhead dredging equipment (USACE 2014).

According to the 2014 EA, typically, each 2-mile reach of channel has three open water placement areas within a reasonable pumping distance that are adequately sized based on the historic shoaling rates for the associated channel reach. In the cases where shoaling rates are consistent with historical rates, a pipeline cutterhead dredge could be used every 12 to 24 months, which would result in a thin-layer placement in each of the three placement sites approximately once every 4 to 6 years. During the approximate 12 to 24 months between pipeline cutterhead dredging events, it is likely that a hopper dredge would be required to remove corner shoaling and the material would be placed in the ODMDS (USACE 2014). The currently proposed project includes the ODMDS as a potential dredge placement area.

Source: Byrnes et al. 2013

Figure 4-4. Navigation channels and associated dredged material placement areas in the vicinity of Mobile Bay, Alabama. Background Landsat image acquired October 3, 2011

4.3.1.4. Beneficial Use Placement

Engineer Manual 1110-2-5026 requires the beneficial use of dredged material be maximized within the coastal system. Dredged materials that qualify for beach or near-shore placement per the applicable State standards shall be beneficially placed in such locations, to the maximum extent practicable. Beneficial use of beach compatible dredged material for beach nourishment is strongly encouraged and supported by EPA. Most sandy material is placed in the Sand Island Beneficial Use Area (SIBUA) located due east of the ODMDS (EPA and USACE 2015).

4.3.1.4.1. Sand Island (Beneficial Use Area and Oil Spill mitigation)

Materials dredged for the Bar Channel portion of the Mobile Harbor Federal Navigation Project authorized project are placed either in the ODMDS or the SIBUA. Additionally, the proposed placement area for the Mobile Harbor Turning Basin expansion was the SIBUA. The SIBUA was established to increase the amount of sediment retained in the Dauphin Island barrier island system and to provide sediment in the downstream circulation (USACE 2010).

In September 2004, the SIBUA was modified to expand the site to include an area surrounding the Sand Island Lighthouse, located near Fort Morgan, which his on the National Register of Historic Place. The dredge material can be placed around the lighthouse rubble foundation to provide protection from wind and currents. In 2008, USACE requested the expansion of the SIBUA to include an area to the southwest of the original placement site. Estimates of the total dredged material in the 2010 EA included between 300,000 CY to 3 mcy of maintenance material and a possible 600,000 CY during the Mobile Harbor Turning Basin construction project. As of 2010, approximately 9.61 mcy of dredge material had been placed in the existing SIBUA. The EA resulted in a Finding of no Significant Impact with concurrence from the USFWS, NMFS, ADEM, and the SHPO (USACE 2010). The currently proposed project includes the use of the SIBUA for dredged material placement.

In 2010, a proposal was submitted to the Congress to build an oil mitigation berm at the mouth of Mobile Bay and rebuild Sand Island to its original size using dredged material from the Mobile Bay Channel (Islam and Parks 2012).

In 2011, the USACE, Mobile District placed dredged material available from the SIBUA and maintenance dredging of the existing bar channel on Sand Island for purposes of mitigating impacts during the Deepwater Horizon Oil spill. Under the authority Sec. 406 of P.L. 111-212 Supplemental Funds, the USACE, Mobile District placed approximately 1.5 mcy of sand on Sand Island, beginning at the Sand Island Lighthouse and proceeding to the northwest. The source of sand for this action was from the SIBUA (with the option of using material directly from the Mobile Bay navigation channel). In addition to attempting to prevent, to the extent possible, submerged oil spill from entering/impacting the entrance of Mobile Bay, the USACE correctly anticipated this action would provide an excellent opportunity to accelerate the return of sediment into the local littoral transport system consistent with established regional sediment management principles and goals. Another secondary benefit resulted by providing additional protection to the Sand Island Lighthouse which is a prominent historical and cultural resource. The State of Alabama submitted a proposal in 2014 to continue to use dredged sediments on Sand Island. Justifications for the $18.5 million request included the statement that placement of sandy material into the Sand Island/Pelican Island complex will help maintain a sediment transport complex in a manner that will reestablish the flow of sand on to the western region of Dauphin Island and enhance restoration of valuable habitat including sea turtle nesting habitat, shorebird foraging and roosting areas, and general coastal ecosystem functions (State of Alabama 2014).

4.3.1.4.2. Brookley Hole Beneficial Use Placement

Brookley Hole is an estuarine dredged borrow pit from which material was removed for construction of the Brookley airfield. The basin and surrounding area are totally submerged with depth in the basin of approximately 23 ft and varying from 3 ft to 6 ft for the surrounding Mobile Bay bottom.

It was determined that Brookley Hole would be filled in stages, allowing for post-restoration monitoring to evaluate the performance of the fill and to modify the plan. Prior to restoration efforts, a joint study was completed in 2011 to assess habitat quality of Brookley Hole. For purposes of comparison, a nearby borrow pit designated as Airport Hole was identified as a reference site. The initial placement action consisted of pumping approximately 1.2 mcy of fine-grained material from the upper reach of the Mobile Bay navigation channel into the deepest area of Brookley Hole. This was accomplished in the summer of 2012 by using a 30-inch hydraulic cutterhead pipeline dredge. No material was placed in Airport Hole. Prior to restoration, conditions were not suitable to sustain a healthy finfish assemblage in the lower water column of Brookley Hole. During the initial habitat assessment study, there was evidence of periodic water column stratification that induced hypoxic and/or anoxic water quality conditions. Hypoxic/anoxic conditions were most severe during summer and least severe during fall. During post-restoration sampling, dissolved oxygen concentrations did not fall below 6 milligrams per liter (mg/L) during any seasonal survey (Parson et al. 2015).

The partial restoration of Brookley Hole has shown a significant increase in benthic diversity and abundance although results are still subpar to the natural bay bottom. From an ecological perspective, the partial or complete filling of these dredged holes (Brookley and Airport) would benefit fishery resources through elimination of hypoxic/anoxic zones common to these bathymetric features. It is predicted that complete filling would restore historical bathymetric contours to that area of upper Mobile Bay. Thus, Brookley Hole remains a suitable candidate for full restoration to its natural bathymetry at a future date (Parson et al. 2015).

The USACE has estimated that the hole has capacity for approximately another 750,000 CY. Once placed, material will consolidate, possibly creating capacity for additional material. The results of the next placement cycle along with the monitoring will determine future actions (Parson et al. 2015).

4.3.1.5. Sediment Transport

4.3.1.5.1. Ebb Tidal Shoal

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 the western end of the island, even though channel dredging has been active. Based on all available information, Byrnes et al. (2008 and 2010) concluded that there appears to be no measurable negative local impacts to the ebb-tidal delta or Dauphin Island shorelines associated with historical channel dredging across the Mobile Pass Outer Bar.

Additionally, the U.S. Geological Survey (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 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 stormy 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 the 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, as documented in Attachment A-2, Appendix A, 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. Simulation time periods included a 2010 wind/wave climatology as well as a 10-year longer 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 near shore 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.

4.3.1.5.2. Mobile Bay

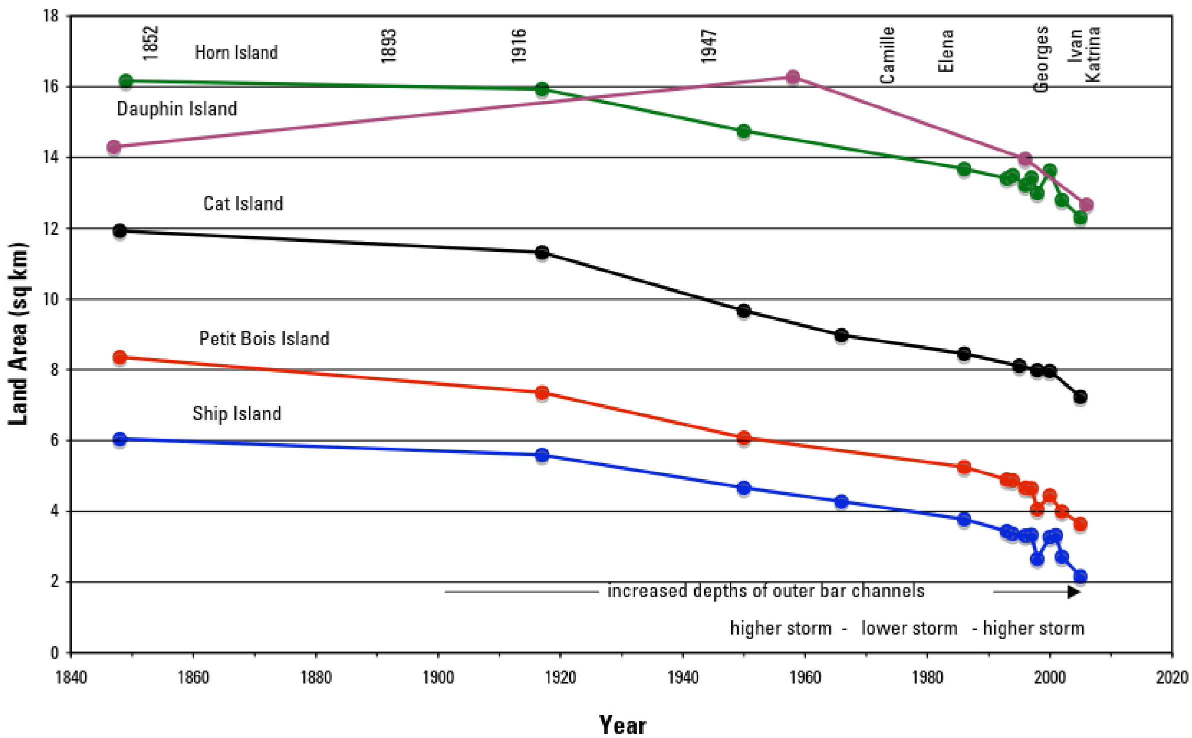
Byrnes et al. (2013) “Sediment Dynamics in Mobile Bay, Alabama: Development of an Operational Sediment Budget” and Byrnes et al. (2017) “Regional Sediment Dynamics in Mobile Bay, Alabama; A Sediment Budget Perspective used bathymetric surveys for the periods 1917–1918, 1984–1987, and 2004–2011 to develop 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 (Fort 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 of 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.

4.4. Physical Setting/Landscape of Mobile & Baldwin Counties which could influence the Bay (Development/Hurricanes/Disasters, etc.)

Hurricanes passing through Mobile Bay and the surrounding coast have had major impacts on the shapes and areas of the Mississippi-Alabama barrier islands. A U.S. Geological Survey (USGS) study published in 2007 used historical maps, aerial photographs and geographic information system (GIS) data to document changes to the islands (where possible) since the early 1800s. **Figure 4-5** shows the historical land loss on the barrier islands which can be attributed to hurricane impacts. In addition to land loss, general current patterns and hurricanes cause the islands to move, some are moving landward (Dauphin Island), while others are moving westward (Petit Bois, Horn and Cat Islands). Hurricane storm surge occasionally breaches the islands (Dauphin and Ship Islands). Prior to 1979, these channels would fill naturally due to current-related deposition (Morton 2007).



Source: Morton 2007

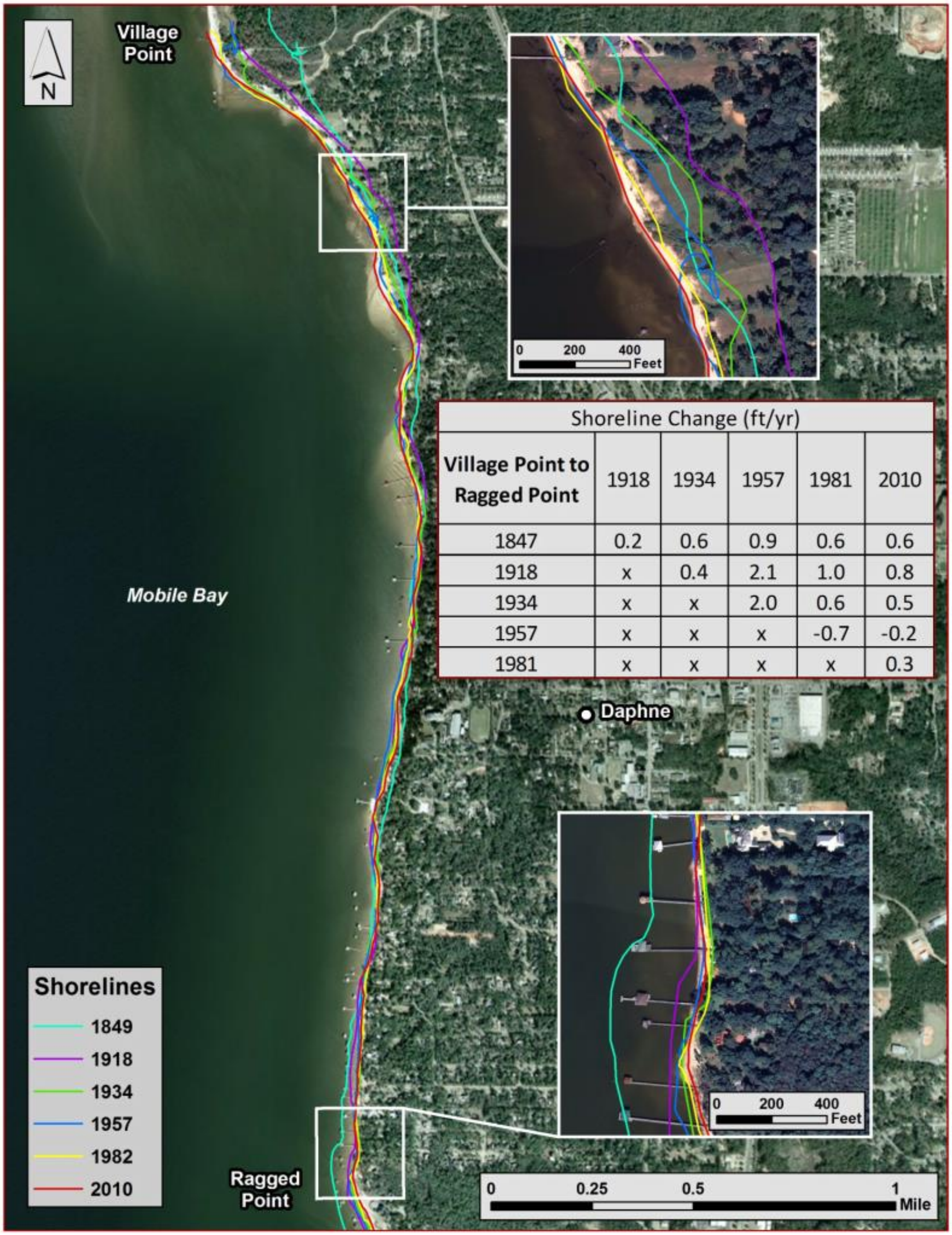
Figure 4-5. Historical land loss trends for the Mississippi-Alabama barrier islands relative to the timing of major hurricanes and human activities that impacted the islands

