WILMINGTON HARBOR 403

DRAFT ENVIRONMENTAL IMPACT STATEMENT

WILMINGTON HARBOR NAVIGATION PROJECT, NORTH CAROLINA

Unique NEPA CEQ ID: EISX-202-00-K7P-1755163795

Prepared by:

United States Army Corps of Engineers, Wilmington District

12 September 2025

Wilmington Harbor 403

Draft Environmental Impact Statement

Lead Agency	U.S. Army Corps of Engineers, Wilmington District
Cooperating Agencies and Roles	National Marine Fisheries Service U.S. Coast Guard U.S. Environmental Protection Agency U.S. Fish and Wildlife Service Military Ocean Terminal Sunny Point
Project Location	North Carolina Brunswick and New Hanover Counties
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Public Comments Must be Received By	November 3, 2025

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Abbreviations

AA1	Action Alternative 1
AA2	Action Alternative 2
AAEQ	Average Annual Equivalent
ACHP	Advisory Council on Historic Preservation
ACS	American Community Survey
ADA	Americans With Disabilities Act
AFSA	Anadromous Fish Spawning Areas
AICP	American Institute of Certified Planners
AIR	Ambient Information Report
AIWW	Atlantic Intracoastal Waterway
ANSI	American National Standards Institute
ASA(CW)	Assistant Secretary of The Army (Civil Works)
BA	Biological Assessment
BCR	Benefit-To-Cost Ratio
BGC	Boys And Girls Club
BHI	Bald Head Island
BO	Biological Opinion
BOEM	Bureau of Ocean Energy Management
BTFA	Brunswick Town/Fort Anderson Historic Site
BU	Beneficial Use
BUDM	Beneficial Use of Dredged Material
CAA	Clean Air Act
CAHA	Cape Hatteras National Seashore
CALO	Cape Lookout National Seashore
CAMA	Coastal Area Management Act
CBRA	Coastal Barrier Resources Act
CBRS	Coastal Barrier Resource System
CEQ	Council On Environmental Quality
CFR	Code of Federal Regulations
CHAT	Comprehensive Hydrology Assessment Tool
CSRM	Coastal Storm Risk Management
CWA	Clean Water Act
CY	Calendar Year; Cubic Yards (lowercase)
CZMA	Coastal Zone Management Act
DMMP	Dredged Material Management Plan
DO	Dissolved Oxygen
DPS	Distinct Population Segments
ECB	Engineering & Construction Bulletin
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
EO	Executive Order

ERDC	Engineer Research and Development Center
ESA	Endangered Species Act
FEIS	Final Environmental Impact Statement
FEMA	Federal Emergency Management Agency
FNP	Federal Navigation Project
FNS	Federal Navigation System
FONSI	Finsing of No Significant Impact
FT	Feet
FWCA	Fish And Wildlife Coordination Act
FWOP	Future Without Project
FY	Fiscal Year
GHG	Greenhouse Gas
GIS	Geographic Information System
GNF	General Navigation Features
HAP	Hazardous Air Pollutants
HAPC	Habitat Areas of Particular Concern
HSI	Habitat Suitability Index
HTRW	Hazardous, Toxic and Radioactive Waste
HU	Habitat Units
IEPR	Independent External Peer Review
IPAC	Information For Planning and Consultation
IPPWC	International Piping Plover Winter Census
LCFR	Lower Cape Fear River
LCFRP	Lower Cape Fear River Program
LD	Lock And Dam
LF	Linear Feet
LR	Letter Report
MBSS	Maximum Bed Shear Stress
MBTA	Migratory Bird Treaty Act
MHHW	Mean Higher High Water
MHW	Mean High Water
MLLW	Mean Lower Low Water
MLW	Mean Low Water
MMPA	Marine Mammal Protection Act
MN	Mean Range of Tide
MOTSU	Military Ocean Terminal Sunny Point
MPRSA	Marine Protection, Research, And Sanctuaries Act
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MSL	Mean Sea Level
NAA	No Action Alternative
NAAQS	National Ambient Air Quality Standards
NC	North Carolina

NCDAQ	North Carolina Division of Air Quality
NCDCM	North Carolina Division of Coastal Management
NCDEQ	North Carolina Department of Environmental Quality
NCDNCR	North Carolina Division of Historical Resources
NCSHPO	North Carolina State Historic Preservation Office
NCUAB	North Carolina Underwater Archaeological Branch
NCWRC	North Carolina Wildlife Resources Commission
NCAC	North Carolina Administrative Code
NCB	North Core Banks
NCSPA	North Carolina State Ports Authority
NED	National Economic Development
NEPA	National Environmental Policy Act
NFIP	National Flood Insurance Program
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NOA	Notice of Availability
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NRHP	National Register of Historic Places
OASACW	Office of the Secretary of The Army for Civil Works
OD	Origin-Destination
ODC	Ocean Dumping Criteria
ODMDS	Ocean Dredged Materials Disposal Site
OGV	Ocean-Going Vessels
OPA	Otherwise Protected Areas
PA	Programmatic Agreement
PBF	Physical And Biological Features
PCE	Primary Constituent Elements
PDC	Project Design Criteria
PE	Professional Engineer
PED	Pre-Construction & Engineering Design
PIANC	Permanent International Association of Navigation Congresses
PINWR	Pea Island National Wildlife Refuge
PM	Particulate Matter
PNA	Primary Nursery Area
POI	Points of Interest
PPT	Parts Per Thousand
QC	Quality Control
ROD	Record of Decision
RQD	Rock-Quality Designation
SARBO	South Atlantic Regional Biological Opinion
SAS	South Atlantic Savannah District

SAW	South Atlantic Wilmington District
SCB	South Core Banks
SERIM	Southeast Regional Implementation Manual
SIP	State Implementation Plan
SLC	Sea Level Change
SMA	Seasonal Management Areas
SMCA	Sunken Military Craft Act
SMMP	Site Management and Monitoring Plans
SPBO	State Programmatic Biological Opinion
TEU	Twenty-Foot Equivalent Unit
TSP	Tentatively Selected Plan
TSS	Total Suspended Solids
TST	Timeseries Toolbox
TWG	Technical Working Group
UCS	Unconfined Compressive Strength
UFGS	Unified Facilities Guide Specifications for Confined Underwater Blasting
UKC	Under Keel Clearance
UMAM	Uniform Mitigation Assessment Method
USACE	United States Army Corps of Engineers
USC	United States Code
USCG	United States Coast Guard
USDOT	United States Department of Transportation
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
VA	Vulnerability Assessment
VOC	Volatile Organic Compound
VWPT	Vessel Wake Prediction Tool
WH	Wilmington Harbor
WHNIP	Wilmington Harbor Navigational Improvement Project
WOFES	Wilmington Offshore Fisheries Enhancement Structure
WQ	Water Quality
WRDA	Water Resources Development Act
YOY	Young of Year

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Foster Sustainability as a way of life throughout the organization.

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Create mutually supporting economic and environmentally sustainable solutions.

Continue to meet our corporate responsibility and accountability under the law for activities undertaken by the USACE, which may impact human and natural environment.

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Leverage scientific, economic, and social knowledge to understand the environmental context and effects of USACE actions in a collaborative manner.

Employ an open, transparent process that respects views of Individuals and groups interested in USACE activities.

PUBLIC REVIEW PERIOD: 19 SEPTEMBER 2025 TO 3 NOVEMBER 2025

HOW TO COMMENT: By Email: WilmingtonHarbor403@usace.army.mil
By Mail: ATTN: Wilmington Harbor 403
69 Darlington Ave.
Wilmington, NC 28403
By Comment Card at the Public Meeting

PUBLIC REVIEW MEETING: 8 OCTOBER 2025 3-7 pm
Cape Fear Community College
502 North Front St
Wilmington, NC 28401

INTRODUCTION: U.S. Army Corps of Engineers (USACE), Wilmington District prepared this draft Environmental Impact Statement (DEIS) in accordance with the National Environmental Policy Act (NEPA), as amended and in accordance with USACE Procedures for Implementing NEPA, found at 33 CFR Part 230. Based on the timing of the Notice of Intent, published on June 7, 2024, the 2020 Council on Environmental Quality NEPA regulations have been applied. The DEIS presents the results of investigations and analyses conducted to evaluate proposed navigation system improvements at Wilmington Harbor, North Carolina.

RESPONSIBLE AGENCIES: The lead agency is the U.S. Army Corps of Engineers (USACE), Wilmington District. The North Carolina State Ports Authority (NCSPA) is the non-Federal sponsor for the effort.

ABSTRACT: This Draft Environmental Impact Statement (DEIS) together with the Draft Letter Report and its other attachments documents the timelines, and process details and presents the results of engineering, economic and environmental investigations and analyses conducted to evaluate potential navigation system improvements at Wilmington Harbor, located near Wilmington, North Carolina.

The draft Letter Report/ EIS identifies the No Action Alternative/ Future without Project, Action Alternative 1 (-47 feet MLLW) and Action Alternative 2 (-46 feel MLLW) as the final array of alternatives. Alternative 1 was conditionally authorized by Congress, through Section 403 of the Water Resources Development Act (WRDA) 2020. The conditional authorization included a requirement to address the issues and concerns identified in the ASA(CW) Assessment Report and conduct an EIS to address National Environmental Policy Act (NEPA) requirements.

Both action alternatives would extend and deepen the entrance channel in combination with deepening and widening the inner harbor channels within the same reaches. The primary difference is that Action Alternative 2 is 1-foot shallower than Action Alternative 1. The difference in depth slightly reduces the width of the side slopes and the length of the entrance channel extension thereby reducing the overall dredging volumes. The DEIS evaluates effects to the full range of cultural, social, and biological resources. The DEIS also documents measures to avoid, offset, or minimizes impacts to resources affected by the proposed action. At the completion of the Wilmington Harbor 403 Letter Report and EIS effort, Congress may fully authorize and potentially fund the improvements. If fully authorized and funded by Congress, subsequent phases of the project would include: Preconstruction Engineering and Design (PED); Construction; and, Operations, Maintenance.

For more information, visit: https://wilmington-harbor-usace-saw.hub.arcgis.com/

DESCRIPTION OF THE SECTION 403 LETTER REPORT AND EIS

The Section 403 Letter Report analyzes the costs, engineering feasibility, benefits and adverse effects associated with various alternatives that address navigational constraints and balances the economic, environmental, and engineering considerations to support a federal decision related to potential channel modifications of the Wilmington Harbor Federal Navigation System (FNS). Attachment 3 of the Letter Report is this draft EIS and the associated appendices for the proposed action.

This DEIS summarizes the results of the 403 Letter Report, presents the detailed analysis of the potential impacts to the human environment, documents compliance with environmental laws, policies and regulations, and describes the public involvement informing this process.

PURPOSE AND NEED

The purpose of the proposed action is to contribute to national economic development (NED) by addressing transportation inefficiencies for the forecasted vessel fleet, consistent with protecting the Nation's environment. Contributions to the NED are increases in the net value of the national output of goods and services. The need for the proposed action is to address the constraints that contribute to inefficiencies in the existing navigation system's ability to safely serve forecasted vessel fleet and cargo types and volumes.

ALTERNATIVES AND TENTATIVELY SELECTED PLAN

The proposed federal action would improve the FNS to address transportation efficiencies and better accommodate the vessel fleet forecasted to serve Wilmington Harbor. The two action alternatives considered in detail would deepen most of the FNS from its current authorized depth of -42 feet MLLW to a new depth of either -47 feet (Alternative 1; AA1) or -46 feet MLLW (Alternative 2; AA2). The tentatively selected plan (proposed action) is AA1 and is the conditionally authorized plan.

For both action alternatives considered in detail, the Entrance Channel would be authorized an additional 2 feet of depth to account for ocean conditions. Furthermore, the proposed Federal action would expand the width of several of the reaches and add an additional reach to the Entrance Channel, referred to herein as Baldhead Shoal Channel - Reach 4. The Entrance Channel extension would be approximately 9 miles long and connect it to the closest naturally occurring desired depth.

Proposed sediment placement areas for both the initial action and operation and maintenance include the Ocean Dredged Material Disposal Site (ODMDS) and various beneficial use placement areas (beaches, bird islands, intertidal marsh restoration, fish habitat enhancement structures, riverbank protection, and back bay marsh restoration). Approximately half of the material dredged for initial construction would be used beneficially rather than disposed of in the ODMDS.

ENVIRONMENTAL IMPACTS AND MITIGATION

A wide range of impacts are described and analyzed in the DEIS. Most are minor, temporary, construction-related impacts associated with dredging and dredged material placement. Two general types of meaningful adverse impacts identified would require compensatory mitigation. They include the direct loss of fish habitat from channel widening and deepening activities and indirect wetland functional impacts associated with shifts in vegetation from increased salinity concentrations within the lower Cape Fear River. Once constructed, the deeper and wider channels would allow more ocean water to mix with the freshwater in the river. Wetlands salt-tolerant vegetation would shift upstream within and somewhat upstream of the deepened reaches of the river system and adjacent wetlands. Although there would be no net loss of wetlands, there would be a loss of freshwater forested wetlands. Along with the adverse impacts, some beneficial effects would be expected. The deepened and widened channels would allow the cargo to be transported on a smaller number of larger and more modern and efficient vessels. In addition to the economic benefits, these transportation efficiencies would result in fewer vessel transits through the harbor yielding beneficial effects such as reduced fuel consumption, air emissions, vessel strikes to animals in the channels and shoreline erosion compared to the No Action Alternative.

To compensate for the loss of aquatic habitat, fish passage improvement projects would be constructed at Lock and Dams 1 and 2 on the Cape Fear River to enable anadromous fish to access quality habitat upstream of those facilities. Proposed compensatory mitigation for changes in wetlands vegetation includes preservation of high-quality forested freshwater wetlands and enhancement of degraded wetlands in the lower Cape Fear River.

SECTION 1 – INTRODUCTION

U.S. Army Corps of Engineers (USACE), Wilmington District has prepared this draft Environmental Impact Statement (DEIS) in accordance with the National Environmental Policy Act (NEPA), as amended and in accordance with USACE Procedures for Implementing NEPA found at 33 CFR Part 230. Based on the timing of the Notice of Intent, published on June 7, 2024, the 2020 Council on Environmental Quality NEPA regulations have been applied. The DEIS presents the results of investigations and analyses conducted to evaluate proposed navigation system improvements at Wilmington Harbor, North Carolina.

1.1 Background

The Section 403 Letter Report analyzes the costs, engineering feasibility, benefits and adverse effects associated with various alternatives that address navigational constraints and balances the economic, environmental, and engineering considerations to support a federal decision related to potential channel modifications of Wilmington Harbor Federal Navigation System (FNS) (Figure 1-1). Attachment 3 of the Letter Report is this draft EIS and the associated appendices for the proposed action. This draft EIS summarizes the results of the 403 Letter Report, presents the detailed analysis of the potential impacts to the human environment, documents compliance with environmental laws, policies and regulations, and describes the public involvement informing this process.

The State of North Carolina, acting through the North Carolina State Ports Authority (NCSPA), completed a feasibility study (Section 203 Report) through the authority of Section 203 of the Water Resources Development Act (WRDA) of 1986 (P.L. 99-662), as amended. The study was conducted to determine the feasibility of potential improvements to the FNS at Wilmington Harbor. The report, recommending deepening the harbor from its current depth of 42 feet below mean lower low water (MLLW) to 47 feet below MLLW, was submitted to the Assistant Secretary of the Army (Civil Works) (ASA(CW)) for review in February 2020. In May 2020, ASA(CW) transmitted the document to Congress for potential authorization with an Assessment Report that identified unresolved issues and recommendations to perform the following work to resolve those issues:

- Reframe assumptions and the screening of alternatives;
- Perform economic analysis for multiple depth alternatives using USACE methodology;
- Conduct NEPA analysis including supporting engineering modeling and appropriate sea level change information;
- Finalize mitigation and real estate plans; and
- Conduct an Independent External Peer Review (IEPR)

Congress conditionally authorized the recommended navigation improvements, at a total cost of $834,093,000, through Section 403 of the Water Resources Development Act (WRDA) of 2020: Authorization of Projects Based on Feasibility Studies Prepared by Non-Federal Interests. The conditional authorization included a requirement to address the issues and concerns identified in the ASA(CW) Assessment Report. In 2022, the USACE Wilmington District was tasked with producing a Letter Report and NEPA document to address those outstanding issues through a cost-shared effort with the NCSPA.

The Section 403 Letter Report documents the results of efforts performed to address the unresolved engineering, economic, environmental and policy comments in the ASA(CW) assessment report. This EIS is an attachment to the Letter report and addresses the need to fulfill NEPA requirements.

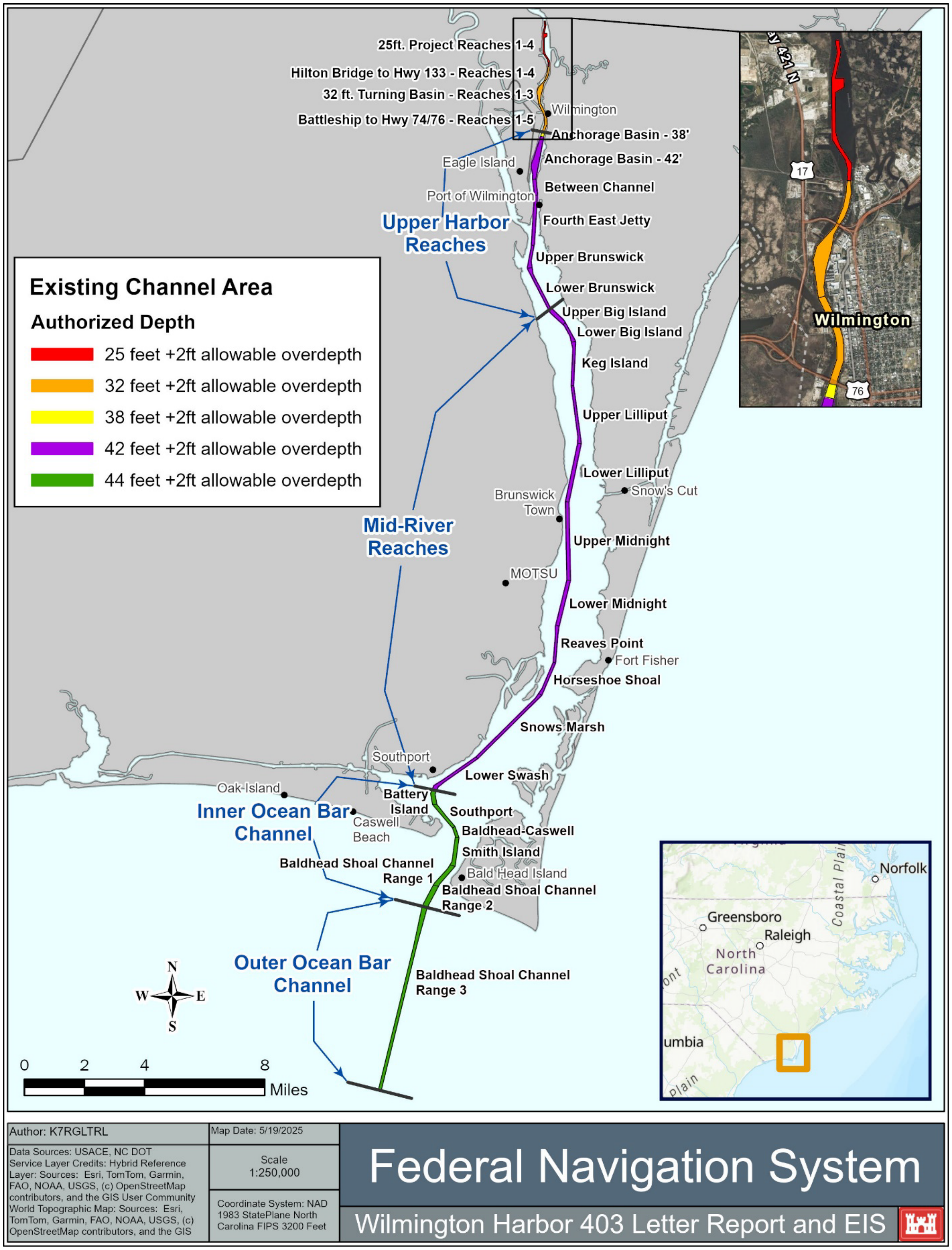

Figure 1-1: Existing Wilmington Harbor Federal Navigation Project and currently authorized depths

1.2 Project Authority

Construction of the FNS to its current dimensions was originally authorized as three separate projects by the Water Resources Development Acts of 1986 (WRDA 86, Public Law (PL) 99-662) and 1996 (WRDA 96 PL 104-303),, The Energy and Water Development Appropriations Act of 1998, PL 105-62, combined the Wilmington Harbor Northeast Cape Fear River Project (WRDA 1986), the Wilmington Harbor Channel Widening Project (WRDA 1996), and the Cape Fear-Northeast (Cape Fear) Rivers Project (WRDA 1996) under a single project known as the Wilmington Harbor 96 Act Project.

The navigation improvements proposed in the Section 203 Report were conditionally authorized by Section 403 of the WRDA of 2020. Congress' conditional authorization of the recommendations from NCSPA's 2020 feasibility study specifies that the Secretary may carry out construction of a specified project only 1) after the concerns, recommendations, and conditions identified in the review assessment for the project have been addressed, and subject to such modifications and conditions as the Secretary considers appropriate and identifies in a final review assessment for the project and 2) the Secretary transmits the final assessment for the project to House Transportation and Infrastructure and Senate Environment and Public Works Committees. In 2022, the USACE Wilmington District received funding to produce a 403 Letter Report and EIS to address those outstanding issues through a cost-shared effort with the NCSPA.

1.3 Proposed Federal Action

The proposed federal action would improve the FNS to address transportation efficiencies and better accommodate the vessel fleet forecasted to serve Wilmington Harbor.

The action alternatives being considered would deepen most of the FNS from its current authorized depth of -42 feet MLLW to a new depth of either -47 feet (Alternative 1; AA1) or -46 feet MLLW (Alternative 2; AA2). In both alternatives, the Entrance Channel reaches would be authorized an additional 2 feet of depth to account for ocean conditions with an additional foot of overdepth dredging where rock is present. Furthermore, the proposed Federal action would also expand the width of several of the reaches and add an additional reach to the Entrance Channel, referred to herein as Baldhead Shoal Channel - Reach 4. The Entrance Channel extension would be approximately 9 miles long and would connect it to the closest naturally occurring desired depth. The extension is illustrated in Figure 1-2. In addition to lengthening and deepening the existing FNS, the proposed action would widen all or parts of most reaches. The proposed changes are summarized in Table 1-1. More detailed description can be found in Section 2.

Proposed sediment placement areas for both the initial action and operation and maintenance include the Ocean Dredged Material Disposal Site (ODMDS) and various beneficial use placement areas (beaches, bird islands, intertidal marsh restoration, fish habitat enhancement structures, riverbank protection, and back bay marsh restoration). Approximately half of the material dredged for initial construction would be used beneficially rather than disposed of in the ODMDS. See Appendix D for additional information and mapping for beneficial use placement.

Table 1-1: Alternative 1 (47-Foot Alternative)

Reach – North to South	Maintenance Segment	Existing Channel Width (Ft)	Proposed Channel Width (**Ft**)	Proposed Authorized Depth (**Ft**)	Proposed Allowable Overdepth[1] (**Ft**)	With Required Rock Overdepth[2] (**Ft**)
Anchorage Basin	Upper Harbor	547-1200	547 - 1509	47	49	50
Between Channel	Upper Harbor	500-550	575-625	47	49	50
Fourth East Jetty	Upper Harbor	450-550	550-575	47	49	50
Upper Brunswick	Upper Harbor	400-775	500-925	47	49	50
Lower Brunswick	Upper Harbor	400-775	500-925	47	49	50
Upper Big Island	Mid-River	540-700	560-700	47	49	50
Lower Big Island	Mid-River	400-700	500-795	47	49	50
Keg Island	Mid-River	400-700	500-795	47	49	50
Upper Lilliput	Mid-River	400-610	500-685	47	49	50
Lower Lilliput	Mid-River	600	600-660	47	49	50
Upper Midnight	Mid-River	600	600	47	49	49 no rock overdepth
Lower Midnight	Mid-River	600	600	47	49	49 no rock overdepth
Reaves Point	Mid-River	400-600	500-600	47	49	49 no rock overdepth
Horseshoe Shoal	Mid-River	400-610	500-710	47	49	49 no rock overdepth
Snows Marsh	Mid-River	400-610	500-710	47	49	50
Lower Swash	Mid-River	400-740	500-1230	47	49	50
Battery Island	Inner Ocean Bar	740	1150 - 1300	49	51	52
Southport	Inner Ocean Bar	500-600	800-1150	49	51	52

Reach – North to South	Maintenance Segment	Existing Channel Width (Ft)	Proposed Channel Width (Ft)	Proposed Authorized Depth (Ft)	Proposed Allowable Overdepth[1] (Ft)	With Required Rock Overdepth[2] (Ft)
Baldhead - Caswell	Inner Ocean Bar	500-650	800	49	51	51 no rock overdepth
Smith Island Channel	Inner Ocean Bar	650-895	900	49	51	51 no rock overdepth
Baldhead Shoal Channel- Reach 1	Inner Ocean Bar	750	750-900	49	51	51 no rock overdepth
Baldhead Shoal Channel- Reach 2	Inner Ocean Bar	900	900	49	51	51 no rock overdepth
Baldhead Shoal Channel - Reach 3	Outer Ocean Bar	500-900	600 - 900	49	51	52
Baldhead Shoal Channel- Reach 4 (Proposed Entrance Channel Extension)	Outer Ocean Bar	N/A	600	49	51	51 no rock overdepth

[1]Proposed Allowable Overdepth includes two feet additional dredging depth allowed (not required) to account for variability in dredging precision and efficiency.
[2]Proposed Total Depth is Authorized Depth plus Required Rock Overdepth of one foot (where rock is present) plus Allowable Overdepth

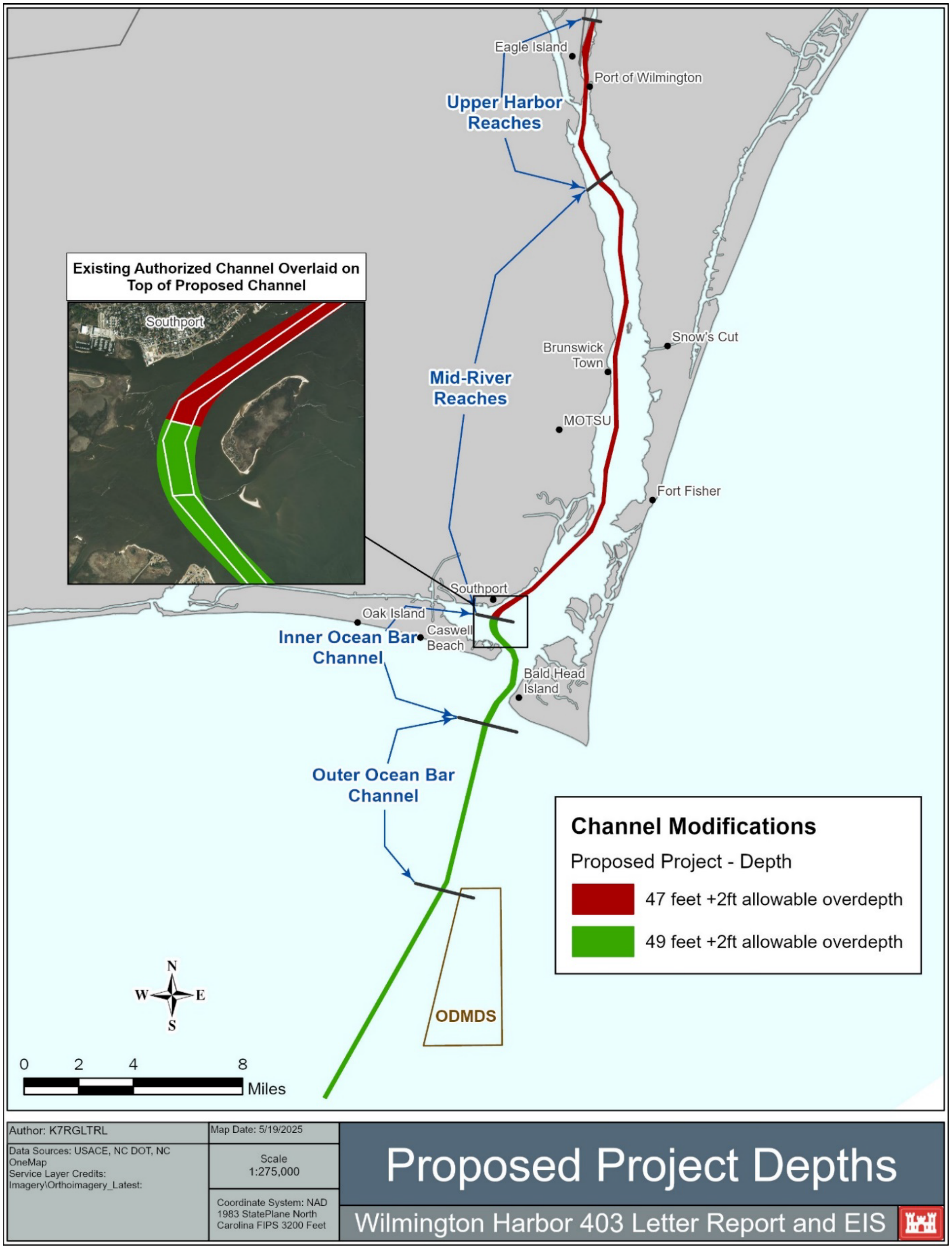

Figure 1-2: Wilmington Harbor Proposed Entrance Channel Extension and Proposed Authorized Depths for Action Alternative 1.

1.4 Purpose and Need for Proposed Action

The purpose of the proposed action is to contribute to national economic development (NED) by addressing transportation inefficiencies for the forecasted vessel fleet, consistent with protecting the Nation's environment. Contributions to the NED are increases in the net value of the national output of goods and services. The need for the proposed action is to address the constraints that contribute to inefficiencies in the existing navigation system's ability to safely serve forecasted vessel fleet and cargo types and volumes.

The marine cargo transportation industry continues to shift to increased use of standardized containers for multimodal (marine, rail, and truck) freight transportation systems. Additionally, the marine vessel fleet is trending to larger, deeper-draft vessels, particularly for containerships. Most of the FNS serving Wilmington Harbor is currently authorized to a depth of -42 feet MLLW (the average lowest daily tide over a 19-year period for the respective area).

Channel depth and width constraints present problems that contribute to inefficiencies under existing conditions. These problems are projected to continue to occur and intensify in the future under without-project conditions as cargo throughput increases, creating more vessel traffic and with larger vessels comprising a greater portion of the vessel fleet. The existing FNS was designed for use by sub-Panamax vessels. Under existing conditions, Panamax and Post-Panamax vessels use Wilmington daily and weekly. Under future conditions, the number and size of Post-Panamax vessels at the port are expected to increase with or without the proposed channel modifications. The various Panamax vessels are described in subsequent sections and shown in Figure .

The primary navigation problems at Wilmington affect bulk and container ship operations. They relate to the inefficient operation of containerships, tankers, and bulkers in the FNS at Wilmington, which affect the Nation's overall waterborne transportation costs and competitiveness. Cargo shippers are experiencing increased operating costs due to light loading, congestion delays, and tidal delays. These inefficiencies will increase in the future as present harbor users increase their annual tonnage throughput and as larger ships that require deeper channels replace older, smaller, and less efficient ships.

1.5 Lead Federal Agency

The USACE is the lead Federal Agency under NEPA. 42 USC §4332 (D)-(F) requires that the lead federal agency:

- Ensure the professional integrity, including scientific integrity, of the discussion and analysis in an environmental document;
- Make use of reliable data and resources; and
- Study, develop, and describe technically and economically feasible alternatives.

1.6 Location and Description of Project

Wilmington Harbor is located in Brunswick and New Hanover Counties in southeast North Carolina. The existing project (Figure 1-1) consists of the Eagle Island Placement Facility, the Wilmington ODMDS, the Upper and Lower Anchorage basins, and approximately 38 miles of Federal navigation channels leading from the ocean, through the existing Entrance Channel to the Cape Fear River and upstream within the Cape Fear River to the Hilton Railroad Drawbridge. This analysis only studies deepening the FNS up to the Cape Fear Memorial Bridge.

1.6.1 Transportation Infrastructure

The Port of Wilmington is approximately 28 miles upstream of the Atlantic Ocean, situated along the eastern bank of the Cape Fear River. The Cape Fear River separates Brunswick County to the west and New Hanover County to the east. Interstate highway 40 connects Wilmington with the state capital Raleigh, and to Interstate 95. U.S. highway 74 connects the port to Charlotte, the state's most populous city.

The Port of Wilmington's hinterland lies primarily within the state of North Carolina. It includes Raleigh, Durham, Greensboro, Fayetteville, and the Wilmington area. The port is connected to the Raleigh-Durham area by Interstate I-40 and to Greensboro by Interstates I-40 and I-73. The primary Port facilities are approximately 75 miles from Interstate I-95 and 200 miles from Interstate I-85, which are the primary north/south transportation corridors through North Carolina. These highways connect the Port of Wilmington to Charlotte, Greensboro, and the Raleigh/Durham metro area. Improvements to Interstate I-74 have added vehicle capacity between the port and I-85, which connects to Charlotte, North Carolina.

Landside transportation to and from the Port of Wilmington is primarily by truck. Trucks must pass through residential areas to reach the interstates. They must traverse Burnett Boulevard (two-lane road) to reach I-74, or Shipyard Boulevard and College Road (four lane bi-directional roads) with a series of stop lights to reach I-40. CSX provides daily rail service to the port via the Queen City and Wilmington Midwest Express services. The rail route is through the City of Wilmington and crosses many of the city's major roads; most crossings within the city are at-grade.

The Wilmington Harbor FNS provides deep draft access to Military Ocean Terminal Sunny Point (MOTSU), commercial liquid and dry bulk terminals, and to the terminals at the Port of Wilmington. The following paragraphs describe the commercial terminals and the Port of Wilmington greater detail. Although the FNS's support to military activities at MOTSU contributes to national security and the national economy, details related to activities at MOTSU are not provided and the associated benefits are not included in the economics analysis because the vessels serving those terminals don't typically utilize the full depth of the channel and the transits cannot be reliably forecasted.

1.6.2 General Setting

Wilmington Harbor is within both New Hanover County and Brunswick County boundaries (1-3) Both counties have natural beaches, settlements on the Cape Fear River, and stretches of the Atlantic Intracoastal Waterway (AIWW). Brunswick County is the southernmost county in the state as well as the sixth largest by land.

Brunswick County is approximately 1,049 square miles with beaches spanning over 45 miles of coastline. New Hanover County is approximately 328 square miles, including 31 miles of beaches.

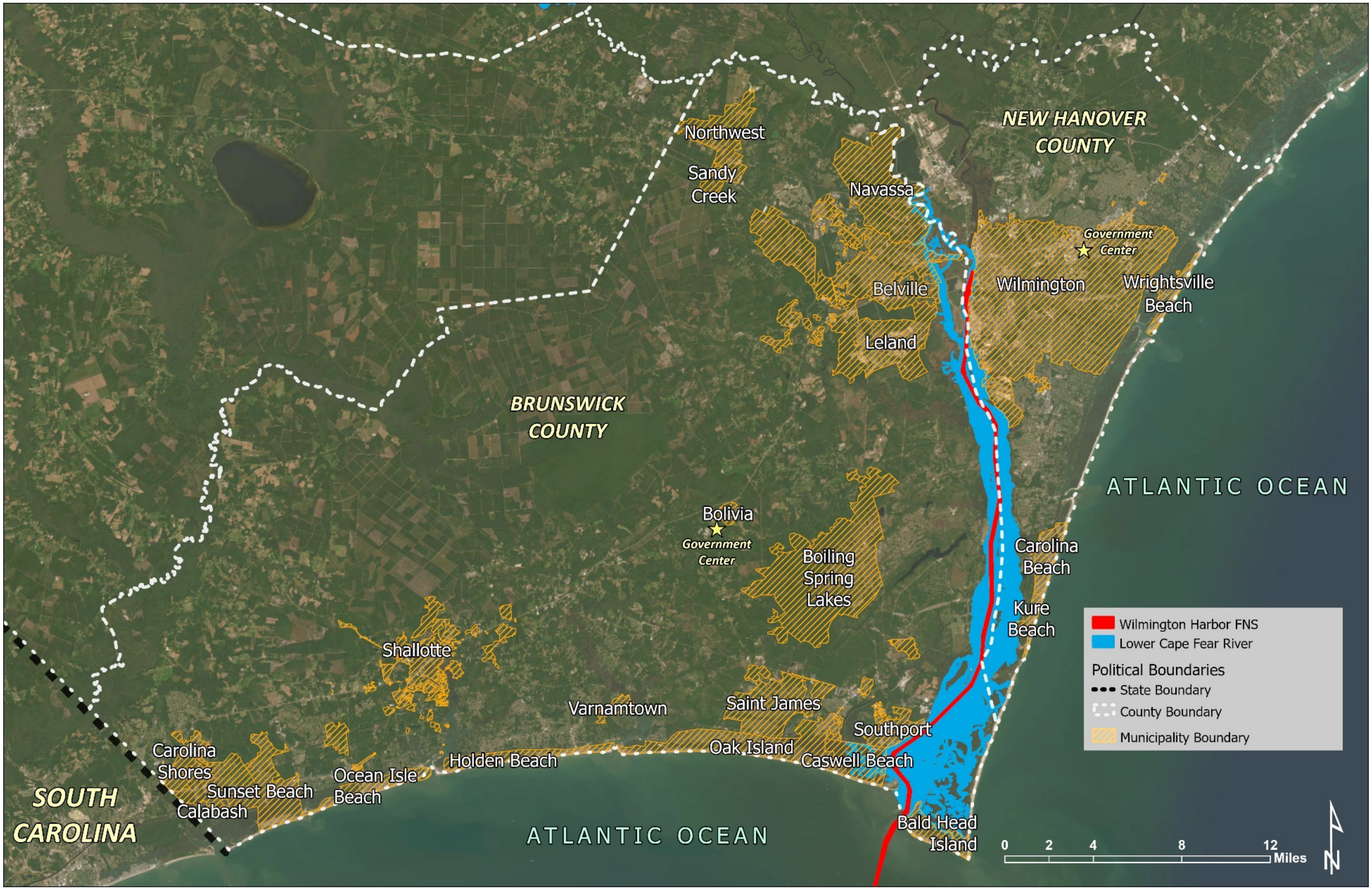

Figure 1-3: Brunswick and New Hanover counties and municipalities and existing Wilmington Federal Navigation Project

1.7 Economic Setting

Based on Waterborne Commerce of the United States, which is a series of publications that provide statistics on the foreign and domestic waterborne commerce in the U.S., Wilmington Harbor handled about 7.6 million tons of commerce in 2022, including 6.6 million tons of foreign commerce and 1.0 million tons of domestic commerce, making it the 67th largest port in the United States in terms of total tonnage (USACE, WCUS, 2022). Foreign imports made up 3.7 million tons while foreign exports accounted for 2.9 million tons. Much of the foreign commerce moving through the port is containerized. In 2022 the port handled 231,000 loaded Twenty Foot Equivalent Units (TEU's) shipping containers, making it the 21st largest U.S. container port for foreign commerce. Commodity shipments have been highly variable in recent years; total shipments reached a high of nearly 9.5 million tons in 2004 but have declined steadily since that time. The recent overall decline in shipments appears to be related primarily to petroleum products. Figure 1-4 illustrates the historic trend in total commerce at Wilmington Harbor between 2002 and 2022.

Figure 1-4 : Total Commerce in Tons Through the Port of Wilmington 2002-2022. "CY" refers to "calendar year".

Based on the most recent five years for which data is available (2018 through 2022), total shipments averaged 6.8 million tons per year, varying from a high of almost 7.5 million tons in 2022 to a low of 6.4 million tons in 2018. Details related to the associated cargo commodities can be found in the Economics Attachment of the Letter Report (Attachment 5).

Many waterborne commodities move in containers, which are standardized metal boxes that are typically shipped on specialized vessels called containerships. In 2020, the latest year for which data are available, U.S. ports handled a total of about 41.1 million loaded TEU's, of which 35 million (90%) were imports and 6 million (10%) were exports. TEU is an acronym for twenty-foot equivalent unit, which is a standardized way of measuring containers of different sizes; thus a 40-foot container is 2 TEU's and a 45-

foot container is 2.25 TEU's. Over 230,000 loaded TEU's were handled at Wilmington Harbor in 2020, making it the 21st largest container port in the United States and the 10th largest container port on the U.S. Atlantic coast.

When measured by volume, containerized cargo represents about 30% of the foreign commerce moved through the Port of Wilmington. Containerized cargo includes a great variety of commodities, including raw materials, manufactured products, liquids, agricultural products, and refrigerated goods. The container terminal at the Port of Wilmington moves loaded and empty containers. Filling and emptying containers (stuffing and stripping) also occurs at the Port. The number of containers handled at the Port of Wilmington has increased recently, as shown Figure 1-5 below.

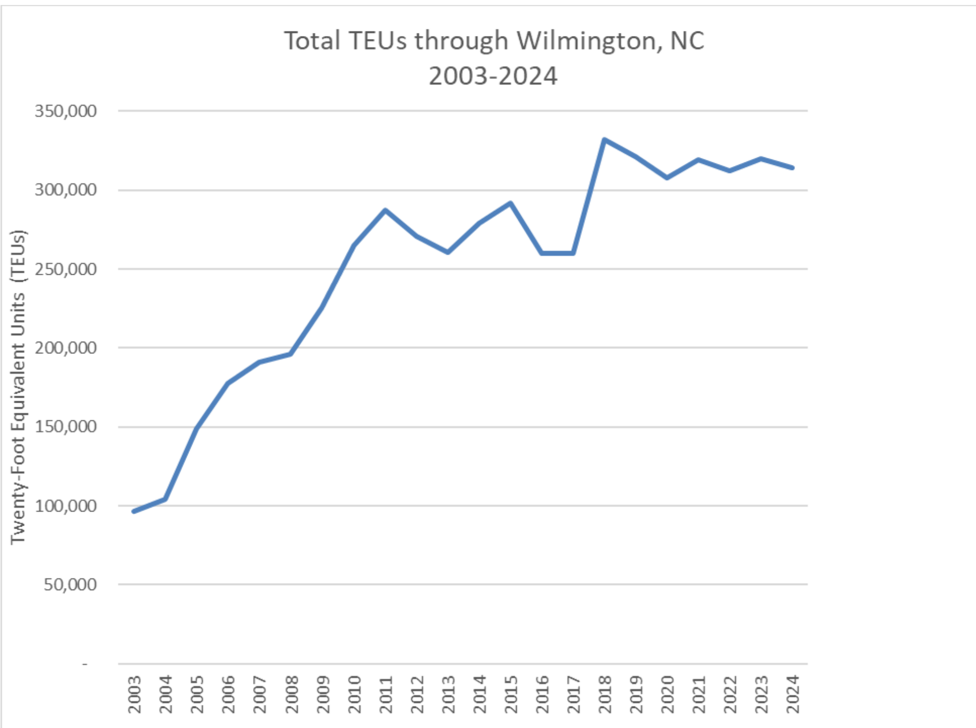

Figure 1-5: Total units of commerce through the Port of Wilmington 2003-2024.