In addition to storms, human modifications of Mobile Bay and the Gulf shores have contributed to changes in the barrier islands. As indicated previously, Federal interest in dredging a navigation channel between the Port of Mobile and the Gulf of Mexico began in 1826. Over time, dredging enlarged the outer bar channel to approximately 41 ft deep and 590 ft wide by 1987. At its present maintained depth of 46 ft, the entrance channel exceeds the original outer bar controlling depth by 28.5 ft, a depth that is substantially greater than the original controlling depth. The outer bar channel now acts as a sediment sink that traps sand that normally would have bypassed around the ebb tidal delta and fed the Mississippi-Alabama barrier islands by downdrift. As dimensions of the Mobile Bay Channel steadily increased, so did the average annual maintenance dredging requirements. Overall, the volume of sand supplied to the Mississippi-Alabama barrier islands by alongshore currents has been reduced progressively since the late 1800s as the outer bars at the entrance to Mobile Bay, Horn Island Pass, and Ship Island Pass were dredged to increasingly greater depths. In the mid-1800s, the natural controlling depths of tidal inlets connecting Mississippi Sound with the Gulf of Mexico were from

14.7 to 18.7 ft. Since then, the outer bar channels have been repeatedly dredged to depths well below their natural depths and the surrounding seafloor. The initial shallow dredging would have had minimal effect on sediment transport. However, later dredging modifications eventually disrupted the littoral system and made the transference of sand across the ebb tidal deltas impossible. Eventually, all the sand in transport along the Gulf shores of the barriers was trapped in the navigation channels, and then dredged and disposed of in placement sites where it was not available for island deposition. Dauphin Island is probably least affected by the induced reduction in sand supply because the large volume of sand stored in the ebb tidal delta is still available for downdrift beach reworking and westward island extension. Additionally, Dauphin Island is still anchored to the Pleistocene core that provides stability to its eastern end. The armoring of the eastern end with bulkheads on the Sound side and a rip-rap revetment along the inlet margin provide additional protection from erosion (Morton 2007).

In addition to changes to the barrier islands induced by hurricanes and dredging/placement patterns, changes to the shorelines of Mobile Bay itself have also been documented. Shorelines within Mobile Bay have experienced significant changes from natural processes and anthropogenic activities. Winds, waves, tides, currents, tropical cyclones, and winter storms, as well as sediment input, transport variations, and SLR, have led to alterations in shoreline position. Dredge and fill activities and construction of shoreline structures have also affected the direction and degree to which shorelines change. A 2013 study by Byrnes et al. documented shoreline changes using six historical surveys. Shoreline recession along the western margin of Mobile Bay may be attributed to waves generated from winds, uncoordinated shoreline structuring, and local sediment transport processes. The main causes of erosion for the eastern shore are waves, coastal currents, and uncoordinated shoreline structuring. Erosion control structures, such as bulkheads and revetments, are numerous throughout Mobile Bay. These have increased in number as the coastal population of the region has grown. **Figure 4-6** depicts an example of human modifications of the shoreline on the western shore of Mobile Bay. Erosion due to large scale stabilization projects has increased erosion downdrift leading to small scale private shoreline stabilization efforts. The inset in the figure shows the shoreline change at a number of private residences. According to a prior study, by 1985, many bulkheads were constructed between Mullet Point and Weeks Bay. By 2010, most of this shoreline segment was protected by bulkheads, and the coast 1.5 miles south of Great Point Clear to Mullet Point is one of the most armored shorelines in Mobile Bay (Byrnes et al. 2013).

In addition to changes in the sediment deposition rates and placement, land has been created near Mobile Harbor using dredged materials from the channel. See Section 2.1.2.2 above for a discussion regarding upland placement practices.



Shoreline Change (ft/yr)					
Village Point to Ragged Point	1918	1934	1957	1981	2010
1847	0.2	0.6	0.9	0.6	0.6
1918	x	0.4	2.1	1.0	0.8
1934	x	x	2.0	0.6	0.5
1957	x	x	x	-0.7	-0.2
1981	x	x	x	x	0.3

Source: Byrnes et al. 2013

Figure 4-6. Historical shorelines and shoreline change rates from Village Point to Ragged Point

4.4.1. Dams and Causeways

The Mobile-Tensaw Delta is a depositional feature that has filled over 40 miles of the original Alabama River estuary in the past 3,000 years. The narrow, elongate land features that border the bays are natural levees. Based on shoreline positions after 1967, minor erosion of the Mobile-Tensaw Delta appears to have occurred, although underwater sediment deposition continues. As land-building at the southern extent of the delta has decreased in recent years, the drift of the delta into Mobile Bay has slowed over the past 70 years. This may be due in part to a decrease in sediment being transported to the bay resulting from upstream impoundments. Beginning in 1911, 36 dams were constructed throughout the Mobile River Basin. Streamflow is regulated within the basin for operation of flood-control and navigational locks and dams, reservoirs for water supplies, and hydroelectric plants. Flood events, whether natural or caused by the release of water from the upstream dams, greatly increase the velocity of water flowing over the delta, which can cause erosion of sediment in northern Mobile Bay (Byrnes et al. 2013).

An earth-filled causeway (the Mobile Bay Causeway) was built in the 1920s which, along with several bridges, provided a roadway from Blakeley Island to the east shore of Mobile Bay just north of Spanish Fort. The causeway was built across Chacaloochee and Justins Bays, isolating them from Mobile Bay. The causeway altered the hydrology of the Mobile-Tensaw delta by reducing and impeding water exchange between Mobile Bay and smaller bays in the lower delta, thereby reducing sedimentation rates (Byrnes et al. 2013).

4.4.2. Deepwater Horizon

On April 20, 2010, the Deepwater Horizon exploded in the Gulf of Mexico while drilling on the Macondo oil well approximately 41 miles southeast of Louisiana. Oil spilled into the Gulf until it was capped on July 15, 2010. A sampling effort was conducted by EA Engineering, Science and Technology on behalf of USACE, Mobile District in late-November and early-December 2010 to determine if the surface sediment quality in the Mobile Harbor Federal Navigation Channels had been impacted by the oil spill. Based on results of poly aromatic hydrocarbons and total petroleum hydrocarbon testing of surface sediments collected in the Mobile Lower Bay Channel, Mobile Bar Channel, EPA-designated reference site, and the Mobile-North ODMDS in November and December 2010, there were no discernable changes observed in the sediment quality that could be attributed to the Deepwater Horizon Oil Spill (EA 2011).

4.4.3. Channelization of Creeks

Urban runoff can have tremendous deleterious impacts on water quality and biological habitat of streams. This is particularly true in watersheds where land use has been substantially changed and stream channels have been modified by channelization. Water quality in these urban streams is typically characterized by excessive nutrients, bacteria, and sediment. In 2006, the Geological Survey of Alabama partnered with the Mobile Bay National Estuary Program and other federal, state, and local agencies, universities, and private groups to systematically assess sediment transport to Mobile Bay from tributaries originating in Baldwin and Mobile Counties. One of these tributaries is Dog River, which drains the south part of the city of Mobile and flows southward into Mobile Bay about 3.5 miles south of Brookley Field (Cook and Ross 2012).

Stream flow characteristics for tributaries of Dog River vary widely due to the wide range of land forms, channel types and flow regimes influenced by urbanization, channel modifications, and floodplain structures designed to control runoff. Generally, streams that are farther away from downtown Mobile have received fewer modifications to floodplains and channels and have fewer impervious surfaces. In the Dog River watershed, stream flow velocities are highest for those streams with extensive channelization and flows are not directly related to stream gradient (Cook and Ross 2012).

Seven of nine monitored sites in the Dog River watershed were assumed to have total sediment loads represented as suspended sediment due to stream channelization or stream bed armoring. Sediment in these streams was measured on hard surfaces where all sediment was suspended or saltating so that samples contained representative concentrations of all grain sizes transported downstream. Changes in land use are the primary causes of excessive erosion and sedimentation in the Dog River watershed where large upland areas of impervious surfaces increase runoff and cause accelerated stream flow velocities, flashy flows, and flooding (Cook and Ross 2012).

4.4.4. Relic Shell Mining

The USACE has been investigating the beneficial use of dredge material to remediate historical oyster shell mining in several locations in Mobile Bay. Thousands of acres of natural bay bottom were deepened in areas of the north eastern and central portion of the bay to depths of greater than 15 ft through the removal of dead reef oyster shell. This practice was first permitted in 1946 and ended in 1982. Although the first permit to dredge dead reef shell was issued in 1946, anecdotal information shows that shell dredging may have been done in Mobile Bay as early as the 1890s. A survey conducted by Radcliff Materials, Inc. and supplemented by data presented in the May (1971) USACE report resulted in the total volume of dead reef shell in Alabama being estimated at 93 mcy in areas throughout the bay. The total volume of shell extracted between 1947 and 1968 was 40 mcy, based on information obtained from Radcliff Materials, Inc. Dredging was done using a cutterhead dredge with a discharge immediately overboard. After the shell had been extracted, sediments were released to the rear of the dredge in an attempt to refill the dredge cut. Based on after-dredged surveys, many of the holes were not refilled (USACE 2015a).

The currently proposed project includes the possibility of placing dredged materials in the Relic Shell Mined Area. The Relic Shell Mined Area is located to the Northeast of Gaillard Island on the eastern side of the channel. 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 reduce hypoxic conditions. One of the primary concerns expressed by the group were the areas in the northeastern portion of the bay where oyster dredging operations were conducted prior to 1982 to mine relic oyster shell deposits. These operations have resulted in an overall deepening of the bay bottom in that area and are believed to be the cause of decreased ecological productivity resulting from hypoxia during certain times of the year. A map of the Relic Shell Mined Area is shown in Figure 4.6 of Main Report.

4.5. Present Actions

4.5.1. Federal Projects

4.5.1.1. The National Fish and Wildlife Foundation

The National Fish and Wildlife Foundation's (NFWF) Gulf Environmental Benefit Fund was established in early 2013 as a result of two plea agreements resolving the criminal cases against BP and Transocean after the 2010 Deepwater Horizon oil spill. The agreements direct a total of $2.54 billion to NFWF over a five-year period. The funds are to be used to support projects that remedy harm to natural resources (habitats, species) where there has been injury to, or destruction of, loss of, or loss of use of those resources resulting from the oil spill. Projects are expected to occur within reasonable proximity to where the impacts occurred, as appropriate. An announcement from the Alabama governor in late 2017 stated that $33 million in funding for five restoration and conservation programs had been obtained. These projects were funded through the NFWF (Wingard 2017). The NFWF has several ongoing projects in Coastal Alabama.

- Little Dauphin Island Restoration Assessment

This project funds a study of both nearshore and onshore restoration options for a future project to enhance and protect Little Dauphin Island. Little Dauphin Island is included in the Bon Secour National Wildlife Refuge and is an important nesting and foraging area for several coastal bird species, including several imperiled shorebird species (NFWF 2018a).

- Salt Aire Shoreline Restoration

This project is located on the previously acquired 233-acre Salt Aire property. It proposes the protection of degraded shoreline and restoration of 30 acres of coastal marsh on the western shore of Mobile Bay. Part of this restoration will be the construction of wave attenuation structures and the beneficial use of dredge material for marsh creation. The 2015 award funded both the acquisition of the property and engineering and design of the requested restoration work. Restoration of the Salt Aire shoreline will be accomplished by placement of approximately 5,600 linear ft of segmented low-profile breakwater structures, and the placement of approximately 150,000 CY of dredge material from an existing nearby placement area, resulting in an estimated 30 acres of restored marsh habitat (NFWF 2018b).

- *Mobile Bay Shore Habitat Conservation Acquisition Initiative*

Phase I of this project involved conserving and protecting coastal habitat through land acquisition in Mobile Bay. Gulf Environmental Benefit Funds were utilized to perform the necessary due diligence activities to inform future acquisition and management of several tidal marsh habitats within the jurisdiction of the City of Mobile. Specific priorities included restoring and conserving habitats which support estuarine and marine fisheries and wildlife, including, up to 300 acres of riparian, wetland, and upland habitats in the Dog River Watershed (Perch Creek) near its connection to Mobile Bay; up to 40 acres of bay shore property in the Garrows Bend Watershed connecting to Helen Wood Park on the mouth of Dog River; and up to 450 acres in the lower reaches of the Three Mile Creek Watershed, which will advance the recommendations of the Three Mile Creek Watershed Management Plan. Work to be completed during Phase I included site-specific assessments of the ecological value and net environmental benefit of protecting identified coastal habitats; real estate due diligence on key parcels; and preliminary restoration and long-term management planning for priority parcels (NFWF 2018c).

Phase II of the Mobile Bay Shore Habitat Conservation and Acquisition Initiative will acquire, restore and preserve intact high-priority, undeveloped properties within three specific areas of the City of Mobile. These three priority intertidal habitat areas include riparian, wetland and upland habitats that are used by a variety of fish and wildlife species injured by the Deepwater Horizon oil spill (NFWF 2018d).

- Dauphin Island Bird Habitat Acquisition and Enhancement Program

This project will enhance coastal bird habitat along one mile of recently restored beach that is immediately adjacent to a 200-acre bird sanctuary on Dauphin Island. Activities include sand fencing, dune plantings, signage, stewardship, and, if necessary, additional sand placement. The funding is intended to acquire and enhance important bird habitats on Dauphin Island to benefit shorebirds, wading birds and seasonal migrants. Part of the plan is the acquisition of an estimated 13 acres of undeveloped habitat to protect critically important migratory stopover habitat and facilitate management of contiguous blocks of conservation lands. Lands acquired through this project will be deeded to and managed by the Dauphin Island Bird Sanctuary (DIBS). DIBS will also undertake prescribed fire and invasive species management to enhance the ecological value of these newly-protected habitats (NFWF 2018e).

- Bon Secour National Wildlife Refuge Acquisition

This project proposes the acquisition of a 251-acre property on the Fort Morgan Peninsula that has been identified as a high conservation priority in the state of Alabama. The parcel will be deeded to the USFWS for inclusion and management within Bon Secour National Wildlife Refuge. The property represents an important priority area within the authorized acquisition boundary of the Refuge and includes scrub/shrub, pine flatwood, saltwater marsh, and tidal creek habitats, with permanent and semi-permanent wetlands scattered across the parcel (NFWF 2018f).

Previously funded projects include:

- *Enhanced Fisheries Monitoring in Alabama's Marine Waters,* Phase I (2014), Phase II (2015), Phase III (2016)
- Fowl River Watershed Restoration: Coastal Spits and Wetlands Project – Phase I (2016)
- Lightning Point Acquisition and Restoration Project – Phase I (2016)
- Bon Secour - Oyster Bay Wetland Acquisition Project (2016)
- Dauphin Island Conservation Acquisition (2016)
- Gulf Highlands Conservation Acquisition (2016)
- Alabama Coastal Bird Stewardship Program (2016)
- Grand Bay Acquisition (2015)
- Mobile County Conservation Acquisition (2015)
- Alabama Artificial Reef and Habitat Enhancement (2015)
- Alabama Barrier Island Restoration Assessment (2014)
- Coastal Habitat Restoration Planning Initiative (2014)
- Alabama Marine Mammal Conservation and Recovery Program (2014)
- Restoration and Enhancement of Oyster Reefs (2013)

- D'Olive Watershed Restoration (2013)
- Fowl River Watershed Restoration – Phase I (2013) (NWFW 2018g)

4.5.1.2. Alabama Barrier Island Restoration Assessment

The USGS and the USACE are jointly completing a Barrier Island Restoration Assessment using funding from the NFWF. Hurricanes Ivan (2004), Katrina (2005), Isaac (2012) and the Deep Water Horizon oil spill (2010) caused substantial ecological changes on Dauphin Island over the past decade. Additionally, residential and commercial development on the barrier island and the surrounding area have resulted in the loss, degradation, and/or encroachment of natural habitats including wetlands, seagrasses, oyster reefs, beach/dune habitats, and maritime forest. Climatic events, including SLR and frequent storms, continue to erode, degrade, and threaten further loss of these habitats as well as threaten the ecological function of the Mississippi Sound and Heron Bay wetlands on the Alabama mainland (USGS et al. 2017).

The overall purpose of this study is to investigate sustainable options through a feasibility study based on science and technical expertise/evaluation that provides the ability to effectively evaluate the natural resource benefits and impacts of restoration activities and alternatives. The study includes modeling Dauphin Island to evaluate beneficial use options and other sand placement activities and other resilient and sustainable island restoration activities in support of critical habitats and resources. An interim report was issued in 2017 describing accomplishments to date and potential future restoration projects that are being considered. The report focused on seven of the nine tasks funded by the NFWF (USGS et al. 2017). These tasks are summarized below.

- Task 1: Update Baseline Conditions and Trends

The Alabama Barrier Island Restoration Assessment Data Management Team is working on data standardization and organization as well as developing the software tools to aid in the management and visualization of the data pertaining to the study (USGS et al. 2017).

- Task 2: Field Data Collection

The task seeks to provide a comprehensive, high-resolution bathymetric Digital Elevation Model around the island up to water depths of 50 ft. Field data collected during this study includes bathymetric and geologic surveys; wave and current measurements; sediment distribution information; and water quality data (USGS et al. 2017).

- Task 3: Data Analyses of Dauphin Island Shorelines and Habitats

Data analysis of Dauphin Island shorelines and habitats will provide the basis for assessing short-term and long-term shoreline change, island width change, and increases or decreases in vegetated communities along the island. Subtasks include mapping of historical shorelines and the historical extent of broad habitats as well as habitats important to identified species and ecosystem endpoints to help support evaluation of restoration alternatives (USGS et al. 2017).

- Task 4: Existing Volumetric Changes and Sediment Budget Analysis

A sediment budget analysis is being performed to describe recent era sediment gains and losses in the nearshore areas of Dauphin Island and Mobile Pass. Available data from various sources including NOAA, USGS, USACE, and other sources are being used to derive sediment transport pathways and quantities (USGS et al. 2017).

- Task 5: Modelling

A suite of numerical models are being developed for Dauphin Island to provide a quantitative understanding of the processes governing the past and present Dauphin Island barrier system, including the nearshore region adjacent to the barrier island complex. The development of the numerical modeling suite of hydrodynamic, water quality, sediment transport, morphologic, and habitat change is intended to support evaluation of restoration alternatives (USGS et al. 2017).

- Task 6: Alternative Evaluations

The goal of the Barrier Island Restoration Assessment study is to investigate viable options for the restoration of Dauphin Island as a sustainable barrier island to protect and restore island resources, including habitat and living coastal and marine resources, as well as protect the coastal resources of the Mississippi Sound/Mobile Bay and the southern portion of Mobile County including the expansive Heron Bay wetlands. This task consists of two basic components. The first is the identification of viable alternatives/projects that could be implemented in the short-term without needing detailed analysis to meet restoration objectives of NFWF and the State of Alabama. The second task is to identify longer-term, more comprehensive restoration alternatives that will be formulated using the results of this study and technical expertise and will be evaluated using study model results. Potential types of alternatives that could be formulated and evaluated as part of this task include options to beneficially use dredged material for habitat restoration and/or preservation; island beach, platform, and dune restoration; acquisition of critical habitats; and the establishment of wetland and seagrass areas. The first part of this task is complete. Twenty-seven potential Interim Projects were identified and evaluated using criteria developed by the USACE and the State of Alabama. These projects were ultimately divided into three groups depending on how well they met the criteria. Group 1 projects are those that were determined to support the long term resiliency of the island and could be implemented in the short-term without needing additional environmental and/or engineering analyses. Group 2 projects are those that appear to support the long term ecological resiliency of the island but need additional detailed engineering and/or environmental analyses to quantify. Group 3 projects are those that, while they may be beneficial to the island from an economic or recreational standpoint, cannot be further developed as they are outside the environmental restoration scope of this effort (USGS et al. 2017). **Figure 4-7** illustrates the locations and has descriptions of the interim projects that remain under consideration.

Id	Project Name	Project Type	Benefits	Cost
1	Dauphin Island Public Beach and Dune Restoration	Beach and Dune Restoration	Restoration to reduce breaching potential and increase protection of habitat for a variety of unique plant and animal assemblages.	$10,000,000
2	West End Beach and Dune Restoration	Beach and Dune Restoration	Restoration to reduce breaching potetnial and increase protection of habitat for a variatety of unique plant and animal assemlages.	$61,501,000
3	Mid Island Land Acquisition and Management - Phase I	Land Acquisition	Conservation of coastal barrier beach and dune habitat for variety of unique plant and animal assemblages including neotropical birds and wintering migratory species.	$2,500,000
4	Mid-Island Land Acquisition and Management - Phase II	Land Acquisition	Public access to natural resources.	$1,000,000
5	Dauphin Island Audubon Bird Sanctuary Shoreline Restoration & Management	Dune Restoration	Increase protection and habitat for a variety of unique plant and animal assemblages.	$445,650
6	Dauphin Island Audubon Bird Sanctuary Shoreline Restoration & Management	Control Burns and Invasive Species Management	Increase in heathly maritime forrest and beach and dune habitiat types.	$1,079,350
7	Little Dauphin Island Nearshore Placement	Nearshore Placement	Increased sediment supply to Little Dauphin Island complex. Subaerial and subtidal habitats benefiting various wildlife including aquatic and avian species.	$2,850,000
8	Improved Bypassing of Beach Sands Dredged from the Mobile Ship Channel	Sand Bypassing	Increased sediment supply to Sand/Pelican complex. Subaerial and subtidal habitats benefiting various wildlife including aquatic and avian species.	$3,960,000
9	Aloe Bay Beneficial Use Restoration	Saltmarsh Restoration	Restore nursery habitat for aquatic and avian wildlife.	$2,445,000
10	Fill Borrow Pits Dug in 2010 to Protect Against Oil Spill Damage	Restore Dredged Holes	Reduce potential for island breaching and potential associated impacts in the Mississippi Sound. Restore Subaerial and subtidal habitats.	$5,600,000
11	Stormwater Quality Rehabilitation Project	Stormwater Drainage Improvements	Improve the overall health of the estuaries in and around Dauphin Island including fishery and shellfish habitats.	$500,000
12	Aloe Bay/Mississippi Sound Water Quality Enhancement Project - Phase I	Wastewater Treatment Plant Upgrades	Improve the overall health of the estuaries in and around Dauphin Island including fishery and shellfish habitats.	$10,050,000
13	Aloe Bay/Mississippi Sound Water Quality Enhancement Project - Phase II	Wastewater Treatment Plant Upgrades	Improve the overall health of the estuaries in and around Dauphin Island including fishery and shellfish habitats.	$13,050,000
14	Dauphin Island Wastewater Collection System Rehabilitation	Wastewater Treatment Plant Upgrades	Improve the overall health of the estuaries in and around Dauphin Island including fishery and shellfish habitats.	$3,145,000
15	Dauphin Island Water Supply Aquifer Improvements	Water Supply	Reduce the impact on existing water aquifers.	$1,842,000
16	Dauphin Island Water Supply Elevated Storage Tank	Water Supply	Provide adequate water supply to the island.	$3,428,000
17	West End Land Acquisition	Land Acquisition	Conservation of coastal barrier resource land that provides stop over habitat for neotropical birds and critical wintering habitat for migtratory species.	$10,000,000
18	Tupelo Gum Swamp Land Acquisition	Land Acquisition	Conservation of migratory bird habitat that includes brackish ponds that become rich sand flats during low tide, rich interior wetlands and maritime forest.	$700,000
19	Gorgas Swamp Land Acquisition	Land Acquisition	Conservation of migratory bird habitat that includes brackish ponds that become rich sand flats during low tide, rich interior wetlands and maritime forest.	$700,000
20	Steiner Property Acquisition	Land Acquisition	Conservation of migratory bird habitat that includes brackish ponds that become rich sand flats during low tide, rich interior wetlands, and maritime forest.	$600,000
21	US Coast Guard Property Disposal / Acquisition	Land Acquisition	Conservation of coastal barrier beach, dune and shurb habitat that act as buffer to adjacent maritime forests.	$2,500,000
22a	Dauphin Island 39 Parcel Property Acquisition - West End	Land Acquisition	Conservation of coastal barrier back beach, washover fans, and island platform.	$900,000
22b	Dauphin Island 39 Parcel Property Acquisition - Graveline Bay	Land Acquisition	Conservation of marsh and nearshore coastal bay bottoms.	$400,000
22c	Dauphin Island 39 Parcel Property Acquisition - Aloe Bay	Land Acquisition	Conservation of nearshore coastal bay bottoms.	$100,000
22d	Dauphin Island 39 Parcel Property Acquisition - Little Dauphin Island and Bay	Land Acquisition	Conservation of coastal barrier beach, dune and shurb habitat that act as buffer to adjacent marsh and bay systems.	$200,000
22e	Dauphin Island 39 Parcel Property Acquisition - East End	Land Acquisition	Conservation of coastal barrier habitat.	$620,000
23	Dauphin Island Management Support System	Data Collection	Better realization of current and future habitat management efforts.	$1,141,000

Source: USGS et al. 2017

Figure 4-7. The interim projects that remain under consideration as part of the USGS/USACE barrier island assessment project.

- Task 7: Monitoring and Adaptive Management

A feasibility/planning level monitoring and adaptive management (MAM) plan is being developed consistent with the Monitoring and Adaptive Management Plan requirements of the Gulf Environmental Benefit Fund as well as the WRDA of 2007 Section 2039. The MAM plan will be used to determine if the project (when implemented) is meeting intended conservation objectives, and if not, whether adaptive management actions may be warranted. A draft conceptual ecological model diagram and associated documentation was developed to help explain the general functional relationships among the essential components of the Dauphin Island system. The conceptual ecological model represents the current understanding of the Dauphin Island dynamics, drivers, and responses. It will be updated and modified, as necessary, as new information becomes available.

4.5.1.3. USACE Maintenance Dredging

In addition to the maintenance dredging the USACE performs in the Mobile Channel, the USACE also performs maintenance dredging in the Bon Secour River Navigation Project and the Bayou LaBatre Navigation Project (USACE 2017a, USACE 2017b).

The original Bayou LaBatre project was authorized by the 1965 River and Harbor Act. Project improvements were authorized by the WRDA of 1990 and provided for an 18-ft deep by 120-ft wide channel from Pascagoula Ship Channel east along the Gulf Intracoastal Waterway (GIWW) and north of the mouth of Bayou LaBatre; an 18-ft deep by 100-ft wide channel up Bayou LaBatre through and including the turning basin with a transition to a 14-ft deep by 75-ft wide channel to a point 1,500 ft above the US. Highway 188 bridge; and a 14-ft deep by 50-ft wide side channel up the Snake Bayou for 500 ft and then a 12-ft deep by 50-ft wide channel for an additional 850 ft. The total channel length is about 23 miles. The currently proposed activities would consist of maintenance dredging the Bayou LaBatre channel to its authorized project dimensions every 3 to 4 years. The dredged material would be placed in either of eight open water sites adjacent to the channel, or two designated upland sites (USACE 2017a).

The Bon Secour River Navigation Project was federally authorized May 16, 1963 by the Chief of Engineers under authority contained in Section 107 of the River and Harbor Act. The authorized and existing project provides for a channel 10 ft deep and 80 ft wide extending from the GIWW through Bon Secour Bay. From Bon Secour Bay the channel extends up Bon Secour River to the vicinity of Swifts' Landing (lower river section) at a depth of 6 ft and a width of 80 ft to a point about 600 ft above Oak Landing (upper river section). There are two turning and maneuvering areas 150 ft wide and 1,100 to 1,200 ft long opposite Swifts' landing and the ice loading dock. The overall length of the project is approximately 4.7 miles. The project was modified to include a channel 10 ft deep and 80 ft wide extending from the Bon Secour Channel down the south Fork channel, which is a distance of about 1.14 miles and it terminates at a 150-ft by 150-ft turning basin. Each dredging cycle (approximately every 3-5 years) involves removal of approximately 350,000 CY of dredged material. The dredged material is placed into a previously used, certified upland placement area located north and west of the project via a pipeline or mechanical dredge. The placement site is located south of County Road 49 in Township 8 South, Range 3 East, and Section 26. Dredged material may also be placed into the nearby certified open water Placement Area 58 for the GIWW (USACE 2017b).