Imports at Wilmington accounted for almost 127,000 loaded TEU's (55%) and exports accounted for about 105,000 loaded TEU's (45%). Empty containers account for approximately 30% of all containers at Wilmington. Recently, exports have increased at a faster pace than imports. In 2005 exports made up only about 33% of total shipments. Even though commodity shipments have been relatively flat at Wilmington Harbor, both import and export container shipments have displayed significant growth since 2003.

Based upon data contained in Waterborne Commerce of the United States, there were a total of 8,236 commercial vessel transits of Wilmington Harbor in 2020. This is a sharp decline from the 80,374 commercial vessel transits that occurred in 2005. Most of the vessel transits were tugs and barges with drafts of less than 10 feet. Of the 2020 total, 6,948 transits (84%) were vessels with drafts of less than 10 feet, while the 2005 there were 78,826 vessel transits (98%) with drafts of less than 10 feet. The decline in vessel transits between 2005 and 2020 is primarily related to vessels drafting less than 10 feet, which are presumably tugs and barges that are not constrained by the channel. Figure 1-6 shows the distribution of vessel types calling at Wilmington Harbor with a Design Draft greater than 30 feet. The resulting distribution is approximately 50% containerships, 25% tankers, and 25% general cargo vessels.

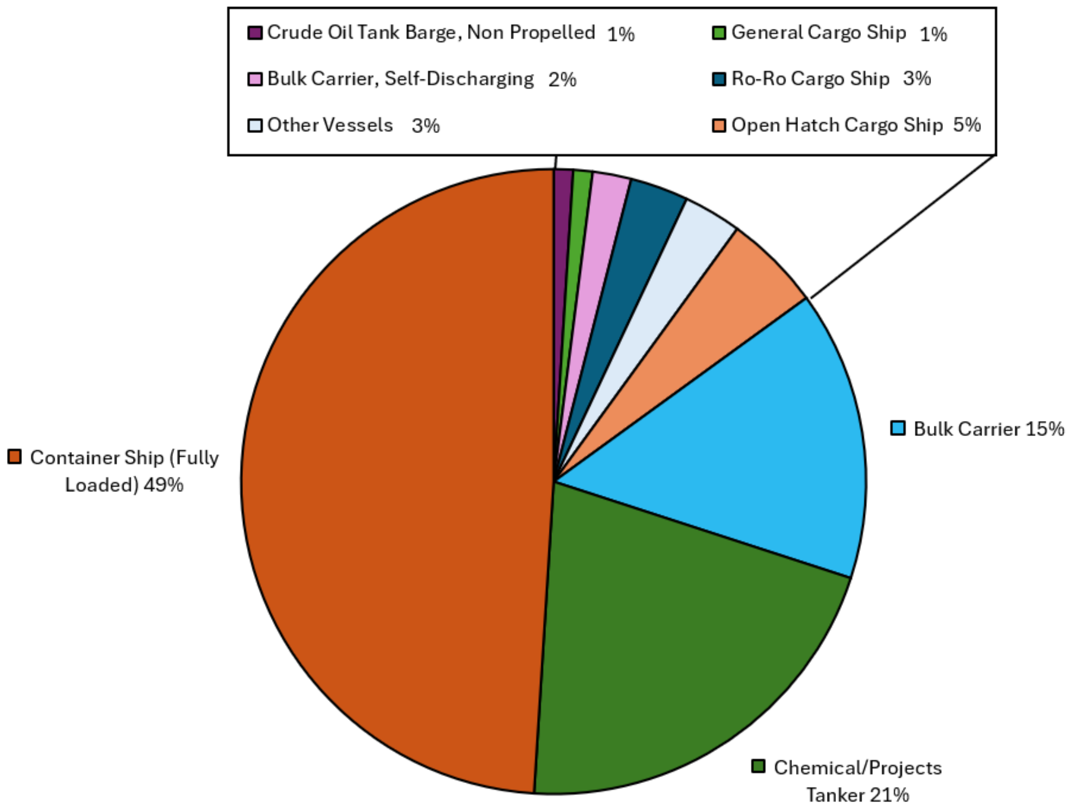

Figure 1-6: Vessel types, all vessels with draft more than 30 feet 2019-2020

Containerships made up nearly 50% of the deep-draft vessels calls at Wilmington Harbor in 2019-2020 (Figure 1-6, above). Based on the relative scale of changes in the volumes of containerized cargo and changes in cargo vessel size over time, the analysis presented below focuses primarily on containerized cargo and container vessel requirements. Additional details related to all cargo types and all vessel types is provided in the Letter Report and in its Economics Attachment.

A variety of different container ship types call on the Port of Wilmington. The vessels have evolved over time and are distinguished based on physical and operational characteristics, including lengths, overall design draft, beam, speed, and TEU capacity as shown Figure 1-7.

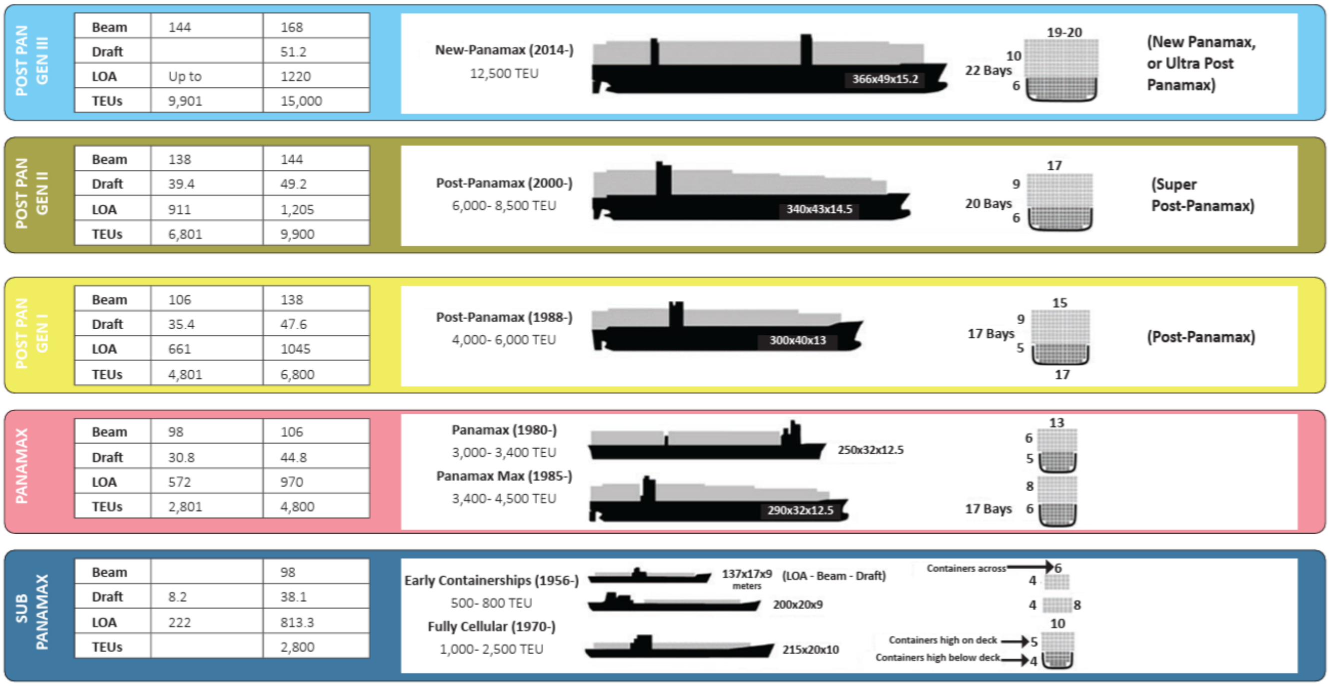

Figure 1-7: Containership growth at U.S. ports, 1956-present

Wilmington is already handling calls from a significant number of Post-Panamax ships. From 2016 through 2020, about 30% of all calls were Post-Panamax calls. Figure 1-8 illustrates the growth in the volume cargo transported by vessel class for years 2016 to 2020. Total cargo movements on PPX Generation II or larger containerships grew from 3% in 2016 to 64% in 2020.

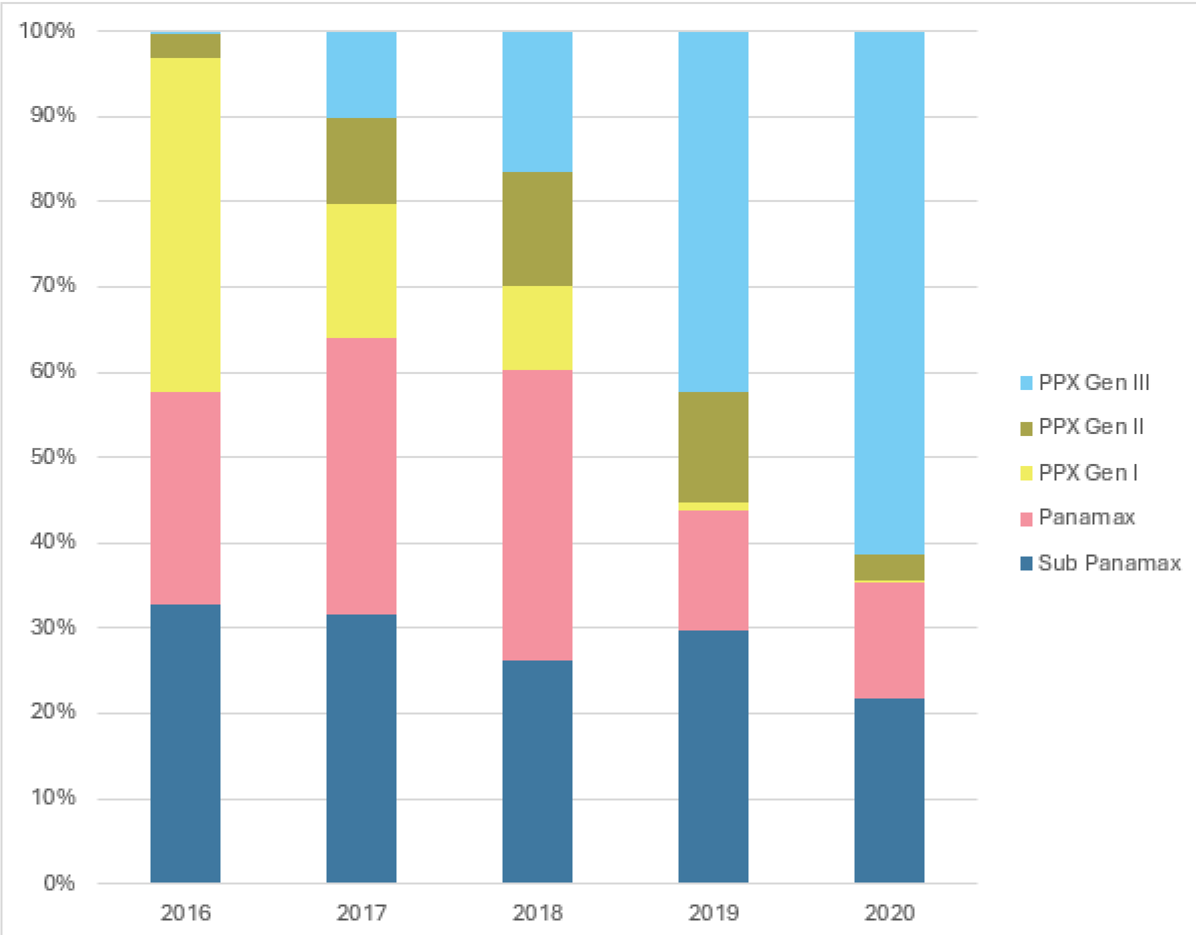

Figure 1-8: Total percentage of tonnage by vessel class for Wilmington Harbor, 2016-2020. Source: USACE 2022.

Total cargo throughput is expected to continue to increase in the future with or without a harbor improvement project. Cargo volumes have increased significantly over the last 20 years. Table 1-2 summarizes the containerized cargo forecast through 2042. More detailed information about the forecast and the associated cargo is provided in the Economics Attachment to the 403 Letter Report.

Although the economic cost and benefits analysis extends to 2085, the forecasted volumes for 2042 are assumed for the period from 2042-2085 based on limited landside capacity.

Table 1-2: Wilmington Total TEU Forecast for Receipts and Shipments

Forecast	2025	2030	2036	2042
Total Loaded Receipts (TEU)	141,667	162,469	497,981	592,746

Forecast	2025	2030	2036	2042
Total Loaded Shipments (TEU)	123,056	145,638	193,545	234,032
Total Empty TEU	82,064	95,513	214,373	256,301
Total Overall TEU	346,788	403,620	905,899	1,083,079

1.8 Port of Wilmington

The NCSPA operates nine berths on the east bank of the Cape Fear River at approximately river mile 38. Berths 1 through 6 handle a wide variety of bulk commodities including forest products such as lumber, logs, woodchips, pulp, and wastepaper, as well as sulfur, clay, salt, and manufactured equipment and machinery. These docks also handle roll-on/roll-off ("Ro-Ro") and some limited containerized cargos. Berths 7, 8, and 9 primarily handle containerized cargo. The port has seven modern container cranes, three of which are capable of servicing the largest post-Panamax containerships.

Currently, containership berths are being modified to simultaneously accommodate one 1,200-foot-long vessel and one 965-foot-long vessel. Vessels over 1,200 feet long routinely call on the port today. The three containership berths are currently serviced by two Panamax ship-to-shore cranes (13- box wide), four post-Panamax ship-to-shore cranes (18-box wide) and three neo-Panamax ship-to-shore cranes (22-box wide). The current container throughput capacity of the port is approximately 600,000 TEUs per year, according to the NCSPA.

Numerous navigation and terminal features associated with deep draft navigation in the Lower Cape Fear River were identified as part of the existing condition for the study. They include a single entry/exit point, one turning basin,12 docks and 16 named channel reaches. The entry/exit point is located at the sea buoy; the turning basin is located just upstream of the NCSPA docks, on the south side of the channel, between the Vopak and Amerada Hess terminals. The 12 docks associated with deep draft commerce area, beginning with the most downstream, Archer Daniels Midland, MOTSU, Gold Bond Building Products, Vopak Terminal, Chemserve Terminal, Altamar-Carolina Marine Terminal, Apex Oil Co., North Carolina State Port Authority (NCSPA) docks 1 through 9, Navy Reserve Dock, Chevron Asphalt Terminal, and the North and SouthAmerada Hess, Colonial Terminals (Figure 1-10).

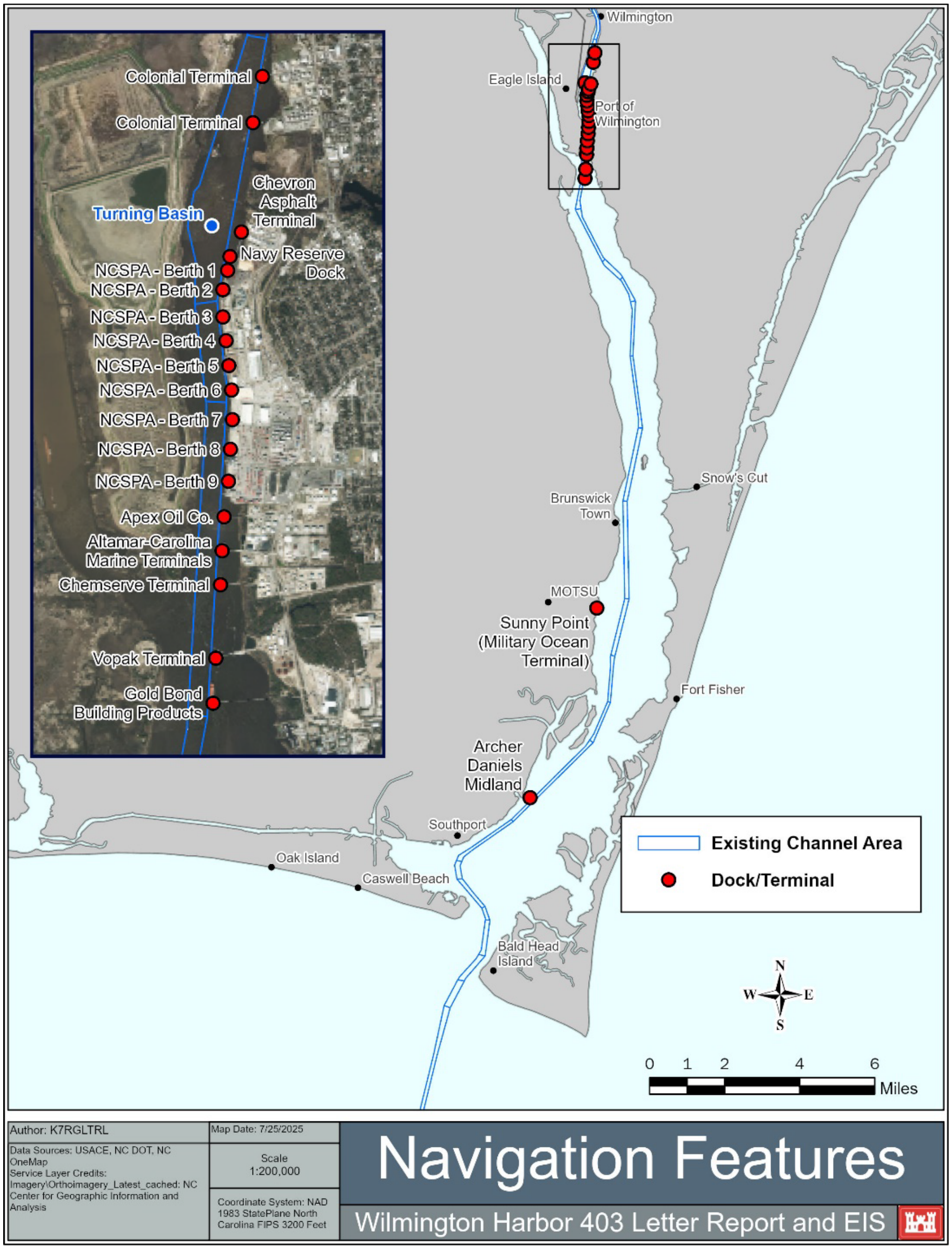

Figure 1-9: Navigation and terminal features associated with deep draft navigation in the Lower Cape Fear River were identified as part of the existing condition for the study

The turning basin is sometimes referred to as an anchorage; however, it is only used to turn vessels and is not used as an anchorage.

The Port of Wilmington will see an increase in vessel traffic to accommodate the increased cargo volumes. Current vessel loading practices, including light-loading, are assumed to persist without a project to address the underlying problems. To accommodate this increase in volume, expansion projects at the port will be completed as planned. The NCSPA terminal improvement program continues to increase the efficiency and throughput capacity of the Port of Wilmington container terminal to 750,000 TEUs at the completion of the projects underway and to 1.3 million TEUs by 2045. These without-project condition terminal improvements enhance current terminal operations and efficiency independent of improvements to the federal channel. An update on completed, underway and scheduled projects include:

1.8.1 Recently Completed Projects

- Turning Basin Phase II expansion to 1,524 feet
- Refrigeration Expansion Phase I (524 plugs)
- Container Berth Expansion to 2,650 feet
- Air Draft Clearance upgrade to 212 feet
- Southgate Container Gate upgrade to 1.2 million annual TEU capacity
- New Terminal Operating System and Gate Operating System to increase efficiency and throughput
- Battery Island Turn
- Resurfacing and upgrade of Area F East to Rubber-Tired Gantry crane capable (5 acres)

1.8.2 Projects Underway

Resurfacing and upgrade of Area L (old gate, 8 acres additional laydown capacity)

- Refrigeration Phase II (704 additional plugs)
- On-dock Intermodal Yard Redesign to double daily rail capacity (4 x 1,250 feet working track)

Resurfacing and upgrade of Area F West

1.8.3 Projects Scheduled

Resurfacing and upgrade Area H, Area K, and Area A to Rubber-Tired Gantry capable

Berth 9 Crane upgrade to Neo-Panamax capability

These without-project condition terminal improvements enhance current terminal operations and efficiency independent of improvements to the federal channel.

Figure 1-10: North Carolina Ports Authority terminal, Wilmington, NC. Credit: Page Productions.

1.9 Cooperating Agencies

The USACE invited the following federal agencies to serve as cooperating agencies: U.S. Fish and Wildlife Services (USFWS), National Marine Fisheries Service (NMFS), U.S. Environmental Protection Agency (EPA), U.S. Coast Guard (USCG), and MOTSU. All federal agencies accepted the invitation in May and June 2023 and USACE has engaged with these agencies in the development of the Draft EIS.

1.10 Public Engagement

USACE has actively engaged the public in the development of the EIS. USACE has engaged through formal and informal scoping, public meetings, and coordination with technical experts.

USACE initiated public engagement with early scoping in the Spring 2023. During early scoping USACE met with state and federal agencies to provide background and purpose of the 403 Letter Report, request relevant data, studies, and reports, solicit early feedback, and formulate technical working groups. USACE hosted the Early Scoping Public Meeting on June 13, 2023, to engage with and inform the public on the development of the 403 Letter Report and EIS and solicit input. The Early Scoping Public Meeting and the following comment period resulted in the submittal of 82 comments from 45 members of the public. A diverse number of organizations attended the meeting and submitted comments including federal, state and local agencies, non-governmental organizations, University of North Carolina

Wilmington, and individuals. USACE published a report that summarizes the engagement and comments received, which can be viewed at:

https://www.saw.usace.army.mil/Missions/Navigation/Dredging/Wilmington-Harbor-403-Letter-Report-and-EIS/

On June 6, 2024, USACE published a notice of intent (NOI) in the federal register formally announcing USACE's intent to prepare an EIS for the proposed federal action and a public comment period which concluded on July 22, 2024. USACE hosted virtual meetings and in-person public meetings during the NOI public comment period. During the public comment period 65 comments from 54 members of the public were received. A diverse number of organizations attended the meeting and submitted comments including federal, state and local agencies, non-governmental organizations, University of North Carolina Wilmington, and individuals. USACE published a report that summarizes the engagement and comments received, which can be viewed at:

https://www.saw.usace.army.mil/Missions/Navigation/Dredging/Wilmington-Harbor-403-Letter-Report-and-EIS/

USACE has also engaged with federal, state, and local technical experts in support of the analysis in the EIS. In October 2023, USACE facilitated a 2.5-day community-based modeling workshop for aquatic and wetland resources. Experts from federal, state, and local organizations came together to inform factors to be considered in habitat modeling, species of concern, and share data and local knowledge.

USACE hosted technical working group meetings for wetlands, fish and fisheries habitat, and beneficial use of dredged material. Technical working groups (TWG) included representatives from the USFWS, NMFS, U.S. EPA, North Carolina Department of Environmental Quality, North Carolina Wildlife Resources Commission, the Natural Heritage Program, and North Carolina Audubon.

The overall framework of the wetland and fish and fisheries habitat resource technical working groups was to 1) review available data sources for baseline conditions, 2) concur on assessment methods to be used, 3) provide technical review and input on the existing conditions and effects analysis for wetland and fish/fisheries habitat, and 4) discuss appropriate mitigation measures. The overall goal of the Beneficial Use TWG was to identify potential uses for future dredged material, including beach placement, bird islands, and marine resource restoration/enhancement that could be further assessed for suitability and cost. Appendices D, H, and I provide additional information.

1.11 Prior Reports and Studies

The federal channel from the Atlantic Ocean to Wilmington has been incrementally improved for more than 100 years (USACE 1996). Over that time many NEPA documents have been developed. Recent improvements are documented in three reports prepared in support of Wilmington Harbor 96 Act Project, created by the Energy and Water Development Appropriations Act of 1998.

Final Supplement to the Final Environmental Impact Statement for Wilmington Harbor – Northeast Cape Fear River (U.S. Army Corps of Engineers, Wilmington District 1996)

Interim Feasibility Report and Environmental Impact Statement on Improvement of Navigation, Wilmington Harbor Channel Widening, (U.S. Army Corps of Engineers 1994). The recommended plan consisted of widening the channel from 400 feet to 600 feet for a length of 6.2 miles to provide a passing lane. The Chief's Report is dated 24 June 1994. The work was completed in 2003.

Final Feasibility Report and Environmental Impact Statement on Improvement of Navigation, Cape Fear – Northeast Cape Fear Rivers Comprehensive Study (U.S. Army Corps of Engineers 1996)

The recommended plan consisted of:

- Deepening the channel from the Atlantic Ocean to Wilmington from a depth of 38 feet to a depth of 42 feet, including the Anchorage Basin; along with deepening the ocean bar channel from 40 to 44 feet;
- Deepening the 32-foot and 25-foot channel reaches in the upriver portion of the harbor to 38 feet and 34 feet, respectively; along with widening the channel from the existing width of 200 feet to 250 feet;
- Deepening the Turning Basin at the upper project limit in the Northeast Cape Fear River from 25 to 34 feet; along with widening the upper Turning Basin from 700 to 800 feet; and

The remaining authorized improvements from the Cape Fear Memorial Bridge to the upper project limit (deepening the 32-foot and 25-foot channel reaches in the upriver portion of the harbor) were deferred due to a marginal cost to benefit ratio.

The project up to the Cape Fear Memorial Bridge was completed in 2003.

Section 905 (b) Analysis Wilmington Harbor Navigation Improvements, New Hanover and Brunswick Counties, North Carolina (U.S. Army Corps of Engineers 2011)

The Section 905 (B) Analysis recommended that the Wilmington Harbor Navigation Improvement study proceed into the feasibility phase only for channel widening, turning basin enlargement, and other modifications at the existing project depth.

In 2011, USACE developed a Reconnaissance Report (Section 905(b) Report), which recommended that a Feasibility Study for additional improvements be performed. The Feasibility Study recommended realignment of the Entrance Channel, widening of the Battery Island channel, and assorted modifications that increase the radius of the turn at Battery Island.

Final Integrated Feasibility Report and Environmental Assessment Wilmington Harbor Navigation Improvements (U.S. Army Corps of Engineers 2018). The recommended plan combines the following components to increase the available turning radius of the Battery Island turn from 2,850 feet to 3,900 feet:

- Realignment of the Entrance Channel reach 1 westward away from a shoal that forms to the east of the channel;
- Widen Battery Island channel from 500 feet to 750 feet;
- Provide additional tapers where Southport and Lower Swash channel join Battery Island Channel; and
- Provide a 750 feet-wide by 1,300 feet-long cutoff between Battery Island Channel and Lower Swash Channel.

Section 203 Report: The NCSPA prepared a feasibility study pursuant to section 203 of the Water Resources Development Act of 1986, as amended, and in February 2020 submitted that study to the ASA(CW) for review for the purpose of determining whether the study, and the process under which the study was developed, comply with Federal laws and regulations applicable to feasibility studies of water resources development project. Congress conditionally authorized the recommended navigation improvements, at a total cost of $834,093,000, through Section 403 of the Water Resources Development Act (WRDA) 2020: *Authorization of Projects Based on Feasibility Studies Prepared by Non-Federal Interests*. The conditional authorization included a requirement to address the issues and concerns identified in the ASA(CW) Assessment Report. This EIS is being prepared to address issues identified in the ASA(CW) Assessment Report.

SECTION 2 – ALTERNATIVES

2.1 Alternatives Development Process

The USACE follows a six-step process to develop and screen alternatives and guide water resources implementation decisions. This process provides a structured approach to problem solving and provides a rational framework for sound decision making. The six steps include:

- Step One: Identify Problems and Opportunities
- Step Two: Inventory and Forecast Conditions
- Step Three: Formulate Alternative Plans
- Step Four: Evaluate Alternative Plans
- Step Five: Compare Alternative Plans
- Step Six: Select a Plan

This process identifies existing and anticipated problems and opportunities to develop planning objectives. It then identifies and refines specific measures that could be combined to assemble alternative plans that comprehensively meet the planning objectives. These alternatives are then repeatedly screened, refined, and compared with each other to identify the alternative that best balances the many factors that need to be considered to make a prudent decision.

During their refinement, the alternatives are designed to be complete, effective, efficient, and acceptable to maximize overall benefits and minimize costs and adverse impacts to the human and natural environment. Preliminary alternatives are compared and screened against a variety of factors and perspectives to identify and recommend the alternative that provides the most reasonable, feasible and prudent solution. These factors and considerations are described below.

- **National Economic Development:** Changes in the economic value of the national output of goods and services
- **Regional Economic Development:** Changes in the distribution of regional economic activity (e.g. income and employment)
- **Environmental Quality:** Non-monetary effects on ecological, cultural, and aesthetic resources
- **Other Social Effects:** Effects on social aspects such as community impacts, health and safety, displacement, energy conservation, resilience, cohesion, and others

2.1.1 Problems, Opportunities, And Constraints

The first step in the six-step planning process is the identification of problems and opportunities. A problem is an existing condition to be considered for change. An opportunity is a chance to create a future, more desirable condition. Constraints are resource, legal, or policy considerations that limit the actions that can be implemented. The identification and development of problems, opportunities, and constraints specific to Wilmington Harbor resulted from internal discussions, external communication with stakeholders and resource agencies, and public meetings. The NEPA scoping process played an important part in gathering information to help identify problems, opportunities, constraints, and stakeholder, public, and agency concerns. This information was also used to develop objectives. Details on the scoping process and documentation of all comments received can be in the scoping report that is published on Wilmington Harbor 403 website:

https://www.saw.usace.army.mil/Missions/Navigation/Dredging/Wilmington-Harbor-403-Letter-Report-and-EIS/.

2.1.2 Problems

Feedback from stakeholders, combined with knowledge of the existing and forecasted makeup of the vessel fleet servicing Wilmington Harbor and the Port of Wilmington, indicates that the most pressing problems are related to meeting the needs of the growing size and increasing depth requirements of container vessels. These problems are causing transportation inefficiencies that will increase in the future if they are not addressed.

Transportation inefficiencies occur when channels and maneuvering areas do not fully accommodate the vessels using them. Currently, large vessels with loaded drafts that exceed 42 feet below MLLW are constrained by insufficient depths and widths of the channels and turning areas. These conditions cause the marine transportation industry to light load large vessels or wait for favorable tide conditions (i.e. high tides), or use smaller, less efficient vessels to transport the cargo. Depth-related problems are expected to be exacerbated by ongoing and forecasted use of larger vessels, particularly for containerized cargo. Details on the economic report can be found in the Letter Report Attachment 5: Economic Considerations.

2.1.3 Opportunities

Opportunities are desirable future conditions that could be achieved through measures addressing specific problems. Several opportunities for improvement over the 50-year period of analysis through implementation of management measures were identified. They include:

- Transporting the forecasted volume of goods into and out of the harbor on fewer vessels;
- Eliminating or reducing navigational restrictions that cause inefficiencies (i.e., channel depth limitations) to enable maritime carriers to avoid the need to wait for favorable tide conditions;
- Improving navigation safety by reducing congestion and/or risks of groundings or collisions;
- Increasing the efficiency of port operations and reducing vessel delays by allowing the forecasted fleet to have less restricted access to berths and terminals;
- Allowing forecasted fleet of cargo vessels to be loaded more efficiently;
- Allowing a smaller number of vessels to transport the forecasted cargo;
- Protecting infrastructure using dredged material; and
- Protecting, restoring, and creating habitat using dredged material.

2.1.4 Constraints

Constraints limit the range of measures that could be implemented to meet the study objectives. Constraints can be related to resource, legal, or policy considerations. The process strives to efficiently meet the study objectives without violating constraints. The constraints identified for potential Wilmington Harbor improvements include:

- Maintain compliance with maritime safety requirements;
- Avoid unacceptable impacts to important natural resources;
- Avoid unacceptable impacts to important cultural and historical resources;
- Avoid unacceptable impacts to existing infrastructure;
- Avoid unacceptable induced flooding; and
- Avoid adverse impacts to MOTSU operations.

When considering constraints, unacceptable refers to adverse impacts that would not be tolerated by regulatory agencies, the local community or society in general.

2.1.5 Objectives

Objectives are summarized in statements that describe the desired results from solving or alleviating problems and realizing opportunities. These objectives must reflect the problems and opportunities and represent desired positive changes in comparison to the future without-project conditions.

Federal Objective

The overall federal objective for water resources implementation decisions is to contribute to National Economic Development (NED), consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders, and other federal planning requirements. Water resources project plans are formulated to alleviate problems and take advantage of opportunities in ways that contribute to this objective.

To determine whether there is a federal interest in implementing navigation improvements at Wilmington Harbor, the expected return to the national economy on the total investment to construct and maintain the improvements over a 50-year period of analysis was calculated. Like most USACE navigation investment decisions, the return to the national economy would be generated by reducing transportation costs by addressing inefficiencies in the existing transportation system. For there to be a federal interest, the contribution to NED must exceed the cost to construct and maintain the project over the period of analysis. The NED benefits associated with each of the alternatives considered are compared with the costs to implement and maintain the improvements and mitigate for adverse impacts. The results, including recommendations, are summarized below. Additional details are provided in the Letter Report and the supporting attachments, particularly the Letter Report economics Appendix I.

Consistent with the Federal objective, project-specific objectives were identified, and these objectives guided the alternative development, screening, and selection process. Objectives must be clearly defined and provide information on:

- the effect desired (quantified, if possible);
- what will be changed by accomplishing the objective;
- the location where the expected result will occur; and
- the timing of the effect (when would the effect occur) and the duration of the effect.

Based on the problems posed by channel dimensions and the opportunities available through channel improvements, the following planning objectives were established to assist in the development of management measures and evaluation of alternatives:

- Planning Objective 1: Contribute to NED by reducing origin to destination transportation costs, at the Port of Wilmington from 2037 to 2086; and

Planning Objective 2: Contribute to NED by reducing waterborne transportation costs at the Wilmington Harbor Federal navigation project by accommodating the transit of larger and more efficient vessels, from 2037 to 2086.

2.1.6 Management Measures

Management measures were identified using information gathered during discussions and interviews with Port of Wilmington operations and management personnel, Cape Fear River Pilots Association, terminal operators, shipping agents, and tugboat operators that work in Wilmington Harbor.

Non-structural measures identified as potential improvements to navigation at Wilmington Harbor include:

- Reduce vessel speeds in the channel;
- Increase the use of tugboat assistance to improve vessel maneuverability;
- Relocate aids to navigation to take advantage of naturally deep areas;
- Use tidal advantage; and
- Use lightering

Structural measures identified as potential improvements to navigation at Wilmington Harbor include:

- Channel deepening;
- Turning basin deepening;

Stepped channel (additional deepening, or step-down, for reaches closer to the entrance of the FNS);

- Expand turning basin;
- Improve existing anchorages and/or create new anchorages;

Channel widening to reduce navigation restrictions such as tide windows and tug assistance; and

Channel widening to accommodate vessel meeting and passing

Local service facility improvements include measures that may be taken by the non-Federal sponsor or local operators to support achievement of the planning objectives. These measures include:

- Berth deepening;
- Container terminal improvements;
- Bulk terminal improvements;
- Breakbulk/general cargo terminal improvements; and
- Relocate cargo terminals.

The management measures were evaluated with respect to their technical feasibility and their ability to meet the objectives based on the following standard USACE screening criteria:

- Effectiveness: does the alternative contribute to achieving the planning objectives;
- Efficiency: is the alternative the most cost-effective means of addressing the specified problems and realizing the specified opportunities, consistent with protecting the nation's environment; and
- Acceptability: is the alternative plan acceptable in terms of applicable laws, regulations, policies and constraints.

The results of the measures screening effort are summarized, below. More thorough and detailed information is provided in the accompanying Letter Report.

All the measures considered were determined to be technically feasible. However, the following measures were eliminated from further consideration based on a lack of effectiveness and efficiency:

- Reduce vessel speeds in the channel;
- Increase the use of tugboat assistance to improve vessel maneuverability;
- Relocate aids to navigation to take advantage of naturally deep areas;
- Use lightering;
- Stepped channel;
- Expand turning basin
- Improve existing anchorages and/or create new anchorages;
- Channel widening to accommodate vessel meeting and passing;
- Container terminal improvements;
- Bulk terminal improvements;
- Breakbulk/general cargo terminal improvements; and
- Relocate cargo terminals.

The following measures were carried forward for additional consideration based on their technical feasibility, acceptability and ability to address at least one of the planning objectives effectively and efficiently:

- Channel deepening;

- Turning basin deepening;
- Channel widening to reduce navigation restrictions; and
- Berth deepening.

The measures identified for further evaluation could be implemented individually or in combination. All three elements of deepening the existing project (channel deepening, turning basin deepening, and berth deepening) are required in order to be complete and effective. Channel widening may be implemented individually or in combination with deepening. Channel widening implemented as an individual alternative would allow the large vessels to use the channel on a regular basis, but the design vessel's operating draft would be constrained. The combination of deepening and widening would allow large vessels to operate in the channel and load more fully. When alternatives are evaluated for completeness (does the alternative contain all the necessary parts to address the problem) criteria are added to the evaluation.

2.2 Alternatives Formulation Assumptions

Alternatives are a set of one or more management measures functioning together to address one or more planning objectives. Through the use of harbor pilot information coupled with engineering and operations professional judgment, several assumptions were made in the development of the action alternatives and are described in the section below.

Vessel Design

Design vessel identification assists with informing design parameters for alternatives. For deep draft navigation projects, the design vessel was selected based on economic studies of the types and sizes of the vessel fleet expected to use the proposed channel over the project life. The design vessel is typically the maximum or near maximum size ship in the forecasted fleet.

The Port of Wilmington is the largest terminal complex and is the only container terminal at Wilmington Harbor. Historically, the maximum sailing draft has been 41 feet, which is confirmed through pilot interviews and pilot log data. Vessels with drafts greater than 38 feet are required to transit using tidal advantage, where the vessel transits at higher tides. Up to four feet of tidal advantage is available, but vessels very seldomly load to 42 feet because of the infrequency of such high tides.

The largest vessels that call at Wilmington Harbor at the present time are Post-Panamax Gen III containerships of 14,220 TEUs. These vessels travel between Far East ports such as China and Korea, and the East Coast of the United States, calling at the North Carolina State Port Authority docks 7, 8 and 9. They are around 1,200 feet long, 168 feet in beam and have design drafts of 51 feet. Their actual sailing drafts were 38 feet or less when calling at Wilmington Harbor in 2020; however, some instances of deeper arrival drafts using high tide did occur. Containerships always maintain an underkeel clearance of at least 10 percent of sailing draft in the channel.

Forecasted Cargo

An important step when evaluating navigation improvements is to analyze the types and volumes of cargo moving through the port. Cargo history can offer key insight into a port's long term trade forecast which is the estimated cargo volume upon which future vessel calls are based. ***In the "future without" and "future with project" conditions, the same volume of cargo is assumed to move through Wilmington Harbor***; however, channel modifications would allow for more efficient vessel use. The total number of TEUs, included loaded and empty containers, by import and export, and route group, are shown in Table 2-1. These forecast figures are taken from the Wilmington Harbor 403 Letter Report, Wilmington, NC, Attachment 5, Economics.

Table 2-1 Wilmington Total TEU Forecast for Receipts and Shipments

	2025	2030	2036	2042
Total Loaded Receipts (TEU)	141,667	162,469	497,981	592,746
Total Loaded Shipments (TEU)	123,056	145,638	193,545	234,032
Total Empty TEU	82,064	95,513	214,373	256,301
Total Overall TEU	346,788	403,620	905,899	1,083,079

Forecasted Vessel Fleet

In addition to a commodity forecast, a forecast of the future fleet is required when evaluating potential navigation projects. To develop projections of the future fleet calling at Wilmington, a world fleet forecast was developed. The commodity forecast was constrained, based on landside capacity, the fleet forecast model was unconstrained with respect to inter-port competition on the U.S. East Coast. This means that forecasted commodity totals were not adjusted based on effects from nearby ports. Therefore, volumes were not increased or decreased based on movements to substitute ports in the region. Further, the forecast did not consider land-based infrastructure as a limiting factor in its projections of the World Fleet. In the without-project condition, the overall vessel fleet is assumed to remain much the same as it is today, burdened by the same set of problems and navigational constraints.

In the without-project condition, the overall vessel fleet is assumed to remain much the same as it is today, burdened by the same set of problems and navigational constraints. The fleet for bulkers will shift towards larger sub-classes of Very Large Bulker vessels but remain draft constrained. The fleet of chemical tankers will shift cargo towards the larger classes of LR-1 tankers, away from smaller classes. The largest classes of chemical tankers will continue to light-load because of the current channel depth. In summary, bulker and tanker vessels will continue to get larger over time to gain efficiencies without a project in place.

The containership fleet is expected to expand to accommodate the significant influx of Far East imports from electric vehicle manufacturers in Central North Carolina. Since this will require more vessels than only a single class of container vessel can provide, the amount of liner services may increase from the two currently scheduled, and the fleet mix of vessels may grow to mirror those calling on other U.S. East Coast ports. Significantly more PPX1 and PPX2 vessels would be required to fulfill the commodity forecast without a project. In conclusion, vessel calls will continue to increase into the future, while still being affected by the navigational constraints described earlier.

Table 2-2 shows the forecasted number of benefiting vessel calls in the future under both action alternatives and the future without project conditions projected for the years 2021 (existing conditions), 2036, and 2056, and 2085. As the channel gets deeper, the loading capacities are increased for all vessels. However, they are increased more significantly for the larger classes that have more spare capacity in the without-project condition. Even if they maintain the same frequency of vessel calls, they're able to carry more cargo per trip with a deeper channel. As the channel gets deeper, smaller vessel call numbers are reduced because of the larger vessel calls handling more cargo, becoming more efficient.

Table 2-2 Combined With- and Without-Project Fleet Forecasts

Vessel Class	Existing Condition (2021)	FWOP			AA2- 46 feet			AA1- 47 feet		
		2036	2056	2085	2036	2056	2085	2036	2056	2085
SPX	163	59	70	70	21	14	14	14	9	9
Panamax	73	166	189	189	166	189	189	165	189	189
PPX Gen I	1	237	289	289	148	185	185	133	165	165
PPX Gen II	4	157	186	186	157	186	186	157	186	186
PPX Gen III	83	103	124	124	103	124	124	103	124	124
GP Tanker	43	49	57	57	6	1	1	6	1	1
MR Tanker	54	49	44	44	49	44	44	49	44	44
LR Tanker	19	26	38	38	26	38	38	26	38	38
Very Small Bulker	5	9	13	13	9	13	13	9	13	13
Small Bulker	1	1	1	1	1	1	1	1	1	1
Medium Bulker	38	71	93	93	59	74	74	56	73	73
Large Bulker	12	12	13	13	11	13	13	11	9	9
Very Large Bulker	38	71	97	97	68	97	97	68	97	97
Total	**534**	**1,010**	**1,214**	**1,214**	**824**	**979**	**979**	**798**	**949**	**949**

Channel Design

As shown in the table, the largest changes over time are associated with containerships and tankers with large decreases in calls from smaller vessels under deeper conditions from the beginning to the end of the period of analysis. Similar trends for the bulk vessels are shown but to a lower extent The inefficient operation of cargo vessels at Wilmington is primarily attributable to insufficient depth of the FNS serving the Port. The existing channel depth constraints cause some carriers to light-load vessels and restricts the efficient vessel size utilized by carriers. Examples of light loading are exhibited in containership operations. Restrictions on efficient vessel size are exhibited by liquid bulk and dry bulk operations, which have the landside capacity to use larger vessels, but the existing channel depth restricts the efficient use of these larger vessels. Light-loading and restricted vessel size both increase cargo transportation costs. Shippers and terminal operators have confirmed that they would utilize larger vessels with a deeper channel. Due to the current channel's configuration, light loading practices would continue as the least-cost alternative to intermodal shifts in cargo. Vessels would continue to call Wilmington in an inefficient manner, as opposed to shifting their cargo to an alternate port nearby, such as Charleston, South Carolina or Norfolk, Virginia, to access their hinterlands via landside transportation. Further details on these dynamics can be found in Appendix 5, Economic Considerations of the Wilmington Harbor 403 Letter Report.