4.5.2. State and County Projects

4.5.2.1. City of Mobile Infrastructure Plans

The City of Mobile has plans to improve the infrastructure throughout the city. The Capital Improvement Plan, a three-year initiative to plan and implement projects that sustainably fix streets, sidewalks, ditches, parks and other key infrastructure based on the renewal of the 1 percent sales tax. The Capital Improvement Plan involves a commitment of $21 million a year for a total of $63 million over three years (2016-2018). The City maintains a GIS interactive map which reveals the locations, type and funding for all of the planned improvements. Many of these are located within the overall Harbor widening project area. The planned improvements are relatively minor, such as street rehabilitation and trash can locations, and most of them have already been completed (City of Mobile 2016).

4.5.2.2. Alabama Coastal Comprehensive Plan

The Alabama Department of Conservation and Natural Resources has partnered with the USACE – Mobile District, the Mississippi-Alabama Sea Grant Consortium, and the Mobile Bay National Estuary Program to develop a constituent-informed, science-based coastal comprehensive plan to strengthen the economic, environmental, and social resilience of coastal Alabama for current and future generations. Specific Goals of the plan include:

- To reduce the susceptibility of residential, commercial and public infrastructure to storm damages, climate change, and SLR;
- To improve habitats for freshwater, coastal, and marine resources to support commercial and recreational harvest;
- To assist in the restoration of natural and human-made features damaged by erosion or unwise land use or development decisions;
- To promote long-term erosion reduction during future natural hazards; and
- To promote diversification of economies within the two coastal counties as a means of economic resilience from future hazards (Morgan 2016).

Currently, a coast-wide vulnerability assessment is being conducted by the partners to identify future risks due to SLR. During the first phase in the development of the Plan, visioning exercises with various sectors of the coastal communities and the general public were conducted (USACE 2018). Nineteen visioning sessions were conducted in 2015 and comments are still being accepted by the USACE (Morgan 2016).

4.6. Future Actions

4.6.1. Federal Projects

4.6.1.1. I-10 Mobile River Bridge and Bayway Widening

The U.S. Federal Highway Administration (FHA) and the Alabama Department of Transportation (ALDOT) are cooperating on a Bridge and Bayway widening project intended to increase the capacity of Interstate 10 (I-10) to meet existing and predicted future traffic volumes and to provide a direct route for vehicles transporting hazardous materials, while minimizing impacts to Mobile's maritime industry. As of 2010, the Average Annual Daily Traffic (AADT) crossing the Mobile River was 111,334 vehicles. The level of traffic creates a Level of Service of F with delays during peak periods. The predicted AADT for 2030 is 182,445, which would create more congestion and longer delays. Additionally, trucks carrying prohibited hazardous materials must detour off I-10. Currently, they are rerouted through the Mobile Central Business District (CBD), using the Cochrane Africatown Bridge to cross the Mobile River (FHA and ALDOT 2014).

The proposed project is to increase the capacity of I-10 by constructing a new six-lane bridge with 215 ft of Air Draft Clearance across the Mobile River and widening the existing I-10 bridges across Mobile Bay from four to eight lanes. A wide range of alternatives was considered in the Draft Environmental Impact Statement (EIS), including mass transit, Transportation System Management (i.e. ramp metering, Intelligent Transportation Systems, etc.), the No Build Alternative, and four Build Alternatives. Fourteen build alternatives were screened during the decision making process. Alternative B was identified in the Draft EIS as the Preferred Alternative (FHA and ALDOT 2014).

Alternative B would require the widening of I-10 from ten lanes to twelve lanes for a distance of 0.87 miles. The widening would end between the I-10/Virginia Street and the I-10/Texas Street interchanges where the bridge would begin. The eastbound truck acceleration lane on the bridge would have a length of approximately 2,410 ft. The bridge would follow the existing I-10 route to the northeast and would then shift east to cross over the I-10/Canal Street interchange, span the Mobile Harbor Federal Navigation Channel, and tie into the I-10 Bayway approximately 0.88 miles east of the Wallace Tunnels. The bridge would begin approximately 600 ft west of the I-10/Texas Street interchange. The cable-stayed bridge structure approaches would begin at the bank of the Mobile River in Mobile County west of Royal Street. The western pylon would be located in an existing open water area set back from the west side of the navigation channel. The eastern pylon would be located on land. The bridge approach structures would begin approximately 5,500 ft east and west of the navigation channel to achieve required vertical clearance. The bridge would have a main span skew length of 1,250 ft with symmetrical side spans of 725 ft each. Modifications would be required for the Canal Street, Broad Street, Virginia Street, US 98, and US 90 interchanges. **Figure 4-8** shows the locations of all the final build alternatives (FHA and ALDOT 2014).

Significant impacts to resources identified in the Draft EIS included the following:

- Twelve businesses would need to be acquired and relocated for the bridge construction. One quarter of the parking spaces at the Austal USA shipyard facility would be lost due to pylon placement.
- Negative impacts to the maritime industry due to new height restrictions and loss of shipyard space.
- Positive economic impacts due to job creation and tax revenue increases
- Positive economic benefits due to reduction in travel costs, maintenance costs and congestion costs
- Positive economic benefits due to the elimination of the hazardous material detour
- Negative visual impacts on historic properties, historic districts, heritage trails, and tourist areas.

- Positive impacts to tourism due to improved transportation access.

Currently, in order for the project to proceed, the Draft EIS must be finalized and approved, the Record of Decision published, and funding and Right-of-Way acquisition must be accomplished (ALDOT 2018a). However, ALDOT continues to move forward with the project, announcing on February 6, 2018 that three design-build-operation management teams had been selected to respond to the Request for Proposals issued by ALDOT (Best 2018).

4.6.2. State and County Projects

4.6.2.1. Mobile Civic Center Redevelopment

The City of Mobile announced plans to redevelop the aging Civic Center in the CBD. Suggested plans include remodeling the existing facility, a baseball stadium, an arena and theater with parking, and some combination of townhomes and retail space. The objective of the redevelopment is to connect that portion of the CBD to the water front and the Lower Dauphin (LoDa) District. The City hopes to have a developer chosen with the design phase starting in 2019 (Knowles 2018).

4.6.2.2. Transportation Projects

The ALDOT has a variety of transportation projects planned and in progress throughout Mobile and Baldwin Counties. Some of the larger projects are discussed below.

The ALDOT is planning a new interchange at I-10 and SR 181. This new interchange, known as the Diverging Diamond Interchange, will be the first one in Alabama. The Diverging Diamond Interchange is designed to improve traffic flow efficiency and safety with fewer traffic lights and safer entry and exit lanes to and from I-10. The improved traffic flow with fewer conflict points is proven to reduce accidents and increase safety of motorists. The ALDOT estimates that construction would begin in the summer of 2018 (ALDOT 2018b).

Several improvement and rehabilitation projects are planned for I-10 in Mobile County. The I-10 East tunnel bridge interchange will be rehabilitated, the I-10 bayway will be widened from Broad Street to the county line, the I-10 interchange from Texas Street to the west tunnel will be modified, the interchange at I-65 and CR-41 will be modified, and I-65 from Main Street to SR-158 will be resurfaced (ALDOT 2016).

ALDOT has continued working to complete designs, secure environmental clearances and purchase right-of-way to resume construction of the SR-158 extension that will connect to the new US-98 that is partially completed. ALDOT is now able to move forward with the US-98 and SR-158 project plans for constructing a two-lane facility from Schillinger Road to the Mississippi State Line. Construction will resume beginning with the Big Creek Bridge extension project that was let to bid in June 2017. Subsequent projects to complete the route will be constructed as six separate projects, with the next section beginning east of Lott Road to Schillinger Road. Construction was scheduled to begin September 2017 and is expected to be completed in approximately 4 to 6 years. The project scope will include building the foundation and performing the earthwork for four lanes, paving two lanes and creating interchanges. ALDOT

Source: FHA and ALDOT 2014

Figure 4-8. The four alternatives for the I-10 Bridge and Bayway widening project from the Draft EIS will pursue the ultimate divided four-lane design with fully functional freeway type interchanges as funding becomes available (ALDOT 2018c).

4.6.3. Local and City Projects

4.6.3.1. Waterway Village Multimodal Access Project

The Waterway Village Multimodal Access Project is located in Gulf Shores, Alabama. The City of Gulf Shores applied for a 2017 TIGER grant to construct a new access corridor to the Waterway Village District. The proposed project will include the construction of transportation infrastructure that is required for economic development within the Waterway Village District, as well as provide alternative transportation routes in and out of the City of Gulf Shores that will improve safety and traffic congestion. The Waterway Village District Master Plan was developed to establish the framework to spark a year-round economic driver that operates in any weather and in the event of a natural or human-caused disaster. The Gulf Shores Waterway Village Multimodal Access project is vital to the overall success and implementation of the Waterway Village District Master Plan. The alternative modes of transportation proposed will reduce congestion and provide residents transportation options to access the economic center of the proposed Waterway Village District. In addition, the proposed transportation improvements will provide multimodal access to hundreds of acres of undeveloped property and to the proposed commercial airport terminal that is planned for Jack Edwards National Airport.

The funding requested in the 2017 TIGER application will provide the additional resources needed to complete the Waterway Village District transportation improvements that are vital to the local and regional economy. In February, 2016 the City of Gulf Shores and the ALDOT initiated the conceptual design and environmental corridor study for the proposed Waterway East Boulevard improvements. The conceptual design and the environmental corridor study are now complete with environmental permits from the USACE issued in 2017. The State Highway 59 improvements include converting the existing paved shoulder to an additional south bound travel lane across the intracoastal canal to provide improved access to the Waterway Village District from State Highway 59 and alleviate safety and congestion problems that currently exist. In addition, the north bound bridge over the intracoastal canal will be retrofitted to include a cantilevered pedestrian walkway outside of the concrete barrier. The Waterway East Boulevard improvements will include rehabilitating existing transportation infrastructure to include bicycle lanes and sidewalks. Water, sewer, power, and telecommunication utilities within this corridor will be upgraded to meet the demand of the proposed economic growth planned for this area of the Waterway Village District. The proposed Waterway East Boulevard Extension new roadway will provide lacking connectivity between State Highway 59 and County Road 4/Foley Beach Express. This segment is vital to the economic growth within the district because it provides access to the Jack Edwards National Airport, Gulf Shores Business and Aviation Park, and Coastal Resort Properties land that is planned for development and currently lacks necessary transportation infrastructure to support the planned growth and development (City of Gulf Shores 2017).

4.6.3.2. Gulf Place Revitalization

The Gulf Shores public beach-front area at the terminus of Highway 59 and Beach Boulevard is one of the City’s most prominent locations and is the center of economic activity for the community. The property currently offers a variety of activities that range from active to passive beach- and water-based recreation. The location is home to festivals and sports events, and provides access to dining, shopping, and other tourism-supported businesses. Annual events held at the public beach attract over 350,000 visitors and generate an estimated regional economic impact exceeding $100,000,000. The City has developed a master plan for redevelopment of the beach-front area known as 'Gulf Place'. The overall vision of this comprehensive plan is to develop the public beach area into a safe, accessible, family-friendly destination that serves different activities and acts as a catalyst for economic development. The project will create public beach access areas with associated amenities and parking on the east and west sides of the City's public beach area. Amenities will include a public boardwalk on the beachside of the parking areas and public green space, walking paths, shade structures, restrooms, and attractive landscaping (City of Gulf Shores 2018).

4.6.3.3. Three Mile Creek Walking Trail

The City of Mobile, Alabama, has applied for funds from the Alabama Department of Economic and Community Affairs to undertake a project known as Three Mile Creek Walking Trail for the purpose of construction of a new 1.7 mile trail segment including sidewalk trail, fitness circuit/parcourse, lighting, benches, and educational/interpretive signage for $386,525 on the North side of Three Mile Creek from Pecan Street on the East to West Ridge Road on the West (City of Mobile 2018).

4.6.4. Private Projects

4.6.4.1. Toyota and Mazda Plant in the Huntsville area

Toyota and Mazda have announced plans to construct an auto plant in the Huntsville area. Although Huntsville is far distant from the project area, there is speculation that imports and exports of raw materials and cars through the Port of Alabama may increase (Specker 2018).

4.6.4.2. Walmart Import Distribution Center

Walmart recently completed the construction of a 2.5 million-square-ft distribution center just outside Mobile. Products were scheduled to begin arriving at the center in June and distribution was set to begin in July 2018, with a Grand Opening in August 2018. The center is expected to create approximately 600 jobs (Donnel 2018).

4.6.4.3. Bombardier/Airbus Partnership

Bombardier and Airbus have formed a partnership in order to build C-series airplanes in Alabama. A trade dispute filed by Boeing was ruled on in January. The decision allows for C-Series planes Bombardier produces in Canada to be sold to Delta Air Lines in the U.S. without additional tariffs. That decision also freed Bombardier and Airbus to construct the planes in the U.S. Although Bombardier and Airbus are still negotiating the terms of the partnership, long term plans include the construction of an additional assembly line, which would result in the creation of approximately 500 new jobs (Tomberlin 2018).

4.7. Cumulative Impact analysis

4.7.1. Geology, Soils and Sediments

Relevant past, present, and reasonably foreseeable future projects that have the potential to result in cumulative effects on geology, soils and sediments associated with the incremental effects from the proposed Mobile Harbor channel improvements include:

- Harbor Construction and Improvements-Navigation Channel and Turning Basin Dredging (past and ongoing),
- I-10 River Bridge and Bayway Widening (expected construction start in 2019),
- Selected National Fish and Wildlife Foundation (NFWF) projects - Salt Aire Shoreline and Little Dauphin Island Restorations (future),
- USGS/USACE joint restoration project at Dauphin Island (assessment studies are in progress),
- USACE maintenance dredging of Mobile Harbor Ship Channel, Bon Secour River and Bayou LaBatre (future), and
- Port of Mobile APM Terminal Expansion (expected completion in 2019).

Mobile Bay is a geologically young estuary and within the southernmost extent of the Alabama Coastal Plain consisting of Miocene, Pliocene, Pleistocene, or younger sediments forming a wedge of seaward thickening sedimentary deposits. The Bay is a submerged river valley system and receives sediment from Mobile-Tensaw River system and Mobile Delta. Sediment is comprised almost entirely of silt and clay. Most of the transported sediment not retained in the Bay discharges through Mobile Pass and to a much lesser extent through Pass aux Herons.