In Wilmington Harbor, navigation benefits would be generated with the reduction in costs from more efficient use of existing vessels and reductions in transit time. By allowing the vessels to arrive and depart closer to their maximum draft, large cargo vessels can minimize the number of voyages to overseas ports each year. Reducing the number of these voyages will be a significant cost savings to the shippers. Also, reducing the number of delays waiting for conditions to improve at the entrance channel will make existing voyages faster and more efficient, incurring fewer operating costs over the year as well.

Local Facilities

The Port of Wilmington is the largest port in North Carolina and is a major component of the State's economy. Since the last two major channel improvements in 2002 and 2013, the Port of Wilmington has experienced significant growth in cargo volume, and in the size of vessels calling at the port has increased. Over the intervening years, the NCSPA has invested in infrastructure to accommodate growth at the Port of Wilmington and the region it serves. The NCSPA is currently implementing Master Plan recommendations valued at over $300 million for yard, gate, and terminal operations improvements to increase annual throughput capacity to 1 million TEUs per year. The NCSPA is implementing these improvements independent of the proposed federal project. Port of Wilmington improvements are described in more detail in Section 1.8.

2.3 Alternatives Eliminated from Detailed Analysis

Economics analysis was performed for a range of depths in order to determine which alternatives best meet the objectives over a 50-year period of analysis. The transportation cost savings benefits and project costs were estimated for all project years, then annualized to produce and Average Annual

Equivalent (AAEQ) by discounting the costs and benefits at the applicable Federal Discount Rate for Corps of Engineers Water Resource Projects of 2.75%. Results are presented in Table 2-3, below.

Table 2-3: Economic Analysis of Proposed Alternatives

Economic Parameter	44 Foot Alternative	45 Foot Alternative	46 Foot Alternative	47 Foot Alternative	48 Foot Alternative
AAEQ* Benefits	$31,767,000	$44,742,000	$57,718,000	$67,521,000	$77,323,000
AAEQ* Costs	$26,057,000	$33,591,000	$42,060,000	$51,647,000	$60,797,000
Incremental AAEQ* Costs	N/A	$7,534,000	$8,469,000	$9,857,000	$9,150,000
Average Annual Net Benefits	$5,710,000	$11,151,000	$15,658,000	$15,874,000	$16,526,000
BCR @ 2.75%**	1.2	1.3	1.4	1.3	1.3

*AAEQ: Average Annual Equivalent
**BCR: Benefit-to-cost ratio

The NED plan is defined as the alternative that reasonably maximizes contributions to NED. Although the -48 foot alternative has the highest average annual net benefits and would normally be carried forward for detailed analysis,

However, the 48-foot alternative would likely require additional specific congressional authorization by Congress to implement., considering the conditional congressional authorization of the -47 foot alternative and uncertainties associated with costs, benefits, adverse environmental impacts and mitigation requirements, the relatively small differences in net benefits,, the USACE and NCSPA determined that the final array of alternatives would include the No Action Alternative/ Future without Project, Action Alternative 1 (-47 feet MLLW), and Action Alternative 2 (-46 feet MLLW).

The two action alternative descriptions below provide details related to potential changes to existing General Navigation Features (GNF) within the Wilmington Harbor FNS. The GNF may include channels, jetties, breakwaters, locks and dams, harbor entrance channels and associated protective works, dredged material placement areas (i.e., beneficial uses of dredged material), mitigation features, including associated lands, primary access channels to the harbor, basins, and anchorages required for channel transit. Also considered in this definition are dredged material placement areas (except those associated with the inland navigation channels such as the Atlantic Intracoastal Waterway), and sediment basins.

The effects generated by the action alternatives will be compared to the Future without Project Alternative (FWoP) to form the basis for engineering, environmental, and economic analyses, and decision-making. This information will be captured in the Wilmington Harbor 403 Letter Report and Environmental Impact Statement (WH 403). Local Service Facilities are those facilities that a Non-Federal Sponsor (i.e., North

Carolina State Ports Authority), of a Federal Project or Action, must construct or operate and maintain to realize the benefits of the GNF. Examples of Local Service Facilities include: a local boat landing and its wharf; and berth maintenance and parking. Changes that are not part of the FNS would be implemented to realize total projected benefits for commercial and recreational interests. Also, associated improvements to GNF will be developed separately from this EIS.

2.4 No Action Alternative (NAA)

The No Action or Future Without Project (FWOP) Alternative assumes that no actions would be taken by the Federal Government to address the problems identified. The USACE would continue operation and maintenance of the currently authorized channel depths and widths, but no channel modifications would occur. The Wilmington Harbor FNS authorized channel depths vary based on location. The FWOP condition is described and evaluated throughout the EIS. The USACE would continue to place material in accordance with the 2023 Wilmington Harbor Dredge Material Management Plan.

2.5 Action Alternative 1 (AA1) – 47 feet

The 47-foot Action Alternative proposes to extend and deepen the entrance channel in combination with channel deepening and widening sections within the inner harbor channels (Figure 2-1). The proposed navigation improvements include:

Extend the existing entrance channel. The new channel would be dredged and extend approximately 48,000 feet (9.1 miles) seaward from Baldhead Shoal Channel - Reach 3 to waters that are consistently deeper than the currently maintained channel depth of -49 feet MLLW (Figure 2-2). The reach offshore of the existing pilot boarding station (Sta 490+00) would have a heading of approximately 30 degrees (inbound), which is an approximate 16-degree shift from the Baldhead Shoal Channel - Reach 3 (14-degree). This heading change would take advantage of the most direct navigation path, which is an existing deeper natural channel, minimizing dredging volumes and environmental impacts, while reducing construction and maintenance costs.

Deepen the existing entrance channel from the Battery Island reach to the pilot boarding station (Sta 490+00). The depth would increase from -44 feet to -49 feet MLLW to allow for adequate underkeel clearance for anticipated container vessels in areas affected by ocean waves.

- Construct side slopes of 5:1 (horizontal to vertical) from the Entrance channel to Battery Island.
- Deepen the existing inner harbor navigation channels, all reaches from Lower Swash to the Anchorage Basin from -42 feet to -47 feet MLLW.

Widen the existing inner harbor navigation channel as described in Table 2-4. Construct side slopes of approximately 3:1 (horizontal to vertical) from Lower Swash to the Anchorage Basin. Over time, the slope will stabilize. The 3:1 design is to promote stability, and it is assumed that after construction, the slope will settle into a stable condition at 3:1.

Where rock is present within the proposed dredging footprint, an additional one foot of dredging below the project depth is required to remove the rock for safety purposes. In such areas, up to two additional feet of overdepth dredging is allowed, resulting in a potential total of three feet beyond the project depth. However, only the first foot is mandatory when rock is encountered. Overdepth dredging may occur during both initial construction and subsequent operation and maintenance dredging activities. Summary of project depth requirements can be found in Table 1-1.

The top of rock was determined using existing geotechnical and geophysical data from the 1996 Deepening Act and the 2012 Channel Improvements Project, along with new geotechnical vibracore data collected in 2023. Additional geotechnical and geophysical information will be collected in Pre-Construction & Engineering Design (PED) to further refine the top of rock surface throughout the channel. Blasting occurred during the last deepening effort in the early 2000s and consisted of removing rock from Lower Brunswick, Upper Big Island, Lower Big Island, and Keg Island reaches. Blasting may be needed again to deepen these reaches to their specified project depths. Ultimately, it will be up to the contractor to determine the correct means and methods to remove dredge material.

Place all dredged material in accordance with the dredged material placement plan, which includes the Ocean Dredged Material Disposal Site (ODMDS; Figure 1-1), bird islands, adjacent beaches and other beneficial uses, as described in Appendix D.

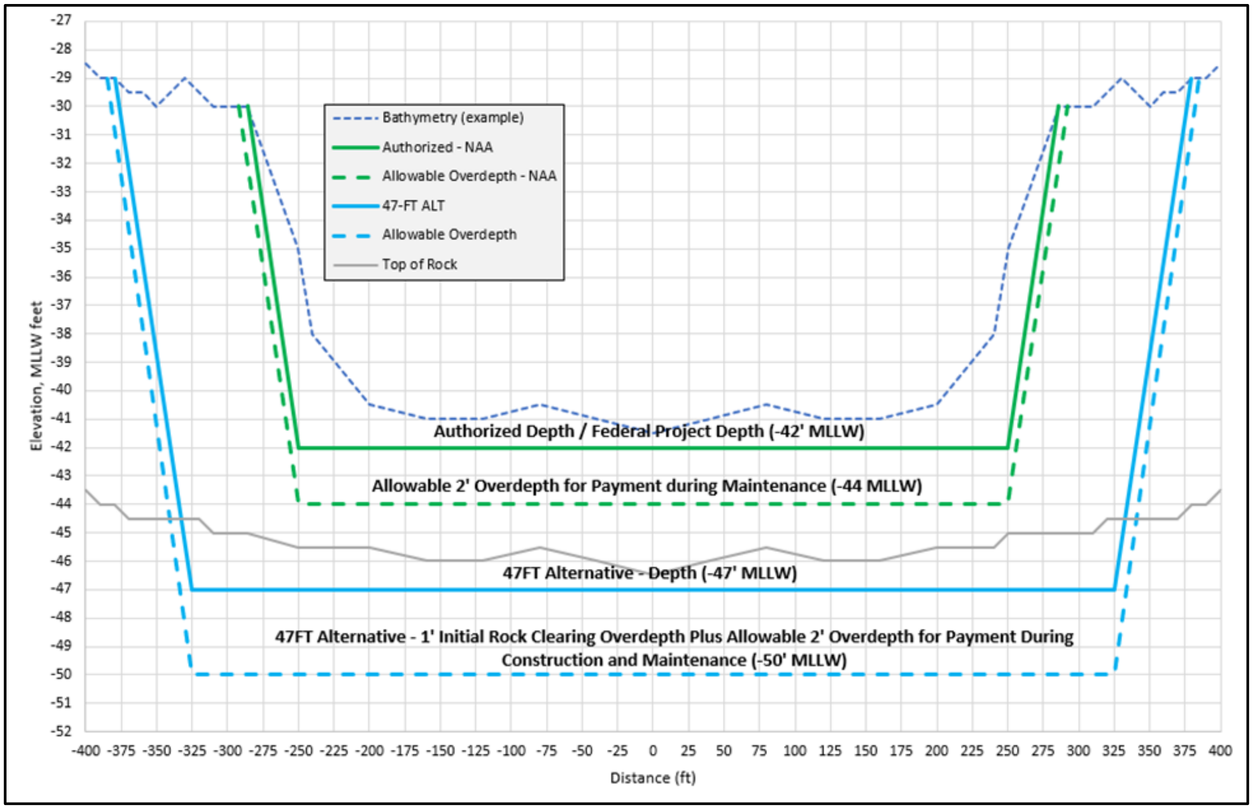

Figure 2-1: Typical cross section of Action Alternative 1 (-47 ft). Please note that the x-axis is more compressed than the y-axis and that the side slopes are not as steep as they appear in the figure.

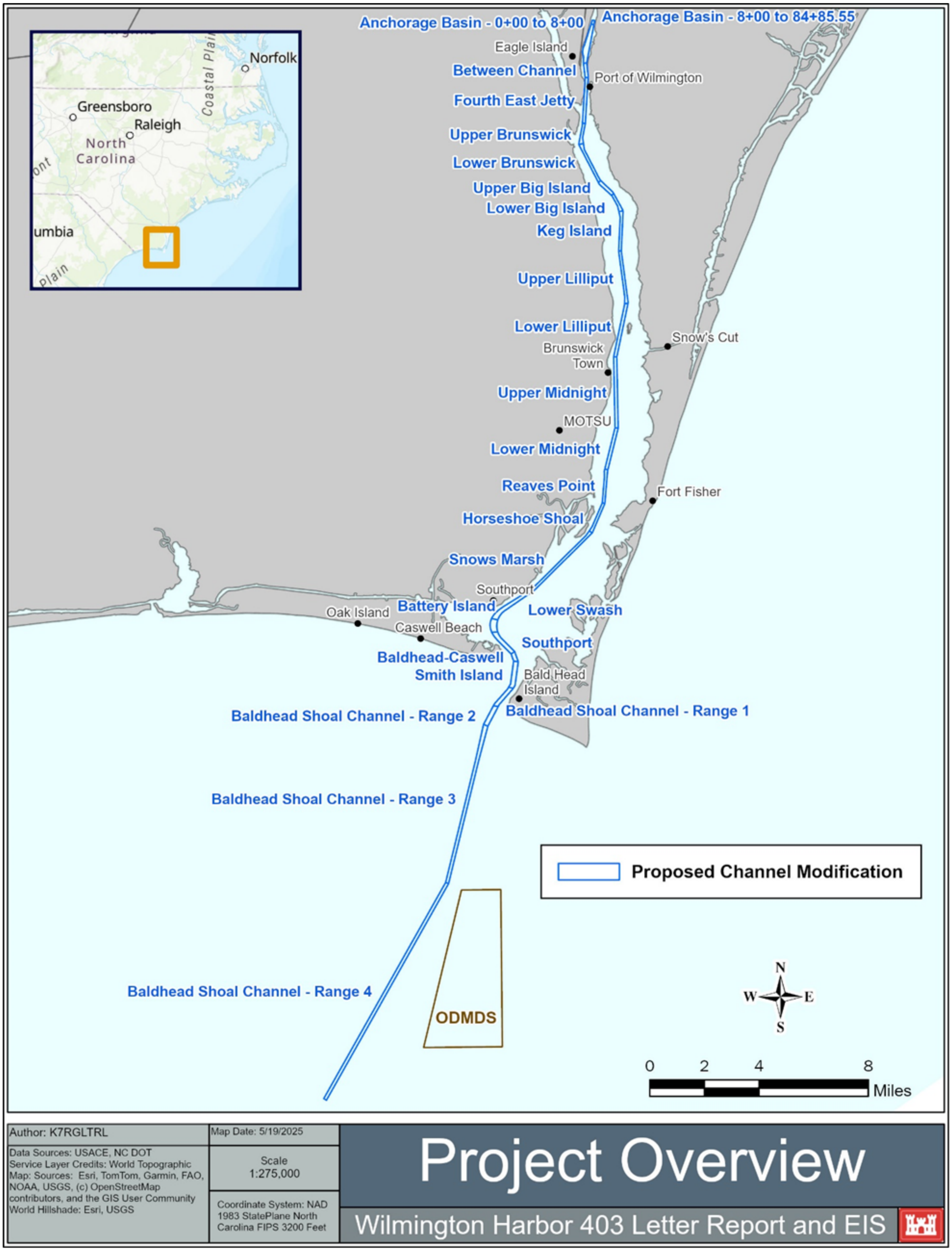

Figure 2-2. Project map with reach names and locations.

Table 2-4: Existing and Proposed Channel Widths (Alternative 1 and Alternative 2)

Reach Name	Reach Width (ft)		Widening Details
	Existing Channel	Proposed	
Baldhead Shoal Channel- Reach 4 (Proposed Entrance Channel Extension)	N/A	600	New
Baldhead Shoal Channel- Reach 3	500-900	600 - 900	Symmetric
Baldhead Shoal Channel - Reach 2	900	900	No Change
Baldhead Shoal Channel - Reach 1	700	900	West Side Only
Smith Island	650	900	East Side Only
Baldhead -Caswell	500	800	East Side Only
Southport	500	800	Re-orientation East Side then West Side
Battery Island	500	800 - 1300	Replaced with 4000-ft Radius Curve and West Side at Apex
Lower Swash	400	800 - 500	West Side to Symmetric
Snows Marsh	400	500	Symmetric
Horseshoe Shoal	400	500	Symmetric
Reaves Point	400	500	Symmetric
Lower Midnight	600	600	No Change
Upper Midnight	600	600	No Change
Lower Lilliput	600	600	No Change
Upper Lilliput	400	500	Symmetric
Keg Island	400	500	Symmetric
Lower Big Island	400	500	Symmetric
Upper Big Island	660	660	No Change
Lower Brunswick	400	500	Symmetric
Upper Brunswick	400	500	Symmetric
Fourth East Jetty	500	550	West Side Only
Between Channel	550	625	West Side Only
Anchorage Basin	625-1200	625 - 1509	West Side at Southern End and East Side at Middle

2.6 Action Alternative 2 (AA2) – 46 feet

Action Alternative 2 proposes to extend and deepen the entrance channel in combination with deepening and widening the inner harbor channels within the same reaches as the 47-foot Action Alternative (Figure 2-3). The proposed navigation improvements include:

Extend the existing entrance channel to create Baldhead Shoal Channel – Reach 4. The new channel would be dredged and extend approximately 48,000 feet (~9.1 miles) seaward from Baldhead Shoal Channel- Reach 3 to waters that are consistently deeper than the currently maintained channel depth of -48 feet MLLW (Figure 2-2). The reach offshore of the existing pilot boarding station (Sta 490+00) would have a heading of approximately 30 degrees (inbound), which is an approximate 16-degree shift from the Baldhead Shoal Channel - Reach 3 (14-degree). This heading change would take advantage of the most direct navigation path, which is an existing deeper natural channel, minimizing dredging volumes and environmental impacts, while reducing construction and maintenance costs.

Deepen the existing entrance channel from the Battery Island reach to the pilot station (Sta 490+00) from -44 feet to -48 feet MLLW for adequate underkeel clearance for anticipated container vessels where ocean waves occur.

- Deepen the existing inner harbor navigation channels, all reaches from Lower Swash to the Anchorage Basin from -42 feet to -46 feet MLLW.
- Construct side slopes of 5:1 (horizontal to vertical) from the entrance channel to Battery Island.

Widen the existing inner harbor navigation channel as described in Table 2-4. Construct side slopes of approximately 3:1 (horizontal to vertical) from Lower Swash to the Anchorage Basin as over time, the slope will naturally stabilize and remain in place without collapsing or eroding. The 3:1 design is to promote stability, and it is assumed that after construction, the slope will settle into a stable condition at 3:1.

Where rock is present within the proposed dredging footprint, an additional one foot of dredging below the project depth is required to remove the rock for safety purposes. In such areas, up to two additional feet of overdepth dredging is allowed, resulting in a potential total of three feet beyond the project depth. However, only the first foot is mandatory when rock is encountered. Overdepth dredging may occur during both initial construction and subsequent operation and maintenance dredging activities. Summary of project depth requirements can be found in Table 1-1.

The top of rock was determined using existing data (geotechnical and geophysical) from the 96-deepening act and new geotechnical survey data, collected in 2023. Additional geotechnical and geophysical information will be collected in Pre-Construction & Engineering Design (PED) to further refine the top of rock surface. Blasting occurred during the deepening effort in the early 2000s and consisted of removing rock from Lower Brunswick, Upper Big Island, Lower Big Island, and Keg Island. Blasting may be needed again to deepen these reaches to their specified project depths. Ultimately, it will be up to the contractor to determine the correct means and methods to remove dredge material.

Place all dredged material in accordance with the dredged material placement plan, which includes the Ocean Dredged Material Disposal Site (ODMDS; Figure 1-1), bird islands, adjacent beaches and other beneficial uses, as described in Appendix D.

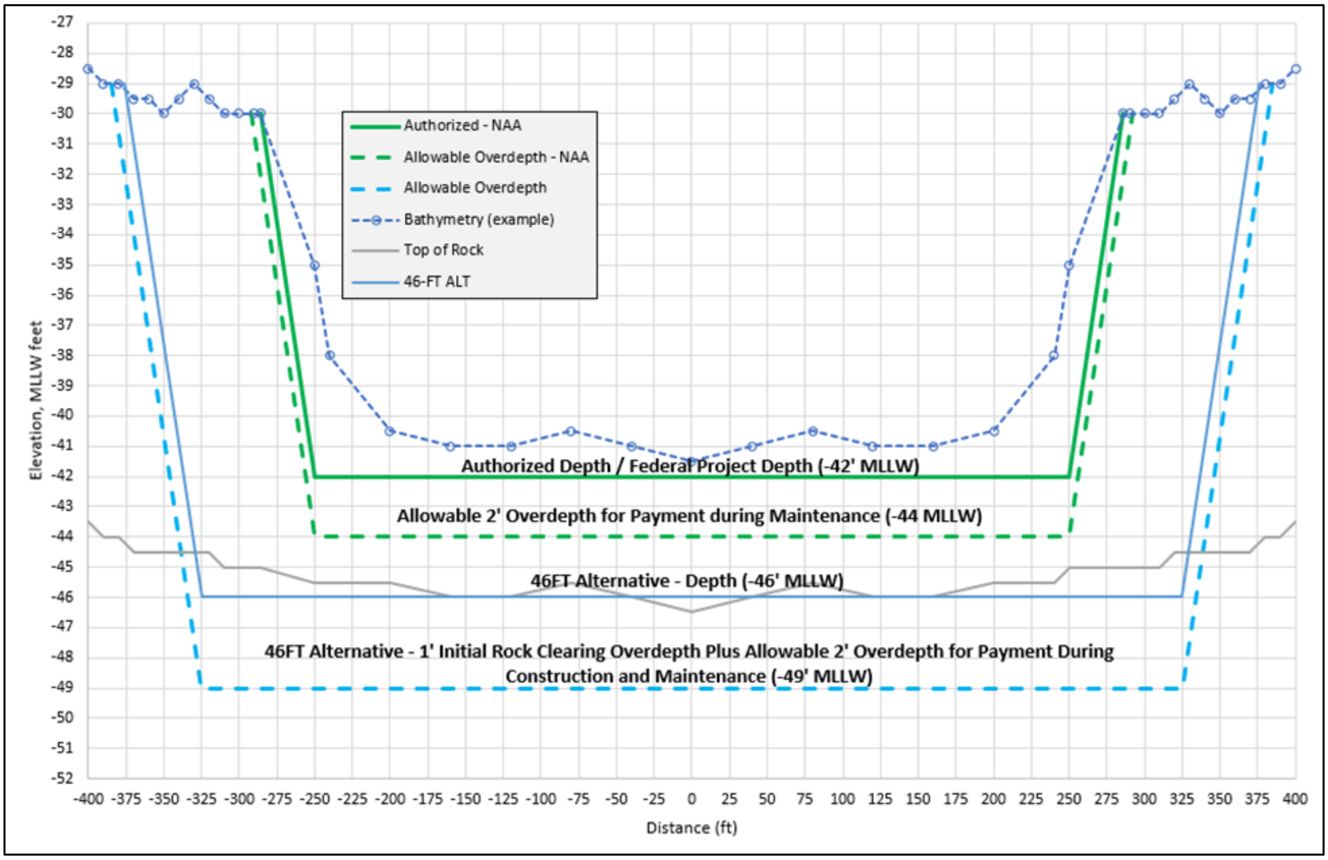

Figure 2-3: Typical cross section of alternative 2 -46 ft. Please note that the x-axis is more compressed than the y-axis and that the side slopes are not as steep as they appear in the figure.

2.7 Action Alternative Construction Methods

The action alternatives would use a combination of dredging methods, primarily involving cutter suction dredges and hopper dredges, depending on the sediment type and placement location. Cutter Suction Dredging will be used for portions of the Cape Fear River where finer sediment can be placed for beneficial use (Appendix D). It involves a rotating cutter head that loosens the material, which is then suctioned and transported through pipelines to designated placement areas such as a beach or bird island. Hopper Dredging would be used for the areas where coarser sediment predominates or where the sediment cannot be placed in a nearby beneficial use area. Hopper dredges remove sediments and temporarily store them in hoppers before transport to placement sites. Mechanical Dredging can also be used in place of Hopper Dredging in which sediment is removed by an excavator bucket and loaded into a barge for transport to placement sites or beneficial use areas. The dredged material would be placed in accordance with federal and state requirements. Proposed placement areas, for both action alternatives, include the ODMDS, the Wilmington Offshore Fisheries Enhancement Structure (WOFES), beaches in Brunswick and New Hanover Counties, and other beneficial use sites in and around the Cape Fear River.

In addition to dredging the federal navigation channel, there are reaches where rock would need to be removed to modify the FNS. Much of the rock is soft rock and can be removed through traditional dredging means, but a portion of the rock in the channel that is considered hard rock and may require blasting to break it up into manageable sized pieces before being removed by a dredge.

The project would likely take approximately six calendar years to complete, depending on environmental conditions, operational limitations, and funding availability, and divided into six contract years as described below:

Contract Year 1: Entrance, Baldhead Shoal Channel- Reach 3, Southport and Battery Island: This contract year would focus on utilizing hopper dredges to conduct work on the Entrance Channel and Baldhead Shoal Channel- Reach 3 with placement in the ODMDS and pipeline dredges to conduct work in Southport and Battery Island with placement on the Brunswick County Beaches or Bald Head Island.

Contract Year 2: Baldhead Shoal Channel - Reach 2 to Baldhead-Caswell and Lower Swash to Reaves Point: This contract year would focus on dredging from Baldhead Shoal Channel - Reach 2 to Baldhead-Caswell with placement of material on Brunswick County Beaches or Bald Head Island and dredging from Lower Swash to Reaves Point with placement of material on neighboring bird islands.

Contract Year 3: Lower Midnight to Keg Island: This contract year would consist of dredging from Lower Midnight to Keg Island with placement of material on neighboring bird islands, shorelines, or New Hanover County Beaches. This contract year may also consist of blasting or another form of pretreatment and removal of material in Keg Island with placement of material in the WOFES or ODMDS.

Contract Year 4: Lower Big Island and Upper Brunswick: This contract year would consist of dredging Lower Big Island and Upper Brunswick with placement of material in the ODMDS. This contract year may also consist of blasting or another form of pretreatment and removal of material in Lower Big Island with placement of material in the WOFES or ODMDS.

Contract Year 5: Upper Big Island, Fourth East Jetty and Between Channel: This contract year would consist of dredging Upper Big Island, Fourth East Jetty, and Between Channel with placement of material in the ODMDS. This contract year may also consist of rock blasting or another form of pretreatment and removal of material in Upper Big Island with placement of material in the WOFES or ODMDS.

Contract Year 6: Lower Brunswick and Anchorage Basin (Stations 8+00 to 84+81)**:** This contract year would consist of dredging Lower Brunswick and Anchorage Basin (Stations 8+00 to 84+81) with placement of material in the ODMDS. This contract year may also consist of rock blasting or another form of pretreatment and removal of material in Lower Brunswick with placement of material in the WOFES or ODMDS.

In developing the project timeline and the means and methods for construction, USACE made assumptions based on historical and collected data. These assumptions were applied to the engineering, environmental and economic analyses. Details regarding the basis for the assumptions can be found in Appendix E but is condensed below –

- The estimated dredging construction schedules were developed based on the quantities of material required to be dredged (29 million cy for the -46 feet alternative and 35 million cy for the -47 feet alternative), established environmental regulatory work windows of approximately 180 days, and historical dredging production rates.
- The geotechnical characteristics of the material to be dredged and removed.
- The required dredge types based on material characteristics, the placement location, and historical dredging production rates.
- Consideration has been given to an on-going industry demand for large dredging equipment, and potential difficulties obtaining large capacity dredging and towing equipment.
- The consolidated rock, with higher values of Rock Quality Designation (RQD), the thicker formations, or with unconfined compressive strength above 4,300 psi, is categorized as a hard rock. Hard rock is expected to be pretreated (i.e. blasting) for dredging by mechanical dredge. This rock occurs in four of the projects reaches: Keg Island, Lower Big Island, Upper Big Island, and Lower Brunswick.
- The consolidated rock with lower values of Rock Quality Designation (RQD), the thinner layer formations, or unconfined compressive strength below 4,300 psi, is categorized as a soft rock. The soft rock can be dredged without blasting. Those channel areas which contain a soft rock are expected to be excavated with a large 30-inch cutterhead type dredge. The dredging operations will be supported with a spider barge and hauling plants.
- The required dredging work and pretreatment of rock where it is needed for the removal of consolidated rock, will be completed within established environmental regulatory windows.

The project timeline is influenced by the quantity of material to be removed from the harbor, expected weather delays, and environmental timeframes for dredging and placing. The quantity of material projected to be dredged was based on bathymetric surveys and historic shoaling rates. Adverse weather conditions, including hurricanes or tropical storms, are anticipated in this area therefore, dredging operations will be paused during severe weather events. Dredging and placement timeframes that have been historically coordinated with state and federal agencies and applied to dredging projects will continue to be applied to protect marine resources such as sea turtles and migratory fish species and their habitat.

Project methodologies are influenced by the expected sediment characteristics. Based on collected boring data in the channel, USACE can confidently assume that the majority of dredged material consists of clean sand, silt, and clay with minimal contamination. Boring data also suggests that the majority of rock found in the navigation channel is soft rock, with the exception of a stretch of channel from Lower Brunswick to Keg Island, which contains hard rock.

Table 2-5: Type of Dredges to Be Used Based On Reach.

Reach Name from South to North	Reach Length (ft)	Distance to ODMDS		Maintenance Segment	Type of Dredge[1]
Baldhead Shoal Channel - Reach 4 (Proposed Entrance Channel Extension)	13,834	13,834 Ft	2.62 Miles	Outer Ocean Bar	Hopper
Baldhead Shoal Channel- Reach 3	26,658	34,954 Ft	6.62 Miles	Outer Ocean Bar	Hopper & Cutterhead
Baldhead Shoal Channel - Reach 2	4,342	51,638 Ft	9.78 Miles	Inner Ocean Bar	Cutterhead to Beach / Hopper to ODMDS
Baldhead Shoal Chanel- Reach 1	4,500	55,915 Ft	10.59 Miles	Inner Ocean Bar	Cutterhead to Beach / Hopper to ODMDS
Smith Island	5,100	60,826 Ft	11.52 Miles	Inner Ocean Bar	Cutterhead to Beach / Hopper to ODMDS
Baldhead-Caswell	1,921	64,205 Ft	12.16 Miles	Inner Ocean Bar	Cutterhead to Beach / Hopper to ODMDS
Southport	5,363	67,742 Ft	12.83 Miles	Inner Ocean Bar	Cutterhead to Beach / Hopper to ODMDS
Battery Island	2,589	71,597 Ft	13.56 Miles	Inner Ocean Bar	Cutterhead
Lower Swash	9,789	78,197 Ft	14.81 Miles	MidRiver	Cutterhead
Snows Marsh	15,775	90,922 Ft	17.22 Miles	MidRiver	Cutterhead
Horseshoe Shoal	6,102	101,746 Ft	19.27 Miles	MidRiver	Cutterhead
Reaves Point	6,531	107,712 Ft	20.40 Miles	MidRiver	Cutterhead
Lower Midnight	8,241	115,051 Ft	21.79 Miles	MidRiver	Cutterhead
Upper Midnight	13,736	125,981 Ft	23.86 Miles	MidRiver	Cutterhead
Lower Lilliput	10,825	138,653 Ft	26.26 Miles	MidRiver	Cutterhead
Upper Lilliput	10,217	148,421 Ft	28.11 Miles	MidRiver	Cutterhead
Keg Island	7,726	157,608 Ft	29.85 Miles	MidRiver	Cutterhead + Blasting + Mechanical
Lower Big Island	3,616	162,469 Ft	30.77 Miles	MidRiver	Cutterhead + Blasting + Mechanical
Upper Big Island	3,533	167,331 Ft	31.69 Miles	MidRiver	Cutterhead + Blasting + Mechanical
Lower Brunswick	8,161	172,339 Ft	32.64 Miles	Anchorage Basin	Cutterhead + Blasting + Mechanical
Upper Brunswick	4,079	178,464 Ft	33.80 Miles	Anchorage Basin	Cutterhead

Reach Name from South to North	Reach Length (ft)	Distance to ODMDS		Maintenance Segment	Type of Dredge[1]
Fourth East Jetty	8,852	184,853 Ft	35.01 Miles	Anchorage Basin	Cutterhead
Between	2,827	190,661 Ft	36.11 Miles	Anchorage Basin	Cutterhead
Anchorage Basin Station 8+00 to 84+81	7,681	196,310 Ft	37.18 Miles	Anchorage Basin	Cutterhead

[1] The type of dredge is subject to change based on the most cost-effective method.

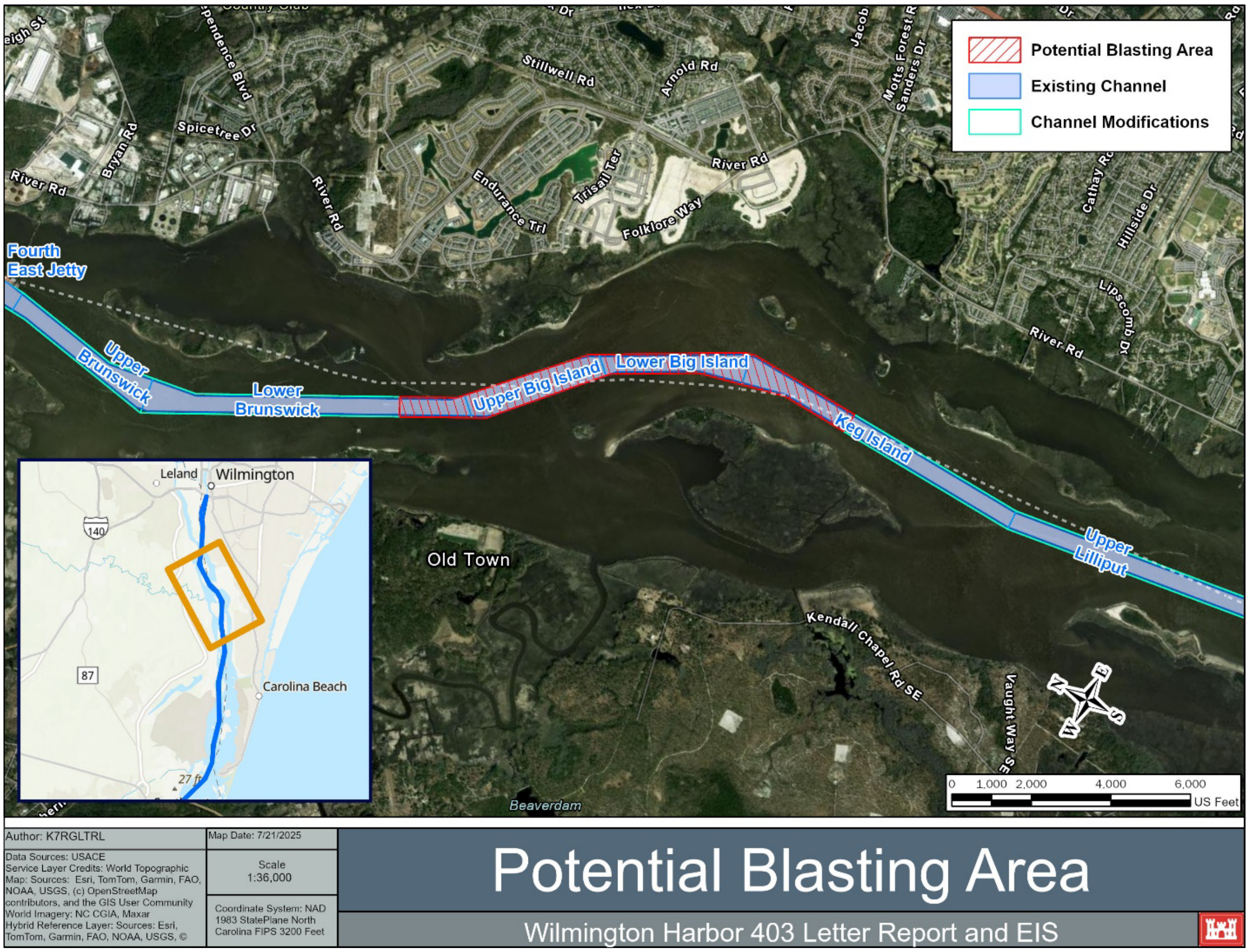

Figure 2-4: Potential blasting areas of the Wilmington Harbor FNS.

2.8 Beneficial Use of Dredged Material

For both action alternatives, approximately half of all material taken out of the federal navigation channel with the initial deepening effort would be placed in a beneficial way with respect to the ecosystem and environment. Additional information on beneficial use sites and their construction can be found in Appendix D. These beneficial use of dredged material (BUDM) projects include: (1) intertidal placement of fine-grained and sandy material along riverbanks, back barrier areas, surrounding bird island areas, and along marshes in the Cape Fear River; (2) beach nourishment in New Hanover and Brunswick Counties; (3) bird island placement, including those existing and historic footprints (renourishment); and (4) fish habitat rock placement at the existing WOFES. These four categories of beneficial use describe the way in which approximately half of the material from the project area will be allocated, for all types of sediment including but not limited to: non-beach quality sediment (fine-grained material including organics, ≤90% sand); beach quality sediment (sand and minimal organics, ≥90% sand); soft rock (rock not requiring blasting that can be removed by cutter-head dredge); and hard rock (may require blasting or fracturing before removal). These sites may be utilized for additional O&M placement activities after initial construction (Figure 2-5).

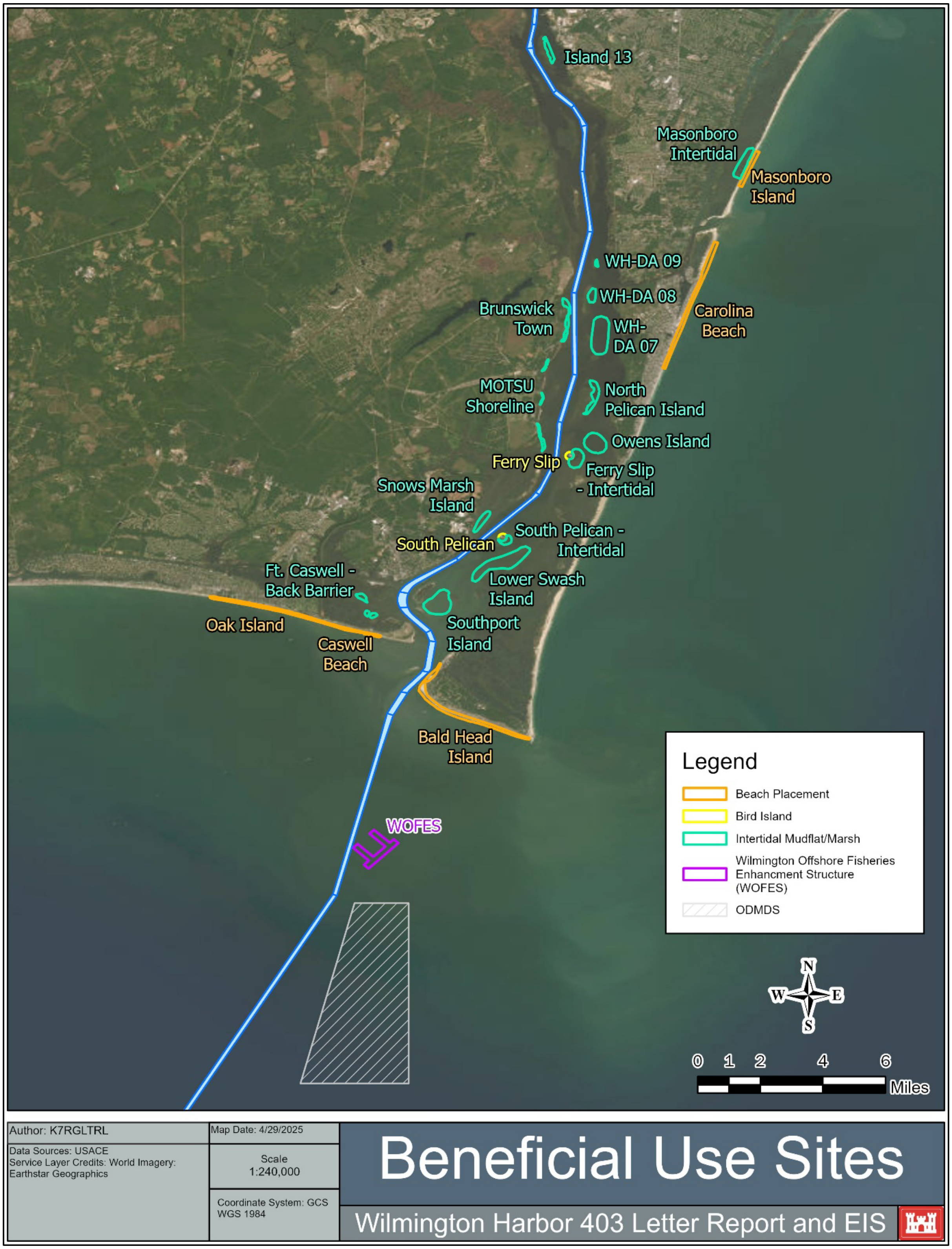

Figure 2-5: Proposed beneficial use sites.

Intertidal Placement

Intertidal mudflat creation via beneficial use includes the deposition of silt and mixed sediments onto the benthic area of a tidal or nontidal area abutting a wetland environment and/or shoreline above the MHW line of a system. These flats can provide substrate for additional sediment deposition over time, creating unique habitats for aquatic and land-based species. These BUDM sites can typically utilize 5,000 to 10,000 cubic yards of sediment per acre of placement. In North Carolina, bird island placements and beach nourishment can only receive 90% or more sand sediment makeup. Mudflats can receive any type of material that typically would go to the ODMDS. The BUDM sites could include perimeter rock walls to keep sediment in, channelized or braided deposition areas to that may provide essential fish habitat (EFH) below MLLW, and other engineering measures to ensure the design of each BUDM site benefits the location in the most ecologically resilient way. Coir logs and hay bales may also be utilized to maintain the placement site's footprint and trap sediment as it flows with the channel and tides. The majority of the beneficial use site for the proposed channel improvements are intertidal creation.

Table 2-6: Proposed intertidal mudflat beneficial use sites.

Intertidal Placement Site (North to South)	Approximate Footprint (Acres)	Approximate Capacity - Quantity of Material (Cubic Yards)
Island 13	50.7	370,525
WH-PA[1] 09	7.5	84,718
WH-PA[1] 08	46.3	511,247
WH-PA[1] 07	302.0	2,554,077
North Pelican Island	92.5	351,489
Brunswick Town Fort Anderson	64.5	693,111
MOTSU	43.1	339,108
Owens Island	183.1	1,566,952
Masonboro Island[2]	130.8	583,606
Ferry Slip Island	106.9	906,446
South Pelican Island	34.6	443,777
Snow's Marsh Island	63.9	354,329
Lower Swash Island	353.9	3,314,046
Southport Island	254.1	1,742,910
Ft. Caswell Back-Barrier	48.6	202,891

[1]Historically referred to as DA (Disposal Area), but is now referred to as a PA (Placement Area)

[2]Not currently economically feasible but may be in the future and/or during O&M. Included in impacts assessment.

Beach Nourishment

Beach nourishment is the deposition of beach quality sand onto beaches and inlets. Coastal storm risk management projects are often led by USACE to renourish beaches that have been eroded over time, often dredging sand from the open ocean and bringing it back to shore. Some beach placement projects take sand out of the federal navigation channel, improving navigability, and subsequently placing on beaches, benefiting local communities in a variety of ways. The proposed project includes five beaches identified for renourishment during construction, O&M, or both.

Table 2-7: Proposed beach nourishment beneficial use sites.

Beach Nourishment Site (North to South)	Approximate Footprint (Acres)	Approximate Capacity- Quantity of Sand (Cubic Yards)
Masonboro Island[1]	74.7	300,000
Carolina Beach[1]	233.8	1,000,000
Bald Head Island	269.5	1,600,000
Oak Island	190.3	2,000,000
Caswell Beach	20.2	

[1]Not currently economically feasible but may be in the future and/or during O&M. Included in impacts assessment.

Bird Island Placement

Bird islands are historically a more common form of BUDM USACE has implemented along the United States coasts that involves the deposition of primarily sand above the MHW mark, creating sandy islands for bird habitat. These islands are typically raised to higher elevations (no higher than 15 feet above MHW by law) than mudflats and may hold 15,000 to 29,000 cubic yards of material per acre. The maximum area as currently permitted by the Wildlife Resource Commission is 25 acres for all bird islands so that larger predators of the bird species would not have suitable habitat. The sand from these islands erodes, particularly in higher energy systems like tidal rivers. Bird islands benefit from vegetation and mudflats in close proximity, which can help trap sediment and create habitat. Two existing bird islands in the Cape Fear River have eroded over time and would be restored to their 25-acre footprint with initial construction measures. These two islands will also have intertidal placement around the "skirt" of the island, creating different types of habitats.

Table 2-8: Proposed bird island beneficial use sites.

Bird Island Site (North to South)	Approximate Footprint (Acres)	Approximate Quantity of Material (Cubic Yards)
Ferry Slip Island	25.0	336,000
South Pelican Island	25.0	227,000

Rock Placement

Rock structures below the MLLW line create EFH in riverine, brackish, and saline environments. The strategic deposition of blasted rock would provide habitat and allow for dredging of channels with rockier geology, like river basins, to place larger and harder sediments. The existing Wilmington Offshore Fisheries Enhancement Structure (WOFES) is the proposed rock placement site for the project, which will receive any hard (blasted) rock from initial construction, estimated to be 1,142,600 cubic yards.

Beneficial Use Construction Methods

The material would be placed using barges, pipelines, and scows, depending on the type of material and location. Historical geotechnical data provided insight into the type and quantity of sediment that would be available if the navigation channel is deepened to the proposed alternative depth. This data was then used to distinguish material types throughout the channel. A collaborative Technical Working Group, composed of Resource Agencies and stakeholders, used this information to identify potential beneficial uses based on the proximity of favorable sediment types.

The methodologies applied to place material, location in respect to vertical tidal range, ecological effects, and general plan for beneficial use of this material is described further in Appendix D. The beach placements at Masonboro Island and Carolina Beach, along with intertidal placement on the back side of Masonboro, are included in assessments in this DEIS as potential placement areas; however, because the cost for these placement options exceed the cost to dispose of the material at the ODMDS, they are not part of the Action alternatives. Further consideration of these options will be performed during the PED phase. For the purposes of cost, impacts and benefits assessments, the three placement areas were not included, and the associated material is assumed to be disposed of at the ODMDS or the most economically feasible location.

2.9 Mitigation Measures

Compensatory mitigation is intended to replace ecological services lost as a result of unavoidable impacts. Detailed information and analysis related to unavoidable impacts and associated mitigation is provided in Section 3 and in Appendices H, I, and M. The Action Alternatives would result in significant impacts to wetlands and aquatic habitat that would require compensatory mitigation.

Although there would not be a net loss of wetlands, some wetlands would be expected to lose partial ecological function through conversion from freshwater forested and marsh wetlands to oligohaline wetlands. Appropriately scaled mitigation in the form of preservation, enhancement, and restoration of wetlands have been identified and the associated costs considered in the alternative development, screening and selection process.

Aquatic habitat suitable for various species in multiple life stages would be adversely impacted requiring mitigation in the form of increased fish passage through the Cape Fear River upstream of existing locks and dams. Impacts were calculated by quantifying the number of habitat units (HU) impacted, and include HU loss of Atlantic sturgeon spawning, Atlantic sturgeon young of year (YOY), blueback herring, American shad riverine, striped bass larval, and striped bass spawning habitats.

Mitigation for wetland impacts includes the preservation of at least approximately 550 acres of forested freshwater wetlands and the restoration and enhancement of approximately 120 acres of *phragmites* and brackish marsh wetlands. Mitigation for aquatic habitat includes the construction of two fish passage structures in the Cape Fear River to restore access to historic spawning grounds for anadromous fish (Appendix M). The four proposed mitigation sites for unavoidable wetland and aquatic impacts are located in southeast North Carolina, specifically:

Wetland mitigation site 1 (Preservation) - Black River Corridor

Wetland mitigation site 2 (Restoration and enhancement) - Eagle Island/Alligator Creek

- Aquatic habitat improvement site 1- Lock and Dam 1 Fish Passage (bypass)
- Aquatic habitat improvement site 2- Lock and Dam 2 Fish Passage (rock ramp)

Additional information on mitigation sites for both wetland and aquatic habitat impacts can be found in Appendix M, including preliminary design plans, economics information, and considered mitigation alternatives.

In addition to the wetland and aquatic mitigation appendix, the proposed deepening may require blasting. The blasting mitigation plan (Appendix L) describes potential impacts and best minimization practices, which will be followed by any contractor involved in the proposed project.

SECTION 3 – AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

This section describes the human and natural environments within the study area (affected environment) and the potential environmental consequences (hereinafter referred to as effects or impacts) of the NAA, Alternative 1 (Recommended Plan; 47- foot deepening), and Alternative 2 (46-foot deepening) in accordance with NEPA and the USACE Procedures for Implementing NEPA (330 CFR 230). The proposed action areas, which include the areas of the FNS that would be widened/deepened/extended, the proposed placement areas (both beneficial use sites and ODMDS), and mitigation sites, are smaller areas within the study area. See Section 2 for additional information on the alternatives. The study area encompasses the Lower Cape Fear River estuary and surrounding areas, Lock and Dams 1 and 2 along the Cape Fear River north of the proposed dredging, the beaches and barrier islands of New Hanover County and Brunswick County, North Carolina, and offshore areas encompassing the extended Entrance Channel and Wilmington Ocean Dredged Material Disposal Site (ODMDS) (3-1). All resources in their associated subsection are evaluated within the larger study area, which is the greatest extent of potential environmental effects and impacts.

Effects or *impacts* refers to the changes to the human environment from the proposed action or alternatives that are reasonably foreseeable and have a reasonably close causal relationship to the proposed action or alternatives, including those effects that occur at the same time and place as the proposed action or alternatives and may include effects that are later in time or farther removed in distance from the proposed action or alternatives. Effects include ecological (such as the effects on natural resources and on the components, structures, and functioning of affected ecosystems), aesthetic, historic, cultural, economic (such as the effects on employment), social, or health effects. These also include both beneficial and detrimental effects, even if the cumulative effect of an action is beneficial. Negligible impacts would be imperceptible or not readily detectable. Minor impacts would be detectable or localized within a relatively small area if detectable. Moderate impacts would be those that are readily apparent and/or widespread. Major impacts would be substantial, highly noticeable, and/or result in changing the character of the landscape.

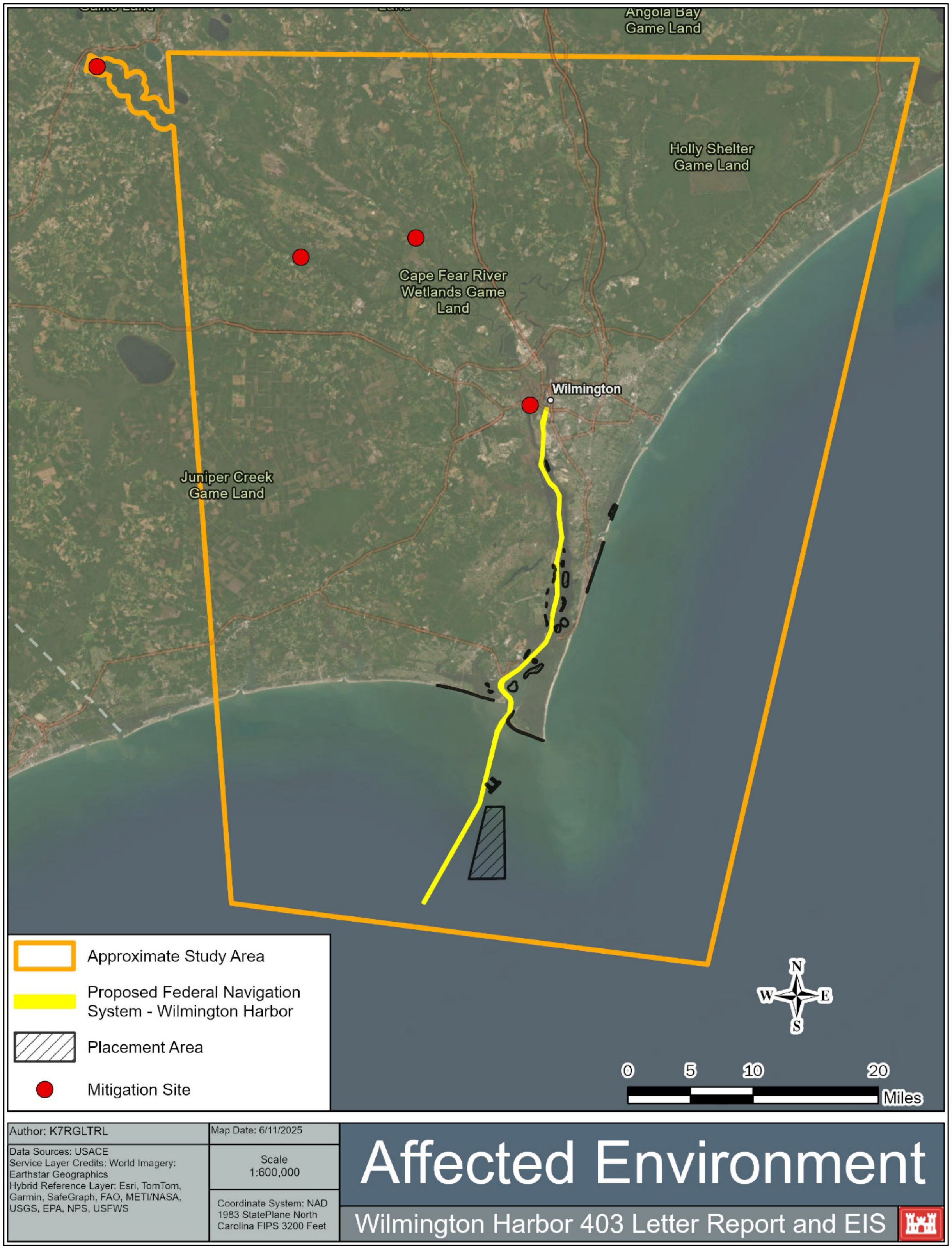

Figure 3-1: Affected environment assessment study area. Potential impacts that may occur within the spatial area seen in orange are assessed in this section of the EIS.

Effects analysis for each of the resources will discuss impacts from each of the action alternatives:

- **Construction-** Impacts from activities that would occur during the construction period. The timing, location, and duration of various construction activities over the course of the six-year construction period would vary according to the construction sequence and annual environmental work timeframes.
- **Deepening-** Long-term impacts resulting from the constructed channel modifications (deepening, widening, and extension). Changes in vessel traffic, water quality, etc.
- **Dredged Material Management and Channel Maintenance-** Impacts from beneficial use of dredged material and disposal in ODMDS. Postconstruction maintenance of the FNS for the duration of the 50-year project would involve the continuation of current dredging and placement practices and maintenance intervals for the existing channel reaches, with the addition of periodic maintenance dredging of the nine-mile offshore entrance channel extension reach.
- **Mitigation Measure-** Short-term impacts during construction of the mitigation feature and long-term effects after construction.

The effects analysis timeframe encompasses the projected six-year project construction period and the subsequent 50-year project life through 2087.

3.1 Considerations

While evaluating the resource impacts from the three project alternatives, the following highlights important considerations from the NAA and action alternatives, the appropriate sections in Section 2 are referenced that provide additional details:

- **No-Action Alternative Considerations**- Regular operations and maintenance activities would occur annually (Anchorage Basin and Outer Ocean Bar) or biennially (Mid River and Inner Ocean Bar) to the authorized depths. Placement would continue to occur in Eagle Island, the ODMDS, and on beaches.
- **O&M During Construction-** Regular O&M dredging would occur before and after the proposed FNS improvements for both the 46-foot and 47-foot alternatives. For example, the Anchorage Basin would be dredged to the currently authorized depth annually while the other reaches of the river get deepened. The converse is true in that reaches that were deepened during construction would receive maintenance annually (Anchorage Basin and Outer Ocean Bar) or biennially (Mid River and Inner Ocean Bar) to the new authorized depth while other reaches get deepened. The 2023 Regional Dredged Material Management Plan (R-DMMP) for Wilmington Harbor describes the current operation and maintenance plan for the existing authorized channels and depths.
- **Construction Timeframe** (Section 2.7)- The initial construction of deepening, widening, and expanding the channel in the proposed areas would take approximately six contract years for both the 46-foot and 47-foot alternatives. However, an estimated 5 million addition cubic yards of material would be taken out of the channel with the 47-foot alternative, which equates to an estimated additional 655 dredging days. The assumption for the proposed project is that more dredges would be working concurrently with the 655 dredging days occurring concurrently with other dredging. For example, during a given construction day, two dredges would be working for the 46-foot alternative, whereas three dredges would be working for the 47-foot alternative.
- **Construction Methodology-** See Appendix E for dredging methodologies, and Appendix C for blasting information.

- **Blasting**- Blasting may or may not be required to construct the proposed FNS improvements for both the 46- and 47-foot alternatives, but for the purpose of evaluating impacts, it is assumed that blasting would occur. In addition to the 2-foot overdepth for all dredging areas, reaches that contain rock will have an additional 1-foot required overdepth. Appendix L further addresses methodologies and impacts related to blasting.
- **Dredged Material Placement-** see Section 2.8 and Appendix D for information on beneficial use placement, and Sections 2.5 and 2.6 for general placement information under each action alternative.
- **Expected Sediment under AA1 and AA2-** The approximate amount and type of sediment that would be taken out of the FNS during each alternative, including the NAA's regular O&M, were estimated using hundreds of geotechnical borings and geophysical surveys to delineate material types and quantities. These quantities are outlined in Table 3-1.
- **Vessel Design/Traffic-** see Section 2.2 for additional information on vessel design and traffic of the Port of Wilmington.
- **Mitigation Measures**- see Section 2.9 and Appendix M.
- **Construction Footprint -** An additional 32 acres of benthos would be disturbed for the 47-foot alternative, compared to the 46-foot alternative. The additional acreage stems from the 3:1 slopes utilized for both alternatives. For every foot deepened, three feet would be widened, which would equate to three additional square feet on either side of the channel being disturbed. Approximately 5 million more cubic yards of material would be dredged with the 47-foot alternative, compared to the 46-foot alternative. Annual maintenance dredging of the existing channel requires approximately 2 million cubic yards of sediment to be removed. Shoaling rates could change over time, requiring more or less dredging, but the NAA would likely require the FNS to be maintained by taking an estimated 2 million cubic yards of sediment annually.

Table 3-1: Estimated quantities, including overdepth, of dredged material for three alternatives during initial construction or authorized operation and maintenance.

Contract Year (Federal Fiscal Year)	NAA (continued maintenance) – quantity dredged in cubic yards[1,2]	AA1 (47-foot deepening) – quantity dredged in cubic yards[3]	AA1 O&M– quantity dredged in cubic yards	AA2 (46-foot deepening) – quantity dredged in cubic yards[3]	AA2 O&M– quantity dredged in cubic yards
Year 1 (2030)	3,124,174	9,574,942	NA[4]	7,774,882	NA[4]
Year 2 (2031)	2,180,026	9,033,524	3,305,911	7,651,158	3,215,450
Year 3 (2032)	3,124,174	7,815,920	4,757,287	6,564,002	4,627,110
Year 4 (2033)	2,180,026	1,829,218	3,305,911	1,626,733	3,215,450
Year 5 (2034)	3,124,174	2,442,262	4,757,287	2,058,609	4,627,110
Year 6 (2035)	2,180,026	4,505,626	3,305,911	4,019,845	3,215,450
Total	**15,912,600**	**35,201,492**	**19,432,307**	**29,695,229**	**18,900,570**

[1] These quantities were based on data from average dredging quantities and shoaling rates from 2005 to 2022.
[2] Assumes funding will be available, shoaling rates will increase by 6%-10% after deepening, and that contracts are awarded and completed.
[3] Based on estimated existing material quantities; actual quantities may vary.
[4] Year 1 consists of removing current O&M materials from the existing channel depths.

3.1.1 Model Scenarios Table and Explanation

The following modeled data considered three SLC scenarios:

- Shoaling and Channel Design
- Oceanfront Shorelines
- Wave Transformation
- Vessel Wake
- Hydrodynamic, Water Quality, and Suspended Sediments
- Tidal Range
- Groundwater
- Habitat Suitability Index

The following modeled data considered storm impacts from Hurricane Florence, 100-year and 500-year storm events:

- Oceanfront Shorelines
- Wave Transformation
- Hydrodynamic, Water Quality, and Suspended Sediments
- Tidal Range

Table 3-2 discusses the modeling details for the associated resource.

Table 3-2: Summary of the modeling details for each applicable resource.

Resource	Modeled Data	Appendix	Summary of Model Details
Channel Morphology	Shoaling and Channel Design	B	FLOW/MOR/WAVE modules were used to simulate morphological changes due to both suspended and bed load sediment transport (e.g. shoaling).
Beach Shorelines	Oceanfront Shorelines	B	Impacts to the shorelines along Oak, Caswell and Bald Head Islands were evaluated using the 1D model, GenCade
	Wave Transformation	B	The Delft3D Wave spectral model was used to simulate and transform waves from the coastal ocean to the study area, using nearshore wave data as a key input.
River Shorelines	Vessel Wake	B	The XBeach model was used to simulate primary waves generated by container vessels. XBeach was adapted in its non-hydrostatic mode to simulate ship wave generation and propagation. One-hundred twenty-six model simulations were complete to assess the shoreline impact of primary waves generated by a 12,400 TEU vessel.
	Fleet Analysis	B	The Vessel Wake Prediction Tool (VWPT) was used to model the bottom stresses and wave heights generated by 13 vessel types for 21 reaches.
	Eagle Island - Slope Stability	C	GeoStudio 2021.4 was used to assess the slope stability of Cell 1 for expected

Resource	Modeled Data	Appendix	Summary of Model Details
			deepening and widening of the channel adjacent to Eagle Island.
Water Quality	Hydrodynamic, Water Quality, and Suspended Sediments	B	A WAQ module was developed to model salinity, total dissolved solids, suspended sediment, temperature, and dissolved oxygen.
Flooding and Tidal Impacts	Tidal Range	B	The validated Delft3D model framework served as the foundation for this analysis. The model was run in 2D rather than 3D, as vertical detail was not needed to simulate tidal water levels accurately.
Sediment	Top of Rock Surface	C	Developed by integrating hundreds of geotechnical data points collected across project area. These data were interpolated over varying distances (500->3000 ft) to create a continuous and subsurface rock layer.
Groundwater	Hydrogeology	C	A regional groundwater model using MODFLOW was built to investigate possible impacts to the groundwater system. A Monte Carlo sensitivity analysis was performed to investigate the uncertainty in the input parameters and understand how it might impact the certainty in the predictions of the modeling project.
Climate Variability	Climate Analysis	B	The current USACE Screening-Level Climate Change Vulnerability Assessment (VA) Tool and other tools described in Engineering & Construction Bulletin (ECB) 2018-14 were used in this analysis, including the Timeseries Toolbox (TST).
	Sea Level Change	B	Evaluated following the guidelines presented in USACE Engineer Pamphlet EP 1100-2-1 “Procedures to Evaluate Sea Level Change: Impacts, Responses and Adaptation” (30Jun2019). ER 1100-2-8162 “Incorporating Sea Level Change in Civil Works Programs” (31Dec2013) provides both a methodology and a procedure for determining a range of SLC estimates based on global sea level change rates, the local historic sea level change rate, the construction (base) year of the project, and the design life of the project.
Aquatic Habitat	Habitat Suitability Index	H	These ecological models were applied to assess how the project impacts to hydrodynamics and water quality would

Resource	Modeled Data	Appendix	Summary of Model Details
			affect aquatic habitat for seven representative species.

3.2 Resources Dismissed

The USACE does not anticipate any effect to hazardous, toxic and radioactive waste (HTRW) or land use from either the NAA or the Action Alternatives. Additionally, navigation and real estate are discussed in detail in the Letter Report. For these reasons, these resources have been dismissed from detailed analysis in Section 3 (Table 3-3).

Table 3-3: Resources Dismissed from Detailed Analysis in Section 3.

Resource Dismissed	Reason
Hazardous, Toxic and Radioactive Waste	An analysis showed no difference in impacts from NAA, AA1 and AA2. This analysis is available in Appendix C.
Land Use	No changes to land use are expected to occur due to the project.
Real Estate	The acquisition of real estate interests or permissions are discussed in the Letter Report, with additional information in Attachment 6: Real Estate Plan.
Navigation	Navigational improvements are a part of the alternatives formulation, and therefore not considered as resource to be evaluated in this section. Please see Letter Report and Section 2 of the EIS for additional information regarding navigation.

3.3 Hydrology and Hydraulics

The Delft3D model suite, developed by Deltares, was used as the primary tool for Hydrology and Hydraulics (H&H) analysis along with other models were used such as GenCade and XBeach. This included water quality, beach shoreline evolution, ocean wave transformation, and impacts due to vessel wakes and traffic. The modeling compared the no action to the two action alternatives while incorporating the three sea level change scenarios. The three sea level change (SLC) scenarios are No SLC, SLC1 (0.5 ft by 2086), SLC2 (1.28 ft by 2086), and SLC3 (3.77 ft by 2086). Statistical dry (HD), typical (HT), and wet (HW) year flow scenarios were also modeled. An overview of each of the selected numerical models and inputs are provided in Appendix B.

3.3.1 Channel Morphology

Modeling of channel morphological changes (i.e., shoaling) incorporated both riverine (flow) and coastal (tidal and wave) processes, and was used to evaluate the impacts under multiple SLC scenarios. The results were used to develop shoaling rates, for each alternative, along each reach of navigation channel. The shoaling rate for each reach of the navigation channel was calculated by summing the total volume of sedimentation within each polygon-defined area. Additional modeling inputs and parameters are provided in Appendix B.

Affected Environment

The shipping channel within the Lower Cape Fear River has undergone extensive dredging to support commercial navigation, and is considered a tidally influenced, meandering estuarine system with variable depths, natural shoals, intertidal marshes, and a dynamic sediment regime. USACE has straightened, widened, deepened, and maintained the channel through a series of dredging and realignment projects. The current channel is maintained to a depth of 42 feet and an authorized depth (including overdepth) of 44 feet. A few sections, specifically Battery Island, Southport, Baldhead-Caswell, Smith Island, and the Baldhead Shoal Reaches, are deeper, with maintained depths of 44 feet and authorized depths of 46 feet. Channel widths vary widely, from 400 to 1200 feet depending on the reach. Regular channel dredging maintains the channel morphology of the Lower Cape Fear River. Additional details regarding the channel design can be found in Appendix A.

Shoaling is persistent throughout the shipping channel, which drives the channel's morphology. Sediment accumulation results from both riverine and marine sources, which include upstream sediment delivery from the Cape Fear River watershed and sand transport from the Atlantic Ocean via tidal and wave action. Areas of regular shoaling are driven by hydraulic transitions, bends, and confluences within the river. Specific locations prone to shoaling include the inner and outer ocean bar reaches and anchorage basin reaches. Shoaling reduces navigable depth and may pose operational constraints for commercial vessels if not regularly managed.

Sediment type can also influence the channel's morphology and rate of shoaling. The modeled inputs defined the upper reaches as cohesive sediments (clays and silts) from Anchorage Basin to Reaves Point and the lower reaches as noncohesive sediments (sands, silty/clayey sands) from Reaves Point to Baldhead Shoal Reach 2. In the upper reaches the sediment entering the system is the same regardless of alternatives, as described in section 9.2.3.1. In the lower reaches the available sediment to enter the system is the same regardless of alternatives, as described in Appendix B section 9.2.3.2. These modeled inputs are what is generally observed as shoaled material throughout the shipping channel.

Environmental Consequences of NAA

The total volume of shoaled material under NAA would be anticipated to be less than that observed in AA1 and AA2. Under the NAA, the channel would continue to shoal at its historic rate depending on SLC, reflecting the ongoing natural processes of sediment deposition (Table 3-4). However, under the NAA, shoaling rates are likely to increase over time due to the cumulative impact of SLC on sediment transport and deposition patterns, which will ultimately change the channel's morphology.

Table 3-4: Historic shoaling quantities per year based on available dredge data 2005-2022.

Reach	Shoaling rate based on dredged volumes (cy/yr)			Number of times dredged between 2005-2022
	Minimum dredged volume	Maximum dredged volume	Annual average shoaling rate	
Anchorage Basin	347,600	1,631,500	1,077,100	18
Between Channel	17,100	93,200	40,300	17
Fourth East Jetty	14,400	63,500	10,700	5
Upper Brunswick	46,800	146,600	46,700	10
Lower Brunswick	50,900	247,900	64,900	10
Upper Big Island	50,000	209,800	34,300	5
Lower Big Island	70,000	84,500	12,900	3
Keg Island	46,600	128,700	19,800	4
Upper Lilliput	9,500	207,600	22,100	3
Lower Lilliput	3,400	413,300	50,800	4
Upper Midnight	38,900	407,500	37,900	3
Lower Midnight	13,900	131,100	8,100	2
Reaves Point	7,100	79,000	4,800	2
Horseshoe Shoal	35,100	139,300	35,200	7
Snows Marsh	9,600	124,500	19,900	6
Lower Swash	-	-	-	0
Battery Island	3,300	346,100	24,200	10
Southport	5,700	24,000	5,600	8
Baldhead- Caswell	78,500	78,500	4,400	1
Smith Island	300,500	1,176,500	182,100	6
Baldhead Shoal 1	15,500	683,200	122,300	7
Baldhead Shoal 2	71,700	804,100	112,500	5
Baldhead Shoal Reach 3	140,600	1,016,700	715,500	18

SLC plays a critical role in modifying the estuary's hydrodynamic regime. As sea levels rise, tidal prisms increase, and the energy and patterns of tidal flows and wave action shift. These changes can result in greater sediment transport into some parts of the channel, accelerating shoaling in localized areas. Overall, impacts from SLC alone were found to be nonlinear and spatially variable in both the upper and lower reaches. For example, the shoaling rate at Anchorage Basin consistently increased with increasing SLC. In contrast, the shoaling rates for Smith Island and Baldhead Shoal Reach 1 increased for SLC1 and SLC2 but decreased notably for SLC3. Among the scenarios, SLC2 resulted in the highest total shoaling rates across the navigation channel, followed by SLC1, with the lowest under No SLC conditions. Additional details regarding the comparison of the various alternatives with SLC can be found in Appendix B.

Environmental Consequences of AA1

Under AA1, reaches that are currently authorized at 42 feet are proposed to be deepened to 47 feet. These will also include an initial allowable overdepth of 2 feet, with an additional 1 foot permitted for rock clearing where applicable, resulting in a total allowable depth of either 49 or 50 feet depending on conditions.

Several reaches that are currently authorized at 44 feet are proposed to increase to 49 feet. These include Battery Island, Southport, Baldhead-Caswell, Smith Island, Baldhead Shoal Reaches 1, 2, and 3, as well as Baldhead Shoal Reach 4, which currently does not have an authorized depth. For most of these 44-foot reaches, the total allowable depth will reach 52 feet, which includes the 2 feet of initial overdepth and an additional 1 foot for rock clearing. However, some of these reaches, specifically Baldhead-Caswell, Smith Island, and Baldhead Shoal Reaches 1 and 2, do not contain rock and therefore rock clearing overdepth is not required, resulting in a total allowable depth of 51 feet instead. Under AA1, the channel would take this new channel morphology for the Lower Cape Fear River. Additional details regarding the AA1 channel design can be found in Appendix A.

Related to shoaling of the channel, impacts of action alternatives change spatially along the navigation channel. In the upper reaches, AA1 resulted in the highest shoaling rates, exceeding the NAA by approximately 6-10% (Table 3-5). In the lower reaches, AA1 produced the highest shoaling rates for all SLCs by a margin of approximately 1-3% compared to the NAA.

Under SLC0, shoaling in the upper reaches increased by 347,859 cy/year (11%) for AA1 compared to the NAA. In the lower reaches, shoaling increased by 69,767 cy/year (6%) for AA1. With Baldhead Shoal Reach 4 included, the total shoaling increases 1,551,276 cy/year (34%). Under SLC3, shoaling in the upper reaches increased by 198,859 cy/year (7%) compared to the NAA, while shoaling increased in the lower reaches by 30,778 cy/year (3%) for AA1. With Baldhead Shoal Reach 4 included, the total shoaling increases 1,225,307 cy/year (30%).

Table 3-5: Modeled shoaling quantities per year for the NAA and AA1.

Channel Reach	NAA - No SLC (cy/year)	AA1 - No SLC (cy/year)	AA1-NAA (% change)
Anchorage Basin	1,549,100	1,559,600	0.67
Between Channel	401,260	420,090	4.69
Fourth East Jetty	851,100	990,930	16.43
Upper Brunswick	93,389	145,600	55.91
Lower Brunswick	53,872	97,135	80.31
Upper Big Island	56,851	98,841	73.86
Lower Big Island	34,411	62,578	81.85
Keg Island	5,780	20,541	225.38
Upper Lilliput	952	5,312	457.98
Lower Lilliput	125,610	129,860	3.38
Upper Midnight	71,727	63,296	-11.75
Lower Midnight	4,900	2,263	-53.82
Reaves Point	312	1,078	245.51
Reaves Point	645	1,282	98.76
Horseshoe Shoal	209	326	55.98
Snows Marsh	4,227	4,319	2.18
Lower Swash	1,273	397	-68.81
Battery Island	8,326	9,218	10.71
Southport Channel	9,264	3,155	-65.94
Baldhead Caswell	1,663	84	-94.95
Smith Island	289,031	276,810	-4.23
Bald Head Shoal Reach 1	115,876	131,506	-13.49
Bald Head Shoal Reach 2	110,745	117,602	6.19
Bald Head Shoal Reach 3*	**715,500**	**781,827**	**9.27**
Baldhead Shoal Reach 4*	**N/A**	**1,133,649**	
Total	**4,506,023**	**6,057,299**	**34.43**

*Bald Head Shoal Reach 3 and Baldhead Shoal Reach 4 were not captured in the channel morphology modeling and values are based on historical dredging quantities and average shoaling increases across other Wilmington Harbor channels.

Environmental Consequences of AA2

Under AA2, reaches that currently have an authorized depth of 42 feet are proposed to be deepened to 46 feet. These generally include an initial allowable overdepth of 2 feet and, in most cases, an additional 1 foot for rock clearing. As a result, the total allowable depth for many of these reaches is 49 or 50 feet. Some sections, such as Upper and Lower Midnight, Reaves Point, and Horseshoe Shoal, do not include rock clearing overdepth, bringing their total allowable depth to 48 feet.

Reaches currently authorized at 44 feet are proposed to increase to 48 feet. These include Battery Island, Southport, Baldhead-Caswell, Smith Island, and Baldhead Shoal Reaches 1 through 3. Most of these allow for a total depth of 51 feet with both overdepth and rock clearing included, though several, namely

Baldhead-Caswell, Smith Island, and Reaches 1 and 2, do not include the extra foot for rock clearing and therefore have a maximum depth of 50 feet. Baldhead Shoal Reach 4, which currently does not have an existing authorized depth, is proposed to be set at 48 feet with a total allowable depth of 50 feet. Under AA2, the channel would take this new channel morphology for the Lower Cape Fear River. Additional details regarding the AA2 channel design can be found in Appendix A.

Related to shoaling of the channel, this channel deepening alternative produced consistent changes spatially along the navigation channel. Overall, AA2 showed higher shoaling rates compared to NAA (Table 3-6). The SLC0 scenarios showed increased shoaling in the upper reaches by a total of 237,603 cy/yr (7%) when compared to the NAA, and 45,369 cy/yr (1%) in the lower reaches. With Baldhead Shoal Reach 4 included, the total shoaling increases 1,385,601 cy/year (31%). The SLC3 scenarios showed increased shoaling in the upper reaches by 153,560 cy/yr (5%) when compared to the NAA and increased shoaling in the lower reaches of 19,649 cy/yr (0%). With Baldhead Shoal Reach 4 included, the total shoaling increases 1,155,871 cy/year (28%).

Table 3-6: Modeled shoaling quantities per year for the NAA and AA2.

Channel Reach	NAA - No SLC (cy/year)	AA2- No SLC (cy/year)	AA2-NAA (% change)
Anchorage Basin	1,549,100	1,544,700	-0.28
Between Channel	401,260	414,920	3.40
Fourth East Jetty	851,100	951,880	11.83
Upper Brunswick	93,389	133,750	43.22
Lower Brunswick	53,872	84,025	55.97
Upper Big Island	56,851	86,645	52.41
Lower Big Island	34,411	57,671	67.59
Keg Island	5,780	17,768	207.40
Upper Lilliput	952	4,294	351.05
Lower Lilliput	125,610	125,480	-0.10
Upper Midnight	71,727	62,566	-12.77
Lower Midnight	4,900	2,243	-54.22
Reaves Point	312	925	196.47
Reaves Point	645	1,190	84.50
Horseshoe Shoal	209	293	40.19
Snows Marsh	4,227	4,244	0.40
Lower Swash	1,273	373	-70.70
Battery Island	8,326	8,378	0.62
Southport Channel	9,264	3,836	-58.59
Baldhead Caswell	1,663	106	-93.63
Smith Island	289,031	277,500	-3.99
Bald Head Shoal Reach 1	115,876	129,823	12.04
Bald Head Shoal Reach 2	110,745	115,952	4.70
Bald Head Shoal Reach 3*	**715,500**	760,433	6.28
Baldhead Shoal Reach 4*	**N/A**	1,102,628	**N/A**
Total	**4,506,023**	**5,891,623**	**30.75**

*Bald Head Shoal Reach 3 and Baldhead Shoal Reach 4 were not captured in the channel morphology modeling and values are based on historical dredging quantities and average shoaling increases across other Wilmington Harbor channels.

3.3.2 Beach Shorelines

A wave transformation model was executed to simulate wave generation and propagation from the deep ocean to the study area were modeled using a spectral wave model for the NAA, AA1, and AA2, under three SLC scenarios. This was to determine whether wave heights would change due to the deepening which then would affect beach shorelines. This approach incorporated bathymetry, water level variations (due to processes such as tides or storm surge), winds, and offshore spectral wave boundary conditions. The impacts on wave heights due to the channel deepening alternatives and SLCs are discussed in terms of the four sites shown in: OCP1, Oak Island, Bald Head, and Eleven Mile (Figure 3-2). Overall, the change in significant wave height across the alternatives rarely reaches 1 cm or 0.1% for both SLC0 and SLC3. This is to be expected since the deepening scenarios only affect a very small and narrow area compared with the tens to hundreds of kilometers over which waves may propagate to reach the site. Additional details can be found in Appendix B.

Simulated long-term shoreline change along Oak Island and Bald Head Island (BHI) for the three alternatives (NAA, AA1, and AA2) was conducted using the 1D model GenCade. GenCade is a shoreline simulation model developed by the USACE that computes shoreline change, wave-induced longshore sediment transport, and morphology at inlets on a local to regional scale. The model was developed using digitized shoreline data from the North Carolina Department of Coastal Management and modeled wave input from the Delft3D model. The GenCade model was initially calibrated using the 2016 and 2020 digitized shorelines as the starting and final shoreline, and then comparative simulations of the NAA, AA1, and AA2 were conducted using the 2016 shoreline as the initial condition. Modeled shorelines for the typical wave conditions were run for 15 years and did not include beach placement activities for the NAA, AA1, and AA2 simulations, which would lessen the impacts of shoreline erosion. Shoreline change was only calculated for the 15-year period, because at least one beach placement activity would occur before the end of this period. The beach placements were not included to allow the direct comparison of shoreline erosion rates without the lessening effects of placement activities that could differ between alternatives. Additionally, the analysis was conducted to compare the NAA with AA1 and AA2 regarding shoreline susceptibility to erosion, wave runup, and wave overtopping.

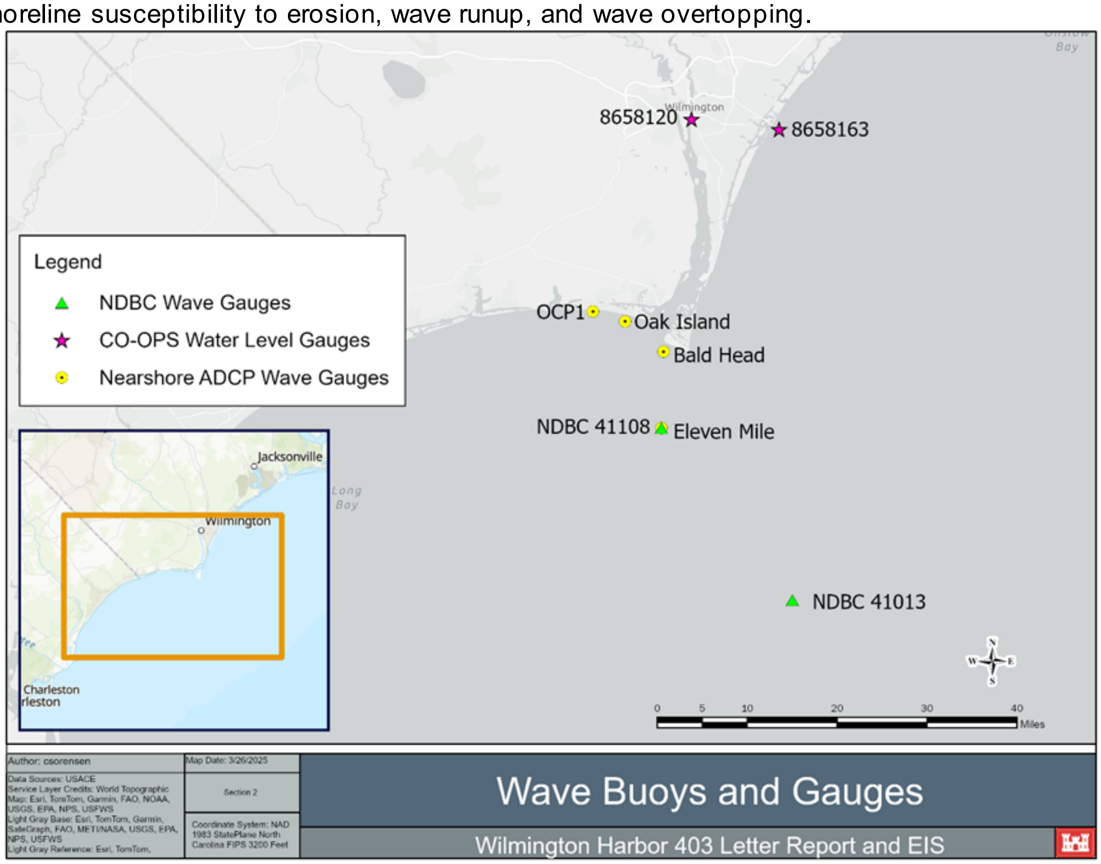

Figure 3-2: Locations of water level gauges, wave buoys and gauges in this study.

Affected Environment

Brunswick County beaches which include Oak Island, Caswell Beach, and Bald Head Island are located along the southern coast of North Carolina. This includes approximately 17 miles of oceanfront shoreline and consists of two barrier islands. These barrier islands exhibit dune heights of >10 ft NAVD88, a berm of 5-6 ft NAVD88 with varying degrees of width, and a gentle slope of the foreshore down to the water's edge. Sediments along the shoreline contain a mix of shell with fine to medium quartz sand sediments. The beaches have a typical tidal range of about 4 to 5 feet.

The wave climate is generally low to moderate in energy. Under normal conditions, significant wave heights range from 1 to 3 feet but can increase to 5 to 8 feet during storm events such as nor'easters and tropical systems. Waves predominantly approach from the southeast, resulting in a net longshore sediment transport from east to west. Seasonal variability leads to accretional conditions in summer and erosional conditions during winter, particularly near inlets and exposed headlands.

Average shoreline retreat rates vary, but due to regular O&M dredging, beach placement is a regular occurrence along these shorelines. According to the current sand management plan two out of every three cubic yards of littoral shoal material removed from the entrance channel is placed back on Bald Head Island and the remaining volume (one of three) is placed on eastern Oak Island/Caswell Beach. Typical quantities on an annual basis from O&M placements range between 300,000 and 1,000,000 cubic yards of sand. These regular nourishment activities prevent extensive shoreline retreat into the current dunes.

Environmental Consequences of NAA

Wave transformation under the various alternatives, which can influence shoreline change, would remain unchanged under existing conditions and is not expected to result in significant environmental consequences. However, the impact of SLC has a much greater effect on the wave transformation throughout the study area compared to the action alternatives. The changes in significant wave height between the SLC0 and SLC3 conditions typically range from 5 cm to 45 cm, with larger changes being associated with larger waves. The relative changes typically range from 5% to 10%.

The shoreline evolution modeling indicates that the NAA for Oak Island, Caswell Beach, and Bald Head Island would continue to experience shoreline change driven primarily by natural longshore sediment transport processes and wave conditions. Simulations under both typical and storm wave scenarios show that shoreline positions and sediment transport rates remain largely unchanged under the NAA. Specifically, differences in mean annual sediment transport between the NAA and the action alternatives are less than 1% under typical wave conditions and up to 8% under storm conditions at select locations. These variations are considered minimal and within the expected range of natural variability.

Additional analysis indicates that the shoreline would likely retreat over time due to SLC under all alternatives, including the NAA. However, given that shoreline changes associated with AA1 and AA2 are minimal, it is inferred that the cumulative effects of SLC and the absence of channel modifications under the NAA would result in comparable shoreline retreat magnitudes. Overtopping and wave runup analyses indicate virtually no difference in outcomes between the NAA and the channel-deepening alternatives, with overtopping rates nearly identical up to the hundredth decimal point for both present-day (SLC0) and projected future (SLC3) sea levels.

In summary, the NAA would result in continued shoreline change consistent with historical trends, with minimal variation in sediment transport and wave impacts compared to the action alternatives. The NAA provides a baseline condition against which the minor effects of channel deepening can be measured, and it demonstrates that such infrastructure changes have negligible influence on the long-term shoreline evolution of Oak Island, Caswell Beach, and Bald Head Island. Appendix B, Section 8.5 provides further analysis and documentation. Beneficial use placement along the beaches through regular O&M dredging would likely continue under the NAA, but were not included in the shoreline erosion modeling.

Environmental Consequences of AA1

For wave transformation modeling showed that AA1 only affected a very small and narrow area of the wave field compared with the tens to hundreds of kilometers over which waves may propagate to reach the site. The change in significant wave height across the alternatives rarely reaches 1 cm or 0.1%. Wave transform modeling shows no changes at Bald Head West Beach or Fort Caswell (Appendix B-IV) which is the main factor in the shoreline erosion given the rest of the environment is the same.