4.7.1.1. Geology

Miocene sediments consist mainly of laminated to thinly bedded clays, sands, and sandy clays overlain by the Pliocene and Pleistocene units. The Pleistocene and middle Miocene units are alluvial materials and terrace deposits of interbedded sands, silts, gravel, and clays and represent the freshwater aquifer zones. The Miocene-Pliocene aquifer system is the source of public water supply and heavily utilized for domestic, agricultural, and recreational purposes in Baldwin County. Public supply wells generally are between 100 and 300 ft deep (USGS, 1996). The surficial aquifer system is divided into three distinct units: the upper Beach Sand aquifer unit (Bay floor to 54 ft in depth), the Miocene-shallow Pliocene aquifer unit (to 150 ft), and the lower Deep Miocene aquifer unit (to 300 ft) (Margulet and Tick, 2008). The surficial aquifer is unconfined, the middle aquifer is semi-confined, and the lower aquifer is confined and is not connected to the upper two aquifers. Saltwater intrusion is indicated for the upper two aquifers. Saltwater intrusion was not confirmed in the lowest aquifer.

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 Highway 90 causeway. Any incremental addition contribution to shoreline alternation from implementation of the RP would be minor and would not result in cumulative geology impacts.

4.7.1.2. Soils

Sediment in Mobile Bay consists of sand to clays with various mixtures of sand, silt, and clay covering most of the Bay bottom. Upland soils surrounding the project area are classified as Urban Land soils with LaFitte Muck soils. Upland soils would not be affected by the RP and would not contribute to incremental effects from RP implementation.

4.7.1.3. Sediments

Sediment of the lower Bay consists mostly of fine-grained material, while sediment near the mouth of the Mobile River is more coarse-grained with more sand present. The surficial sediments of the lower bay are primarily estuarine silty clay and clay, while sediments of the upper bay are comprised of deltaic deposits of sand, silty sand, silts and clayey silts. Oyster reefs and shell deposits occur in isolated portions of Mobile Bay. Resuspension of deposited sediments by wind is a common occurrence in the Bay, and sediments also are re-suspended by vessel and boat traffic and navigation channel maintenance and open-water placement.

The Mobile Delta shoreline releases accumulated sediment. Erosion occurs primarily along the banks of the major river channels. The western shoreline of Mobile Bay has experienced persistent erosion, whereas the eastern shoreline has not experienced substantial erosion.

A cumulative impacts analysis of vessel generated wave energy (VGWE) effects on Mobile Bay shorelines was completed at three representative locations along the western shore. One of these locations indicated a possible correlation between shoreline change rates and vessel calls from 1957 till approximately 1997, and no correlation at all sites between 1997 and present. Because there was no correlation found at any of the sites since 1997 and VGWE associated with the recommended plan is expected to be reduced (Allen, 2018), the present and foreseeable cumulative impacts of VGWE on Mobile Bay shorelines are considered not significant. A detailed report of the analysis on VGWE and associated cumulative impacts is included as Attachment A-4, Appendix A.

Historical channel dredging records show that maintenance dredging in Mobile Bay navigation channel has been consistent since about 1913, regardless of channel depth, width, and changes in dredged material placement. Monitoring and modeling of open-water, thin-layer placement areas has shown that sediment removed from the navigation channel has finer grain size, and when placed in thin-layer placement areas is less erodible than native bay bottom. Sediments eroded from designated placement areas is transported and deposited in the navigation channel and remaining material becomes re-suspended and widely dispersed throughout the Bay by wind, river, and tide-driven currents and returned to the Bay's natural sediment transport system (ERDC, 2014).

Testing of sediment from the Mobile Bay navigation channel, including bulk sediment testing, elutriate testing, water column bioassays, and bioaccumulation studies, showed that the sediment met the Limiting Permissible Concentration (LPC) for water quality, toxicity, and bioaccumulation (USACE, 2014).

4.7.1.4. Shoaling Rates

4.7.2. Marine Sanctuaries, Protected Managed Lands, and Impoundments

Relevant past, present, and reasonably foreseeable future projects that have the potential to result in cumulative effects on Marine sanctuaries, protected managed lands and impoundments associated with the incremental effects from the RP include:

- Harbor Construction and Improvements-Navigation Channel and Turning Basin Dredging (past and ongoing),
- Selected NFWF projects (future),
- USACE beneficial use dredge materials placement (ongoing),
- USACE maintenance dredging of Mobile Harbor Channel, Bon Secour River and Bayou LaBatre (future), and
- The Alabama Coastal Comprehensive Plan (in progress).

There are no National Marine Sanctuaries in the Mobile Bay area. Essential Fish Habitat (EFH) does exist in Mobile Bay and is discussed in Sections 2.6.5 and 3.8.5. The entirety of Mobile is managed by the Gulf of Mexico Fisheries Management Council (GMFMC) for a total of 21 species. The GMFMC and their Fishery Management Plans are also discussed in Section 3.8.5.

In 1995, Mobile Bay was designated a National Estuary by the EPA under Section 320 of the Water Quality Act Amendments of 1987. The designation recognizes the national significance of the Bay and its associated resources. It is one of only 29 estuaries currently in the National Estuary Program. The goal of the MBNEP is “to maintain and promote the wise stewardship of the water quality characteristics and living resource base of the Mobile Bay Estuarine System.” (USACE 2003)

A Comprehensive Conservation and Management Plan was recently adopted (2017). The plan identified land and water uses within the coastal area which have known and deleterious impacts to the coastal zone. The Alabama Coastal Area Management Program (ACAMP) regulates these activities. The ACAMP is authorized to inventory and designate Special Management Areas (SMA) within the Coastal Area. These areas are identified as requiring attention beyond the general provisions of the ACAMP. Certain areas that have been designated as SMAs are further classified as Geographic Areas of Particular Concern or Areas for Preservation and Restoration (APR). ACAMP policies apply to the general public, all levels of government, and others interested in promoting the policies of the ACAMP and/or who submit applications for state permits, federal assistance, federal licenses and permits, or undertake federal development activities or Outer Continental Shelf activities that affect any land or water use or natural resource within the Coastal Area to ensure that activities are undertaken in a manner consistent with the coastal regulations (ADCNR 2017).

Cumulative impacts to the National Estuary may be caused by the various dredging projects in conjunction with the RP. The cumulative impacts would be related to reduction in water quality and changes to sediment loads in Mobile Bay (discussed in Sections 2.4 and 3.5). As these activities would all be regulated by ACAMP, which would help minimize the potential for adverse impacts, cumulative impacts are not anticipated.

As all work conducted during the construction and operation of the RP would be water-based, no protected managed lands would be impacted. Additionally, as all work would be in Mobile Bay, which is estuarine, no impoundments would be impacted by the RP.

No cumulative impacts to marine sanctuaries, protected managed lands or impoundments are anticipated in relation to the RP.

4.7.3. Water Quality

Relevant past, present, and reasonably foreseeable future projects that have the potential to result in cumulative effects on biological resources associated with the incremental effects from implementation of the RP include:

- Harbor Construction and Improvements-Navigation Channel and Turning Basin Dredging (past and ongoing),
- I-10 River Bridge and Bayway Widening (expected construction start in 2019),
- Selected NFWF projects - Salt Aire Shoreline and Little Dauphin Island Restorations (future),
- USGS/USACE joint restoration project at Dauphin Island (assessment studies are in progress),
- USACE maintenance dredging of Mobile Harbor Channel, Bon Secour River and Bayou LaBatre (future), and
- Port of Mobile APM Terminal Expansion (expected completion in 2019).

Mobile Bay receives water and sediment from the Mobile-Tensaw River system. River sediment discharge to northern Mobile Bay enters through the Mobile, Tensaw, Appalachee, and Blakely Rivers. Parts of Mobile Bay are impaired (Section 303(d)) waters due to organic enrichment/low dissolved oxygen and pathogens (Tetra Tech 2012).

4.7.3.1. Dissolved Oxygen and Hypoxia

High organic loading, high bacterial activity related to decomposition of organic matter, and restricted circulation due to stratification of the water column during summer months can cause near-bottom waters of Mobile Bay to be depleted of dissolved oxygen (DO). Depleted DO events (hypoxic-DO <2 mg/L) frequently occur within Mobile Bay with the most frequent and severe oxygen deficiency near the bottom, generally less than one meter above the bottom, when waters become stratified (University of South Alabama 2011). Low oxygen levels are common in western Mobile Bay. Historically, low DO stress was indicated by the mass shoreward movement of aquatic organisms, known as a Jubilee. This phenomenon was present before any significant man-made environmental impact (Tetra Tech 2012). Industrial and municipal wastewater discharges and non-point source discharges contribute to biochemical oxygen demand. Ongoing channel maintenance dredging and open-water placement of dredged material temporarily affects DO levels due to the suspension of organic material.

Adverse impacts from channel improvement and maintenance result from the resuspension of sediment containing organic materials with high biochemical oxygen demand. The resulting effects are transitory and localized to the area of construction activity. Temporary, localized effects also could result from present and foreseeable future projects that would re-suspend bottom sediments or restore nearshore or beach areas by depositing dredged material. However, these projects would not occur at the same location and are unlikely to occur at the same time as construction under the RP. Implementation of the RP is not expected to significantly deplete short-term or long-term DO levels and the effects would be localized. DO is predicted to be well above minimum oyster tolerance ranges and expected to be sufficient in the area of dredging and open water dredged material placement. Restoration of the Relic Shell Mined Area with dredged material may have a local, minor beneficial effect on DO levels. Adverse incremental cumulative effects on DO are unlikely to occur.

4.7.3.2. Fecal Coliform Bacteria

Fecal coliform bacteria presence indicates recent fecal pollution by animals or man. These bacteria can enter surface water through direct discharge of waste from mammals and birds, from agricultural and storm runoff, and from untreated human sewage (ADEM 2004) and are associated with the surface of bottom sediments.

Hydraulic dredging of contaminated sediment suspends bottom material and associated bacteria and can result in increased bacteria concentrations in the water column down-current from the dredging area. Grimes (1980) found that mean turbidity values were directly and significantly related to fecal coliform densities during dredging in the Upper Mississippi River. However, neither turbidity nor bacteriological effects extended far down-current. Effects from past, present, and reasonably foreseeable future projects that would involve suspending bottom sediment in the water column would be transient and localized. Implementation of the RP would result in temporarily suspended sediment and associated bacteria due to dredging and open-water dredged material placement. Any increase in fecal coliform concentrations are expected to quickly dissipate through dilution and settling of particulates. The incremental effect on water quality is expected to be temporary and minor and unlikely to result in adverse cumulative effects.

4.7.3.3. Nutrients

Nutrient concentrations can increase as a result of suspended bottom sediment from dredging and open-water placement of dredged materials. High levels of nutrients can facilitate plankton growth followed by the bacterial decomposition of organic matter that can lead to depleted DO levels. More efficient agricultural methods to compensate for the decline in the availability of agricultural land have increased the use of concentrated fertilizers and herbicides, resulting in excessive nutrient loading to the Bay.

Dredging and placement activities under the RP would release minor amounts of sediment nutrients (i.e., ammonia nitrogen and total kjeldahl nitrogen). Release of sediment nutrients can enhance algal productivity, but reduced light due to increased turbidity inhibits photosynthesis. These effects are temporary and localized and would cease after the construction activity stops or moves to a new location. Temporary, localized effects also could result from present and foreseeable future projects that would re-suspend bottom sediments or restore nearshore or beach areas by depositing dredged material. However, these projects would not occur at the same location and are unlikely to occur at the same time as construction under the RP. Testing of sediment from the Mobile Bay navigation channel including bulk sediment testing, elutriate testing, water column bioassays, and bioaccumulation studies showed that the sediment met the Limiting Permissible Concentration for water quality, toxicity, and bioaccumulation. Minimal changes in water quality are expected from implementation of the RP, and incremental cumulative impacts on nutrients are unlikely.

4.7.3.4. Salinity

A salinity wedge extends from the Gulf along the bottom of the channel and up the Mobile River. Subsequent channel enlargement modified the hydrology allowing more high salinity Gulf water to travel northward increasing the salt wedge intrusion into the Mobile River. The 1980 Final EIS for Mobile Harbor channel improvements (USACE 1980) determined that the upstream boundary of the salinity wedge would remain essentially unchanged, although the lower 5 miles of the Mobile River would be subject to longer period salinity intrusions. Moderate changes in surface and bottom water salinity of the upper Bay were predicted, with a general trend of increased salinities in the upper Bay and greater storage of freshwater in the Bon Secour Bay area as a result of channel deepening. The 404(b)(1) analysis for the Mobile Harbor turning basin determined no significant effects on salinity (USACE 2007). Other past, present, and reasonably foreseeable future projects that do not involve deepening of the channel are not expected to affect salinity. Minimal salinity changes and a potential minor increase in average salinity are expected from implementation of the RP. Transition from saline to freshwater is expected to remain similar to baseline conditions. Relative to the historical effects on salinity distribution from the past channel and harbor improvements, the RP is not expected to result in significant incremental cumulative impact on salinity distribution in Mobile Bay.

4.7.3.5. Temperature

The coastal area of the Gulf of Mexico has a humid, warm-temperature to sub-tropical climate with occasional subfreezing temperatures. Mobile Bay is a shallow estuary with an average depth of 3 meters and subject to wide seasonal variations in water temperature. Water temperatures range from highs of 20-25 degrees Celsius (°C) to lows of 6°C (ice; Tetra Tech 2012).

The existing channel provides a thermal refuge for aquatic organisms during the passing of cold fronts. The Port of Mobile APM Terminal Expansion may have an inconsequential effect on surface water temperature due to shading from the dock expansion. Present and other foreseeable future projects would not be expected to affect water temperatures. Increased depth as a result of implementing the RP would not significantly affect water temperatures in the Bay, and there would be no incremental adverse cumulative effects on water temperature.

4.7.3.6. Turbidity and Suspended Solids

Natural turbidity levels within the Bay are high. Common causes of turbidity are erosion, storm runoff, waste discharges, algal activity, shoreline construction, boat traffic, and suspension of bottom sediments. Turbidity from freshwater input is hydraulically restricted by the barrier islands and morphological characteristics of Mobile Bay. The Bay's shallow depth and mixing from wind, tides and currents, promotes resuspension of sediments.

Turbidity in the immediate vicinity of the dredging, open-water placement, and other past, present, and reasonably foreseeable future construction activities that would disturb bottom sediment would temporarily increase turbidity during the construction. These effects would be localized and transitory. During implementation of the RP, dredging and placement activities would be controlled and monitored so that turbidity would not exceed the state water quality standard of 50 nephelometric turbidity units (NTUs) above background levels outside of a 750-ft mixing zone. Should these conditions be exceeded, the USACE suspends operations and work will not be resumed until turbidity levels return to compliance conditions. Other relevant projects must also meet state water quality standards. Because of the existing depth of the navigation channel, turbidity created by the channel dredging would tend to remain near the bottom of the channel. Any incremental adverse cumulative effects from implementation of the RP would be minor and transitory.