For AA1, under typical wave conditions, the maximum deviation in shoreline position over 15 years compared to the NAA is 1.3 feet at Oak Island (Figure 3-4, red line) and 4.2 feet at Bald Head Island (BHI) (Figure 3-5, red line), with changes in mean annual sediment transport of less than 1% for both locations (Table 3-7). During storm conditions, the maximum shoreline deviation compared to the NAA is less than 0.25 feet at Oak Island and 1.53 feet at BHI. Sediment transport shows a slightly larger deviation during storm conditions, especially at BHI, where there is an 8% increase, although Oak Island remains below 1% (Table 3-8). Overall, AA1 has a minor impact on long-term shoreline change, with only localized and minor variations in sediment transport and erosion patterns relative to the NAA.

BU placement along the beaches through regular O&M dredging would continue under AA1, but were not included in the shoreline erosion modeling. Modeled shoaling rates under AA1 are expected to slightly increase and material is available from the initial construction, which could result in more material being available for placement on these beaches. Therefore, expanding beach shorelines and critical habitats for marine life.

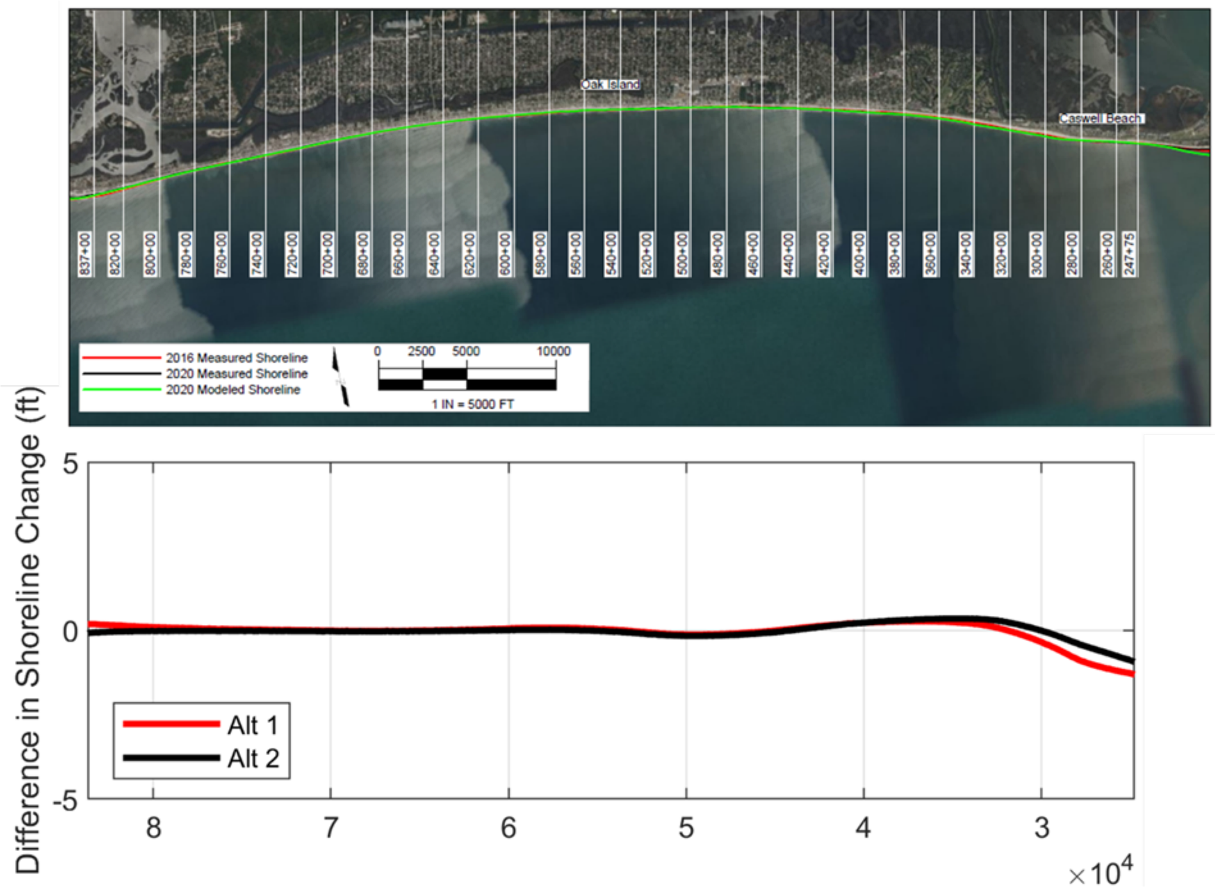

Figure 3-3: Measured modeled shorelines change for Oak Island (top); Relative difference in shoreline change (bottom) for AA1 and AA2, compared to the NAA shoreline after 15 years of typical wave conditions for Oak Island.

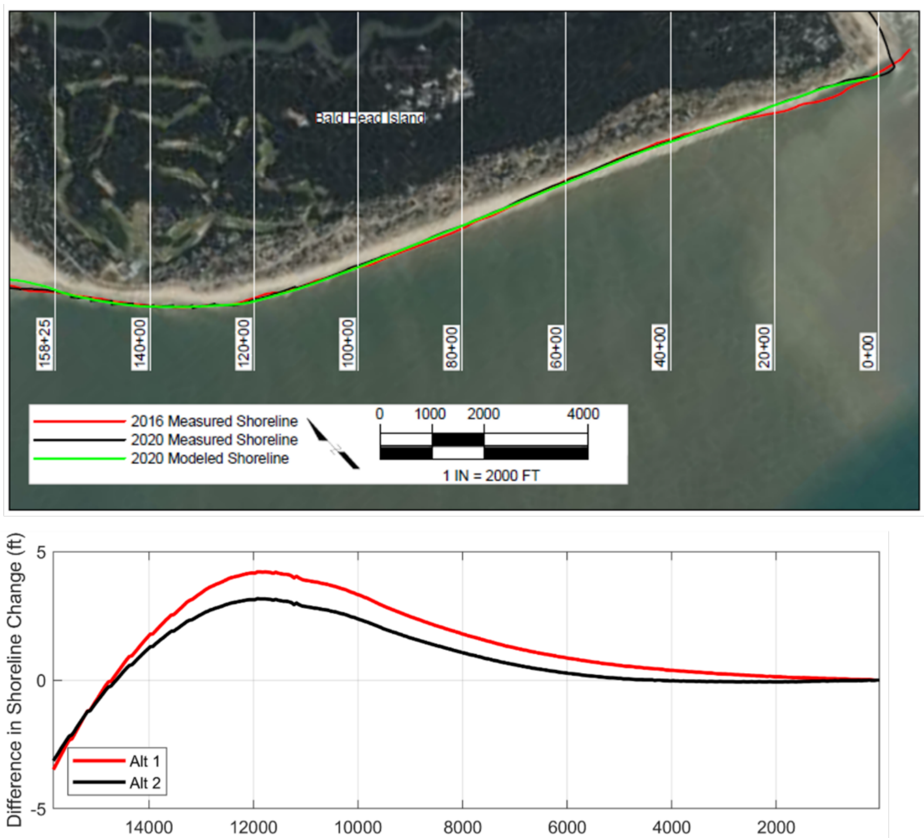

Figure 3-4: Measured and modeled shorelines change for Bald Head Island (top); Relative difference in shoreline change (bottom) for AA1 and AA2, compared to the NAA shoreline after 15 years of typical wave conditions for Bald Head Island

Table 3-7: Change in shoreline position and sediment transport along Oak Island and BHI with no SLC for NAA vs. AA1 during typical wave conditions

Channel Reach	Oak Island	BHI
Max Difference in Shoreline Position (15 years) (ft)	1.3	4.2
Max Difference in Mean Annual Transport (cy/yr)	360	1370
Max Difference in Mean Annual Transport (%)	<1%	<1%

Table 3-8: Change in shoreline position and sediment transport along Oak Island and BHI with no SLC for NAA vs. AA1 during a storm year

Channel Reach	Oak Island	BHI
Max Difference in Shoreline Position (15 years) (ft)	<0.25ft	1.53
Max Difference in Mean Annual Transport (cy/yr)	326	4037
Max Difference in Mean Annual Transport (%)	<1%	8%

Environmental Consequences of AA2

For wave transformation modeling showed that AA2 only affected a very small and narrow area of the wave field compared with the tens to hundreds of kilometers over which waves may propagate to reach the site. The change in significant wave height across the alternatives rarely reaches 1 cm or 0.1%. Wave transform modeling shows no changes at Bald Head West Beach or Fort Caswell (Appendix B-IV) which is the main factor in the shoreline erosion given the rest of the environment is the same,

AA2 shows minimal impacts on shoreline change and sediment transport compared to the No Action Alternative (NAA). Under typical wave conditions, the maximum shoreline deviation over 15 years is 0.9 feet at Oak Island (Figure 3-4, black line) and 3.2 feet at Bald Head Island (BHI) Figure 3-5, black line), with changes in mean annual sediment transport of less than 1% for both areas (Table 3-9). During storm conditions, shoreline position changes remain small—less than 0.25 feet at Oak Island and 1.3 feet at BHI. The variation in sediment transport increases slightly under storm conditions, particularly at BHI, where an increase of up to 7% is observed, though Oak Island remains below 1% (Table 3-10). Overall, AA2 results in minor, localized deviations in shoreline and sediment dynamics, indicating negligible long-term effects from this channel deepening alternative relative to existing conditions.

BU placement along the beaches through regular O&M dredging would continue under AA2. Modeled shoaling rates under AA2 are expected to increase, which could result in more material being available for placement on these beaches. Therefore, expanding beach shorelines and critical habitats for marine life.

Table 3-9: Change in shoreline position and sediment transport along Oak Island and BHI with no SLC for NAA vs. AA2 during typical wave conditions

Channel Reach	Oak Island	BHI
Max Difference in Shoreline Position (ft)	0.9	3.2
Max Difference in Mean Annual Transport (cy/yr)	327	822
Max Difference in Mean Annual Transport (%)	<1%	<1%

Table 3-10: Change in shoreline position and sediment transport along Oak Island and BHI with no SLC for NAA vs. AA2 during a storm year

Channel Reach	Oak Island	BHI
Max Difference in Shoreline Position (ft)	<0.25 ft	1.3
Max Difference in Mean Annual Transport (cy/yr)	307	3444
Max Difference in Mean Annual Transport (%)	<1%	7%

3.3.3 River Shorelines

A vessel wake analysis was performed to evaluate the potential impacts of two different action alternatives on ship-induced hydrodynamics and bed shear stress in the Cape Fear River. The combined results of the XBeach numerical modeling, analytical secondary wave analysis, upstream empirical calculations, and vessel throughput evaluation provide a comprehensive understanding of the relative impacts associated with vessel wake-induced bed shear stress in Wilmington Harbor. Seven model domains were established, extending from Bald Head Island to River Lights, and the simulations incorporated three water level conditions: MLLW with No SLC), MLLW + 4 feet (including tide induced water levels with no SLC), and MLLW + 7.77 feet (accounting for tides and sea level change under SLC 3). Vessel-induced wakes were modeled as a moving pressure field for a single 12,400 TEU vessel with the vessel properties detailed in Table 11-3 in the Wilmington Harbor 403 Letter Report.

A primary wave and secondary wave bed shear stress analysis was performed. For the primary wave a total of 126 XBeach simulations were run, covering various combinations of vessel size, travel direction, water level, and model domains of a 12,400 TEU vessel for each action alternative. The water surface elevation and bed shear stress values associated with the vessel primary wave were taken directly from the XBeach model output. Maximum and average water surface elevations—used as proxies for primary wave height—and bed shear stress values were computed across 7 model domains, including 32 observation areas.

Secondary vessel wakes were not modeled with XBeach due to technical limitations but were instead estimated using established analytical methods. Empirical equations from PIANC (1987) and Kriebel and Seelig (2005) were employed to estimate wave height and period for secondary waves generated by transiting vessels. These methods incorporate vessel speed, geometry, and the distance from the vessel to points of interest (POIs) near the shoreline. Calculations were performed at 51 points of interest (POIs) distributed throughout the channel from Baldhead Shoal to the USS North Carolina.

For areas upstream of Upper Brunswick to the USS North Carolina, XBeach modeling was not performed due to model extent limitations. To assess potential primary wave impacts in this region, an empirical method developed by Blaauw et al. (1984) was applied. This analytical approach estimates wave height based on vessel geometry, channel depth, and the distance between the vessel and shoreline. The analysis focused on the northern end of the Anchorage Basin, where large vessels slow down to dock and maneuver. A throughput analysis was also completed to evaluate cumulative bed shear stress impacts from vessel transit frequency. Lastly, a vessel fleet analysis was modeled and looked at 13 different types of vessels with a present-day total of 534 annual vessel passages, see Appendix B-II for additional details.

Affected Environment

The riverine shorelines along Wilmington Harbor encompass a diverse and ecologically significant mosaic of habitats that support both aquatic and terrestrial species along the 27 miles of river shoreline on the west side of the river and 30 miles of river shoreline on the east side of the river from the entrance channel to port of Wilmington. The shoreline along this corridor features a mix of natural and modified shoreline environments, including tidal marshes, brackish wetlands, and urbanized waterfronts. These riverine shorelines play a critical role in shoreline stabilization and habitat support.

The area supports diverse ecological zones, including salt marsh and intertidal mud flats, which serve as nurseries for fish and invertebrates and help buffer inland areas from storm surge and erosion. Anthropogenic and cultural features are prominent throughout the shipping channel riverbanks. Notable sites include the USS North Carolina Battleship Memorial, Brunswick Town/Fort Anderson, and Fort Fisher. The riverbanks also host port facilities, urban infrastructure, and residential developments along much of the river shorelines. Active conservation initiatives are underway to protect and rehabilitate the river shorelines. Restoration projects, such as living shorelines and oyster reef development, have been implemented to reduce erosion and improve shoreline stability.

Due to SLC and increased vessel traffic over the years, river shoreline erosion has become a significant concern at numerous locations throughout the Wilmington Harbor study area. Rising sea levels contribute to higher water elevations and more frequent tidal inundation, which intensifies wave action along the shoreline. This persistent wave energy gradually undermines riverbanks, leading to increased rates of erosion, bank retreat, and loss of critical habitat.

In addition, larger vessels and higher traffic volumes generate vessel wakes to induce river shoreline erosion. Some of the erosion hotspots along the river shorelines of the shipping channel include – Placement Areas: 7, 8, and 9, MOTSU, Brunswick Town/Fort Anderson, Ferry Slip, South Pelican Island, and Fort Fisher. This erosion not only threatens ecological habitats such as marshes and riparian forests but also poses risks to infrastructure, including docks, seawalls, and utilities.

Environmental Consequences of NAA

Increased vessel traffic over time would continue to elevate sediment disturbance and increase river shoreline vulnerability throughout Wilmington Harbor. The analytical evaluation of secondary waves, using conservative formulations, confirmed that even small vessel-generated waves can produce measurable bed shear stress in shallow nearshore zones. While these stresses were generally lower than those from primary waves, their frequency makes them significant contributors to long-term shoreline dynamics. Therefore, due to smaller vessels generating bed shear stresses even under the NAA, impacts are expected because the frequency of vessels would be higher compared to the existing fleet, increasing bed shear stresses throughout the project area.

Under the NAA, bed shear stress impacts will continue to escalate due to rising vessel traffic. The results showed that the maximum bed shear stress (MBSS) increased by approximately 19.8% due only to the higher number of vessel transits. In comparison, in the AA1 and AA2 project scenarios, the same increase in vessel traffic caused a smaller rise in MBSS—about 9.3%.

Vessel-induced shear stress is cumulative and contributes to long-term morphological change along vulnerable shorelines. Increased throughput may intensify localized impacts at specific locations such as Bald Head Island, Jay Bird Shoal, and Fort Caswell. These findings show that even without channel modifications, increased vessel frequency under the NAA could elevate erosion rates beyond current levels.

Related to the fleet analysis, assessing the number of vessels under the NAA includes increasing the total number of yearly vessel passages from 534 to 1214 while keeping the channel bathymetry the same. This increase is shown to significantly increase the total annual bottom stress experienced by the channel due to the increased number of vessel wakes caused by the increased number of vessel passages. The analysis reveals that this would lead to an increase in erosion rates seen throughout the channel under the NAA. The PPX Gen I and PPX Gen II vessels see the greatest increase in vessel numbers and therefore contribute the most to the total increase in bottom stress. For more information see Appendix B-II.

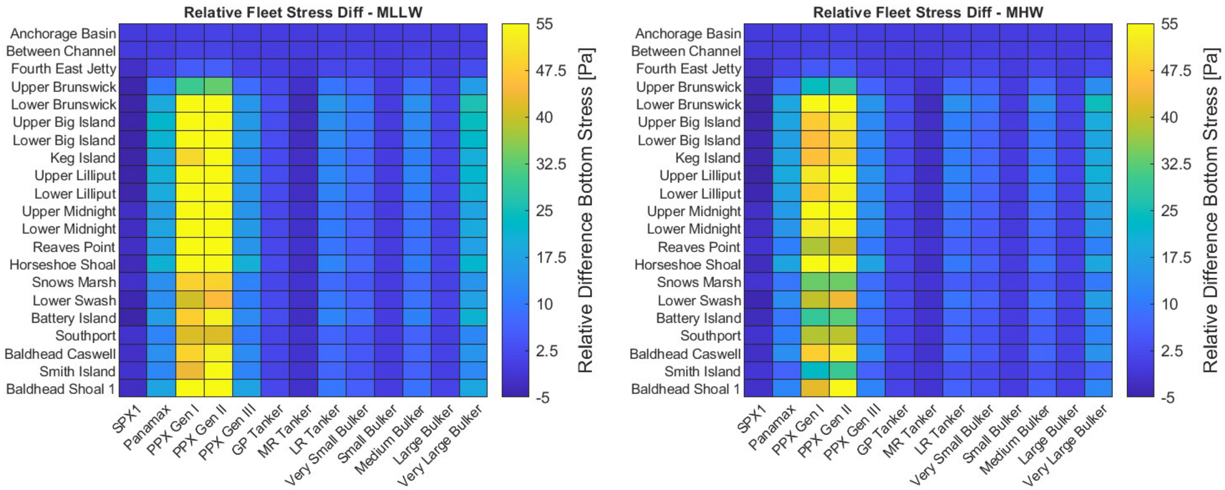

Figure 3-5: Normalized relative differences in bottom stress from Existing Conditions to the FWOP scenario at MLLW (a) and MHW (b) when considering the yearly number of vessels.

Under the NAA, no new work or O&M material will be placed for BU purposes along river shorelines aside from a few existing areas (i.e. Ferry Slip and South Pelican), meaning natural erosion could increase due to the absence of stabilization efforts through BU placement. This would lead to sediment loss, increased turbidity, and degradation of aquatic vegetation, fish spawning grounds, and wildlife habitats. Cultural resources and infrastructure would also be at greater risk due to shoreline retreat from no BU placement.

Environmental Consequences of AA1

Bed shear stress decreases under AA1 compared to NAA due to increased under-keel clearance, made possible by both sea level change and the deeper channel designs in the alternatives, which allows more space between the vessel and the seabed, reducing the intensity of vessel-induced turbulence. AA1, which provides slightly more under-keel clearance than AA2, may offer localized reductions in wake-related impacts.

Overall, AA1 exhibited the lowest impact among the action alternatives. It performed comparably to the existing channel and, in many cases, showed reduced bed shear stress, particularly at lower water levels. This is attributed to increased clearance between the vessel hull and the channel bed. This effect was most evident at mean lower low water (MLLW), where AA1 saw deeper vessel drafts, where AA1 demonstrated localized reductions in bed shear stress due to improved under keel clearance (UKC). Regardless of the action, increased vessel traffic over time would continue to elevate sediment disturbance and shoreline vulnerability throughout Wilmington Harbor.

At MLLW, AA1 demonstrated a 1.0% decrease in maximum bed shear stress and a 0.7% decrease in average bed shear stress compared to NAA. These increases became more pronounced at higher water levels in Figure 11-10 in the Wilmington Harbor 403 Letter Report. At MLLW +4 ft, these values increased slightly by 1.7% and 1.8%, respectively. Under SLC3 (+7.77 ft), AA1 showed minimal changes: a 0.04% increase in maximum stress and a 1.7% increase in average.

The throughput analysis emphasized that vessel-induced stresses will rise over time under any alternative, but AA1 would have the least cumulative impact. The fleet analysis showed a decrease in yearly passages from 1,214 to 949 under AA1, helping reduce bottom stress which in turn would reduce river shoreline erosion throughout the project area. For more information see Appendix B-II.

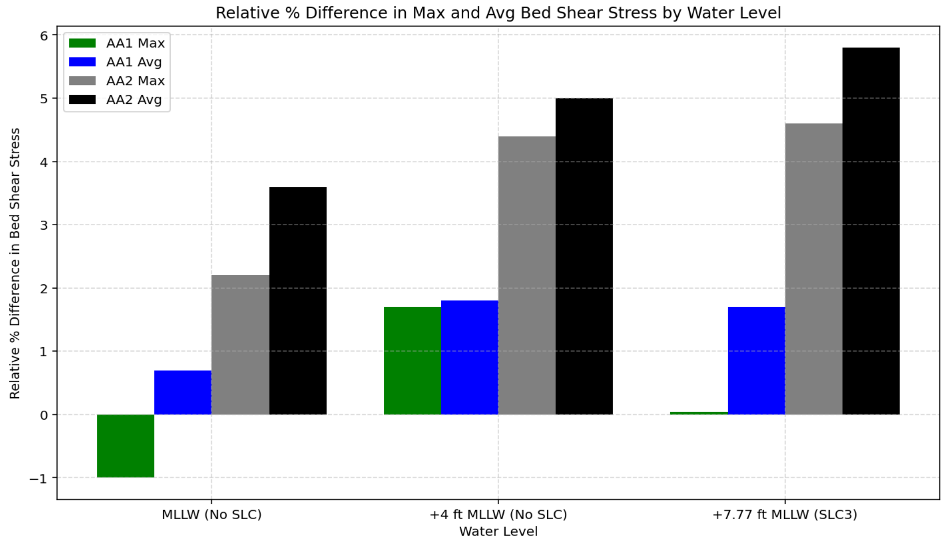

Figure 3-6: Relative Percent Difference in Maximum and Average Bed Shear Stress Compared to Existing NAA/ by Water Level.

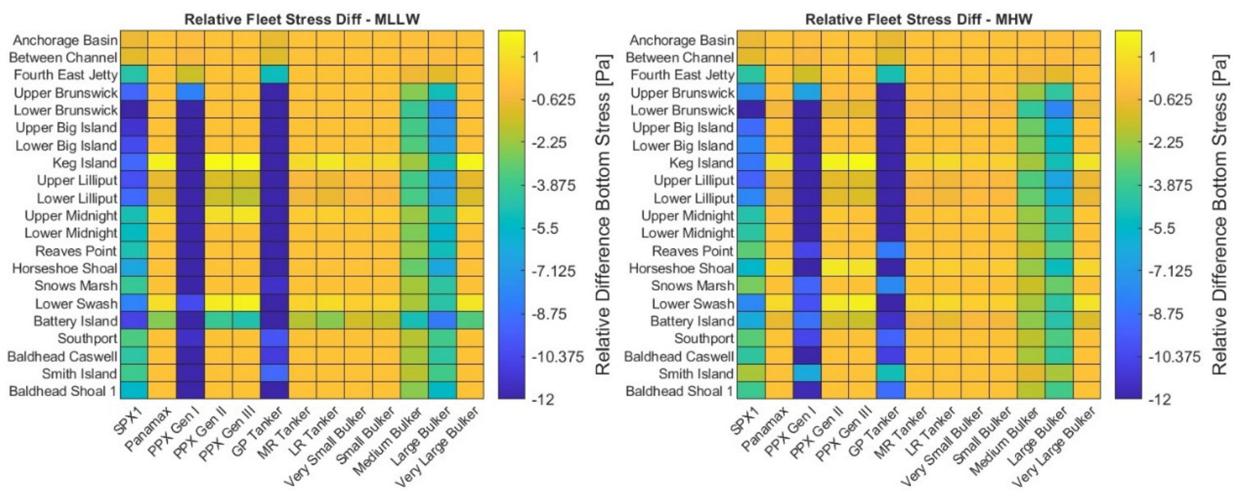

Figure 3-7: Normalized relative differences in bottom stresses from FWOP scenario to the AA1 scenario at MLLW (a) and MHW (b) when considering the yearly number of vessels.

For beneficial use, AA1 includes placement of new work and O&M material along the riverbanks, offering significant benefits for shoreline stabilization and habitat enhancement. These efforts protect vegetation, spawning areas, and infrastructure, while increasing resilience to storm events and sea level change. AA1 provides the most shoreline protection and ecological benefit of the alternatives.

Environmental Consequences of AA2

Bed shear stress decreases under AA2 compared to the NAA, due to increased under-keel clearance, made possible by both sea level change and deeper channel designs, which allows more space between the vessel and the seabed, thereby reducing the intensity of vessel-induced turbulence. However, AA2 provides slightly less under-keel clearance than AA1, which may lead to increased wake-related impacts on the seabed and in turn would lead to higher erosion along the river shorelines.

When comparing AA2 directly to AA1, the relative differences in maximum and average bed shear stress ranged from 2.5% at MLLW to 4.5% at +7.77 ft MLLW (SLC3). These values indicate that while both proposed actions would increase vessel wake-induced bed shear stress compared to existing conditions, AA2 is likely to have slightly greater impacts than AA1. This is reflected in the larger grey and black bars compared to the blue and green bars in Figure 3-8.

At higher water levels, both alternatives—particularly AA2—resulted in increased bed shear stress magnitudes and a wider spatial extent of impacts. AA2 generally produced the largest increases in wake impacts across the model domains, especially in narrow or shallow channel sections, where vessels operate at greater draft, leading to more intense wake-induced energy transfer to the bed.

The throughput analysis highlighted that vessel-induced stresses will increase over time, regardless of the alternative. The projected rise in vessel transits alone would amplify the frequency and intensity of wake impacts, further elevating cumulative bed stress across the system and causing erosion to the project's river shorelines. AA2 decreases the total number of yearly vessel passages from 1214 to 979 when compared to the NAA but contains a higher yearly vessel passage when compared to the AA1 (949). However, even in AA2 compared to NAA the analysis reveals that all sections of the channel would see a decrease in erosion. For more information see Appendix B-II.

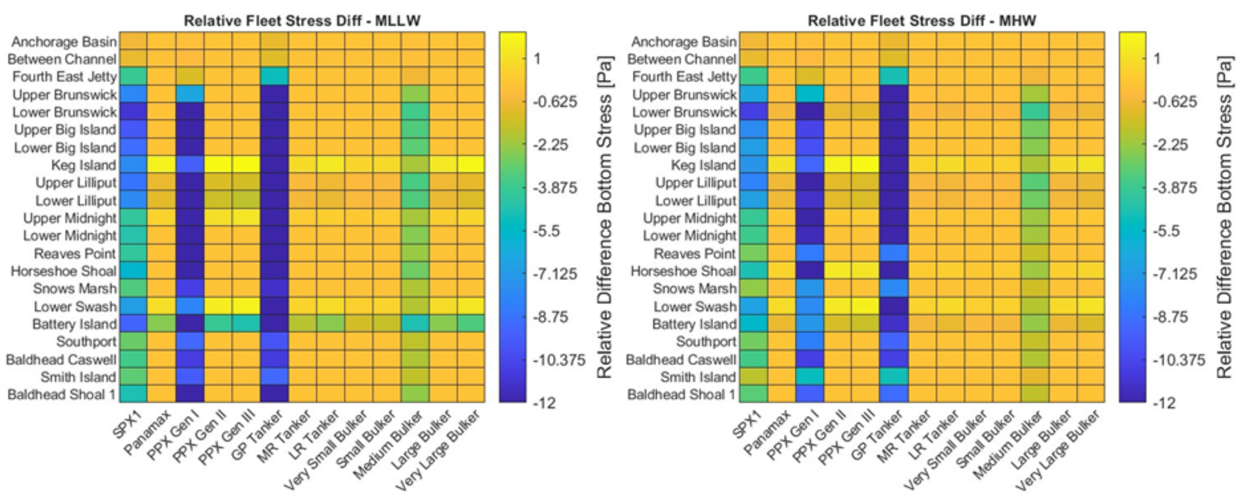

Figure 3-8: Normalized relative differences in bottom stress from the FWOP scenario to the Alternative 2 scenario at MLLW (a) and MHW (b) when considering the yearly number of vessels

For BU under AA2, material is placed along river shorelines compared to the NAA, but in lesser quantities than under AA1. While AA2 offers some benefits for bank stabilization and habitat support, the reduced volume of material limits the overall extent of erosion control and ecological enhancement. As a result, compared to AA1, more areas may experience continued shoreline erosion or receive less habitat reinforcement.

3.4 Water Quality

Simulations analyzed the variations in salinity, dissolved oxygen (DO), water temperature, and suspended solids for each alternative. The modeling approach integrated both riverine inflows and tidal processes and was designed to assess the influence of SLC3. Results from these simulations were used to compare future water quality conditions with and without the project over a representative annual cycle at 14 monitoring stations within the Lower Cape Fear River Program (LCFRP Figure 3-9). Additional details regarding water quality modeling results can be found in Appendix B-IX.

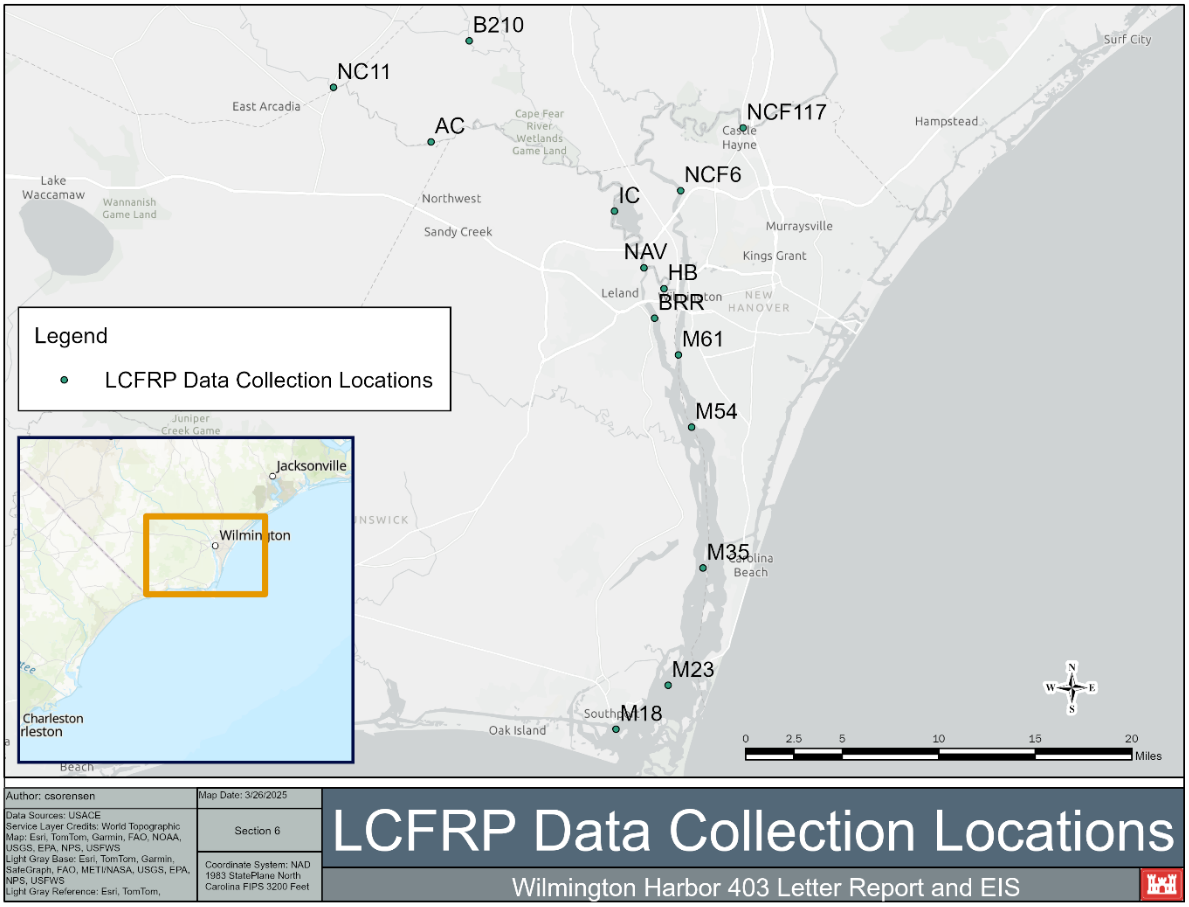

Figure 3-9: LCFRP data collection locations

3.4.1 Affected Environment

Water quality in the Lower Cape Fear River (LCFR), particularly within the Wilmington Harbor shipping channel, reflects a dynamic estuarine system influenced by freshwater inflows, tidal exchange, and seasonal variability. Baseline conditions were characterized using data collected by the LCFRP between 2004 and 2017, which provide a representative snapshot of existing conditions (Table 3-11).

Salinity levels in the harbor and adjacent estuarine waters exhibit clear seasonal trends, with the lowest values typically observed from January through March and the highest during summer and early fall (June–July and September–October), likely reflecting seasonal flow patterns and marine water intrusion. Across eight LCFRP monitoring stations, surface salinity ranged from 1.0 to 27.7 parts per thousand (ppt), with an average of 11.7 ppt, indicating a broad salinity gradient typical of a tidally influenced estuary. These conditions suggest periodic saline water encroachment well into the estuarine reaches of the river, particularly during low-flow periods or drought conditions, which can affect aquatic habitats and freshwater intakes near the shipping channel.

DO levels also displayed pronounced seasonal variability. Concentrations were generally highest during winter and spring months (December–March), peaking in February when river flows are typically elevated, and water temperatures are lower. Conversely, DO levels declined significantly during summer and early fall (June–September), especially under low flow conditions. Measured surface DO ranged from 3.2 mg/L to 12.4 mg/L, with an average of 7.2 mg/L. Several stations—including NCF117, NAV, HB, BRR, M61, and M54—frequently recorded DO concentrations below North Carolina's regulatory thresholds of 4.0 and 5.0 mg/L during warmer months. These seasonal low DO events are likely exacerbated by higher temperatures, reduced mixing, and biological activity.

Water temperature data followed expected seasonal trends, ranging from 4.3°C in winter to 31.3°C in summer, with an annual average of 19.5°C. These fluctuations directly influence other water quality parameters, such as DO saturation and biological metabolism. Suspended solids concentrations did not exhibit consistent seasonal trends, although spatial differences were noted across monitoring sites. Stations B210, NCF117, M61, and M35 showed relatively low interannual variability, while concentrations across all sites ranged from 2.1 mg/L to 54.8 mg/L, averaging 12.3 mg/L. Elevated suspended solids may reflect episodic sediment resuspension due to vessel traffic, storm events, or tidal currents within the shipping channel.

Total suspended solids (TSS) at the surface show no seasonal trends. Stations B210, NCF117, M61, and M35 had less variation in suspended solids concentrations across years than other stations. The maximum, minimum, and average observed surface water temperature across the 14 LCFRP monitoring locations were 54.8 mg/L, 2.1 mg/L and 12.3 mg/L respectively.

Table 3-11. Summary of LCFRP data measured at 14 monitoring locations.

LCFRP Station	Salinity (ppt)			Dissolved Oxygen (mg/L)			Water Temp. (deg C)			Suspended Solids (mg/L)		
	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean
B210	-	-	-	12.3	2.9	6.9	31.1	3.4	18.3	14.7	0.0	2.2
NC11	-	-	-	13.7	4.4	8.5	32.2	4.4	19.1	97.0	1.4	13.8
NCF117	-	-	-	11.6	0.3	6.1	30.8	5.2	19.3	41.0	1.0	4.0
AC	-	-	-	13.3	4.0	8.1	31.2	4.5	19.2	87.0	2.0	14.0
NCF6	22.3	0.0	2.9	12.1	1.7	6.5	31.4	3.1	19.7	86.0	0.0	13.3
IC	-	-	-	12.7	3.2	6.9	32	3.5	19.3	43.0	3.0	10.4
NAV	-	-	-	12.9	3.1	6.8	31.3	3.2	19.3	85.0	1.5	18.1
HB	21.3	0.0	3.4	12.6	3.1	6.9	31.4	3.3	19.7	47.0	3.8	14.3
BRR	22.8	0.0	4.2	12.7	3.2	7.0	32.3	3.6	19.8	35.0	3.9	12.8
M61	25.3	0.0	7.2	12.5	2.7	6.9	31.7	4.4	19.9	35.0	3.0	11.8

LCFRP Station	Salinity (ppt)			Dissolved Oxygen (mg/L)			Water Temp. (deg C)			Suspended Solids (mg/L)		
	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean
M54	26.8	0.0	9.5	12.2	3.0	7.2	31.3	4.3	19.8	71.0	4.0	15.5
M35	32.3	0.1	15.9	11.9	3.3	7.7	31.2	5.0	20.0	34.3	2.4	12.5
M23	35.1	1.9	22.9	11.8	4.0	7.8	30.5	6.0	20.0	38.0	1.5	13.5
M18	35.5	5.9	27.4	11.2	5.2	7.7	30.4	5.9	20.0	53.0	1.4	16.2
Average	27.7	1.0	11.7	12.4	3.2	7.2	31.3	4.3	19.5	54.8	2.1	12.3

3.4.2 Environmental Consequences of NAA

While overall conditions are expected to remain consistent with those described in the affected environment, SLC, particularly under the SLC3 scenario, affects several key water quality parameters when considered under the NAA. Below is the comparison between SLC0 and SLC3 for the surface and bottom layers. Sub-Appendix IX includes additional results including plots for the typical year of DO, salinity, temperature and TSS.

Dissolved Oxygen: DO levels tend to decrease under SLC3 compared to SLC0, suggesting that rising sea levels may lead to greater stratification or altered flow patterns that reduce oxygen availability in shallower or more enclosed areas. Surface DO levels decreased in the uppermost locations (B210, NC11, NCF117, and AC) and the lowermost locations (M54, M35, M23, and M18), but increased in the middle of the estuary (NCF6, IC, NAV, HB, BRR, and M61; (Table 3-12). The changes in the bottom DO closely followed changes in surface DO. Observations suggest that DO levels regularly fall below the state thresholds of 4.0 mg/L and 5.0 mg/L in the summer months at multiple locations: NCF117, NAV, HB, BRR, M61 and M54. The most notable impact was observed at LCFRP monitoring location B210, where the average change in surface DO for a typical year was -0.80 mg/L. Conversely, the least impact was noted at NCF117, where the average change was -0.03 mg/L.

Table 3-12: Mean difference in dissolved oxygen at the surface and bottom under typical year flow conditions for the NAA SLC0 and NAA SLC3 scenarios.

LCFRP Location	Mean Difference at Surface (mg/L)	Mean Difference at Bottom (mg/L)
B210	-0.80	-0.49
NC11	-0.23	-0.23
NCF117	-0.03	-0.02
AC	-0.65	-0.66
NCF6	0.23	0.23
IC	0.67	0.70
NAV	0.54	0.53
HB	0.42	0.31
BRR	0.25	0.22
M61	0.11	0.08
M54	-0.10	-0.06
M35	-0.27	-0.21
M23	-0.19	-0.19
M18	-0.24	-0.19
Average	**-0.02**	0.00

Water Temperature: SLC3 caused a change of less than 0.5 deg C, on average, in surface and bottom temperature across the project site (Table 3-13). The changes in the bottom temperature closely followed changes in surface temperature for a well mixed water column. The most notable impacts were observed at LCFRP monitoring locations M54 and M35, where the average change in surface temperature for a typical year was 0.62 deg C. Conversely, the least impact was noted at NC11, where the average change was 0.05 deg C. This indicates that water temperature tends to rise with increasing sea level, likely due to changes in water depth, flow patterns, and heat retention.

Table 3-13: Mean difference in surface and bottom temperature under typical year flow conditions for the NAA SLC0 and NAA SLC3 scenarios.

LCFRP Location	Mean Difference at Surface (deg C)	Mean Difference at Bottom (deg C)
B210	0.41	0.42
NC11	0.05	0.05
NCF117	0.43	0.43
AC	0.22	0.22
NCF6	0.34	0.34
IC	0.29	0.29
NAV	0.46	0.50
HB	0.58	0.62
BRR	0.59	0.61
M61	0.60	0.63
M54	0.62	0.63
M35	0.62	0.60
M23	0.56	0.55
M18	0.58	0.54
Average	**0.45**	**0.46**

Salinity: SLC increased surface and bottom salinity at 8 LCFRP locations, with an average increase of 4.40 ppt for the surface and 4.19 ppt for the bottom (Table 3-14). In the upper estuary (NCF6, HB, BRR, M61), the impact was less from January to March. Other locations showed a consistent impact year-round. The SLC3 scenario increases the salinity concentrations up the channel, particularly in the Northeast Cape Fear River and the Town Creek areas. The values close to the mouth of the channel increase from around 15 - 20 ppt to upwards of 25 ppt. The areas around the Black River and Cape Fear River show minimal response to increased SLC. Overall, salinity changes generally increase with rising SLC compared to the impacts of the deepening alternatives. The largest increase was at the HB station bottom layer at 5.94 ppt.

Table 3-14: Mean difference in salinity (ppt) at the surface and bottom under typical year flow conditions between the NAA SLC3 and NAA SLC0 scenarios.

LCFRP Location	Mean Difference at Surface (ppt)	Mean Difference at Bottom (ppt)
B210	-	-
NC11	-	-
NCF117	-	-
AC	-	-
NCF6	5.04	5.06
IC	-	-
NAV	-	-
HB	4.57	5.94
BRR	5.01	5.60
M61	5.45	5.48
M54	5.52	4.84
M35	4.37	3.90
M23	2.67	1.49
M18	2.60	1.23
Average	**4.40**	**4.19**

TSS: SLC3 caused an average change of -3.06 mg/L in suspended solids at the surface and –3.12 mg/L for the bottom across the project site Table 3-14. The largest changes were recorded at LCFRP monitoring location IC, where the average change in suspended solids at the surface for a typical year was -7.86 mg/L and the bottom was –8.09 mg/L. The smallest change occurred at NC11, with an average change of -0.53 mg/L and –0.57mg/L for the bottom. No seasonal trends in the impacts were observed over the course of the typical year considered (Appendix B-IX).

Table 3-15: Mean difference in TSS at the surface and bottom under typical year flow conditions for the NAA SLC0 and NAA SLC3 scenarios.

LCFRP Location	Mean Difference at Surface (mg/L)	Mean Difference at Bottom (mg/L)
B210	-0.57	-0.59
NC11	-0.53	-0.57
NCF117	-2.06	-2.06
AC	-1.36	-1.42
NCF6	-7.28	-7.26
IC	-7.86	-8.09
NAV	-5.97	-5.60
HB	-4.60	-4.05
BRR	-4.20	-3.95
M61	-2.46	-2.43
M54	-1.74	-2.17
M35	-1.30	-1.56
M23	-1.34	-2.02
M18	-1.52	-1.89
Average	**-3.06**	**-3.12**

3.4.3 Environmental Consequences of AA1

Under AA1, evaluation of potential surface and bottom water quality impacts were modeled across 14 LCFRP monitoring locations with two SLC change scenarios. This analysis focused on changes in dissolved oxygen (DO), water temperature, salinity, and total suspended solids (TSS) to identify any notable trends, hotspots, or periods of concern. All water quality parameters will meet the state criteria at NCF117, NAV, HB, BRR, M61 and M54 except DO concentration which regularly falls below the state thresholds of 4.0 mg/L and 5.0 mg/L in the summer months under the NAA. This would be expected to remain under AA1 as well. Overall, minimal changes were observed throughout the project area and upper estuary, with SLC emerging as the primary driver of water quality changes compared to the channel modifications. Sub-Appendix IX includes additional results including plots for the typical flow year of DO, salinity, temperature and TSS and includes observed data from the LCFRP.