4.7.4. Ground Water

The proposed RP would have no impacts to groundwater, and the selected cumulative projects should not impact groundwater either. However, some of Mobile County and most of Baldwin County obtain potable municipal water from groundwater wells. As populations in the area increase, saltwater intrusion is taking place in coastal Baldwin County (Murgulet and Tick 2007). As populations are projected to continue increasing, in part due to infrastructure improvements which may be associated with the selected projects, saltwater intrusion in coastal communities may increase. The extent of this impact is not analyzable as the accuracy of population projections is unknown and the relationship amongst the RP and other projects to these projections is indefinite.

4.7.5. Biological Resources

Relevant past, present, and reasonably foreseeable future projects that have the potential to result in cumulative effects on biological resources associated with the incremental effects from the RP include:

- Harbor Construction and Improvements-Navigation Channel and Turning Basin Dredging (past and ongoing),
- I-10 River Bridge and Bayway Widening (expected construction start in 2019),
- Selected NFWF projects - Salt Aire Shoreline and Little Dauphin Island Restorations (future),
- USGS/USACE joint restoration project at Dauphin Island (assessment studies are in progress),
- USACE maintenance dredging of Mobile Harbor Channel, Bon Secour River and Bayou LaBatre (future), and
- Port of Mobile APM Terminal Expansion (expected completion in 2019).

No impacts to upland terrestrial resources from the RP are anticipated. The RP would take place within Mobile Harbor and at the ODMDS. New dredged material would be deposited in open water using thin layer placement and placement within the approved offshore ODMDS and SIBUA. No upland placement of dredged material is proposed. Natural hardbottom habitats would not be impacted by the RP because there are no hardbottom habitats within Mobile Harbor or surrounding waters. There would be no incremental cumulative effect from the RP on these resources and cumulative impacts when added to other past, present, and reasonably foreseeable future actions would not occur.

4.7.5.1. Wetlands

No wetland losses are anticipated as a result of the RP. Minimal changes in salinity and water quality are expected, but vegetation would experience acceptable environmental tolerance ranges and growth conditions. There would be no incremental contribution to cumulative impacts on wetlands.

4.7.5.2. SAV

Submerged seagrass beds have historically declined in the Bay due to physical removal of habitat due to deepening of the navigation improvements and shoreline construction leading to increased turbidity in the Garrows Bend area (USACE 2007). No loss of SAV is anticipated for the RP. There are no SAV beds in the vicinity of the project. Within Mobile Bay, SAV occurs primarily along the northern shorelines within the immediate shoreline. Any effect on seagrass productivity from reduced light penetration due to suspended sediments would be minor and temporary. Effects would be localized in the immediate vicinity of the dredging operation and cease when the dredging operation ends or moves to another location. DO would be sufficient and the potential increase in average salinity would pose stress for only three species, Eurasian watermilfoil (an invasive plant species), water celery, and coon’s tail, across the 55 SAV community types present in the project area. Because there would be no loss of SAV due to implementation of the RP, there would be no incremental contribution to adverse cumulative impacts.

4.7.5.3. Essential Fish Habitat (EFH)

EFH in Mobile Bay includes estuarine emergent wetlands, seagrass beds, algae flats, mud, sand and shell substrates, and the estuarine water column. EFH likely exists for red drum, brown shrimp, pink shrimp, and white shrimp in the project area. Of these habitats, SAV is not present in the project area and no wetlands or SAV would be impacted. The RP has the potential to affect substrates and the estuarine water column. Direct effects on shallow bottom substrates would result from channel widening and open water placement of dredged materials. Channel widening would result in relatively minor loss of shallow water habitat. This would be offset by the open water placement of dredged material, especially the restoration of the Relic Shell Mined Area to shallower water habitat that would improve seasonal oxygen depletions.

Salinity distribution in Mobile Bay is dependent upon river flows and tides. High river discharges can reduce surface salinities from 20 parts per trillion (ppt) to near 0 ppt. Salinity is always higher in bottom water. During low flow, saline water can intrude as far as 21 miles upstream in the Mobile River. Minimal changes in salinity and water quality are expected to result from the implementation of the RP.

Other known projects could result in minor loss of substrates and temporary, localized effects on water quality; foreseeable future projects are unlikely to affect salinity distribution. Therefore, there would be no cumulative adverse impacts on EFH.

4.7.5.4. Plankton and Algae

In the immediate vicinity of active dredging, some physical loss of plankton populations could occur and suspended sediments would reduce light penetration for photosynthesis and potentially impair feeding by zooplankton that can adversely affect plankton productivity. Nutrients ccould temporarily increase as a result of suspended sediment from the dredging operation. The effects would be temporary and localized and cease once dredging operations stop or move to new areas. There would be an inconsequential adverse effect on plankton and algal populations and productivity, while an increase in nutrient levels could enhance phytoplankton productivity. Plankton populations have a high turnover rate and can recover in a matter of hours to days. The temporary and localized effects of the RP, along with past, present, and reasonably foreseeable future actions would have no cumulative adverse effect on plankton and algae. Incremental effects on water quality would be temporary and localized, and cumulative adverse impacts on plankton and algae are unlikely.

4.7.5.5. Benthic Communities

Minimal changes in salinity are expected from implementation of the RP. Benthos community transitions from saline to freshwater would remain similar to baseline conditions. Dredging and open water dredged material placement would directly impact benthic invertebrates. Declines in benthic abundance and diversity from dredging and thin-layer placement of dredged material would be temporary. Changes in bed level due to sediment transport in Mobile Bay and on the ebb-tidal shoal and nearshore coastal area are expected to be minimal. Changes in benthic species diversity or abundance can have indirect effects on species such as crabs, fish and birds that prey on benthic organisms. Recolonization would be expected to be completed within one to two recruitment seasons, so no long-term cumulative impacts are expected to occur. Changes in sediment composition at the ODMDS would alter the benthic community, but based on historical data, it is unlikely that permanent or long-term adverse effects would occur.

Other present and foreseeable future projects would result in minor direct loss of non-motile benthic invertebrates, but are not expected to affect salinity distribution or benthic community transitions from saline to freshwater. Significant cumulative adverse effects are not anticipated.

4.7.5.6. Fisheries

Mobile Bay supports a mix of commercially and recreationally important finfish and shrimp species. Commercially important crustacean species include the brown shrimp, pink shrimp, white shrimp and blue crab. Red drum is common in the Mobile Bay area and striped mullet occur throughout the Bay. Oyster harvesting is active in the Bay with most oyster reefs occurring in the lower Bay. Blue crabs are widely distributed throughout the Bay. Past actions associated with navigation channel maintenance and improvements have resulted in minor, temporary adverse effects on fisheries. The RP and some relevant future actions would result in temporary, localized effects on commercial and recreational fisheries in the immediate area of construction activity. Restoration of the Relic Shell Mined Area would likely have a beneficial effect on fisheries by eliminating oxygen deficient conditions. Cumulative, long-term adverse impacts on fisheries are not anticipated.

4.7.5.7. Mollusks

There would be negligible direct adverse effects from the loss of mollusks that do not have the ability to move away from the dredging activity for channel widening, turning basin enhancements, and thin layer placement of dredged material. DO levels would remain well above minimum tolerance levels for oysters at the 13 adult oyster reefs, and salinity would remain within oyster tolerance ranges. There would be no increase in larval oyster flushing out of the Bay. Indirect effects on these filter feeders from increased turbidity and any decrease in plankton prey would be temporary and localized.

Other known and foreseeable future projects could result in minor, direct loss of mollusks that cannot move away from project construction. Recruitment from unaffected areas is expected to occur. Effects from increased turbidity would be temporary and localized. Incremental adverse effects from the RP are not expected to result in significant direct or indirect cumulative effects on mollusks.

4.7.5.8. Crustaceans

Crustaceans are mobile and can seek optimal salinity and water quality conditions. Minimal changes in salinity and water quality are expected as a result of implementing the RP. Transitions from saline to fresh water would remain similar to baseline conditions. Other relevant projects are not expected to impact salinity, and effects on water quality would be temporary and localized. Incremental adverse effects from the RP are not expected to result in significant direct or indirect cumulative effects on crustaceans.

4.7.6. Protected Resources

Federally listed species may occur in the area of the RP. The dredging method proposed is not known to take or harm any federally listed threatened or endangered species (USACE 2012). Therefore, protected species are not likely to be cumulatively affected. Terrestrial wildlife and birds would not be affected by the RP because terrestrial habitat would not be impacted and there would be no upland placement of dredged material. Foreseeable future projects could have a minor, temporary impact on terrestrial wildlife and birds. . Due to lack of suitable habitat and their location in coastal freshwater or nearshore coastal estuarine environments, species other than those discussed below, would not occur in the RP area; these include inflated heelsplitter, Pearl darter, Alabama red-bellied turtle, yellow-blotched map turtle, ringed map turtle, and Mississippi sandhill crane.

4.7.6.1. Fish

No adverse impacts to freshwater, resident estuarine, or marine species are expected due to salinity and only minimal changes in water quality are expected as a result of implementing the RP. Benthic community transitions from saline to fresh water would remain similar to baseline conditions, and impacts on fish due to any changes in the availability of prey would be negligible. Monitoring would be conducted during the RP to protect adverse effects on Gulf sturgeon, and standard surveillance and evasive measures would be employed to protect sea turtles and marine mammals during placement operations at the ODMDS. Execution of other related actions is unlikely to affect Gulf sturgeon that can move away from construction activities. Because of the distance to known populations and the lack of preferred habitat, smalltooth sawfish is unlikely to occur in the project area.

4.7.6.2. Sea Turtles

Sea turtles are mobile and can avoid dredging areas and equipment. Standard surveillance and evasive measures would be employed to protect sea turtles during channel dredging and widening and the placement operations at the ODMDS. There would be no cumulative, adverse impacts on sea turtles from the RP and other relevant actions.

4.7.6.3. Whales

Protected whale species are unlikely to occur in the nearshore project area of the RP or other relevant actions due to shallow waters. Only the North Atlantic right whale and humpback whales may be present in nearshore waters off the Gulf of Mexico and their occurrence is rare. The other threatened or endangered whale species are inhabitants of deeper waters off the continental shelf and are unlikely to be affected by the RP. It is unlikely that whales would be affected by the dredging or construction activities of other relevant projects because of their ability to move away from dredging operations and other construction areas avoiding encounters with construction equipment and materials. There would be no cumulative, adverse impacts on whales.

4.7.6.4. West Indian Manatees

In recent years, the West Indian manatee has become a more common transient migrating from Florida in warmer weather and typically remain close to the coast. Should a manatee be sighted near active dredging or placement operations of the RP, standard manatee construction conservation measures would be implemented. Other relevant project construction activities would abide by requirements to protect manatees. Therefore, no cumulative adverse impact on the West Indian manatee is anticipated.

4.7.6.5. Birds

Federally protected bird species would not be affected by the RP because terrestrial habitat would not be impacted and there would be no upland placement of dredged material. While other relevant projects could result in a minor effect on the habitat required for some protected bird species, upland placement of dredged materials are not anticipated, and these projects would abide by environmental regulations and commitments to protect listed bird species. Therefore, there would be no cumulative adverse impact on federally protected bird species.

4.7.6.6. State Protected Species

State protected bird species would not be affected by the RP because terrestrial habitat would not be impacted and there would be no upland placement of dredged material. While other relevant projects could result in a minor effect on the habitat required for some protected bird species, upland placement of dredged materials are not anticipated, and these projects would abide by environmental regulations and commitments to protect birds. Therefore, there would be no cumulative adverse impact on state protected bird species.

4.7.7. Marine Mammals

The Atlantic bottlenose dolphin, Atlantic spotted dolphin, and spinner dolphin are commonly found along nearshore areas within Mississippi Sound and near the barrier islands. These species can avoid construction areas of the RP and other construction locations of relevant, nearshore, construction projects. Standard surveillance and evasive measures would be employed during the RP to protect marine mammals during placement operations at the ODMDS. Cumulative adverse impact on marine mammals is not anticipated.

4.7.8. Birds

The RP would take place in Mobile Bay and at the offshore ODMDS and SIBUA. No mature upland vegetation or forests would be affected by the RP. Birds would not be affected because terrestrial habitat would not be impacted and there would be no upland placement of dredged material.

4.7.8.1. Shorebirds

Shorebirds would not be affected by the RP because terrestrial and intertidal habitats would not be impacted. There would be no placement of dredged material on beaches or nearshore tidal habitat and there would be no upland placement of dredged material. Relevant and foreseeable future projects that would result in upland or intertidal placement of dredged material for restoration could have a minor, temporary adverse impact on shorebirds. However, the habitat restoration would have a beneficial effect in the long-term. There would be no cumulative adverse effect on shorebirds.

4.7.8.2. Seabirds

There would be no direct or indirect adverse impacts on seabirds. There would be no direct adverse effects from the RP because there would be no upland placement of dredged material to affect potential nesting sites. Some seabirds may indirectly benefit from prey availability resulting from dredging activities and the open water placement of dredged material. Relevant and foreseeable future projects that would result in upland or intertidal placement of dredged material for restoration could have a minor, temporary adverse impact on seabird nesting and foraging habitat. However, the habitat restoration would have a beneficial effect in the long-term. There would be no cumulative adverse effect on seabirds.

4.7.8.3. Migratory Species

The RP would take place in Mobile Bay and at the offshore ODMDS and SIBUA. No mature upland vegetation or forests would be affected by the RP. Birds would not be affected because terrestrial habitat would not be impacted and there would be no upland placement of dredged material. There would be no incremental cumulative impact on migratory bird species. Other migratory species are discussed elsewhere in this section.

4.7.9. Commercial and Recreational Fishing

Relevant past, present, and reasonably foreseeable future projects that have the potential to result in cumulative effects fisheries associated with the incremental effects from the proposed Mobile Harbor channel improvements include:

- Harbor Construction and Improvements-Navigation Channel and Turning Basin Dredging (past and ongoing),
- I-10 River Bridge and Bayway Widening (expected construction start in 2019),
- Selected NFWF projects - Salt Aire Shoreline and Little Dauphin Island Restorations (future),
- USGS/USACE joint restoration project at Dauphin Island (assessment studies are in progress),
- USACE maintenance dredging of Mobile Harbor Channel, Bon Secour River and Bayou LaBatre (future), and
- Port of Mobile APM Terminal Expansion (expected completion in 2019).

Implementation of the RP would accommodate current and anticipated growth in containerized and bulk cargo vessel traffic and improve vessel transit safety.