Minimal changes in dissolved oxygen (DO) were observed at the surface across the 14 LCFRP monitoring locations, with variations of less than ±0.1 mg/L, as shown in Table 3-16 for SLC0 and Table 3-17 for SLC3. The mean difference in surface DO across all monitoring stations was -0.03 mg/L for both SLC0 and SLC3, with no discernible hotspots or specific periods of concern. The bottom layer followed the changes in the surface DO levels with a mean change of -0.05 mg/L for SLC0 and -0.03 for SLC3.

Overall, SLC has a more pronounced impact on DO distribution than the dredging alternatives themselves.

Water temperature also showed negligible variation, with changes of less than ±0.1°C at all monitoring sites for the surface and bottom layers, as detailed in Table 3-18 for SLC0 and Table 3-19 for SLC3. The mean difference in surface water temperature was 0.02°C for SLC0 and 0.04°C for SLC3 across all monitoring locations. No hotspots or concerning time periods were identified with changes in the bottom layer following trends on the surface. The state criteria for temperature is no increase of 0.8 °C Jun-Aug and 2.2 °C rest of year. Modeled results show this not being exceeded for both the surface and bottom layers. Overall, temperatures generally increase with rising SLC compared to the impacts of the deepening alternatives.

The most notable salinity impact occurred at monitoring location M61 (mid-estuary, near the Port of Wilmington), where the average surface salinity change during a typical year without SLC was 1.28 ppt at the surface and 2.51 at the bottom layer, as shown in Table 3-20 and Table 3-21. The mean difference in surface salinity was 0.84 ppt for SLC0 and 0.93 ppt for SLC3 across all monitoring stations. For the bottom layer, mean difference in salinity was 1.21 ppt for SLC0 and 1.10 ppt for SLC3 across all monitoring stations. The state criteria for changes in salinity for Class SC waters is no removal of the functions of Primary Nursery Areas, which were assessed in the Habitat Suitability Index analysis in Section 3.18. The impacts of salinity shifts to environmental resources are further discussed in Section 3.5 Wetlands, Section 3.18 Aquatic Habitat, and Section 3.19 Essential Fish Habitat and in more detail in each section's associated Appendix.

TSS exhibited minimal surface and bottom changes, with variations of less than ±1.0 mg/L at the monitoring sites, as shown in Table 3-22. The average change in surface TSS across monitoring locations was –0.10 mg/L for SLC0 and 0.21 mg/L for SLC3. For the bottom layer the average change was –0.10 mg/L for SLC0 and 0.24 mg/L for SLC3.

Table 3-16: Mean differences in surface and bottom dissolved oxygen (DO) AA1 and NAA with SLC0.

LCFRP Location	Surface DO (mg/L)		Bottom DO (mg/L)	
	NAA	AA1 – NAA	NAA	AA1 – NAA
B210	5.55	-0.04	4.99	-0.03
NC11	8.03	0.00	8.00	0.00
NCF117	8.03	0.01	8.00	0.01
AC	7.03	-0.01	6.95	-0.01
NCF6	7.52	-0.05	7.50	-0.05
IC	6.82	0.02	6.66	0.02
NAV	6.83	0.01	6.80	0.01
HB	6.90	-0.02	6.91	-0.05
BRR	7.03	0.01	6.95	0.00
M61	7.22	-0.09	7.14	-0.13
M54	7.49	-0.09	7.37	-0.11
M35	7.83	-0.08	7.67	-0.08
M23	7.62	-0.08	7.24	-0.11
M18	7.46	-0.08	7.09	-0.11
Average	**7.24**	**-0.03**	**7.09**	**-0.05**

Table 3-17: Mean differences in surface and bottom dissolved oxygen (DO) between AA1 and NAA with SLC3.

LCFRP Location	Surface DO (mg/L)		Bottom DO (mg/L)	
	NAA	AA1 – NAA	NAA	AA1 – NAA
B210	4.76	0.02	4.50	0.03
NC11	7.80	0.00	7.78	0.00
NCF117	8.00	0.00	7.98	0.00
AC	6.38	0.00	6.29	0.00
NCF6	7.75	-0.07	7.73	-0.07
IC	7.49	0.00	7.37	0.00
NAV	7.37	-0.03	7.33	-0.04
HB	7.32	-0.06	7.21	-0.07
BRR	7.27	-0.05	7.17	-0.06
M61	7.33	-0.09	7.22	-0.11
M54	7.39	-0.09	7.30	-0.09
M35	7.56	-0.07	7.46	-0.07
M23	7.43	-0.04	7.05	0.01
M18	7.22	0.01	6.90	0.07
Average	**7.22**	**-0.03**	**7.09**	**-0.03**

Table 3-18: Mean difference in surface and bottom water temperature between AA1 and NAA with SLC0.

LCFRP Location	Surface Temperature (°C)		Bottom Temperature (°C)	
	NAA	AA1 – NAA	NAA	AA1 – NAA
B210	18.64	0.01	18.64	0.01
NC11	17.99	0.00	17.99	0.00
NCF117	19.44	0.00	19.43	0.00
AC	18.63	0.00	18.62	0.00
NCF6	19.24	0.00	19.24	0.00
IC	18.65	0.00	18.65	0.00
NAV	18.74	0.01	18.77	0.01
HB	18.88	0.01	18.95	0.03
BRR	18.86	0.02	18.89	0.03
M61	19.19	0.02	19.36	0.06
M54	19.37	0.03	19.52	0.07
M35	19.83	0.04	19.90	0.05
M23	20.33	0.05	20.62	0.06
M18	20.55	0.04	20.80	0.05
Average	**19.17**	**0.02**	**19.24**	**0.03**

Table 3-19: Mean differences in surface and bottom water temperature between AA1 and NAA with SLC3.

LCFRP Location	Surface Temperature (°C)		Bottom Temperature (°C)	
	NAA	AA1 – NAA	NAA	AA1 – NAA
B210	19.06	0.00	19.05	0.00
NC11	18.04	0.00	18.03	0.00
NCF117	19.86	0.00	19.86	0.00
AC	18.84	0.00	18.84	0.00
NCF6	19.58	0.02	19.57	0.02
IC	18.94	0.01	18.94	0.01
NAV	19.21	0.02	19.27	0.03
HB	19.46	0.03	19.57	0.04
BRR	19.45	0.04	19.51	0.04
M61	19.79	0.04	19.99	0.07
M54	19.99	0.05	20.15	0.09
M35	20.45	0.08	20.51	0.09
M23	20.89	0.11	21.17	0.13
M18	21.13	0.12	21.34	0.13
Average	**19.62**	**0.04**	**19.70**	**0.05**

Table 3-20: Mean differences in surface and bottom salinity between AA1 and NAA with SLC0.

LCFRP Location	Surface Salinity (ppt)		Bottom Salinity (ppt)	
	NAA	AA1 – NAA	NAA	AA1 – NAA
B210	-	-	-	-
NC11	-	-	-	-
NCF117	-	-	-	-
AC	-	-	-	-
NCF6	1.63	0.69	1.63	0.69
IC	-	-	-	-
NAV	-	-	-	-
HB	3.00	0.85	5.54	1.69
BRR	2.46	0.80	3.50	1.11
M61	6.55	1.28	12.64	2.51
M54	9.66	1.23	15.90	2.13
M35	17.20	0.96	19.21	0.82
M23	23.73	0.53	30.17	0.42
M18	26.42	0.36	31.24	0.30
Average	**11.33**	**0.84**	**14.98**	**1.21**

Table 3-21: Mean differences in surface and bottom salinity between AA1 and NAA with SLC3.

LCFRP Location	Surface Salinity (ppt)		Bottom Salinity (ppt)	
	NAA	AA1 – NAA	NAA	AA1 – NAA
B210	-	-	-	-
NC11	-	-	-	-
NCF117	-	-	-	-
AC	-	-	-	-
NCF6	6.67	1.22	6.69	1.23
IC	-	-	-	-
NAV	-	-	-	-
HB	7.57	1.08	11.48	1.45
BRR	7.47	1.14	9.10	1.22
M61	12.00	1.08	18.11	1.69
M54	15.18	0.99	20.74	1.47
M35	21.57	0.81	23.11	0.70
M23	26.40	0.58	31.66	0.57
M18	29.02	0.52	32.47	0.50
Average	**15.74**	**0.93**	**19.17**	**1.10**

Table 3-22: Mean differences in surface and bottom suspended solids (TSS) between AA! And NAA with SLC0 .

LCFRP Location	Surface TSS (mg/L)		Bottom TSS (mg/L)	
	NAA	AA1 – NAA	NAA	AA1 – NAA
B210	3.08	-0.01	3.10	-0.01
NC11	17.25	-0.02	17.39	-0.02
NCF117	6.54	0.02	6.53	0.02
AC	14.89	-0.03	15.03	-0.03
NCF6	16.01	0.32	16.39	0.37
IC	14.44	0.26	14.80	0.27
NAV	13.20	0.22	13.35	0.21
HB	11.98	0.04	12.52	0.09
BRR	10.89	-0.12	11.78	0.05
M61	10.81	-0.41	14.28	-0.04
M54	11.31	-0.53	15.38	-0.98
M35	11.78	-0.43	12.67	-0.49
M23	10.79	-0.35	12.43	-0.37
M18	9.94	-0.31	11.22	-0.44
Average	**11.64**	**-0.10**	**12.63**	**-0.10**

Table 3-23: Mean difference in surface and bottom suspended solids (TSS) between AA1 and NAA with SLC3.

LCFRP Location	Surface TSS (mg/L)		Bottom TSS (mg/L)	
	NAA	AA1 – NAA	NAA	AA1 – NAA
B210	2.51	0.00	2.51	0.00
NC11	16.72	0.00	16.82	0.00
NCF117	4.47	0.03	4.47	0.03
AC	13.53	-0.01	13.61	-0.01
NCF6	8.73	0.31	9.14	0.35
IC	6.58	0.25	6.71	0.26
NAV	7.23	0.32	7.74	0.38
HB	7.37	0.29	8.46	0.31
BRR	6.69	0.20	7.83	0.25
M61	8.35	0.03	11.85	0.26
M54	9.58	0.01	13.21	-0.51
M35	10.48	0.21	11.11	0.25
M23	9.45	0.53	10.41	0.88
M18	8.42	0.74	9.33	0.92
Average	**8.58**	**0.21**	**9.51**	**0.24**

3.4.4 Environmental Consequences of AA2

Under AA2, potential surface water quality impacts were similar to AA1. Overall, minimal changes were observed throughout the project area and upper estuary, with SLC emerging as the primary driver of water quality changes compared to the deepening effort.

Minimal changes in dissolved oxygen (DO) were observed at the surface across the 14 LCFRP monitoring locations, with variations of less than ±0.1 mg/L, as shown in Table 3-24 for SLC0 and Table 3-25 for SLC3. The mean difference in surface DO across all monitoring stations was -0.03 mg/L for SLC0 and –0.02 mg/L for SLC3, with no discernible hotspots or specific periods of concern. The bottom layer followed the changes in the surface DO levels with a mean change of -0.04 mg/L for SLC0 and -0.02 for SLC3.

Water temperature also showed negligible change, with variations of less than ±0.1°C at all 14 LCFRP monitoring sites, as shown in Table 3-26 and Table 3-27. The mean difference in surface water temperature was 0.01°C for SLC0 and 0.03°C for SLC3 across all monitoring stations. No hotspots or specific time periods of concern were identified. The mean difference in bottom water temperature was

0.02°C for SLC0 and 0.02°C for SLC3 across all monitoring stations. Modeled results indicate state criteria for temperature will not being exceeded.

The most notable salinity impact was observed at LCFRP monitoring location M61 (mid-estuary, adjacent to the Port of Wilmington), where the average surface salinity change during a typical year with no SLC was 1.00 ppt, as noted in Table 3-28. The bottom salinity change at location M61 was 2.01 ppt, see Table 3-28. The mean difference in surface salinity was 0.66 ppt for SLC0 and 0.67 ppt for SLC3 across all monitoring stations. For the bottom layer, the salinity difference was 0.96 ppt for SLC0 and 0.76 ppt for SLC3.

TSS also showed minimal surface and bottom changes, with variations of less than ±1.0 mg/L at the LCFRP monitoring locations, as shown in Table 3-30. The mean difference in TSS across all monitoring stations was –0.08 mg/L for SLC0 and 0.18 mg/L for SLC3 across the project site, see Table 3-31. For the bottom layer, the mean TSS difference was 0.09 for SLC0 and 0.19 ppt for SLC3.

Table 3-24: Mean differences in surface and bottom dissolved oxygen (DO) between AA2 and NAA with SLC0.

LCFRP Location	Surface DO (mg/L)		Bottom DO (mg/L)	
	NAA	AA2 – NAA	NAA	AA2 – NAA
B210	5.55	-0.03	4.99	-0.03
NC11	8.03	0.00	8.00	0.00
NCF117	8.03	0.01	8.00	0.01
AC	7.03	-0.01	6.95	-0.01
NCF6	7.52	-0.04	7.50	-0.04
IC	6.82	0.02	6.66	0.02
NAV	6.83	0.01	6.80	0.01
HB	6.90	-0.01	6.91	-0.04
BRR	7.03	0.01	6.95	0.00
M61	7.22	-0.07	7.14	-0.11
M54	7.49	-0.07	7.37	-0.09
M35	7.83	-0.06	7.67	-0.07
M23	7.62	-0.07	7.24	-0.10
M18	7.46	-0.07	7.09	-0.10
Average	**7.24**	**-0.03**	**7.09**	**-0.04**

Table 3-25: Mean differences in surface and bottom dissolved oxygen (DO) between AA2 and NAA with SLC3.

LCFRP Location	Surface DO (mg/L)		Bottom DO (mg/L)	
	NAA	AA2 – NAA	NAA	AA2 – NAA
B210	4.76	0.02	4.50	0.02
NC11	7.80	0.00	7.78	0.00
NCF117	8.00	0.00	7.98	0.00
AC	6.38	0.00	6.29	0.00
NCF6	7.75	-0.05	7.73	-0.05
IC	7.49	0.00	7.37	0.00
NAV	7.37	-0.02	7.33	-0.03
HB	7.32	-0.05	7.21	-0.05
BRR	7.27	-0.04	7.17	-0.04
M61	7.33	-0.07	7.22	-0.07
M54	7.39	-0.07	7.30	-0.05
M35	7.56	-0.05	7.46	-0.04
M23	7.43	-0.02	7.05	0.02
M18	7.22	0.02	6.90	0.06
Average	**7.22**	**-0.02**	**7.09**	**-0.02**

Table 3-26: Mean differences in surface and bottom water temperature between AA2 and NAA with SLC0.

LCFRP Location	Surface Temperature (deg C)		Bottom Temperature (deg C)	
	NAA	AA2 – NAA	NAA	AA2 – NAA
B210	18.64	0.01	18.64	0.01
NC11	17.99	0.00	17.99	0.00
NCF117	19.44	0.00	19.43	0.00
AC	18.63	0.00	18.62	0.00
NCF6	19.24	0.00	19.24	0.00
IC	18.65	0.00	18.65	0.00
NAV	18.74	0.00	18.77	0.01
HB	18.88	0.01	18.95	0.02
BRR	18.86	0.01	18.89	0.02
M61	19.19	0.01	19.36	0.05
M54	19.37	0.03	19.52	0.06
M35	19.83	0.04	19.90	0.04
M23	20.33	0.04	20.62	0.05
M18	20.55	0.04	20.80	0.04
Average	**19.17**	**0.01**	**19.24**	**0.02**

Table 3-27: Mean differences in surface and bottom water temperature between AA2 and NAA with SLC3.

LCFRP Location	Surface Temperature (deg C)		Bottom Temperature (deg C)	
	NAA	AA2 – NAA	NAA	AA2 – NAA
B210	19.06	0.00	19.05	0.00
NC11	18.04	0.00	18.03	0.00
NCF117	19.86	0.00	19.86	0.00
AC	18.84	0.00	18.84	0.00
NCF6	19.58	0.01	19.57	0.01
IC	18.94	0.01	18.94	0.01
NAV	19.21	0.02	19.27	0.02
HB	19.46	0.02	19.57	0.03
BRR	19.45	0.03	19.51	0.03
M61	19.79	0.02	19.99	0.05
M54	19.99	0.03	20.15	0.06
M35	20.45	0.05	20.51	0.06
M23	20.89	0.07	21.17	0.08
M18	21.13	0.08	21.34	0.08
Average	**19.62**	**0.02**	**19.70**	**0.03**

Table 3-28: Mean differences in surface and bottom salinity between AA2 and NAA with SLC0.

LCFRP Location	Surface Salinity (ppt)		Bottom Salinity (ppt)	
	NAA	AA2 – NAA	NAA	AA2 – NAA
B210	-	-	-	-
NC11	-	-	-	-
NCF117	-	-	-	-
AC	-	-	-	-
NCF6	1.63	0.54	1.63	0.54
IC	-	-	-	-
NAV	-	-	-	-
HB	3.00	0.67	5.54	1.31
BRR	2.46	0.63	3.50	0.87
M61	6.55	1.00	12.64	2.01
M54	9.66	0.97	15.90	1.70
M35	17.20	0.77	19.21	0.67
M23	23.73	0.43	30.17	0.34
M18	26.42	0.30	31.24	0.26
Average	**11.33**	**0.66**	**14.98**	**0.96**

Table 3-29: Mean differences in surface and bottom salinity between AA2 and NAA with SLC3.

LCFRP Location	Surface Salinity (ppt)		Bottom Salinity (ppt)	
	NAA	AA2 – NAA	NAA	AA2 – NAA
B210	-	-	-	-
NC11	-	-	-	-
NCF117	-	-	-	-
AC	-	-	-	-
NCF6	6.67	0.93	6.69	0.93
IC	-	-	-	-
NAV	-	-	-	-
HB	7.57	0.81	11.48	1.04
BRR	7.47	0.86	9.10	0.90
M61	12.00	0.80	18.11	1.21
M54	15.18	0.71	20.74	1.01
M35	21.57	0.57	23.11	0.46
M23	26.40	0.38	31.66	0.31
M18	29.02	0.30	32.47	0.25
Average	**15.74**	**0.67**	**19.17**	**0.76**

Table 3-30: Mean differences in surface and bottom suspended solids (TSS) AA2 and NAA with SLC0.

LCFRP Location	Surface TSS (mg/L)		Bottom TSS (mg/L)	
	NAA	AA2 – NAA	NAA	AA2 – NAA
B210	3.08	-0.01	3.10	-0.01
NC11	17.25	-0.01	17.39	-0.01
NCF117	6.54	0.02	6.53	0.02
AC	14.89	-0.02	15.03	-0.02
NCF6	16.01	0.28	16.39	0.32
IC	14.44	0.21	14.80	0.22
NAV	13.20	0.17	13.35	0.17
HB	11.98	0.03	12.52	0.07
BRR	10.89	-0.09	11.78	0.05
M61	10.81	-0.33	14.28	0.00
M54	11.31	-0.42	15.38	-0.91
M35	11.78	-0.34	12.67	-0.39
M23	10.79	-0.30	12.43	-0.32
M18	9.94	-0.28	11.22	-0.40
Average	**11.64**	**-0.08**	**12.63**	**-0.09**

Table 3-31: Mean differences in surface and bottom suspended solids (TSS) between AA2 and NAA with SLC3.

LCFRP Location	Surface TSS (mg/L)		Bottom TSS (mg/L)	
	NAA	AA2 – NAA	NAA	AA2 – NAA
B210	2.51	0.00	2.51	0.00
NC11	16.72	0.00	16.82	0.00
NCF117	4.47	0.02	4.47	0.02
AC	13.53	-0.01	13.61	-0.01
NCF6	8.73	0.26	9.14	0.29
IC	6.58	0.20	6.71	0.21
NAV	7.23	0.27	7.74	0.31
HB	7.37	0.25	8.46	0.25
BRR	6.69	0.17	7.83	0.22
M61	8.35	0.05	11.85	0.25
M54	9.58	0.06	13.21	-0.53
M35	10.48	0.23	11.11	0.25
M23	9.45	0.46	10.41	0.71
M18	8.42	0.59	9.33	0.73
Average	**8.58**	**0.18**	**9.51**	**0.19**

3.5 Wetlands

Surface water salinity outputs of the Delft3D model were used in conjunction with various wetland classifications in the project area to assess project impacts to wetlands. The analysis identified the amount of change to the salinity zones of each tidal wetland class under various sea level change and flow conditions. All analyses presented in this section utilize typical flow conditions, but analysis of other flow conditions is present in Appendix I along with a detailed wetlands impact assessment.

3.5.1 Affected Environment

Human activities and sea level change over the last two centuries have dramatically altered the composition and distribution of tidal wetland communities in the Cape Fear River estuary (Hackney and Yelverton 1990). The initial impact of European settlement, beginning in the late 1700s, was the conversion of essentially all tidal freshwater swamp forests in the lower to middle estuary to rice plantations. In the late 1800s, USACE initiated major navigation dredging modifications of river channel for access to the Port of Wilmington. Incremental channel deepening and sea level change since the late

1800s have increased the tidal range in Cape Fear River, resulting in the conversion of tidal freshwater swamp forests to brackish marsh along the middle to upper reaches of the estuary. Hackney and Yelverton (1990) suggest that the distribution of former rice fields is a reliable indicator of the pre-settlement extent of tidal freshwater wetlands along the river, as rice is incapable of growing in fields that are flooded by saline water >1 part per thousand (ppt). Based on this indicator, tidal freshwater wetlands would have been present at least as far downriver as Orton Plantation approximately 12 miles above the river mouth.

The NCSPA developed a baseline tidal wetland classification for the study area as part of the WHNIP Section 203 Study (Appendix F of the 203 study: Wetland Impact Assessment). The final classification identified 66,671 acres of tidal wetlands distributed among six wetland classes (Table 3-32) using satellite imagery collected in fall of 2016. Figure 3-10 depicts an overview of the estuary-wide classification.

The composition of tidal wetland communities in the Cape Fear River estuary is principally determined by their position along salinity gradients. Salt marshes consisting of nearly monospecific zones of smooth cordgrass (*Spartina alterniflora*) and black needlerush (*Juncus romerianus*) dominate the contiguous tidal floodplains along the lower polyhaline to mesohaline reach of the Cape Fear River mainstem from the river mouth up to the vicinity of Barnards Creek (approximately 21 river miles). Low marsh smooth cordgrass zones along the river channel are backed by high marsh black needlerush zones on the outer tidal floodplain. Along the upper portion of the salt marsh reach, big cordgrass (*S. cynosuroides*) and saltmarsh bulrush (*Bolboschoenus robustus*) occur intermittently on the slightly elevated riverbanks immediately adjacent to the channel. Dense patches of non-native common reed (Phragmites australis australis) are interspersed throughout the salt marshes of the lower estuary on dredged material and other fill deposits that are higher than the natural tidal floodplain and somewhat protected from exposure to high salinity waters.

The reach above Barnards Creek is characterized by the decline of smooth cordgrass and black needlerush and the rapid establishment of narrow-leaved cattail (*Typha angustifolia*) as the primary dominant tidal marsh species. The marshes above Barnards Creek exhibit distinct vegetation zones, including a narrow fringing smooth cordgrass zone along the edge of the river channel; a narrow top-of-bank zone dominated by big cordgrass and salt-marsh bulrush; and a broad outer marsh zone dominated by narrow-leaved cattail. Cattail is a strong dominant of the oligohaline brackish marshes along the approximately ten-mile mainstem reach above Barnards Creek, forming vast monospecific stands across large sections of the tidal floodplain. The cattail-dominated marshes are interspersed with large dense stands of common reed and areas of mixed brackish marsh that are dominated by variable combinations of cattail, common reed, big cordgrass, salt-marsh bulrush, sawgrass (*Cladium jamaicense*), and softstem bulrush (*Schoenoplectus tabernaemontani*). Along the upper portion of the reach (above the mouth of the Northeast Cape Fear River), species that are characteristic of more diverse freshwater tidal marsh communities begin to occur sporadically along the margins of the channel, including wild rice (*Zizania aquatica*), bull-tongue arrowhead (*Sagittaria lancifolia*), pickerelweed (*Pontederia cordata*), and arrow-arum (*Peltandra virginica*). Freshwater species occur with increasing prevalence toward the upper end of the reach, becoming a consistent component of the narrow top-of-bank zone and eventually appearing as constituents of the cattail-dominated marshes on the outer tidal floodplain. The I-140 bridge marks the approximate transition from cattail-dominated tidal marshes to tidal freshwater marsh and tidal swamp forest communities along the Cape Fear River mainstem. Tidal freshwater marshes are characterized by a diverse assemblage of species that includes wild rice, bull-tongue arrowhead, arrow-arum, pickerelweed, sawgrass, Olney's three-square (*Schoenoplectus americanus*), dotted smartweed

(*Persicaria punctatum*), tussock sedge (*Carex stricta*), water parsnip (*Sium suave*), marshmallow (*Kosteletzkya pentacarpos*), salt-marsh fleabane (*Pluchea odorata*), salt-marsh aster (*Symphyotrichum tenuifolium)*, water primrose (*Ludwigia bonariensis*), and salt-marsh water-hemp (*Amaranthus cannabinus*). The tidal swamp forest communities are strongly dominated by bald cypress (*Taxodium distichum*), water tupelo *(Nyssa aquatica*), and swamp tupelo *(N. biflora).* Tidal freshwater marshes are primarily confined to a narrow (approximately 100-foot-wide) zone along the edge of the channel, with freshwater swamp forests occupying the vast majority of the outer tidal floodplain. Fringing tidal freshwater marshes occur intermittently along the approximately four-mile river reach above the I-140 Bridge before being displaced entirely by tidal swamp forests. Tidal freshwater marshes occur under very low oligohaline salinities that exceed the tolerances of swamp forest trees. Many of the freshwater marshes are interspersed with dead and severely salt-stressed trees that are the remnants of recently converted tidal swamp forest communities.

Tidal wetlands along the Northeast Cape Fear River are characterized by a brackish marsh to freshwater marsh/swamp forest gradient similar to that of the Cape Fear River mainstem. Cattail marshes dominate the tidal floodplain along the lower approximately eight-mile oligohaline reach of the Northeast Cape Fear River. As in the case of the Cape Fear River, the transition to freshwater marsh occurs concurrently with the establishment of expansive tidal freshwater swamp forests along the Northeast Cape Fear River. The freshwater marshes are generally confined to a narrow zone along the edge of the channel, with freshwater swamp forests occupying the broad landward portion of the tidal floodplain. Fringing tidal freshwater marshes occur intermittently along the approximately four-mile river reach above the brackish reach before being displaced entirely by tidal swamp forests. Similar tidal wetland communities and salinity gradient distribution patterns characterize the tidal creeks that join the mesohaline to oligohaline reaches of Cape Fear River and Northeast Cape Fear River.

Table 3-32: Study Area Tidal Wetland Classification

Tidal Wetland Class	Area (acres)	Percent
Smooth Cordgrass Dominant	12,733	19.1
Brackish Mix	696	1.0
Cattail Dominant	6,066	9.1
Common Reed	2,403	3.6
Freshwater Marsh	1,379	2.1
Swamp Forest	43,394	65.1
Total	**66,671**	**100**

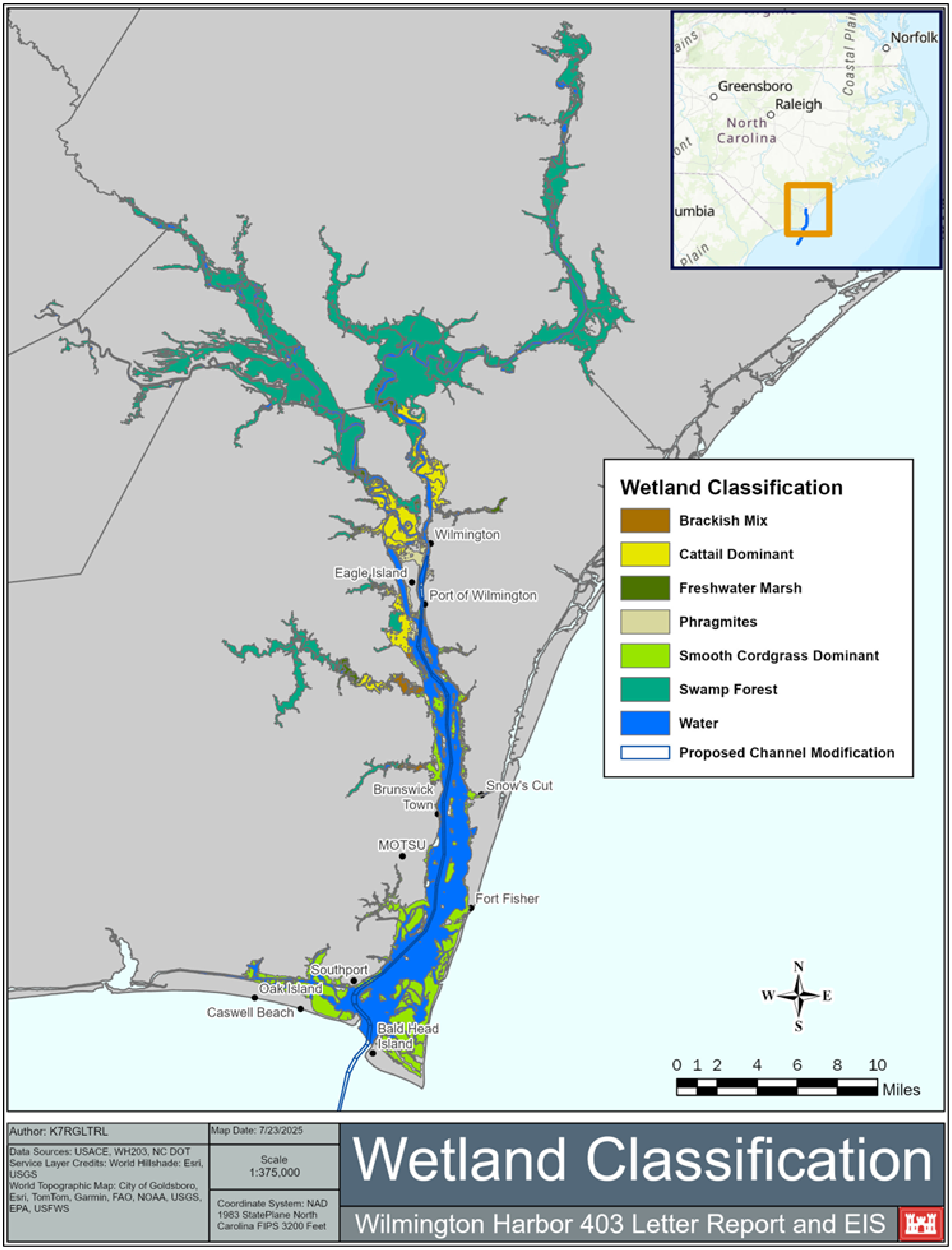

Figure 3-10: Estuary-wide Imagery-Derived Classification of Wetland Communities

3.5.2 Environmental Consequences of NAA

Under the NAA, salinity modeling results indicate that SLC will cause upstream shifts in the oligohaline-freshwater (0.5 ppt) salinity isopleths resulting in loss of tidal freshwater wetlands (Figure 3-11). The quantity of wetlands that will be affected by the projected upstream shifts in salinity under the NAA under each of the three SLC scenarios (low, intermediate, high) are shown in Table 3-33 and Figure 3-11: Salinity defined wetland classifications (left; SLC0) and tidal freshwater wetlands loss due to SLC (SLC1-SLC3). The models predict a loss of up to 9,627 acres of freshwater wetlands over the 50-year period of analysis due to sea level change.

SLC is projected to result in a minor, short term decrease (161-181 acres) in oligohaline wetlands under low and intermediate SLC conditions, but all other SLC scenarios under the NAA are expected to result in an increase in brackish and higher salinity wetlands.

Table 3-33: Total acres within each salinity zone of each SLC scenario under the NAA.

Salinity Zone	SLC0	SLC1	SLC2	SLC3
Tidal Fresh	32,730	32,071	30,574	23,103
Oligohaline	7,543	7,382	7,362	9,334
Mesohaline	5,977	6,560	7,656	11,192
Polyhaline	8,109	8,417	8,639	10,192
Euhaline	222	151	351	761

Table 3-34: The change (delta; Δ), in acres, between SLC0 the other modeled SLC scenarios under the NAA. Negative values reflect loss and positive values reflect gain.

Salinity Zone	SLC1	SLC2	SLC3
Tidal Fresh	-659	-2,156	-9,627
Oligohaline	-161	-181	1,791
Mesohaline	583	1,679	5,215
Polyhaline	308	530	2,083
Euhaline	-71	129	539

Placement of Dredged Material

Under the NAA, no impacts to wetlands are expected from the placement of material during routine maintenance and beneficial use efforts.

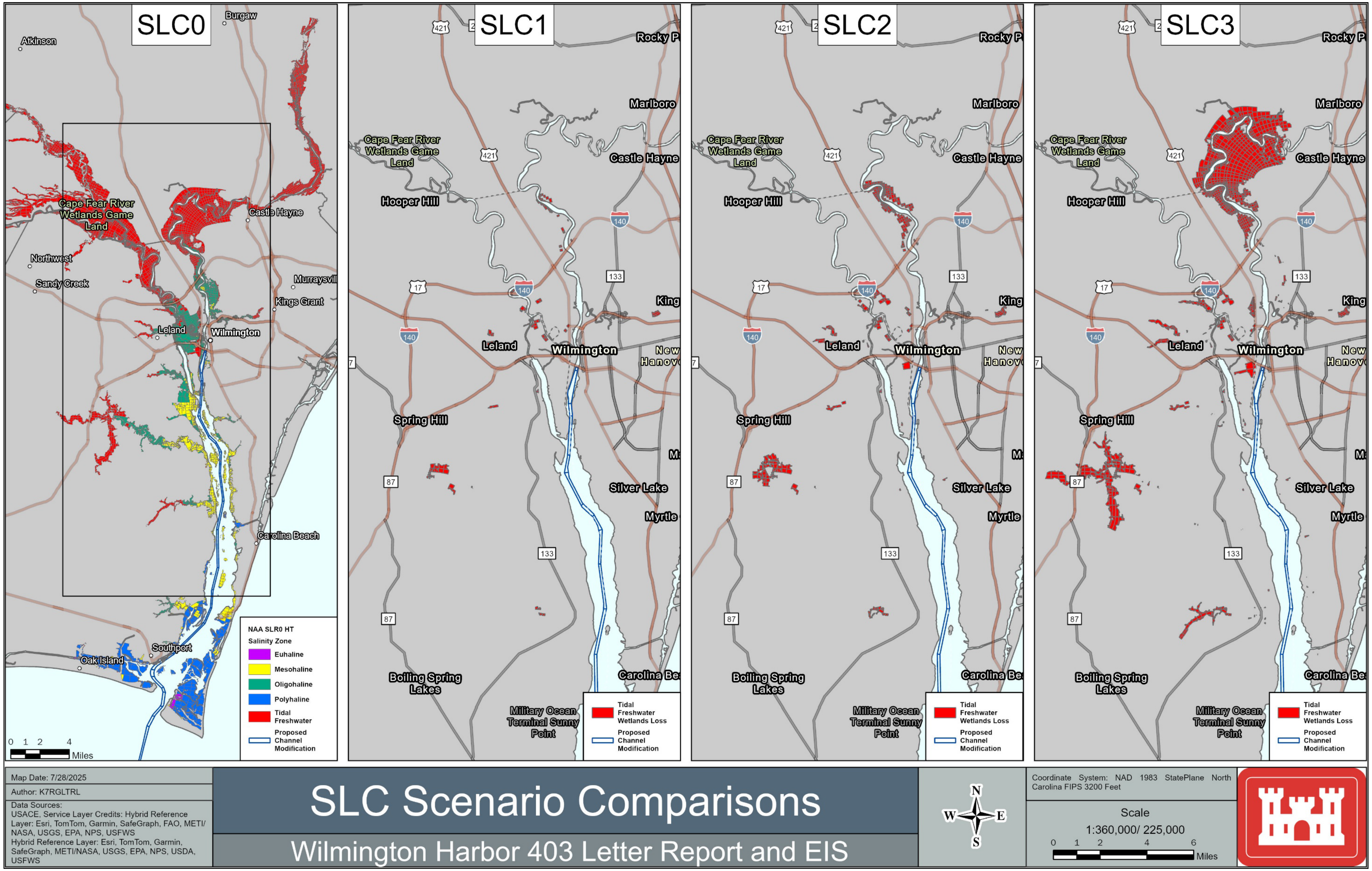

Figure 3-11: Salinity defined wetland classifications (left; SLC0) and tidal freshwater wetlands loss due to SLC (SLC1-SLC3)

3.5.3 Environmental Consequences of AA1 & AA2

Under the Action Alternatives, the salinity modeling results indicate that action alternatives would cause relative upstream shifts in the freshwater (0-0.5 ppt) to oligohaline (0.5-5 ppt) salinity isopleths. Wetlands potentially affected by the projected upstream shifts in the 0.5 ppt isopleths include approximately 1,071 acres of tidal freshwater wetlands under AA1 and 972 acres under AA2 which is further broken down to specific habitats in Table 3-35. Under either Action Alternative, negative values refer to conversion of wetland classes as vegetation communities respond to changes in salinity, not net loss of wetland area.

Table 3-35: The change (delta; Δ), in acres, between the NAA and Action Alternatives, under SLC0 and SLC3. Negative values reflect loss and positive values reflect gain.

Salinity Zone	SLC0		SLC3	
	AA1 Impacts (Acres)	AA2 Impacts (Acres)	AA1 Impacts (Acres)	AA2 Impacts (Acres)
Tidal Fresh	-1,071	-972	-635	-484
Oligohaline	-204	5	-579	-487
Mesohaline	1,114	825	790	646
Polyhaline	87	142	174	100
Euhaline	75	0	250	225

Table 3-36: Transition zone acres of each scenario (AA1 and AA2) compared to the baseline (NAA) under no sea level change (SLC0). These transition zone acres are further broken down by the imagery-derived wetland classifications from the WHNIP Section 203 Study (2016).

Transition Zone	NAA to AA1 (Acres)	NAA to AA2 (Acres)	Imagery-Derived Wetland Classification (2016)	NAA to AA1 (Acres)	NAA to AA2 (Acres)
Tidal Freshwater to Oligohaline	1,071	975	Brackish Mix	5	2
			Cattail Dominant	216	207
			Freshwater Marsh	131	119
			Phragmites	163	161
			Smooth Cordgrass Dominant	7	7
			Swamp Forest	548	449
Oligohaline to Tidal Freshwater	0	4	Cattail Dominant	0	4
Oligohaline to Mesohaline	1,275	967	Brackish Mix	95	74
			Cattail Dominant	799	611
			Freshwater Marsh	11	4
			Phragmites	160	147
			Smooth Cordgrass Dominant	71	60
			Swamp Forest	140	71
Mesohaline to Polyhaline	161	142	Brackish Mix	2	2
			Phragmites	3	3
			Smooth Cordgrass Dominant	156	137
Polyhaline to Euhaline	74	0	Smooth Cordgrass Dominant	74	0

Tidal Freshwater Wetlands

The Action Alternatives would result in adverse effects to tidal freshwater wetlands within the project area. Modeling efforts predict a loss of 1071 acres of tidal freshwater wetlands under AA1 and 972 acres under AA2 during SLC0 conditions. Under SLC3 conditions, AA1 and AA2 result in a loss of 635 acres and 484 acres, respectively. However, the USACE would provide compensatory mitigation for the projected functional loss of tidal freshwater wetlands under existing sea level conditions (SLC0), as requested by the EPA. More information on the compensatory mitigation plan is outlined in Appendix M: Mitigation Plan. The impacts due to implementation of the mitigation plan are discussed below.

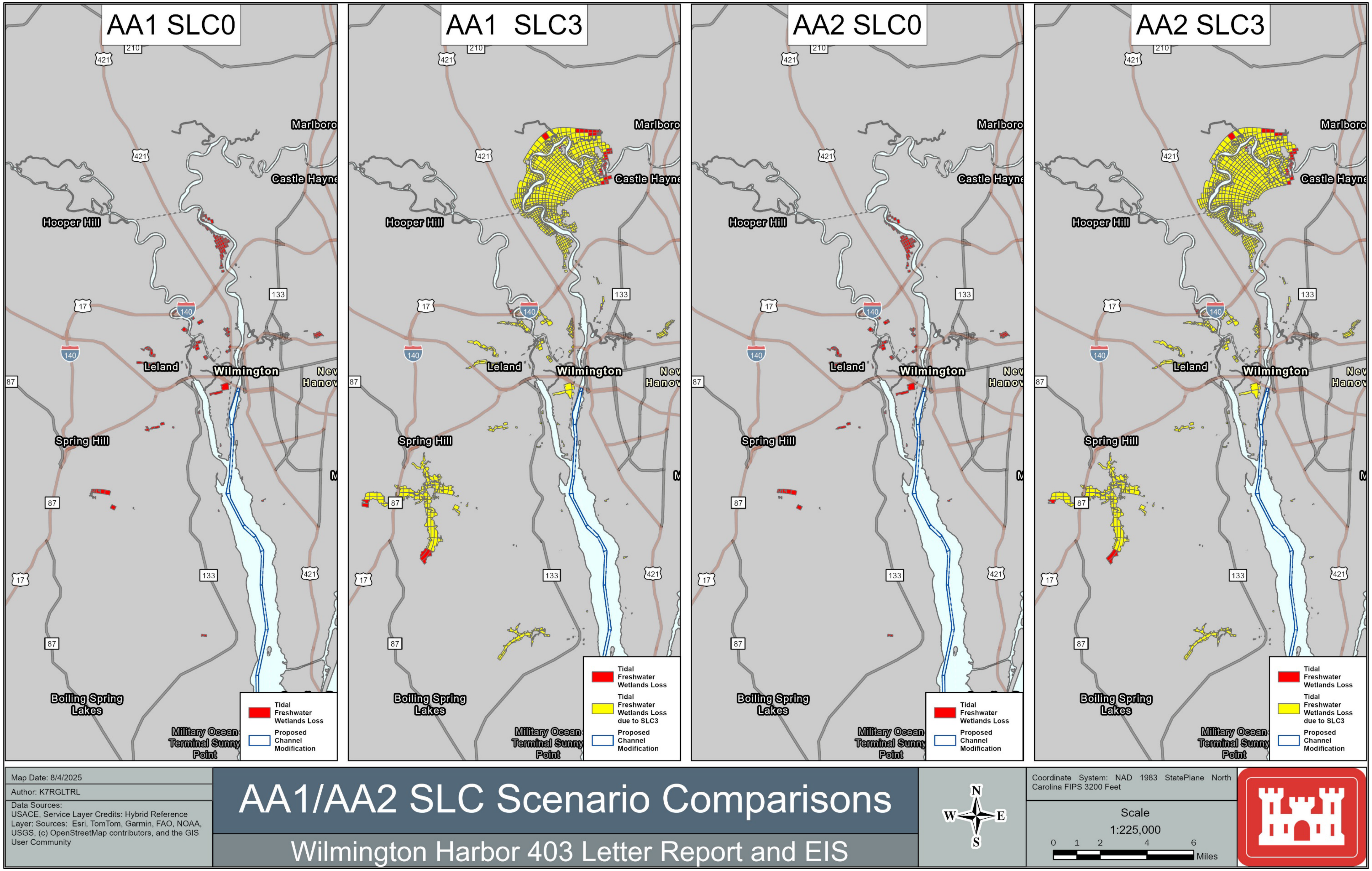

Figure 3-12: Tidal wetland loss from Action Alternatives and Sea Level Change.

Oligohaline Wetlands

Projected shifts in the oligohaline (0.5-5.0 ppt) communities under each action alternative are confined to the existing brackish marsh-dominated reaches of the estuary. Under AA1, approximately 204 acres of oligohaline wetlands are projected to be converted to other wetland types while AA2 is expected to result in a net increase of 5 acres of oligohaline wetlands in response to changing salinity levels due to the project. Most existing oligohaline wetlands in the projected impact areas are cattail or Phragmites dominated wetlands which have varying degrees of tolerance to salinity. Slight changes in salinity for these communities would not be expected to alter vegetation communities already present in these areas. Therefore, the anticipated effects of action alternatives on existing oligohaline marshes would be insignificant and will not be considered in determining any compensatory wetland mitigation requirements for the proposed project.

Mesohaline, Polyhaline, and Euhaline Wetlands

Under each action alternative, the quantity of mesohaline (5-18 ppt), polyhaline (18-30 ppt), and euhaline (30+ ppt) are projected to increase or remain unchanged. These wetlands have similar vegetation communities and would continue to provide habitat for fish and wildlife. Few changes in species composition would be expected due to the minor changes in salinities in the identified impact areas.

Placement of Dredged Material

Under either Action Alternative, no impacts to wetlands are expected from the placement of material in any of the project placement sites including beaches, ODMDS, bird islands, and other beneficial use areas.

Mitigation Plan

The Mitigation Plan in Appendix M identifies both conservation and restoration measures in tidal freshwater and brackish wetlands. Preservation efforts are not expected to result in negative wetland impacts and will prevent negative impacts such as development or clearing in the identified preservation area. Restoration measures would remove and control invasive species from a brackish marsh to provide improved functional value to wildlife communities. Construction efforts may result in minor, short-term impacts to the restoration area, but BMPs identified in the mitigation plan would be utilized to avoid and minimize impacts.

3.6 Flooding and Tidal Impacts

Storm surge flooding and tidal range modeling and analysis were performed for each alternative. The tidal range analysis excluded riverine discharge and wind effects to focus on tide-dominated processes. The modeling and analysis looked at the impact of multiple sea level change (SLC) scenarios: No SLC, SLC1 (0.5 ft), SLC2 (1.28 ft), and SLC3 (3.77 ft). Model results were used to compute changes in tidal datums and range for the proposed alternatives and SLC scenarios throughout the lower Cape Fear River basin. Tidal datums were computed according to the NOAA definitions in Table 3-37. The storm surge flooding analysis simulated Hurricane Florence as well as the 100- and 500-year return period storm surge events to assess the effects of the deepening alternatives, including SLC, on the elevation and extent of flooding in the CFR.

Table 3-37: NOAA tidal datum definitions.

Datum	Acronym	Definition
Mean Higher High Water	MHHW	The average of the higher high-water level of each tidal day
Mean High Water	MHW	The average of all the high-water levels
Mean Sea Level	MSL	The arithmetic mean of hourly water level
Mean Low Water	MLW	The average of all the low water levels
Mean Lower Low Water	MLLW	The average of the lower low water level of each tidal day
Mean Range of Tide	MN	The difference in elevation between MHW and MLW

In general, each of the deepening alternatives would result in a larger bathymetric cross-section and a larger volume of water in the estuary at a given water level. This larger cross-section will allow for increased tidal exchange with the Atlantic and more water to enter the lower CFR. At Wilmington, NC (NOAA Station 8658120), deepening of the channel (NAA → AA2 → AA1) results in a small but measurable increase in tidal range with the largest change seen in the lowering of MLLW. Mean Low Water (MLW) is also lowered, while MHW increases. Table 3-38 presents the modeled tidal datums and differences at Wilmington, NC for the three channel deepening alternatives with no SLC.

Table 3-38: Modeled tidal datums and comparisons at Wilmington, NC (NOAA Station 8658120) for each Alternative; no SLC.

Datum	NAA	AA1	AA2	AA1 - NAA		AA2 - NAA	
	ft MSL	ft MSL	ft MSL	ft	%	ft	%
MHHW	2.47	2.57	2.56	0.1	4.0%	0.09	3.6%
MHW	2.09	2.2	2.18	0.11	5.3%	0.09	4.3%
MSL	0	0	0	0	--	0	--
MLW	-2.29	-2.44	-2.41	-0.15	-6.6%	-0.12	-5.2%
MLLW	-2.41	-2.55	-2.52	-0.14	-5.8%	-0.11	-4.6%
MN	4.38	4.64	4.59	0.26	5.9%	0.21	4.8%

3.6.1 Affected Environment

The Wilmington Harbor shipping channel is subject to a semi-diurnal tidal regime, characterized by two high and two low tides each day. The average tidal range varies from approximately 4.5 feet during neap tides to over 5.5 feet during spring tides. Flooding in the Wilmington Harbor area results from both tidal influences and storm-driven events (i.e. Hurricane Floyd and Florence). The harbor and adjacent urban areas along the river are increasingly vulnerable to tidal flooding during high tide events, especially when combined with heavy rainfall or storm surge. Downtown Wilmington, near Water Street, has historically shown inundation from large tidal and storm events and was closely looked at to see if deepening efforts increased inundation.

3.6.2 Environmental Consequences of NAA

Under NAA, tidal processes remain relatively stable, but sea level change (SLC) significantly influences both tidal datums and storm surge impacts. Inundations from tides and storms would follow normal trends and impacts would be similar to what is seen regularly. As SLC increases from SLC0 (no change) to SLC3 (3.77 ft), all tidal datums rise correspondingly; however, the mean tidal range (MN) actually decreases due to a larger area of inundation that spreads floodwaters more broadly, thereby reducing the vertical tidal range. For example, under SLC3, the mean high water (MHW) increases by 3.35 feet (160%), but the tidal range decreases by nearly a foot (22%).

In terms of storm surge, the 500-year return period event under SLC3 shows a 47% increase in peak water levels at Wilmington and a 33% increase in inundation area compared to no SLC, highlighting that sea level change is the dominant driver of flooding risk. Table 3-39 presents the modeled tidal datums and differences at Wilmington, NC for the four SLC scenarios for the NAA alternative. Because baseline inundation area increases with SLC, peak storm surge levels do not increase at the same rate as SLC, as storm surge water is distributed over a larger area.

Table 3-39: Modeled tidal datums and comparisons at Wilmington, NC for each SLC scenario, NAA.

Datum	SLC0	SLC1	SLC2	SLC3	SLC1 – SLC0		SLC2 – SLC0		SLC3 – SLC0	
	ft MSL	ft MSL	ft MSL	ft MSL	ft	%	ft	%	ft	%
MHHW	2.47	2.89	3.55	5.75	0.42	17%	1.08	44%	3.28	133%
MHW	2.09	2.53	3.21	5.44	0.44	21%	1.12	54%	3.35	160%
MSL	0	0.5	1.28	3.77	0.5	--	1.28	--	3.77	--
MLW	-2.29	-1.76	-0.9	2.02	0.53	23%	1.39	61%	4.31	188%
MLLW	-2.41	-1.88	-1.02	1.91	0.53	22%	1.39	58%	4.32	179%
MN	4.38	4.29	4.11	3.42	-0.09	-2%	-0.27	-6%	-0.96	-22%

3.6.3 Environmental Consequences of AA1

AA1 leads to the most changes in tidal dynamics, though still modest overall. For Wilmington, NC (NOAA Station 8658120), MHW increases by 0.11 feet (5.3%) and MLW drops by 0.15 feet (6.6%) compared to NAA, resulting in a tidal range increase of 0.26 feet (5.9%).

For the 500-year storm surge event under no SLC, AA1 increases peak water levels by 3.1% at Wilmington and expands the total inundation area by 0.5% compared to NAA. Under the highest SLC scenario (SLC3), the increases are similarly small, reinforcing the conclusion that while channel deepening slightly affects water levels, it does not meaningfully worsen storm surge flooding. Overall, AA1 has localized, incremental effects on tidal characteristics near Wilmington, but the broader system-wide impacts are minimal, especially when compared to the substantial influence of sea level change under NAA.

For the entire model domain, the mean and maximum water levels were increased by 0.0032 ft (0.20%), and 0.039 ft (0.63%), respectively, due to deepening alternative AA1, and increased by 3.53 ft and 3.61 ft, respectively, due to high SLC (SLC3). The land area inundated by storms, on average, increased by 1,236,983 ft^2 (0.61%) due to deepening alternative AA1, and increased by 667,503,883 ft^2 (32.5%) due to SLC3. For Downtown Wilmington no significant change in inundation was observed, as the MHHW varied by only 0.09 ft to 0.12 ft along this section, which was insufficient to cause additional inundation within the model. Additional details can be found in Appendix B.

3.6.4 Environmental Consequences of AA2

This action alternative results in a slightly larger estuarine cross-section and volume compared to NAA but smaller impacts when compared to AA1. This increased capacity allows for more tidal exchange with the Atlantic Ocean, leading to small but measurable changes in tidal datums. At Wilmington, AA2 causes the MHW to increase by 0.09 feet (4.3%) and the MLW to decrease by 0.12 feet (5.2%), resulting in a tidal range increase of about 0.21 feet (4.8%) compared to NAA. However, these vertical changes do not significantly impact the horizontal extent of tidal flooding.

During storm surge events, AA2 produces minimal increases in flood elevation and inundation areas, with changes generally less than 1% when compared to NAA under both current and future SLC scenarios. Overall, AA2 have localized, incremental effects on tidal characteristics near Wilmington, but the broader system-wide impacts are minimal, especially when compared to the substantial influence of sea level change under NAA. Mean and maximum water levels and land area inundated by storms is lower when compared to AA1, and for Downtown Wilmington no significant change in inundation was observed under AA2. Additional details can be found in Appendix B.

3.7 Sediment

Data from hundreds of geotechnical borings, wash probes, and vibracore samples as well as extensive geophysical surveys were assessed to characterize the new work dredge material that could be encountered from potential deepening, widening, and/or realignment of the navigation channel (Figure 1-1). The volume of sediment to be removed will depend on the selected design alternative. Additional details may be found in Appendix C.

All proposed dredged materials from the navigation channel have been, or will be, sampled and analyzed in accordance with Section 103 of the Marine Protection, Research, and Sanctuaries Act (MPRSA) and in coordination with the U.S. EPA (EPA) Region 4 allowing for dredged material placement within the EPA-designated Wilmington ocean dredged material disposal site (ODMDS). Analyses would be performed in accordance with the Evaluation of Dredged Material Proposed for Ocean Disposal Testing Manual (EPA/USACE 1991), which is supplemented by the Southeast Regional Implementation Manual (SERIM)

(EPA/USACE 2008) and involves geophysical, chemical, and bioaccumulation tests to assess the potential impact of contaminants on the marine environment, specifically focusing on dredged materials compatibility with native Wilmington ODMDS sediments and the uptake of sediment contaminants by benthic organisms.

Sampling areas are divided into dredging units, which are designed to represent dredged materials having similar characteristics. ODMDSs are co-managed with the USACE in accordance with Site Management and Monitoring Plans (SMMP). Sampling and analysis plans that guide Section 103 testing methodologies, and associated testing results are coordinated with the EPA Region 4 to ensure that placement of dredged materials within EPA-designated ODMDSs will not unreasonably degrade or endanger human health, welfare, or amenities, or the marine environment, ecological systems, or economic potentialities (33 U.S.C. 1401 et seq). Additionally, the 2023 Wilmington ODMDS Site Management and Monitoring Plan (SMMP) describes requirements for all placement activities at the Wilmington ODMDS (Appendix P). EPA shares the responsibilities of conducting management and monitoring activities at EPA-designated ODMDSs with the USACE. Under MPRSA Section 102, EPA, in cooperation with the USACE (EPA and USACE 2017), is responsible for developing an SMMP for each designated ODMDS. The objective of each SMMP is to ensure that dredged material ocean disposal activities will not unreasonably degrade the marine environment or endanger human health or economic potentialities or other uses of the ocean. The SMMP provisions are an integral part of managing all disposal activities at an ocean disposal site and provide a framework for site monitoring and management as required by the MPRSA.

Based on past results of sediment testing in accordance with Section 103 of the Marine Protection, Research, and Sanctuaries Act, and coordination with the EPA, Region 4, for the Wilmington Harbor FNP, dredged materials originating from specific dredging units (each of which are comprised of one or more navigation channel reaches) may be associated with load volume and placement restrictions based upon short term fate of dredged material (STFATE) modeling. STFATE modeling predicts how suspended materials (like dredged sediments) disperse horizontally and vertically after being released into the water column. Restrictions may also be influenced by dredging methodology (e.g., mechanical, hydraulic).

The below navigation channel reaches may be subject to load and placement restrictions based on recent sampling, analyses, and coordination with the EPA:

- Anchorage Basin
- Between Channel
- Fourth East Jetty
- Upper Brunswick
- Lower Brunswick
- Upper Big Island
- Lower Big Island
- Keg Island
- Upper Lilliput
- Battery Island
- Bald Head Shoal Channel Reach 1

The USACE would not place materials in the Wilmington ODMDS until EPA, Region 4, concurs that ocean placement of dredged material complies with Section 103 of the MPRSA and other applicable regulations and criteria. Compliance with Section 103 of the MPRSA allows for increased flexibility regarding dredged material placement should alternative placement options (e.g., upland dredged material disposal sites) become unavailable or not provide sufficient volume capacity.

3.7.1 Affected Environment

The sedimentary environment of Wilmington Harbor is shaped by the natural geomorphology of the Cape Fear River and the ongoing influence of tidal and riverine processes. Geotechnical and geophysical assessment of the sediments in the shipping channel indicate a mixture of sediment types, ranging from unconsolidated materials (e.g., sand, silt, and clay) to consolidated materials (e.g., gravel, limestone, sandstone, and mudstone). 3-13 summarizes the general material types found within the proposed shipping channel that would be dredged.

The highest quantities of rock are present in the upper reaches of the project, from Anchorage Basin to Keg Island. Hard rock is encountered between Lower Brunswick to Keg Island, which may require some form of pretreatment (i.e. blasting) prior to removal. Downstream of Keg Island, rock quantities decrease, with the top rock surface becoming more sporadic or absent in these areas. Any O&M dredging following initial construction would involve only unconsolidated sediments, as the rock will have been removed during initial excavation. Historical dredging, vessel traffic, and port operations have contributed to the redistribution of sediments throughout the navigation channel. Grain size tends to become coarser moving downstream from the Port as the depositional environment transitions from riverine to tidal. Additional details regarding each reach’s material make-up can be found in the Appendix C.

Sediment testing for containments were conducted as part of the 1996 WRDA “Wilmington Harbor 96 Act” project and test results revealed those sediments contained acceptable concentrations of toxic contaminants commonly associated with historical industrial and maritime activities. Most recently, toxicity and bioaccumulation tests were performed in 2013 for the entirety of the Wilmington Harbor Federal Navigation Project (FNP) and in 2016 for improvements to the channel near Battery Island and Bald Head Island. These tests also revealed that sediments contained acceptable concentrations. Toxicity and bioaccumulation data are valid for a 10-year period. Wilmington Harbor FNP materials proposed for ODMDS placement most recently obtained concurrence from the EPA on April 3, 2023. Concurrence documentation provided by the EPA is valid for three years and may be conditional on adherence to load and placement restrictions for dredged materials originating from specific dredging units. Load and placement restrictions are dictated by the Short-Term Fate of Dredged Material Model results and are necessary for Wilmington Harbor FNP dredged material to meet the Ocean Dumping Criteria (ODC). EPA-provided concurrence documentation was also contingent upon compliance with all specifications and conditions of the Wilmington ODMDS SMMP, most recently updated and signed on March 9, 2023.

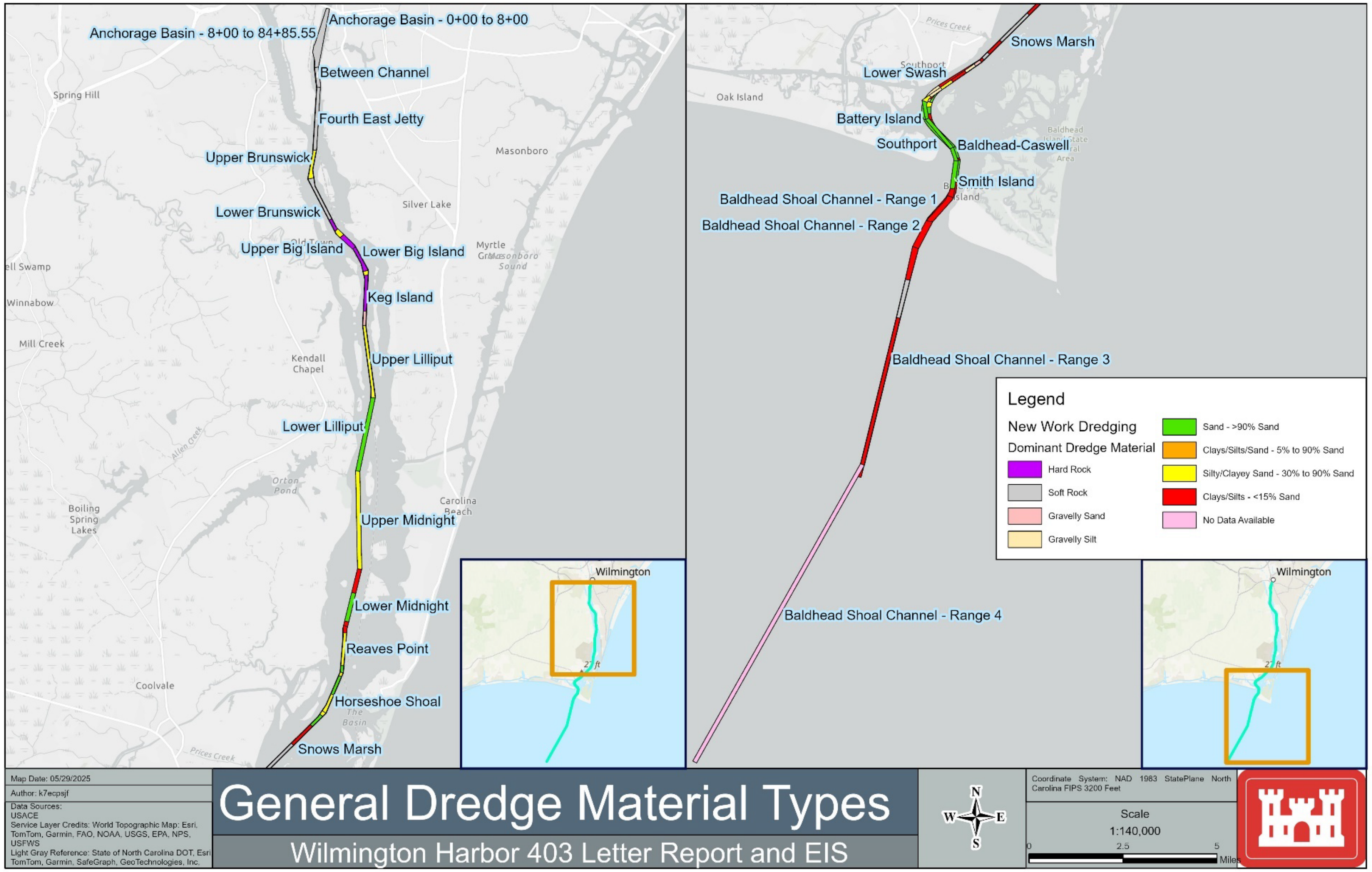

Figure 3-13: General dredge material types throughout the Wilmington Harbor Ship Channel. The general material types noted here is for new work dredging and not maintenance dredging.

3.7.2 Environmental Consequences of NAA

Under the NAA, routine maintenance dredging would continue to ensure safe navigation at existing authorized depths and widths. Annual O&M dredging removes about 2.5 million cubic yards per year and places it at Eagle Island, Brunswick County beaches, or the ODMDS. This alternative would have minimal new environmental impacts. Modifications such as dike raises or construction of new placement area to Eagle Island) may be necessary to accommodate future O&M material. Additionally, placement of material in the ODMDS would be tracked to ensure sufficient capacity for future O&M needs.

3.7.3 Environmental Consequences of AA1 & AA2

The estimated percent breakdown of material types for new work and operation and maintenance (O&M) quantities was calculated for the AA1 and AA2. Percentages and material types are subject to change. Table 3-40 shows the relative percentages of affected sediment types anticipated to be encountered during new work and O&M dredging activities.

Table 3-40: Material type percentages anticipated during new work and O&M for both action alternatives.

Dredged Material Type	Percentage of Material in Navigation Channel AA1	Percentage of Material in Navigation Channel AA2
Sand[1]	17%	18%
Silty/Clayey Sand	21%	22%
Clays/Silts	25%	25%
Mix[2]	19%	21%
Soft Rock[3]	10%	8%
Hard Rock[4]	3%	3%
Unknown[5]	5%	3%
Total	**100%**	**100%**

AA1 would require the removal of approximately 35.1 million cubic yards of sediment, including unconsolidated materials. Disturbing these sediments would impact benthic habitats and cause temporary water quality degradation during construction. While AA2 would require dredging approximately 29.6 million cubic yards of sediment, which is slightly less than AA1. As such, environmental impacts under AA2 would be somewhat

[1] Contains beach compatible material; greater than 90% sand and contains no more than 10% silts/clays/gravel.
[2] Contains a mixture of gravel, sand, silt, and clay. There is no dominant material type present.
[3] Will not require pre-treatment of rock for removal and can be removed via cutter-head.
[4] Will likely require a form of pre-treatment of rock (i.e. rock chopping or underwater confined blasting).
[5] Baldhead Range 4 does not have any geotechnical subsurface data. Sub-bottom profile data was collected in 2017 to assess the top of rock within this area.

reduced, with fewer construction-related disturbances to benthic habitats and temporary water quality degradation from removal and suspended sediments.

Following temporary construction impacts, sediment conditions within the channels would return to levels similar to those under the NAA, with slight increases in annual maintenance dredging quantities. The upper reaches of the channel, from Anchorage Basin to Keg Island, would require rock removal while reaches south of Keg Island would mostly be a mixture of gravels, sands, silts, and clays.

Approximately half of the new work and O&M material would be placed for beneficial use purposes for AA1 and AA2, such as creating habitats or protecting beaches or habitat along shorelines throughout the Cape Fear River. The other half of the material would be placed in the ODMDS. At time of this report, capacities show approximately 150 million cy available for placement in the ODMDS, which is enough to cover construction and regular O&M placement for AA1 and AA2.

No material would be placed in the ODMDS until EPA, Region 4, concurs that ocean placement of dredged material complies with Section 103 of the MPRSA and other applicable regulations and criteria. Ensuring compliance with Section 103 of the MPRSA allows for increased flexibility regarding dredged material placement should alternative placement options (e.g., upland dredged material disposal sites) become unavailable or not contain sufficient volume capacity.

3.8 Groundwater

A regional groundwater model was built to investigate possible impacts to the groundwater system from the proposed modifications. The model was developed using available data and was calibrated to the 2011-2018 time period. The calibrated model was then rerun for the period 2036 – 2086 (the 50-year expected lifetime of the deepening project) to compute the NAA. The computational grid was adjusted to account for AA1 and rerun for the same period to compute with project conditions. These two conditions were compared to predict the impact of the deepening project in terms of salinity movement and gradient changes. Given that this is a regional model, localized salinity results are uncertain and saltwater may move at different rates than the model suggests.

3.8.1 Affected Environment

The study area is characterized by a multi-aquifer system of interbedded sand, silt, and clays, often overlying a fractured rock aquifer (USACE, 1996). The primary aquifers in the southeastern North Carolina Coastal Plain, from oldest to youngest, are the Black Creek, Peedee, Castle Hayne, and the Tertiary or Surficial (USACE, 2000; Figure 3-14). Three main confining units—the Black Creek, Peedee, and Castle Hayne—separate these aquifers.

Within the study area, there are three aquifers: the Peedee, Castle Hayne, and Surficial, all of which have a discharge relationship with the Cape Fear River (Lautier, 1994 and 1998). Although the Black Creek aquifer is within the footprint of the study area, it is located about 300 feet below the study area and is known to be a well-confined unit (Harden et al., 2003). Therefore, this aquifer was not considered in the groundwater modeling. Additional details related to the modeling effort can be found in Appendix C.

System	Series	Geologic Units	Hydrogeologic Units	Description
Quaternary	Holocene	Surficial sand deposits	Surficial aquifer	light gray to light yellow sand, silt, and clay
	Pleistocene	Undifferentiated Pleistocene and Pliocene deposits		
Tertiary	Pliocene		Castle Hayne confining unit	silt, clay, and sandy clay overlies moldic limestone and sand aquifer
	Oligocene	River Bend Formation[6]	Castle Hayne aquifer	
	Eocene	Castle Hayne Formation[7]		
	Paleocene	Beaufort Formation[8]		
Cretaceous	Upper Cretaceous	Peedee Formation	Peedee confining unit	gray, fine to medium-grained sand interbedded with black clay
			Peedee aquifer	
		Black Creek Formation	Black Creek confining unit	sandy clay, silty clay, and clay

Figure 3-14: Generalized relation between geologic and hydrologic units in the Brunswick, New Hanover, and Pender County North Carolina (USGS, 2014).

Apart from a few very small areas, the Cape Fear River is largely a gaining river, meaning that almost all interchange between the river and the groundwater is from groundwater to the river. Within the limited areas where impacts to groundwater salinity are indicated by the model, they are not due to new or increased flows from the river into the aquifers but are generally due to small changes in the flow fields that adjust the direction or velocity of existing salinity movement.

3.8.2 Environmental Consequences of NAA

Groundwater conditions under NAA would remain primarily influenced by existing factors, groundwater pumping and sea level change. The regional groundwater model predicts that saltwater intrusion into aquifers, particularly in coastal areas between the Cape Fear River and the Atlantic Ocean, will continue to worsen over time due to these stressors. Without the deepening project, no additional impacts to groundwater flow or salinity movement would occur beyond those already expected. The groundwater model highlights the existing vulnerability of the aquifers, particularly in coastal areas where saltwater intrusion is already occurring due to sea level change and extensive pumping. Given the region's high dependence on these aquifers for drinking water, these potential impacts warrant close monitoring.

[6] Exists only in southern New Hanover County (Zarra, 1991).
[7] Unit is discontinuous in study area.
[8] Exists only in southeastern Brunswick and southern New Hanover Counties (Zarra, 1991).

3.8.3 Environmental Consequences of AA1

Modeling results indicate that deepening the channel would not introduce new flows of salinity from the Cape Fear River into the aquifers. However, it could slightly modify the existing flow field, altering the direction or velocity of salinity movement. The impacts predicted for AA1 were minor and were found within the model's range of error. These changes are localized and minor compared to the larger impacts driven by sea level change and groundwater pumping and usage in the area, specifically near Carolina and Kure Beach.

3.8.4 Environmental Consequences of AA2

Although a regional groundwater model was not developed specifically for AA2, the predicted impacts from this alternative are expected to be minor and not exceed model uncertainty. The adjustments to the groundwater flow field caused by AA2 would likely be similar in nature—but smaller in magnitude—than those associated with AA1. Therefore, it is reasonable to conclude that AA2 would result in comparable or lesser impacts. These changes are localized and minor when compared to broader regional influences such as sea level change and groundwater pumping.

3.9 Air Quality

Pursuant to the Clean Air Act (CAA) [42 United States Code (USC) 7401 et. seq.], the USEPA has set National Ambient Air Quality Standards (NAAQS) for commonly occurring "criteria pollutants" that may harm public health or the environment. National Ambient Air Quality Standards (NAAQS) have been established for seven criteria pollutants: nitrogen dioxide (NO_2), carbon monoxide (CO), particulate matter less than ten microns in diameter (PM_{10}), particulate matter less than 2.5 microns in diameter ($PM_{2.5}$), sulfur dioxide (SO_2), lead (Pb), and ozone (O_3). All US counties are assigned a designation of either "attainment," "maintenance," or "nonattainment" for each individual criteria pollutant. The individual states are responsible for achieving and maintaining the NAAQS through the development of State Implementation Plans (SIPs). Major stationary sources (i.e., industrial and commercial facilities) of criteria pollutants and other regulated Hazardous Air Pollutants (HAPs) require operating permits under the state administered Title V Operating Permits program. Title V of the CAA defines major source facilities as those having the potential to emit ≥100 tons of any criteria pollutant, ≥10 tons of any single HAP, and/or ≥25 tons of any combination of HAPs on an annual basis. Mobile sources of emissions such as vessels, automobiles, aircraft, and other fuel-powered machinery are addressed in SIPs through vehicle emission budgets, transportation planning efforts, and enforcement of federal emissions standards through state-administered vehicle inspection programs.

The pollutants of concern for the air quality analysis are the following pollutants:

- Criteria pollutants nitrogen oxides (NO_x), CO, SO_2, particulate matter size 30 micrometer aerodynamic diameter and smaller (PM), PM_{10}, $PM_{2.5}$, Pb, and Volatile Organic Compounds (VOCs).
- Air toxics also known as HAPs.
- Greenhouse gases (GHG) methane (CH_4), nitrous oxide (N_2O), carbon dioxide (CO_2), and total GHG of the species above expressed as carbon dioxide equivalents (CO_2e).

GHG emissions are presented in terms of CO_2e, a measure that standardizes each gas according to its global warming potential (GWP) value. The calculation of CO_2e emissions involves multiplying the total of each GHG by its corresponding GWP value and summing the results. The 100-year time horizon GWP values are as follows:

- CO_2 - 1

- CH_4 – 25
- N_2O – 298

A port-related emissions inventory was prepared to assess air quality impacts for existing conditions, future without project (FWOP) (also called the No-Action Alternative), and two action alternatives for the future with project based on the EPA's Ports Emissions Inventory Guidance: Methodologies for Estimating Port-Related and Goods Movement Mobile Source Emissions. The inventory quantifies and compares maritime and stationary source-related emissions at the port for the calendar year 2023 (i.e., baseline emission inventory), the NAA and the two action alternatives. The scope of the inventory is defined by the sectors included, geographical boundaries, time domains, and the pollutants of concern.

The inventory sectors include the following:

- Mobile source sectors such as ocean-going vessels (OGV), harbor craft (e.g., tugboats, support vessels), cargo handling equipment, on-road vehicles, and rail.
- Stationary source sectors occurring at the landside terminal, such as emergency generators, loading and unloading equipment, storage facilities storage piles, etc. The stationary emission sources included in the analysis are both those associated with the Wilmington Port Authority and those associated with leased facilities within the property boundary of the Port of Wilmington.

The two action alternatives also include emissions from construction equipment. Dredging equipment includes a hopper dredge, hydraulic dredge, and mechanical dredge. Dredged material brought to the surface would be wet and is therefore assumed to have zero material handling emissions. Dredging equipment emissions are calculated similar to the way they are calculated for harbor craft.

The geographical domain for the inventory covers both land and overwater activities. The property boundary of the Port of Wilmington defines the landside boundary for port activities. The overwater geographical boundary for the analysis is defined as starting at the Bald Head Shoal Channel and ending at the Anchorage Basin. Emission estimates for the baseline emission inventory are based on available port-related data for activities that occurred during calendar year 2023. The FWOP and the two action alternatives emission estimates are based on forecasted OGV data over the 50-year life span of the project with economic data forecasted in years 2036, 2056, and 2085.

3.9.1 Affected Environment

Wilmington Harbor is located in New Hanover and Brunswick counties. Both counties are currently designated as attainment areas for all criteria pollutants (USEPA 2018) and meet the NAAQS. Existing air quality of the area is monitored by the N.C. Division of Air Quality (DAQ) via the Ambient Information Report (AIR) tool. The tool contains statewide weather and air quality observations about past, current, and forecast air quality events. Existing air quality was evaluated via a port-related emissions inventory which is discussed further in the following subsections and Appendix K.

3.9.2 Environmental Consequences of NAA

Under the NAA, the economic forecast indicates the number of OGV's will increase from the baseline or existing conditions. Air emissions will increase due to the economic changes resulting in importing and exporting an increased quantity of cargo. Table 3-41 summarizes average annual emissions under the NAA conditions.

Table 3-41: 50-Year Average FWOP & Action Alternative Emissions Summary

Pollutant	NAA Emissions (tpy)
NOx	7,752
CO	2,295
SO2	172
PM	2,807
PM10	1,415
PM2.5	415
VOC	533
CO2e	3,048,923
Total HAP	102

3.9.3 Environmental Consequences of AA1 & AA2

Under the Action Alternatives, dredges and other heavy machinery would produce exhaust emissions similar in composition to those of continuing maintenance dredging operations under the FWOP scenario. During periods of active construction, temporary increases in dredging activity and exhaust emissions would be expected. Initial construction would dredge and place approximately 35 million cubic yards of material over a multi-year period, compared to the few million cubic yards dredged and placed annually as a part of operation and maintenance. Emissions would be driven by the amount of material, which is driven by production rate of dredging. Of the three alternatives, the proposed action would cause the higher emissions during construction; however, those impacts would be temporary, localized, and minor Table 3-42.

Considering both construction and operational activities, there is an overall air emissions decrease for every pollutant between the NAA and the Action Alternatives. The decrease in emissions is due to the fewer vessel visits needed to import and export the forecasted cargo volumes. OGVs would be able to contain a heavier load and therefore visit the port less often to transport the same volume of cargo.

Table 3-42: Comparison of pollutants to the NAA.

Pollutant	NAA Emissions (tpy)	AA2 Alternative Emissions (tpy)	AA1 Alternative Emissions (tpy)	AA2 Construction Emissions (tpy)	AA1 Construction Emissions (tpy)	Comparison to NAA
NOx	7,752	7,247	7,152	2,232	2,595	Emissions Decrease
CO	2,295	2,246	2,237	358	416	Emissions Decrease
SO2	172	159	153	1.38	1.61	Emissions Decrease
PM	2,807	2,801	2,797	54.67	63.39	Emissions Decrease
PM10	1,415	1,408	1,407	54.67	63.39	Emissions Decrease
PM2.5	415	409	408	53.03	61.49	Emissions Decrease
VOC	533	514	510	64.29	74.68	Emissions Decrease
CO2e	3,048,923	3,026,327	3,021,768	152,738	177,551	Emissions Decrease
Total HAP	102	100	100	4.82	5.61	Emissions Decrease

The future emission estimates for all alternatives do not account for any future emission reductions resulting from technology improvements over time.

In respect to potential increased port traffic, emissions would lessen with newer, more efficient vessels for both action alternatives. The 10,000 to 11,000 TEU container vessels that currently call on the Port of Wilmington would be replaced by larger container vessels. The larger and more modern fleet of would consist of newer vessels with more efficient engines that emit less air pollutants per unit weight of cargo when fully loaded.

Of the three alternatives, the NAA would cause the highest emissions. Emissions during construction would be highest during the AA1; however, impacts would be temporary, localized, and minor. There would be very limited direct impacts to air quality as dredging and other equipment are utilized will cause temporary and minor emissions, but neither action alternative is expected to change the overall air quality of the region for any period of time. Both Action Alternatives would result in less ships coming into the Wilmington Port, causing indirect effects to air quality by decreasing vessel emissions over time.

3.10 Climate Variability

3.10.1 Affected Environment

Based on the Climate and Sea Level Change (SLC) Analysis presented in Appendix B-I, temperatures are forecasted to increase in the near future with more extreme rain events; however, there is less consensus on future annual precipitation totals. The changing climate is projected to lead to more extreme drought events.

Within the Cape Fear River basin, the Comprehensive Hydrology Assessment Tool (CHAT) tool predicts increasing annual maximum temperatures, annual mean temperatures, and annual precipitation. Observed monthly maximum and monthly average streamflow data within the region do not indicate a widespread trend.

An analysis of watershed climate vulnerability using the USACE VA Tool shows the area to be relatively less vulnerable for the USACE navigation and flood risk reduction business lines compared to the entire USACE portfolio. The variables used to compute the watershed vulnerability score for the navigation business line include increased low flow reduction, decreased cumulative 90% exceedance flows, increased cumulative flood magnification, and increased sedimentation. The variables used to compute the watershed vulnerability for the flood risk reduction business line include increased cumulative flood magnification, changes to percentage of urban area in the 500-year floodplain and increased local flood magnification. No nonstationarities were detected in nearby stream gages from both monthly maximum and monthly average streamflows. This indicates that within the records for the gages, there hasn't been a change in the distribution of the streamflow means and/or variance.

The potential for an increase in extreme drought events coupled with increased extreme rain events could lead to more sedimentation within the Wilmington Harbor navigation channel, creating a need for more frequent dredging.

Increasing sea level trends have been observed at the Wilmington gauge station. Over the 50-year period of analysis the sea level is expected to rise up to 3.77 feet (high SLC scenario at the Wilmington gauge station) in the study area. Potential impacts of sea level change include overtopping of waterside structures, increased shoreline erosion, and increased flooding of low-lying areas. Increased sea level change could lead to a reduction in required maintenance due to increased depth in the channel.

3.10.2 Environmental Consequences of NAA

The potential for an increase in extreme drought events coupled with an increase in extreme rain events could lead to more sedimentation within the Cape Fear River navigation channel, increasing the maintenance dredging quantities. Future Sea Level Change could lead to overtopping of waterside structures, increased shoreline erosion, and increased flooding of low-lying areas. Both climate change and sea level change would reduce the resilience of the navigability of the area.

3.10.3 Environmental Consequences of AA1

The potential for an increase in extreme drought events coupled with an increase in extreme rain events could lead to more sedimentation within the Cape Fear River navigation channel, increasing the maintenance dredging quantities. Dredging the 47-foot template would increase the resilience of the area's navigability versus the No Action plan.

3.10.4 Environmental Consequences of AA2

The potential for an increase in extreme drought events coupled with an increase in extreme rain events could lead to more sedimentation within the Cape Fear River navigation channel, increasing the maintenance dredging quantities. Dredging the 46-foot template would increase the resilience of the area's navigability versus the No Action plan, but less than the 47-foot template. The proposed project would not directly or indirectly impact climate variability or sea level change.

3.11 Visual Resources (Aesthetic)

3.11.1 Affected Environment

Aesthetics addresses the physical, biological, and cultural landscape elements that contribute to perceptions of scenic beauty. The North Carolina coast encompasses a broad range of natural landscape elements that are highly valued for their scenic beauty, including marine and estuarine water resources, tidal marshes, sandy beaches and dunes, maritime forests, and associated wildlife resources. Cultural elements such as lighthouses and historic waterfront districts contribute to a sense of place and the perception of the coast as a unique scenic resource. The study area encompasses a diverse assemblage of viewscapes, including natural forested tidal wetlands in the upper estuary, the historic downtown Wilmington waterfront, industrialized waterfront port facilities, expansive natural salt marshes in the lower estuary, and the sandy beaches, dunes, and maritime forests of Baldhead and Oak Islands. Aesthetic value is not easily quantified, as perceptions of scenic beauty vary among different stakeholder groups. While many are likely to associate scenic beauty with natural and historically significant landscapes, others may place aesthetic value on industrialized port facilities to the extent that they are perceived as part of the maritime history and culture of the North Carolina coast.

3.11.2 Environmental Consequences of NAA

Under the NAA, continuing maintenance dredging of the Wilmington Harbor FNS and placement activities would have short-term and localized effects on aesthetics. During beach placement events, the presence of pipelines and construction equipment on the beach and associated noise emissions and artificial nighttime lighting would temporarily diminish the aesthetic quality of the beach. Public exposure to aesthetic impacts would be limited, as adherence to the sea turtle nesting environmental work window for beach placement would limit operations to the colder months when recreational beach use is at its lowest point.

Operation and maintenance dredging regularly occurs throughout the current Wilmington federal navigation channel, with annual dredging occurring in the northern and southernmost areas (Anchorage Basin and Outer Ocean Bar, respectively). Dredges, which range in size of 150 to 400 feet, can be seen from riverbanks. The average width of the Lower Cape Fear River is approximately 1,500 feet. Even when dredge and barge vessels utilize turning basins and are turned perpendicular to the channel, a very small portion of the viewshed is affected. When not in operation, these vessels can travel a thousand feet per minute when traveling to and from the dredging sites. Continuity of current dredging cycles have temporary and minor effects to visual resources and are not likely to affect significantly in the future under this alternative.

3.11.3 Environmental Consequences of AA1

Under AA1, channel deepening and placement operations would have short-term and localized effects on aesthetics that are similar to but longer in duration than the NAA. Initial construction would require more dredging than standard maintenance dredging, which would last approximately six contract years (within annual environmental timeframes) to modify the channel to the proposed depths and widths. Placement onto bird islands, intertidal areas, riverbanks, beaches, and offshore sites could take up to three months to complete. The dredge vessels and associated equipment required for transporting and placing material would primarily be within the river channel, far enough away from the riverbank and settlements to take up a large area of the public's viewshed. The proposed deepening area is south of Wilmington, where there are waterfront recreational areas. The primary effects to visual resources would be during beach placement onto Bald Head Island, and Oak Island. Similar to the NAA, beach placement would occur during off-season tourism times of year, during the environmental timeframe of 16 November to 30 April. Beach placement in these areas could take around a month to complete, limiting beach access and affecting the viewshed during this time. This alterative would require the most dredging, and likely the most placement in various areas on and offshore of the considered alternatives. Placement projects would rebuild existing beaches and bird islands, leaving more sediment within the viewshed along the river and beaches.

Because the deeper channel would accommodate larger cargo vessels, AA1 would likely also reduce the number of cargo vessel transits through the harbor, resulting in an indirect reduction of overall visual impacts. Placement of sand on local beaches would create improved aesthetics and recreational experiences. Placement of dredged material onto beneficial use areas would support revegetation and improve wetland habitat that would contribute to maintaining and improving aesthetics associated with the natural environment. Placement on riverbanks adjacent to historic sites like Brunswick Town/Fort Anderson (BTFA) would reduce energy from wave action and enhance protection of cultural and historic resources.

The mitigation plan for the wetlands sites would have negligible impacts on aesthetics as these areas are not used by the general public and are relatively secluded. The fish habitat mitigation areas located at L&D 1 and 2 are utilized by fishermen and sometimes pedestrians, who may be temporarily and minorly impacted by construction of the fish passage structures.

3.11.4 Environmental Consequences of AA2

Construction related dredging and placement under AA2 is expected to have similar effects on visual resources as AA1, but with slightly less dredging and placement days due to the shallower depth of dredging. Under this alternative, minimal and temporary direct viewshed impacts would occur with dredging vessels operation throughout the study area, with primary visual changes occurring at beaches, bird islands, and riverbanks where dredged materials are placed. Similar to AA1 and the NAA, dredging and placement would have temporary and minor visual impacts, and would occur during colder months. AA2 would have a similar beneficial use plan and placement, protecting historic and natural resources, and enhancing aesthetics.