Mobile Bay supports a mix of commercially and recreationally important species of finfish and shellfish that are present in the Bay throughout all or part of their life cycles. Finfish include red drum, black drum, spotted sea trout, flounder, sheepshead, and stripped mullet, while shellfish include shrimp, blue crab and oysters. Shrimp, blue crab, and mullet are important commercial species, and recreational fishing is a major industry in the Bay area.

4.7.9.1. Fish

Stripped mullet are abundant in shallow Gulf waters and the Bay. Red drum is common in Mobile Bay and exploited by commercial and recreational fisherman to the point that catch restrictions are in place to prevent overfishing. Recreational fishermen use boats, piers, jetties, and shorelines. Access for shoreline fishing is limited along the eastern shore by industrial activities and private properties. Commercial and recreational boats must avoid shipping vessel traffic near the channel, dredges and barges, and other areas of over- or in-water construction in the Bay. Past actions associated with navigation channel maintenance and improvements have resulted in minor, temporary adverse effects on fisheries as will present and foreseeable future projects that take place in or over the water. The RP is expected to result in only temporary, localized effects on finfish resources with no adverse impacts expected from minimal changes in salinity distribution in the Bay. There could be potential temporary localized disruption of fishing activities due to noise and increased turbidity from the dredging operation.

4.7.9.2. Crustaceans and Mollusks

Shrimping is an important commercial fishery both in terms of catch and value. Commercially important species are brown, white, and pink shrimp. Commercial shrimp catches in large part are comprised of brown shrimp. Oyster harvesting and crabbing also are active in Mobile Bay. The majority of oyster reefs are found in the higher salinity waters of southern Mobile Bay. Blue crabs are abundant throughout the Bay, congregating in channels and marine and brackish water marshes. Commercial and recreational boats must avoid shipping vessel traffic near the channel. Past actions associated with navigation channel maintenance and improvements have resulted in minor, temporary adverse effects on shellfish due to loss of non-mobile species that have been offset by recruitment from undisturbed areas of the Bay. Implementation of the RP would have localized temporary effects on shellfish. Mobile species such as blue crab and shrimp can move away from the localized areas affected by increased turbidity, noise or reduced dissolved oxygen levels. Dissolved oxygen levels would remain well above minimum tolerance levels for oysters, and not long-term effects are anticipated. There could be potential temporary, localized disruption of fishing activities due to the dredging operation.

4.7.10. Invasive Species

Relevant past, present, and reasonably foreseeable future projects that have the potential to result in cumulative effects on invasive species associated with the incremental effects from the proposed Mobile Harbor channel improvements include:

- Harbor Construction and Improvements-Navigation Channel and Turning Basin Dredging (past and ongoing),
- I-10 River Bridge and Bayway Widening (expected construction start in 2019),
- Selected NFWF projects - Salt Aire Shoreline and Little Dauphin Island Restorations (future),
- USGS/USACE joint restoration project at Dauphin Island (assessment studies are in progress),
- USACE maintenance dredging of Mobile Harbor Channel, Bon Secour River and Bayou LaBatre (future), and
- Port of Mobile APM Terminal Expansion (expected completion in 2019).

Two plant and two animal invasive species known to occur in the Mobile Bay area are Eurasian watermilfoil (*Myriophyllum spicatum*), water hyacinth (*Eichhornia crassipes*), nutria (*Myocastor coypus*) and cattle egret (*Bubulcus ibis*). The animals, nutria and cattle egret, inhabit wetland and upland areas, respectively, and would not be affected by implementation of the RP. No wetland loss is anticipated and there would be no upland placement of dredged material. Therefore, there would be no potential for incremental cumulative effects on these species.

The plants, Eurasian watermilfoil and water hyacinth are freshwater species known to occur in the Mobile Delta and Mobile Bay areas (USGS 2018a). Eurasian watermilfoil is present in brackish waters of the Mobile Delta tidal creeks, bays and bayous and reaches into Mobile Bay south of the I-10 and 98 bridges. It can spread by transport of plant fragments by boats, other vehicles and water currents. Water hyacinth also occurs in the Mobile Delta in local coastal drainages (USGS 2018b) and is typically found in freshwaters, wetlands, and marshes. It has been recorded in the wetlands of Meaher State Park. This species reproduces seasonally from the growth of daughter plants. Other freshwater invasive species in the Mobile Delta include coon's tail (Ceratophylum demersum) and water celery (Oenanthe javanica; Barry A. Vittor & Associates 2004).

It is unlikely that water hyacinth would be present in the RP area of interest. It is typically found in freshwaters and wetlands. Eurasian watermilfoil could be encountered during construction of the I-10 River Bridge and Bayway widening project and possibly could be encountered in the upper reaches of the RP area of interest. However, it is unlikely that this species would be present in the navigation channel or turning basin that would be deepened under the RP and therefore not subject to distribution to new areas of the Bay. Dredging and open-water placement is not expected to result in the spread of this species. Modeling indicates that Eurasian watermilfoil, coon's tail and water celery may experience stress for short durations because of the minor increase in salinity in some areas. Incremental adverse cumulative effects on invasive submerged aquatic plant species are unlikely.

4.7.11. Air Quality

Relevant past, present, and reasonably foreseeable future projects that have the potential to result in cumulative effects on air quality around the port associated with the incremental effects from the RP would most likely include those closest to the deepening and widening project areas. These projects include:

- Harbor Construction and Improvements-Navigation Channel and Turning Basin Dredging (past and ongoing),
- I-10 River Bridge and Bayway Widening (expected construction start in 2019),
- Selected NFWF projects (future),
- USGS/USACE joint restoration project at Dauphin Island (assessment studies are in progress),
- USACE beneficial use dredge materials placement (ongoing),
- USACE maintenance dredging of Mobile Harbor Channel, Bon Secour River and Bayou LaBatre (future),
- Port of Mobile APM Terminal Expansion (expected completion in 2019), and
- The Alabama Coastal Comprehensive Plan (in progress).

Air emissions due to potential multiple overlapping construction projects in an active stage at the same time may increase, resulting in cumulative impacts. However the cumulative increase in air emissions would be temporary and the adverse cumulative impacts during construction periods would be less than significant.

As described in Section ?, the operational air emissions under implementation of the RP are anticipated to reduce as compared to the No Action Alternative due the mobility improvement at the port and a slight reduction of vessel traffic. Therefore, the cumulative air quality impacts under the operational condition would be less than significant. Consequently, the incremental contribution from implementation of the RP combined with the past, present, and reasonably foreseeable future projects, would not result in significant impacts within the ROI.

4.7.12. Hazardous, Toxic, and Radioactive Waste

Relevant past, present, and reasonably foreseeable future projects that have the potential to result in cumulative effects from hazardous, toxic and radioactive wastes (HTRW) associated with the incremental effects from the RP include:

- Harbor Construction and Improvements-Navigation Channel and Turning Basin Dredging (past and ongoing),
- I-10 River Bridge and Bayway Widening (expected construction start in 2019),
- USACE beneficial use dredge materials placement (ongoing),
- USACE maintenance dredging of Mobile Harbor Channel, Bon Secour River and Bayou LaBatre (future), and
- Port of Mobile APM Terminal Expansion (expected completion in 2019).

The implementation of the RP would not generate any HTRW, and it is not expected that dredging / placement activities would encounter any HTRW during operations. None of the other selected projects would generate any HTRW during construction. Therefore, no direct cumulative impacts from HTRW are anticipated with respect to the RP.

Potential cumulative impacts from HTRW are possible due to the other projects selected (not including the RP) because of changing methods of transportation through the Mobile area. HTRW are currently transported through Mobile on either I-65 or I-165 and over the Africatown Bridge. Once the I-10 Bridge and Bayway is complete, trucks carrying these materials would travel over these roads instead of through downtown Mobile and residential neighborhoods. This would represent a beneficial impact due to the reduction of risk of accidents and spills of these materials in a populated area. This has no bearing on the construction or operation of the RP; however, as this would occur only if the I-10 Bridge and Bayway are constructed. The presence or absence of the RP would not influence the transportation of these materials in any way.

Although they are not considered hazardous, nor are they wastes, cumulative impacts from petroleum products are possible in relation to the construction and operation of the proposed RP. While the RP is under construction, the transportation of petroleum products to and from the port would continue as currently because dredging operations would not disrupt port activities; and dredging vessels would move to accommodate passing ships. However, if the I-10 Bridge and Bayway is constructed prior to the completion of the RP, the mode of transportation of petroleum products may change to include the new bridge. After construction, the potential for larger quantities of petroleum products to travel the channels in larger vessels and to be on-/off-loaded in the port exists. Larger quantities of coal may be stored at the port at one time, and barge traffic may increase occasionally. However, as there is no predicted change in the overall annual amount of products shipped or received, this cumulative impact would be insignificant.

4.7.13. Noise

Relevant past, present, and reasonably foreseeable future projects that have the potential to result in cumulative effects on noise levels associated with the incremental effects from the RP would cause a noticeable change in noise levels at any one place when occurring at the same time. These projects would most likely include those closest to the deepening and widening project areas. Examples are:

- Harbor Construction and Improvements-Navigation Channel and Turning Basin Dredging (past and ongoing),
- I-10 River Bridge and Bayway Widening (expected construction start in 2019),
- Selected NFWF projects (future),
- USGS/USACE joint restoration project at Dauphin Island (assessment studies are in progress),
- USACE beneficial use dredge materials placement (ongoing),
- USACE maintenance dredging of Mobile Harbor Channel, Bon Secour River and Bayou LaBatre (future),
- Port of Mobile APM Terminal Expansion (expected completion in 2019), and
- The Alabama Coastal Comprehensive Plan (in progress).

Noise levels in air would be perceived by receptors near the Mobile Port and River Channel. Airborne noise along the Bar and Bay Channels would not be perceived by receptors on land due to the distance.

Airborne noise due to multiple construction projects in an active stage at the same time may increase at a nearby receptor, leading to cumulative impacts. For example, if widening and deepening operations were to occur in the Port at the same time as the APM terminal expansion, noise from both projects would contribute to potential annoyance to residents in the area. These cumulative impacts to noise would be temporary and would only occur if and when the construction activities were in close proximity to each other. If the projects were not concurrent, but sequential, local noise levels perceived would last longer than they would without the RP.

There are residences near the Port and the River Channel to the west of I-10 and to the west of I-165. Due to the proximity of the freeways and the Port, this area already has relatively high noise levels. Noise levels are projected to increase in the future as traffic levels increase over time. The relatively high ambient noise levels in the sensitive neighborhoods and the presence of structures in between residences and the harbor and port facilities that would shield widening and deepening operational noise, cumulative noise increase as a result of the RP would not likely be perceptible to residents in the area. Employees and businesses in the port and harbor would be the only impacted receptors if cumulative noise increases were to occur. Cumulative noise levels would not exceed safety regulations leading to injury or hearing loss. In addition, noise levels could be monitored for the duration of the RP in this area, and mitigation could be implemented to prevent employee injury. Mitigation could include timing operations to not coincide with other construction projects, issuing hearing protection to workers, or moving noise-generating operations away from concurrent projects. Therefore cumulative impacts to airborne noise would not be significant.

Cumulative underwater noise levels could increase in the Bar and Bay Channel areas if multiple projects were to occur concurrently. Projects which might contribute to cumulative noise increases would be water based dredging operations, beneficial use projects, and, potentially, near-shore restoration projects. The risk of injuries to marine mammals may increase with a cumulative increase in underwater noise. This would only occur if several underwater noise sources were to be active at the same time in the same area. Given the relatively low underwater noise levels generated from typical dredging equipment as discussed in Sections 2.14 and 3.16, the cumulative underwater noise impacts would likely be less than significant. However, best management practices (BMP) and monitoring could be considered to ensure marine mammal safety. Mitigation may include noise monitoring, on-board mammal-sighting personnel, restrictions as to how many vessels can operate in close proximity, and general coordination with other projects in the area. With BMP and/or potential monitoring implemented, cumulative underwater noise impacts would be prevented, if necessary.

4.7.14. Coastal Barrier Resources

Relevant past, present, and reasonably foreseeable future projects that have the potential to result in cumulative effects on biological resources associated with the incremental effects from the proposed Mobile Harbor channel improvements include:

- Selected NFWF projects - Salt Aire Shoreline and Little Dauphin Island Restorations (future).
- USGS/USACE joint restoration project at Dauphin Island (assessment studies are in progress), and
- USACE maintenance dredging of Mobile Harbor Channel, Bon Secour River and Bayou LaBatre (future).

The Coastal Barriers Improvement Act (CBIA) of 1990 (P.L. 101-591) is the reauthorization of the Coastal Barriers Resources Act of 1982 (CBRA). The original legislation established the Coastal Barriers Resources System (CBRS) to protect undeveloped barrier islands by limiting Federal expenditures for development.

Section 6 of CBRA (16 U.S.C. § 3505) permits certain federal expenditures and financial assistance within the CBRS after consultation with the USFWS. Federal expenditure is allowable within the CBRS for the maintenance or construction of improvements of existing federal navigation channels (including the Intracoastal Waterway) and related structures (such as jetties), including the placement of dredge materials related to such maintenance or construction. A federal navigation channel or a related structure is an existing channel or structure, respectively, if it was authorized before the date on which the relevant System unit or portion of the System unit was included within the CBRS (USFWS 2017).

OMB's Circular A-11, Section 12.5(s) states that civil works estimates must not include any new federal expenditures or financial assistance prohibited by the CBRA (PL 97-348). In addition, the CBIA (PL 101-591), amending CBRA, requires that the USACE certify annually to Congress and the Secretary of Interior that it was in compliance with the provisions of CBRA, as amended, during the previous fiscal year (USACE 2015b).

4.7.15. Cultural and Historic Resources

Relevant past, present, and reasonably foreseeable future projects that have the potential to result in cumulative effects on cultural resources associated with the incremental effects from the RP include:

- Harbor Construction and Improvements-Navigation Channel and Turning Basin Dredging (past and ongoing),
- I-10 River Bridge and Bayway Widening (expected construction start in 2019),
- USGS/USACE joint restoration project at Dauphin Island (assessment studies are in progress),
- USACE beneficial use dredge materials placement (ongoing),
- USACE maintenance dredging of Mobile Harbor Channel, Bon Secour River and Bayou LaBatre (future), and
- Port of Mobile APM Terminal Expansion (expected completion in 2019.

Prehistoric terrestrial sites exist in very close proximity to the current shoreline. While locating and avoiding submerged sites is probability-based, known terrestrial sites were considered for the effects, both direct and indirect, that the Mobile Harbor project may have on them. Of particular concern to terrestrial sites is the threat of erosion as a result of this project. There is also the threat of damaging or destroying an inundated Paleo or Archaic site.

As the widening and deepening of the channel is proposed to take place in different areas of the bay for cost/benefits/logistical concerns, cultural resources were assessed based on where in the Bay they may be found. Only those marked on a map or chart (Navy, NOAA, Coast Guard, etc.) and/or with some historical documentation that they may be in close proximity to the proposed widening or deepening of the channel were considered.

Due to previous and ongoing dredging and placement activities within the Mobile Harbor Channel, it is highly unlikely that inundated prehistoric sites or intact historic shipwrecks are still present within the area that would potentially be impacted with implementation of the RP.

Even though Mobile Bay (especially the Bay Channel area) is archaeologically sensitive, implementation of the RP is not expected to have any adverse impact on known cultural resources and when combined with the relevant past, present, and reasonably foreseeable future projects is unlikely to result in adverse cumulative effects.

4.7.16. Aesthetics and Recreation

Relevant past, present, and reasonably foreseeable future projects that have the potential to result in cumulative effects on aesthetics and recreation resources associated with the incremental effects from the RP include:

- Harbor Construction and Improvements-Navigation Channel and Turning Basin Dredging (past and ongoing),
- I-10 River Bridge and Bayway Widening (expected construction start in 2019),
- Selected NFWF projects (future),
- USGS/USACE joint restoration project at Dauphin Island (assessment studies are in progress),
- USACE beneficial use dredge materials placement (ongoing),

- USACE maintenance dredging of Mobile Harbor Channel, Bon Secour River and Bayou LaBatre (future),
- Port of Mobile APM Terminal Expansion (expected completion in 2019), and
- The Alabama Coastal Comprehensive Plan (in progress).

Aesthetic resources in the majority of the project area include open water areas along the Bar and Bay Channels, and industrial settings in the Mobile Harbor and 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.

In the Bar and Bay Channels, cumulative impacts to aesthetics could occur if multiple projects were active in the same general area. For example, if the deepening project were to be in progress in the Bar Channel at the same time as a restoration project on Dauphin Island or the Fort Morgan Peninsula. Impacts would consist of additional equipment and vessels in the area causing visual disturbances in a generally open water vista. 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. Additionally, dredging operations are generally done from barges, which have a low profile on the water, and most of the activity is below the surface. Dredges also do not remain in one place for a long time. Adding dredging barges to any number of the potential projects in this portion of the project area would constitute a minor visual intrusion.

In the Mobile Harbor and River Channels, impacts to aesthetics could also occur if multiple projects were active at the same time; for example, the construction of the I-10 River Bridge in combination with dredging operations in the harbor. In this area, impacts due to additional equipment in the vicinity would be less noticeable than in the open water areas. This portion of the study area already has large numbers of industrial equipment and is a transportation hub. Dredging operations would likely appear visually smaller than the equipment needed for the other potential projects. They would be relatively low to the water, and likely hidden by other Port and River Channel structures and the large cargo vessels in the harbor.

Recreational resources in the project area include many parks and waterfront areas in Mobile, and adjacent to the Bar, Bay, and River Channels. Recreational fishing is very popular in the bay in general. Other recreational activities, such as sailing, hiking along the water and other water sports are also common. Cumulative impacts to recreational resources in the project area could occur if more than one project was occurring at one time. Cumulative noise increases due to multiple types of equipment in any one place could impact fish, making them leave the area, reducing the catch. If this were to occur, it would temporary, as dredging operations would not remain in one place for a long time. Also, anglers could move to another location in the Bay temporarily until the fish returned. Visually, large equipment may be able to be seen along the coasts, disturbing hikers and other shoreline activities, but this is unlikely due to the low profile of the dredging barges. Users of the parks in Mobile and other shoreline recreational areas may see additional equipment in the Harbor and River Channel area. However, as this area is highly industrial already, this cumulative impact would be insignificant. Additionally, it is unlikely that port and river channel operations would be visible from recreational areas, they are too far away and the industrial structures would block the view of dredging operations in combination with other projects. Overall, although minor disturbances to recreational activities may occur due to cumulative impacts, these disturbances would be insignificant as they would be short in duration and small in effect.

4.7.17. Socioeconomics

Relevant past, present, and reasonably foreseeable future projects that have the potential to result in cumulative effects on socioeconomics associated with the incremental effects from the RP include:

- Harbor Construction and Improvements-Navigation Channel and Turning Basin Dredging (past and ongoing),
- I-10 River Bridge and Bayway Widening (expected construction start in 2019),
- USGS/USACE joint restoration project at Dauphin Island (assessment studies are in progress),
- USACE beneficial use dredge materials placement (ongoing),
- USACE maintenance dredging of Mobile Harbor Channel, Bon Secour River and Bayou LaBatre (future),
- Port of Mobile APM Terminal Expansion (expected completion in 2019),
- The Alabama Coastal Comprehensive Plan (in progress), and
- ALDOT road projects, the I-10 improvements, the I-10/SR 181 interchange, and the SR 158 extension.

Several of the projects in the project area would result in varying levels of temporary job creation. Implementation of the RP would cause the creation of approximately 72 full time equivalent construction jobs for approximately 36 months. The majority of these workers would be transient workers residing outside of the ROI, as dredging personnel typically travel to the location of dredging work. Local workers would be hired if needed. Therefore, minor beneficial cumulative impacts to socioeconomics could occur in association with the various projects in the vicinity through the creation of additional temporary jobs.

Additional potential minor beneficial cumulative impacts could occur for the local economy in association with the purchase of materials, equipment, and services, and expenditure of wages. There may also be minor cumulative economic stimulus to the community through housing demands and ancillary services supporting the temporary workers and their families. Revenue generated by income tax and sales tax from new temporary workers associated with the construction activities would also benefit the local economy.

Overall, cumulative socioeconomic impacts for the implementation of the RP and maintenance dredging are anticipated to be minor and beneficial.

4.7.18. Environmental Justice

Relevant past, present, and reasonably foreseeable future projects that have the potential to result in cumulative effects on socioeconomics associated with the incremental effects from the RP include:

- Harbor Construction and Improvements-Navigation Channel and Turning Basin Dredging (past and ongoing),
- I-10 River Bridge and Bayway Widening (expected construction start in 2019),
- USGS/USACE joint restoration project at Dauphin Island (assessment studies are in progress),
- USACE beneficial use dredge materials placement (ongoing),
- USACE maintenance dredging of Mobile Harbor Channel, Bon Secour River and Bayou LaBatre (future),
- Port of Mobile APM Terminal Expansion (expected completion in 2019),
- The Alabama Coastal Comprehensive Plan (in progress), and
- ALDOT road projects, the I-10 improvements, the I-10/SR 181 interchange, and the SR 158 extension.

Section 3.23 evaluated the impacts of the project in regard to environmental justice. That analysis concluded that the potential environmental impacts of the proposed facility would be similar to existing conditions in the vicinity. Therefore, overall impacts to environmental justice would be minor.

As described in Subsections 5.13 and 4.2.2, cumulative impacts to noise and transportation are possible due to the projects in the vicinity. However, due to the distances from residences and other potential sensitive receptors, the noise increases would not be perceived as significant and it is unlikely that the additional traffic would negatively impact transportation resources. Additionally, mitigation in the form of coordination between the construction processes could reduce any impacts.

As described in Subsection 5.11 the cumulative effect of all area emitters is anticipated to meet applicable air quality standards. It is unlikely that the implementation of the RP in combination with these other sources would cause local air quality to reach nonattainment levels, resulting in no cumulative impacts.

As described in Subsection 5.12, assuming compliance with BMPs and proper handling and placement procedures, the cumulative impacts associated with hazardous wastes and solid waste would be minor. As described in Subsection 5.19, cumulative impacts to public and occupational health and safety from these projects in conjunction with the proposed action would be minor.

Based on the analyses summarized above, overall, potential cumulative impacts to environmental justice would be considered minor.

4.7.19. Public and Occupational Health and Safety

Relevant past, present, and reasonably foreseeable future projects that have the potential to result in cumulative effects on public and occupational health and safety associated with the incremental effects from the RP include:

- Harbor Construction and Improvements-Navigation Channel and Turning Basin Dredging (past and ongoing),

- I-10 River Bridge and Bayway Widening (expected construction start in 2019),
- Selected NFWF projects (future),
- USGS/USACE joint restoration project at Dauphin Island (assessment studies are in progress),
- USACE beneficial use dredge materials placement (ongoing),
- USACE maintenance dredging of Mobile Harbor Channel, Bon Secour River and Bayou LaBatre (future),
- Port of Mobile APM Terminal Expansion (expected completion in 2019),
- The Alabama Coastal Comprehensive Plan (in progress), and
- ALDOT road projects, the I-10 improvements, the I-10/SR 181 interchange, and the SR 158 extension.

Other large construction projects may also include cumulative impacts to public health and safety, but are not considered here due to the distance between the projects and the RP or the types of projects. For example, although the Gulf Place Revitalization project in Gulf Shores may occur at the same time as the RP, cumulative impacts to health and safety would not be anticipated due to the lack of interactivity the two workforces would have.

Cumulative impacts to public and occupational health and safety could result due to increases in the workforce, leading to increases in statistical probabilities of work-place accidents and injuries; increases in the number of vehicles traveling through the area, including equipment, materials and workers, leading to potential increases in traffic accidents; and increases in emissions due to larger numbers of vehicles and equipment operating in one place.

Workforce training programs can minimize the number of injuries occurring on the job. All of the potential concurrent projects, which would contribute to cumulative impacts to health and safety, would have OSHA-regulated safety plans and training programs. However, a statistical increase in workplace incidents and injuries is still possible due to an increase in the number of construction-related jobs in the Mobile area. Due to the uncertainty of whether the potential projects would occur sequentially or concurrently, the potential increase in accidents on the job is unknowable. Due to workplace training programs and regulations, this possible increase is anticipated to be minor and insignificant.

Increases in the number of traffic accidents due to increased vehicles (personal worker vehicles, equipment, and materials) are also possible if projects were to occur at the same time and place, or nearby. Since little land-based work is anticipated under the RP, most operations during the construction and operation would occur on the water; therefore, cumulative impacts related to traffic would likely be caused by an increased workforce traveling to and from embarkation points along the channels and ports. If traffic congestion related to these worker vehicles is perceived, mitigation could be implemented to relieve congestion and thus reduce the likelihood of additional accidents. Mitigation could include changing shift and/or departure times, designating parking areas for workers, and providing bus service, however, this will most likely not be necessary as an increase of approximately 72 workers for 36 months would not create a significant traffic impact.

During maintenance and operation of the RP an increase in port-related traffic is possible due to the larger vessel sizes which can be accommodated by the deeper channels and harbor. If several other large construction projects were in progress in the vicinity of the port during on- or off-loading, traffic congestion and an increase in accidents could occur. Truck and train traffic could be timed such that it would not interfere with worker or material transportation related to other projects. This mitigation would minimize the potential for increased accidents related to truck and train traffic near the port.

Cumulative increases to emissions which may impact public health and safety are possible if large construction projects are operating in the same place at the same time. Mobile and Baldwin counties are in attainment as far as air quality is concerned. The addition of mobile sources associated with operating construction equipment such as dredging barges, cranes, and earth moving equipment would not be large enough to cause the counties to reach out of attainment status. Minor, local impacts to air quality may occur due to emissions and fugitive dust. However, due to the locations of the projects, mainly in non-residential areas, impacts to air quality would not be significant with respect to public health. Once the construction projects are complete, emissions would return to the current conditions and would not present a cumulative risk to public health.

During construction, increased numbers of barges and other support vessels in the channels and harbor may lead to an increase in accident and spill risk. However, only three additional dredge barges are anticipated, and dredging barges would not be clustered along the channel during construction. Ample room would be available for other vessels to pass the dredging vessels in both the channels and the harbor. Current maintenance operations have the same operating procedures as the proposed RP. Therefore, a cumulative increased risk of accidents on the water would be minimal and insignificant. During operations, large vessels traveling in Mobile Bay could increase the likelihood of accidents as well; however, as the channel would be both deeper and wider, more maneuvering room will be available, resulting in a reduction of accident risk, a beneficial impact.

Although there would not be negative impacts to public and occupational health and safety post construction of both the RP and the proposed I-10 River Bridge and Bayway Widening project, minor increases in congestion during construction of the Bridge and Bayway will likely occur due to blocked lanes and other obstacles. The RP would not contribute to these traffic-related safety issues as all work would be water-based. Currently, all hazardous material and petroleum product-carrying trucks are routed north on I-65 or I-165, traveling through downtown Mobile and the Africatown neighborhood before crossing the Mobile River on the Africatown bridge. Once the Bridge and Bayway are constructed, these hazardous materials and petroleum products could travel over I-10 instead of through commercial and residential neighborhoods. The removal of these vehicles from city streets and smaller roadways would significantly increase public health and safety, by both reducing the number of larger vehicles on small roads and by removing hazardous materials and petroleum products from areas where residents and businesses could be severely impacted by a spill. During operation of the RP, traffic to and from the port may increase periodically due to the larger vessel sizes. This may contribute to negative impacts to public health and safety with respect to traffic and accidents. However, if the I-10 Bridge and Bayway project were to be constructed, the cumulative impacts to public and occupational health and safety would be positive, in that hazardous materials and increased numbers of large vehicles would not be traveling through downtown Mobile and other residential areas.

4.8. Magnitude and Significance of Cumulative Effects

Implementation of the RP 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 RP 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 RP, 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 percent. Impacts to sediment from implementation of the RP 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 (LPC) for water quality, toxicity, and bioaccumulation, and is suitable for open-water placement. Implementation of the RP 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 RP, 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 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-ft 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 percent of available Bay habitat. Permanent loss of habitat would be offset by the benefits of open-water placement and restoration of the Relic Shell Mined Area. 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 RP 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. Future restoration and enhancement projects at Dauphin Island and within and along Mobile Bay are expected to have a cumulative, long-term beneficial effect on ecosystem services and biological resources such as wetlands, aquatic biota, and 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 RP. Further, it is unlikely that future actions would occur at the same time as the RP, 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 RP area. Effects from the RP, 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 RP 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, beneficial use restoration of the Relic Shell Mined Area and SIBUA from deposition of dredged materials, and placement at the ODMDS may be a temporary inconvenience to commercial and recreational fishermen during construction, although 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 RP would result in insignificant cumulative impact on fishery resources.

The Mobile District has determined that the proposed maintenance dredging activities associated with the Mobile Harbor 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 RP would not occur.