The effect to aesthetics for mitigation sites are similar to those of AA1 in that there would be negligible impacts.

3.12 Noise

Section 4(b) of the Noise Control Act of 1972 directs federal agencies to comply with applicable federal, state and local noise requirements with respect to the control and abatement of environmental noise. Congress defined environmental noise in the Noise Control Act of 1972 to include the intensity, duration, and character of sounds from all sources. Applicable federal guidelines for noise regulation are derived from the U.S. Department of Transportation (USDOT) or, more specifically, the Federal Transit Administration and the Federal Highways Administration.

Sound becomes noise when it is considered undesirable because it interferes with communication, results in health effects such as sleep disorder or hearing damage if intense enough, and it diminishes the quality of the environment. Responses to noise vary depending on the type and the characteristics of the noise source, distance from the source, receptor sensitivity, and time of day.

Noise can be intermittent or continuous, steady or impulsive, and it may be generated by stationary or mobile sources. Noise is described by a weighted sound intensity (or level), which represents sound heard by the human ear and is measured in units called decibels (A-weighted decibels [dBA]). The EPA recommends an average 24-hr exposure limit of 70 dBA to protect against hearing damage, and a limit of 55 dBA in outdoor areas to protect public health and welfare (USEPA 1978).

Noise sensitive receptors are of particular interest when analyzing potential noise impacts. These receptors are locations where quiet forms a basic element of their purpose; residences and buildings where people normally sleep (e.g., homes, hotels, hospitals), where nighttime noise is most annoying; and institutional land uses (e.g., schools, libraries, parks, churches) with primarily daytime and evening use. Because noise levels at sensitive receptors are reduced by obstructions (such as sound walls, buildings, vegetation) lying between them and the noise source, special emphasis is placed on sensitive receptors having a direct line of sight to the construction sites.

Many fish and wildlife resources are susceptible to noise because they use sound for communication or predation (Tyack, 2008). This is especially true for aquatic resources because sound travels three times faster in water than it does through the air. For example, bottlenose dolphins, who fall into a mid-frequency generalized hearing range of 150 Hz to 160 kHz, are susceptible to hearing impacts from underwater noise. However, if the frequency of a sound source is outside of the hearing range of a species, then the likelihood of hearing loss caused by that sound source is low (NOAA, 2018).

The City of Wilmington, NC currently has a noise ordinance that includes provisions for “construction operation noise” (Article II – Noise Control). Applicable activities are, “any activity analyzed and determined by the city to be an activity that cannot be avoided for the purpose of construction, public safety, constitutionally, or any other activity otherwise prohibited which the city considers acceptable to be permitted for a limited period of time.” (Section 6-29). The ordinance prohibits “construction activity in residential or downtown areas between the hours of Midnight and 6:00 am, or at any time on the following holidays: New Year’s Day, Thanksgiving Day, or Christmas Day, except by permit for necessary activity.” (Section 6-30 – Specific Prohibitions). The ordinance lists several exemptions, including “construction activity performed by or for an agency of government, provided that all equipment is operated in accordance with manufacturer’s specifications and is equipped with all noise-reducing equipment in proper condition.” (Section 6-31 – Exceptions).

The City of Southport, NC also has a noise ordinance that includes construction activity which is only permitted between the hours of 7:00 am and 6:00 pm (Section 9-93b(8) – Construction Activity).

The study area for noise consists of the entire study area, and the communities closest to the study area including the Wilmington, Sunset Park, River Lights, Carolina Beach, Kure Beach, Southport and Bald Head Island.

3.11.1 Affected Environment

Existing sources of noise in the study area are primarily from vessel traffic and industry, such as dock side port operations and rail operations. There are also relatively low levels of noise from downtown activities, highway traffic, and residential and recreational areas. Currently there are a number of construction projects taking place which generate noise. However, construction noise is usually limited to daytime hours and Saturdays per the City's noise ordinance described above. Typical noise from the Wilmington Harbor includes large commercial vessels, dredging vessels, cruise ships, smaller recreational boats, and rescue vessels (e.g., Coast Guard ships). There are also several passenger ferries and water taxis. Airplanes going to/from the Wilmington Airport (the airport physically outside of the ROI) are also a source of noise.

3.11.2 Environmental Consequences of NAA

With the NAA, it is assumed that the City of Wilmington would continue to enforce its current noise ordinance, so noise levels within the city would be expected to remain the same. It is unclear whether noise levels from other sources around the greater Wilmington area, such as from air and marine transportation, would change in the future, but an analysis of this range of alteration is beyond the scope of this study. There is no proposed construction under the NAA. However, the NAA would have an increase in the number of vessels required to meet the cargo forecast; therefore, an increase in associated vessel noise impacts are anticipated.

3.11.3 Environmental Consequences of AA1

Most of the proposed channel improvements of AA1 would not have any permanent effects on noise. However, the deepening result of Alternative 1 would enable ships to transit the harbor with more cargo at one time, therefore decreasing the number of vessel trips required to transport the forecasted cargo volumes. This could lead to an overall reduction in vessel-related noise. Cargo handling noise at the port and ground transportation systems would remain unchanged.

Construction Related Effects

The Lower Brunswick to Keg Island reach of the channel has undergone confined underwater blasting for past deepening efforts. Consequently, it is assumed that this specific area may continue to require blasting for any future deepening projects. Using a conservative approach, this area is designated for confined underwater blasting although the Unconfined Compressive Strength (UCS) suggests that mechanical means could potentially remove the rock in this area based on recent advancements in dredging technology. If a chosen contractor believes that their mechanical equipment is capable of efficiently removing the material within this location, blasting may not be required.

Other considerations for dredgeability are rock having a UCS greater than 6,000 pounds per square inch (psi) and a rock-quality designation (RQD) less than 50%, which may be mechanically removed as seen from Miami and Wilmington Harbor projects (Potts, 2024). Other sections along the channel, such as the Anchorage Basin, Between Channel, Upper and Lower Lilliput, Snows Marsh, Lower Swash, Battery Island, and Baldhead Shoal Reach 3, feature thicker rock sequences with lower UCS. While mechanical means may be applicable, blasting might still be necessary due to the thickness of the rock.

The blasting of hard rock would only be carried out if necessary to support the construction of the proposed action. If it is determined that blasting is needed, projected aquatic species, such as Atlantic sturgeon, sea turtles, and marine mammals may be impacted by intense underwater noise and shock waves. USACE would employ avoidance and minimization measures during all blasting activities and would require the implementation of effective mitigation and monitoring measures by the construction contractor for all proposed blasting activities. Depending on the species present during the time of blasting, injurious effects may include a temporary or permanent change in hearing (threshold shift), lung or gastrointestinal tract injury (from pressure waves), or direct injury or mortality. Behavioral responses to blasting are less understood but may include changes in swim speed or direction, dive duration, foraging, resting, social state, distribution, or stress level. To predict the extent to which underwater noise from the potential blasting may impact marine species, acoustic ranges to protected species' auditory and non-auditory impact thresholds would be calculated and included in the Comprehensive Plan. These ranges represent the distance from explosive activity within which species could experience injuries or behavioral effects. The ranges correlate to in-water impact zones, and these zones can inform viable mitigation technologies and monitoring strategies. It is expected that the impact zones would be estimated by applying a combination of empirical- and physics-based computational models. Modeling of acoustic fields produced by explosive force should include shock pulse pressure, impulse, and sound exposure level modeling. Acoustic thresholds for marine mammals, sea turtles, and fish are available from the (Navy, 2024), (NMFS, 2024), and ANSI-Accredited Standards Committee (Popper et al. 2014). To assess the potential level of impact from blasting and inform the development of specific mitigation measures, a thorough impact analysis during the development of the Comprehensive Plan during pre-construction phase will be developed, which will include an assessment of explosive underwater noise. More information on recommended blast mitigation measures and blast mitigation plan development are available in Appendix L: Conceptual Blast Mitigation Plan.

3.11.4 Environmental Consequences of AA2

This alternative assumes that the City of Wilmington's noise ordinance would be in place in the future. Most of the proposed channel improvements of AA2 would not have any permanent effects on noise. Alternative 2 would allow ships to carry more cargo per trip, reducing the number of trips needed to meet cargo forecasts. This could lead to a reduction in vessel-related noise overall. Cargo handling noise at the port would remain unchanged. Construction related effects, particularly the potential for impacts from blasting, if required, would be similar but lesser than AA1 since less rock material would need to be removed.

Overall, AA2 will have a similar but smaller impact than AA1, due to decreased quantities and decreased construction duration.

3.13 Vegetation

3.13.1 Affected Environment

Vegetation in the study area, not including wetland species, can generally be categorized into three habitat categories: upland, modified or constructed habitat, and beach dune. Information regarding wetland vegetation can be found in Section 3.5.

Upland Habitat

Hardwood forest stands within the study area are generally small and uncommon. Intensive land use practices including timbering, farming, and burning may have been responsible for precluding the regeneration of hardwood forest stands. Most of the stands in the study area are associated with sandy ridges located along the east bank of the Cape Fear River in New Hanover County. Canopy species include longleaf pine (*Pinus palustris*), loblolly pine (*Pinus taeda*), sweetgum (*Liquidambar styraciflua*), oak (*Quercus spp.*), and hickory (*Carya spp.*). Subcanopy species include American holly (*Ilex opaca*), dogwood (*Cornus florida*), and shrubs such as yaupon (*Ilex vomitoria*), wild olive (*Osmanthus americanus*), and American beauty berry (*Callicarpa americana*). Upland vegetation is the least tolerant of increased salinity compared to modified or constructed and beach dune habitat.

Modified or Constructed Habitat

Modified or constructed features are those habitats that have been created as a result of the activities of man. Urban-residential areas, borrow pits, landfills, dredged material placement areas, utility areas, construction areas, roads, fields and agricultural areas, buildings, and recently abandoned usage areas are all considered part of this habitat, which occupies a significant area of the installation. The main habitat type found in the study area would consist of the various bird islands in the Cape Fear River. Vegetation found on bird islands are typically more tolerant to increased salinity due to the proximity to saline waters. Typical species on these islands include: yellow nutsedge (*Cyperus esculentus*), crab-grass (*Digitaria filiformis*), persimmon (*Diospyros kaki*), frost aster (*Aster pilosus*), horse-weed (*Conyza canadensis*), common reed (*Phragmites australis*), silverling (*Paronychia argyrocoma*), camphor weed (*Heterotheca subaxillaris*), pig-weed (*Chenopodium ambrosioides*), and Johnson grass (*Sorghum halepense*).

Beach and Dune Habitats

Beach and dune habitats within the study area can be found along the coastline above the mean high tide line, on Oak Island, Caswell Beach, Bald Head Island, Carolina Beach and Masonboro Island. They are seasonally flooded by high spring tides and storm surges, but rainwater and salt spray contribute to moist conditions in some areas. The beach environment is severe due to constant exposure to salt spray, shifting sands, wind, and sterile soils with low water retention capacity. Common vegetation of the upper beach includes beach spurge (*Euphorbia polygonifolia*), sea rocket (*Cakile edentula*) and pennywort (*Hydrocotyle bonariensis*). The dunes are more heavily vegetated, and common species include American beach grass (*Ammophila breviligulata*), panic grass (*Panicum amarum*) sea oats (Uniola paniculata), broom straw (*Andropogon virginicus*) and salt meadow hay (*Spartina patens*).

3.13.2 Environmental Consequences of NAA

According to the Climate and Sea Level Change (SLC) Analysis presented in Appendix B-I, temperatures are forecasted to increase in the future. Increasing sea level trends have been observed at the Wilmington gauge station. In the next 50 years, the sea level is expected to rise up to 3.77 feet (high SLC scenario at the Wilmington gauge station) in the study area. Potential direct impacts of sea level change (SLC) include overtopping of waterside structures, increased shoreline erosion, and increased flooding of low-lying areas. The primary concern regarding sea level change (SLC) is the indirect impact to vegetation resulting from increased salinity levels in surface water Modified or constructed and beach and dune vegetation are likely to be directly impacted by the increase in sea level due to their proximity to saline waters; however, vegetation in these habitat areas are tolerant to increased salinity. Upland vegetation is usually set back further from saline waters and may not be as likely to be impacted by sea level change. It is difficult to predict impacts to vegetation over the next 50 years, but overall, current vegetated areas within the study area would likely survive within their current range. Therefore, under the NAA, vegetation throughout the study area would show varying degrees of change depending on the rate of SLC. Should there be a change in habitat due to this alternative, it could potentially introduce more salt tolerant wetland species to these habitats. Caswell Beach, Bald Head Island (via the Wilmington Harbor O&M) and Carolina Beach (via the Carolina Beach Coastal Storm Risk Management [CSRM]) would still receive their maintenance dredging, reducing shoreline erosion providing positive impacts to the beach and dune vegetation. Overall, the O&M of the current project would have no adverse effect on vegetation within the study area.

3.13.3 Environmental Consequences of AA1

The direct impacts of AA1 would be the covering and killing of current vegetation during placement of material above mean high water to South Pelican Island and Ferry Slip Island, but it is expected to provide terrestrial habitat that was once under water, recolonizing and succeed to maturity quickly.

All three vegetation habitats would show negative effects, but the project is not expected to cause significant salinity impacts to a point where vegetation habitats would change considerably as compared to the NAA.

In conjunction with the scheduled Wilmington Harbor and Carolina Beach O&M, the addition of sand on Oak Island, Caswell Beach, Bald Head Island, Carolina Beach and Masonboro Island would reduce impacts due to erosion and provide protection of the vegetation on the beach and dune.

Overall, there would be minor long-term negative impacts due to salinity change, minor short-term impacts to covered vegetation during bird island placement, and long-term positive impacts due to protecting the shoreline. Therefore, the anticipated effects of AA1 on vegetation are considered to be insignificant.

3.13.4 Environmental Consequences of AA2

The direct and indirect impacts of AA2 would be similar to AA1, but with a slight reduction in upstream shifts and with reduced impacts due to beach erosion. The same amount of material would be placed on the bird islands resulting in the same impacts as AA1. Action Alternative 2 also places material on the same beaches as AA1, but the amount of material would be slightly reduced.

Overall, there would be minor long-term negative impacts due to salinity change, minor short-term impacts to covered vegetation during bird island placement, and long-term positive impacts due to protecting the shoreline. Therefore, the anticipated effects of AA2 on vegetation are considered to be insignificant.

3.14 Wildlife

3.14.1 Affected Environment

Wildlife present in the study area includes a mix of mammals, birds, reptiles, and amphibians common to Coastal North Carolina. A large variety of terrestrial wildlife can be commonly found throughout the upland and riverine habitats, these include: gray squirrel (*Sciurus carolinensis*), marsh rabbit (*Sylvilagus palustris*), Whitetailed deer (*Odocoileus virginianus*), raccoon (*Procyon lotor*), mink (*Neovison vison*), muskrat (*Ondatra zibethicus*), otter (*Lontra canadensis*), fox (*Vulpes vulpes*), nutria (*Myocaster coypus*), opossum (*Didelphis virginiana*), shrew (*Sorex araneus*), mole (*Talpidae spp.*), vole (*Microtus pennsylvanicus*), house mouse (*Mus musculus*) southern leopard frog (*Lithobates sphenocephalus*), green tree frog (*Hyla cinerea*), black rat snake (*Pantherophis obsoletus*), eastern cottonmouth (*Agkistrodon piscivorus*), yellow-bellied turtle (*Trachemys scripta scripta*), and snapping turtle (*Chelydra serpentina*). The beaches of the project vicinity are heavily used by migrating shorebirds. However, dense development and high public use of study area ocean front beaches may reduce their value to shorebirds. The shoreline area along beaches provides bird-nesting and foraging habitat for Black skimmers (*Rynchops niger*), least terms (*Sterna antillarum*), Wilson's plovers (*Charadrius wilsonia*), piping plovers (*Charadrius melodus*), common terns (*Sterna hirundo*), willet (*Catoptrophorus semipalmatus*), and American oystercatcher (*Haematopus palliates*). Other birds often found within the inlet at different times of year include common loon (*Gavia immer*), double-crested cormorants (*Phalacrocorax auritus*), Brown pelicans (*Pelecanus occidentalis*), various gull species, egret species and heron species (Fussell 1985).

3.14.2 Environmental Consequences of NAA

Over the 50-year period of analysis the sea level is expected to rise up to 3.77 feet (high SLC scenario at the Wilmington gauge station) in the study area. Upland species not resistant to a higher saline environment would expect to move to a more suitable habitat. Short-term transient effect could occur to mammalian species using the dune and fore-dune habitat, but those species are mobile and would be expected to move to other, undisturbed areas of habitat during periodic nourishment events.

3.14.3 Environmental Consequences of AA1

Direct impacts of AA1 could cause a short-term transient effect to occur to mammalian species using the dune and fore-dune habitat, but those species are mobile and would be expected to move to other, undisturbed areas of habitat during periodic nourishment events.

The indirect impacts of AA1 is the additional relative upstream (approximately 0.08- to 0.75-miles) shifts in the freshwater (0-0.5 ppt) to oligohaline (0.5-5 ppt) salinity isopleths as compared to the NAA alternative. Upstream habitats would show negative effects, but the project is not expected to cause significant salinity impacts to a point where wildlife habitats would change considerably. Also, in conjunction with the scheduled Wilmington Harbor and Carolina Beach Operations and Maintenance, AA1 proposes additional beach placement to Oak Island, Caswell Beach, Bald Head Island, Carolina Beach and Masonboro Island. The addition of sand on these beaches provide protection to the beach and dune systems.

Overall, there would be minor long-term negative impacts due to salinity change and long-term positive impacts due to protecting the shoreline. Therefore, the anticipated effects of AA1 on wildlife are considered to be insignificant.

3.14.4 Environmental Consequences of AA2

The direct and indirect impacts of AA2 would be similar to AA1, but with a slight reduction in upstream shifts and with reduced impacts due to beach erosion. Action Alternative 2 also places material on the same beaches as AA1, but the amount of material would be slightly reduced. Under AA2, the salinity modeling results indicate that channel deepening to 46-feet would still cause additional relative upstream shifts in the freshwater (0-0.5 ppt) to oligohaline (0.5-5 ppt) salinity isopleths, but slightly less as compared to AA1. Action Alternative 2 also places material on the same beaches as AA1, but the amount of material would be slightly reduced. Overall, there would be minor long-term negative impacts due to salinity change and long-term positive impacts due to protecting the shoreline. Therefore, the anticipated effects of AA2 on wildlife are considered to be insignificant.

3.15 Coastal Birds

3.15.1 Affected Environment

The expansive estuarine complex of tidal marshes and creeks, oyster reefs, and intertidal sand and mud flats provides highly productive foraging habitats that support breeding populations of coastal waterbirds, as well as thousands of migratory shorebirds and waterbirds that use the Cape Fear River estuary as a stopover refueling site during the spring and fall migration periods. The barrier island beaches of the study area (Oak Island, Caswell Beach, Bald Head Island, Carolina Beach and Masonboro Island) also provide important foraging and roosting habitats for shorebirds and colonial waterbirds, including sanderlings (Calidris alba), willets(Tringa semipalmata), ruddy turnstones (Arenaria interpres), semipalmated plovers (Charadrius semipalmatus), laughing gulls, ring-billed gulls (Larus delawarensis), herring gulls (L. argentatus), and brown pelicans (Grippo et al. 2007). Material from Baldhead Shoal Channels 1 and 2 and the Smith Island Channel is dredged with an ocean certified pipeline dredge every other year with placement at either Oak Island and Caswell Beach or Bald Head Island, in accordance with the Regional Sand Management Plan. Maintenance events have generally placed approximately 1.1 million cubic yards of material. The black skimmer, least tern, gull-billed tern, common tern and American oystercatcher are state-listed species of concern for New Hanover County, North Carolina, and are found on Carolina Beach and Masonboro Island year-round during both the breeding season and during migration, with peak abundance occurring in the summer months. Terns feed by diving from the air on insects and small fish, the black skimmer feeds on shrimp or small fish by flying just above the water with the tip of the long lower mandible shearing the surface and the American Oystercatcher forages by walking in the shallow water searching for shellfish and marine worms by sight. All these bird species may use Carolina Beach or Masonboro Island for roosting, foraging, breeding, and nesting. Dense development and high public use of study area ocean front beaches may reduce their value to shorebirds. These species formerly nested primarily on the barrier islands of the region but have had most of these nesting sites usurped by development or recreational activities. With the loss of their traditional nesting areas, these species have retreated to the relatively undisturbed dredged material placement islands, which border the navigation channels in the area. These islands often offer ideal nesting areas as they are close to food sources, removed from human activities, and are isolated from mammalian egg and nestling predators. Dunes of the study area support fewer numbers of birds than the beaches but can be very important habitats for resident songbird species and for other species during periods of migration.

Table 3-43: Ten Most Abundant Colonial Waterbird and Shorebird Species Observed in Project Area Oceanfront Beach Habitats:

Species		Abundance birds/km/survey		
Common Name	**Scientific Name**	**Eastern Oak Island**	**Western Oak Island and Eastern Holden Beach**	**Western Holden Beach**
Colonial Waterbirds				
Laughing Gull	*Leucophaeus atricilla*	67.1	55.6	34.9
Ring-billed Gull	*Larus delawarensis*	50.4	49.6	25.4
Brown Pelican	*Pelecanus occidentalis*	7.3	7.0	4.0
Herring Gull	*Larus argentatus*	1.2	1.1	1.0
Forster's Tern	*Sterna forsteri*	0.3	1.0	0.9
Royal Tern	*Thalasseus maximus*	15.3	14.0	8.9
Great Black-backed Gull	*Larus marinus*	2.5	1.1	1.0
Bonapartes Gull	*Chroicocephalus philadelphia*	5.7	5.3	2.1
Double-crested Cormorant	*Phalacrocorax auritus*	0.5	0.6	0.4
Sandwich Tern	*Thalasseus sandvicensis*	0.6	0.5	0.7
Shorebirds				
Sanderling	*Calidris alba*	5.8	9.0	10.1
Willet	*Tringa semipalmata*	0.4	0.1	0.0
Short-billed Dowitcher	*Limnodromus griseus*	1.8	2.5	4.5
Ruddy Turnstone	*Arenaria interpres*	0.25	0.6	1.2

Species		Abundance birds/km/survey		
Common Name	**Scientific Name**	**Eastern Oak Island**	**Western Oak Island and Eastern Holden Beach**	**Western Holden Beach**
Black-bellied Plover	*Pluvialis squatarola*	0.6	0.9	0.9
Semipalmated Plover	*Charadrius semipalmatus*	0.1	0.1	3.0
Semipalmated Sandpiper	*Calidris pusilla*	0.6	<0.1	0.2
Killdeer	*Charadrius vociferous*	0.1	0.1	0.1
Whimbrel	*Numenius phaeopus*	0.1	<0.1	0.1
American Oystercatcher	*Haematopus palliatus*	<0.1	<0.1	0.1

Source: Brunswick County Beaches Shorebird/Waterbird Monitoring Dec 2000-Nov 2002.

Ferry Slip and South Pelican Islands were created in the early 1970s and are small, dredged material placement areas in the lower river that are not diked and are also managed by the Audubon Society for colonial nesting waterbirds. The islands are composed of entirely dredged sand and are periodically renourished by the USACE when suitable, beach-quality sand is available. These islands are posted and patrolled throughout the nesting season to prevent disturbance to nesting birds. Ferry Slip supports a large colony of Royal (*Thalasseus maximus*) and Sandwich terns (*Thalasseus sandvicensis*), and a small colony of Laughing Gulls (*Leucophaeus atricilla*). The island also supports a significant colony of Brown Pelicans (*Pelecanus occidentalis*). South Pelican Island is an important nesting site for Royal Terns, Sandwich Terns, and a few Gull-billed Terns (*Gelochelidon nilotica*). An average of 10 to 11 breeding pairs of American Oystercatchers nest there annually. Snowy Egret (*Egretta thula*), Tricolored Heron (*Egretta tricolor*), and Cattle Egret (*Bubulcus ibis*) nest on the site in some years. The two islands are the most important nesting areas for royal and sandwich terns and support the largest colony of brown pelicans in the southeast region of North Carolina. Sand is occasionally placed on these islands during maintenance dredging. Each island is permitted to a size of seven acres above mean high water (MHW). Locations of bird islands are shown in Figure 3-15.

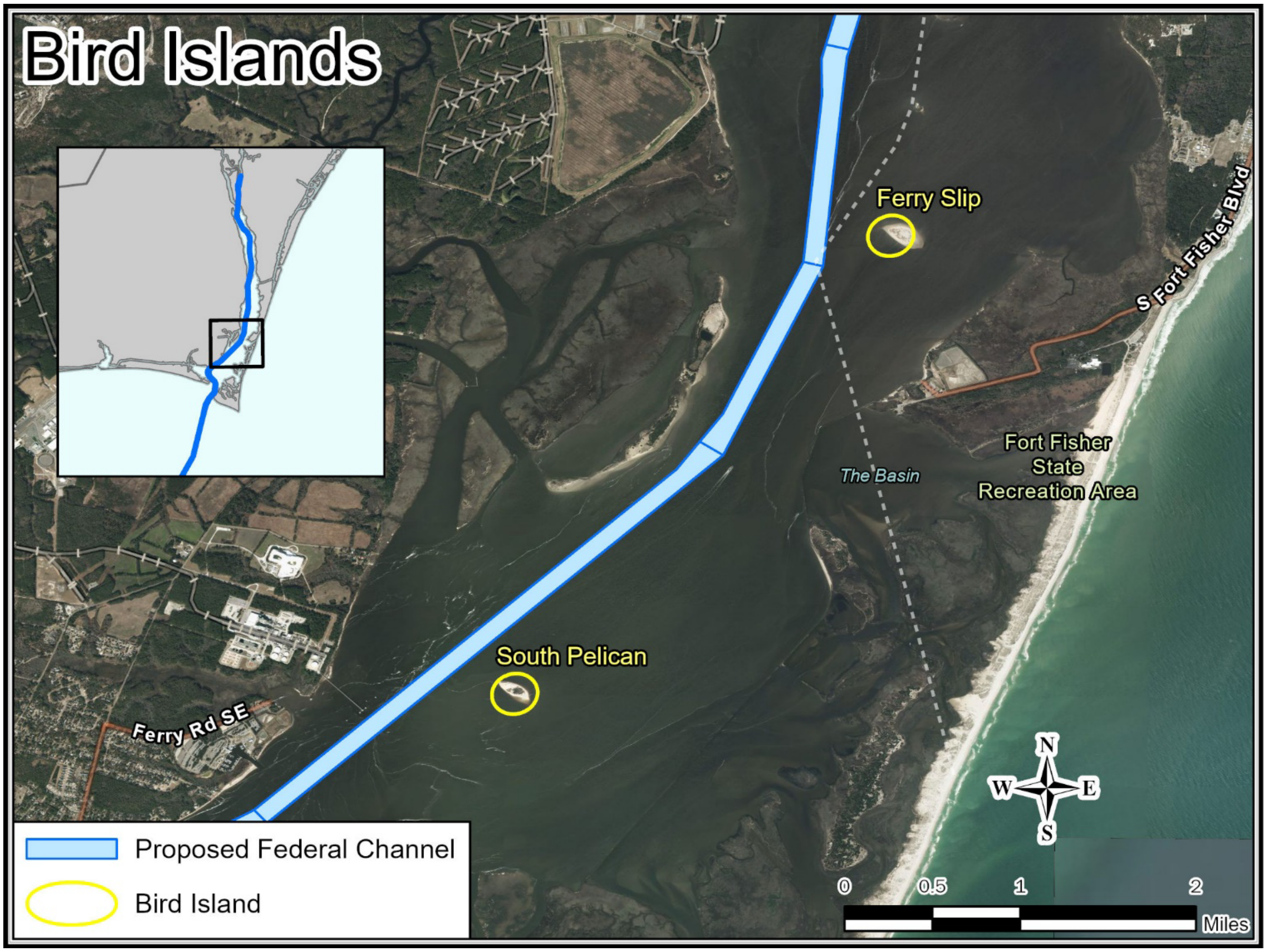

Figure 3-15: Lower Cape Fear River Bird Islands

3.15.2 Environmental Consequences of NAA

Under the NAA alternative, continuing beach placement operations on Oak Island, Caswell Beach and Bald Head Island would affect coastal waterbirds through disturbance and impacts on intertidal beach foraging habitats. Beach construction activities would temporarily disrupt the foraging and/or roosting activities of shorebirds and colonial waterbirds. Beach placement would result in the burial and temporary loss of intertidal benthic invertebrate infauna within the beach fill templates, thereby reducing the availability of benthic infaunal prey for shorebirds. Most benthic infaunal recovery studies have reported recovery within one year of the initial impact when highly compatible beach fill sediments were used and larval recruitment periods were avoided (Jutte et al. 1999a, Burlas et al. 2001, Van Dolah et al. 1994, Van Dolah et al. 1992, Gorzelany and Nelson 1987, Salomon and Naughton 1984, Parr et al. 1978, and Hayden and Dolan 1974). The Wilmington District USACE anticipates continuing maintenance dredging and beach placement on Oak Island, Caswell Beach and Bald Head Island. This will be in accordance with current conservation measures to minimize effects on coastal waterbirds, including adherence to a November 16 through April 30 beach placement environmental work window, beach fill compatibility standards, and the use of onshore delivery pipeline routes that avoid high value inlet habitats for shorebirds.

3.15.3 Environmental Consequences of AA1

The direct effects to coastal birds due to the AA1 is the temporary displacement during bird island and beach placement. The addition of Carolina Beach (6,250 LF) and Masonboro Island (4,750 LF) as potential placement areas for the proposed improvements would also cause of burial and temporary loss of intertidal benthic invertebrate infauna within the beach fill templates, thereby reducing the availability of benthic infaunal prey and roosting areas for shorebirds.

The indirect effects are small projected increases in average annual surface salinity (≤0.3 ppt) which may cause minor changes in tidal wetland community composition at the upper ends of salinity gradients in the estuary; however, these changes would not be expected to affect the availability or quality of coastal waterbird habitats. And a significant long-term improvement to bird island and beach habitat by reducing the impacts due to ongoing shoreline erosion.

Channel deepening would not be expected to result in impacts on intertidal or supratidal waterbird habitats. As described in Appendix B, the XBeach hydrodynamic model was used to assess the effects of larger vessels, and their associated ship wakes on historically erosional shorelines in the lower Cape Fear River from Bald Head Island up to Orton Point. The XBeach hydrodynamic model was used to assess the effects of vessels and their wakes on bird nesting islands in the lower estuary. Model-projected primary and secondary ship wakes and wave generated bed shear stress were evaluated along with underkeel clearance and the number of cargo vessel transits expected as indicators of shoreline erosion potential. The modeling results indicate that the primary consideration is the number of vessel transits and that the reduction in the number of vessels transiting the harbor and the increase underkeel clearance would generally reduce overall erosion rates and volumetric sediment losses. Small projected increases in average annual surface salinity (≤0.3 ppt) may cause minor changes in tidal wetland community composition at the upper ends of salinity gradients in the estuary; however, these changes would not be expected to affect the availability or quality of coastal waterbird habitats. As described in Appendix B, the XBeach model results indicate that channel deepening would have minimal effects on sediment transport and shoreline erosion rates along the beaches of Oak Island, Caswell Beach, Bald Head Island, Carolina Beach or Masonboro Island. Beach placement for Oak Island (19,000 linear feet (LF)), Caswell Beach (3,500 LF) and Bald Head Island (11,250 LF) would be the same as the NAA alternative. Beach placement operations would adhere to the established sea turtle nesting environmental work window (November 16 – April 30) and beach fill compatibility standards, thereby avoiding peak infaunal recruitment periods and increasing the likelihood of relatively rapid benthic infaunal recovery. Overall, AA1 would have a temporary and minor impact during beach placement events.

To reduce erosion on Masonboro Island from the bayside, material may be placed in the intertidal mud flat. Construction would tie into the existing shoreline elevation and would be filled no higher than the current MHW projection and would utilize the September 1 through April 30 environmental window.

Placement of material on or around important bird islands in the Cape Fear River would also be performed under the environmental bird work window of September 1 through April 30. The placement of material in and around important bird islands and Masonboro Island would have a short-term negative impact to feeding and roosting birds during construction but with a significant long-term improvement to overall bird habitat by providing resilience to ongoing shoreline erosion.

3.15.4 Environmental Consequences of AA2

The direct and indirect impacts of AA2 would be similar to AA1, but with a slight reduction in upstream shifts and with reduced impacts due to beach erosion. Action Alternative 2 also places material on the same beaches as AA1, but the amount of material would be slightly reduced. Under AA2, the salinity modeling results indicate that channel deepening to 46-feet would still cause additional relative upstream shifts in the freshwater (0-0.5 ppt) to oligohaline (0.5-5 ppt) salinity isopleths, but slightly less as compared to AA1.

Beach placement would also cause of burial and temporary loss of intertidal benthic invertebrate infauna within the beach fill templates, thereby reducing the availability of benthic infaunal prey for shorebirds. Beach placement operations would adhere to the established sea turtle nesting environmental work window (16 November - 30 April) and beach fill compatibility standards, thereby avoiding peak infaunal recruitment periods and increasing the likelihood of relatively rapid benthic infaunal recovery. Placement of material on or around important bird islands in the Cape Fear River would also be performed under the environmental bird work window of September 1 through April 30. The placement of material in and around important bird islands and Masonboro Island would have a short-term negative impact to feeding and roosting birds during construction but with a significant long-term improvement to overall bird habitat by reducing ongoing shoreline erosion.

3.16 Protected Species – U.S. Fish and Wildlife Service

The Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 15 31–1543), provides a program for the conservation of threatened and endangered (T&E) plants and animals and the habitats in which they are found. The NMFS and the (USFWS have shared jurisdiction for recovery and conservation of threatened and endangered sea turtles. The NMFS leads the conservation and recovery of sea turtles in the marine environment, while the USFWS has the lead for the conservation and recovery of these animals on nesting beaches. This section addresses only the species under the USFWS purview and therefore addresses sea turtle nesting beaches. For more information regarding sea turtles in the marine environment, see Sections 3.16.4 and 3.17.1.

In accordance with section 7(a)(2) of the ESA, the USACE has been in consultation with the USFWS since beginning this study to ensure that effects of the proposed project would not jeopardize the continued existence of listed species or result in the destruction or adverse modification of designated critical habitat of such species. All conditions and conservation recommendations of the USFWS 2017 North Carolina Coastal Beach Sand Placement Statewide Programmatic Biological Opinion (SPBO) or superseding BO, would be followed, thereby minimizing any adverse impacts to listed sea turtle, bird species, or plant species, or their designated critical habitat. An updated list of T&E species for the study area was obtained from the USFWS (Field Office, Raleigh, NC) using their online Information for Planning and Consultation (IPAC) tool. The list was used to develop Table 3-44, which includes T&E species that could be present in the area based upon their historical occurrence or potential geographic range. However, the actual occurrence of a species in the area depends upon the availability of suitable habitat, the season of the year relative to a species' temperature tolerance, migratory habits, and other factors.

A total of 22 ESA-listed threatened and endangered species may occur in the study area (Table 3-44). Additionally, the study area includes a number of defined geographic areas that are designated under the ESA as critical habitats for threatened and endangered species (Table 3-45). Critical habitats are areas considered essential to the conservation of a species that may require special management or protection. Designated critical habitats have essential habitat features known as “primary constituent elements” that are considered requirements for survival and reproduction.

The USACE has determined the proposed action alternative will have no effect on the tricolored bat, northern long-eared bat, Bermuda petrel, wood stork, roseate tern, red cockaded woodpecker, American alligator, Atlantic pigtoe, monarch butterfly, Cooley's meadowrue, American chaffseed, and rough-leaved loosestrife.

Table 3-44: USFWS T&E Species that May Occur in Study Area and USACE Project Determination.

Category	Listed Species within the Study Area	Status	Proposed Action[1]
Mammals	West Indian Manatee/ *Trichechus manatus*	Threatened	MANLAA
	Tricolored Bat/ *Perimyotis subflavus*	Proposed Endangered	No Effect
	Northern Long-eared Bat/ *Myotis septentrionalis*	Endangered	No Effect
Birds	Piping Plover/ *Charadrius melodus*	Threatened	MALAA
	Red Knot/ *Calidris canutus rufa*	Threatened	MALAA
	Bermuda Petrel/ *Pterodroma cahow*	Endangered	No Effect
	Wood Stork/ *Mycteria americana*	Threatened	No Effect
	Roseate Tern/ Sterna dougallii	Endangered	No Effect
	Red-cockaded Woodpecker/ *Picoides borealis*	Threatened	No Effect
Reptiles	American Alligator/ *Alligator mississippiensis*	Threatened[2]	No Effect
	Green Sea Turtle/ *Chelonia mydas*	Threatened	MALAA
	Kemp's Ridley Sea Turtle/ *Lepidochelys kempii*	Endangered	MALAA
	Leatherback Sea Turtle/ *Dermochelys coriacea*	Endangered	MALAA
	Loggerhead Sea Turtle/ *Caretta caretta*	Threatened	MALAA
Clams	Atlantic Pigtoe/ *Fusconaia masoni*	Threatened	No Effect
Snails	Magnificent Ramshorn *Planorbella magnifica*	Endangered	No Effect
Insects	Monarch Butterfly/ *Danua plexippus*	Proposed Threatened	No Effect
Flowering Plants	Seabeach Amaranth/ *Amaranthus pumilus*	Threatened	MALAA
	Cooley's Meadowrue/ *Thalictrum cooleyi*	Endangered	No Effect
	Golden Sedge/ *Carex lutea*	Endangered	No Effect
	American Chaffseed/ *Schwalbea americano*	Endangered	No Effect
	Rough-leaved Loosestrife/ *Lysimachia asperulaefolia*	Endangered	No Effect

[1]MANLAA- May Affect, Not Likely to Adversely Affect; MALAA- May Affect, Likely to Adversely Affect
[2]Similar in Appearance to threatened species, *Crocodylus acutus,* which is not found in North Carolina.

Table 3-45: Species Critical Habitat Units within Study Area.

Critical Habitat Type[1]	Mapped Unit ID	Description	Length/Area
Piping Plover: Wintering	NC13 Masonboro	North end of Masonboro Island Masonboro Inlet	150 acres
	NC14 Carolina Beach Inlet	South end of Masonboro Island Carolina Beach Inlet emergent shoals North end of Carolina Beach	924 acres
	NC15 Fort Fisher	Fort Fisher Islands and ocean beach south of the ferry terminal	1,951 acres
	NC16 Lockwoods Folly Inlet	West end of Oak Island Lockwoods Folly Inlet emergent shoals	90 acres
	NC17 Shallotte Inlet	West end of Holden Beach Shallotte Inlet emergent shoals	296 acres
	NC18 Mad Inlet	West end of Sunset Beach Marshes behind west end of Sunset Beach East end of Bird Island	278 acres
Loggerhead Turtle: NW Atlantic Distinct Population Segment (USFWS Jurisdiction)	LOGG-T-NC-05	Pleasure Island	11.5 miles
	LOGG-T-NC-06	Bald Head Island	9.4 miles
	Unit LOGG-T-NC-07	Oak Island	13.0 miles
Magnificent Ramshorn	**1** = Big Pond (aka Pleasant Oaks Pond) **2** = Orton Pond	Both ponds are immediately west of the Cape Fear River and likely on private property.	N/A
Rufa Red Knot Proposed Critical Habitat	NC-07	Includes the entire sandy shoreline and a sandbar on Bald Head Island.	N/A

3.16.1 Florida Manatee

Affected Environment

The Florida manatee (*Trichechus manatus latirostris*), a subspecies of the West Indian manatee, was originally listed as endangered in 1967 (32 FR 4001) under the Endangered Species Preservation Act of 1966. In 1969, the endangered listing was expanded to include the Antillean manatee (*T. manatus manatus*), a subspecies occurring in the Caribbean and South America. In 2017, both subspecies were reclassified as threatened throughout their ranges (82 FR 16668). Manatees are intolerant of cold-water temperatures, and consequently, are generally restricted to warm water sites of peninsular Florida during the winter. In the spring, as water temperatures reach 68°F, manatees disperse from winter sites and can undertake extensive movements along the coast and up rivers and canals (USFWS 2001). Manatees inhabit marine, brackish, and freshwater environments where they are found in seagrass beds, salt marshes, freshwater bottom areas, and many other habitat types. Manatees feed on a wide variety of submerged, floating, and emergent vegetation. Seagrasses are a staple in coastal habitats, and preferred foraging habitats consist of shallow seagrass beds with access to deep water. Manatees are also known to feed on salt marsh vegetation (i.e., smooth cordgrass), which they access at high tide. Although manatees tolerate a wide range of salinities, they prefer areas where osmotic stress is minimal or areas that have a natural or artificial source of fresh water (USFWS 2001). The principal anthropogenic threats to manatees include watercraft strikes, entrapment and/or crushing in water control structures, entanglement in fishing gear, and ingestion of marine debris. Of 1,877 deaths that were attributed to anthropogenic causes between 1978 and 2007, the majority (82%) were attributed to watercraft strikes. Water control structures accounted for ten percent of the deaths, and the remaining eight percent were attributed to a combination of entanglement, ingestion of marine debris, entrapment in pipes and culverts, and other human causes (USFWS 2009). Although no manatee strandings have been reported from the action area, nine strandings were reported along the NC coast from 1991-2012. Rapid declines in water temperature during the early fall can cause cold stress syndrome in manatees that have not departed NC waters for Florida (Cummings et al. 2014). Of the nine strandings that were reported in NC from 1991-2012, seven occurred during the months of November, December, and January, with four showing signs of cold stress at necropsy.

Cummings et al. (2014) described the temporal and spatial distribution of manatees in NC based on sighting and stranding records from 1991-2012. Although sightings were reported along the entire NC coast, most were concentrated around the densely populated areas of Wilmington and Beaufort, NC. Sightings were most common in the Atlantic Intracoastal Waterway (AIWW); however, manatees were also observed in sounds, bays, rivers, creeks, marinas, and the open ocean. Of 99 opportunistic sightings and nine strandings that were reported in NC between 1991 and 2012, nearly all (93%) occurred between June and October when water temperatures were above 68°F. Dramatic rapid declines in water temperature during the early fall can be hazardous to manatees that have not departed NC waters for Florida. Sightings reported from the mainstem Cape Fear River were confined to the lower estuary near the river mouth; however, two sightings were reported in the Northeast Cape Fear River ~20 to 30 river miles above Wilmington. A number of additional manatee sightings were reported from the AIWW behind Oak Island and Myrtle Grove Sound behind Carolina Beach.

Environmental Consequences of the NAA

Under the NAA, continuing maintenance of the currently authorized Wilmington Harbor project would not be expected to have any adverse effects on the Florida manatee. It is anticipated that the Wilmington District USACE would continue to conduct maintenance dredging operations in accordance with the USFWS Guidelines for Avoiding Impacts to the West Indian Manatee: Precautionary Measures for Construction Activities in North Carolina Waters.

Environmental Consequences of AA1

Although manatees are highly unlikely to be in the ODMDS area, vessel strikes, primarily associated with support vessel operations and scow transits between the dredge sites and the ODMDS, is a potential direct impact of AA1. Confined blasting operations also have the potential to cause direct impacts due to shock wave peak pressure.

Nearly all manatee sightings in NC waters have occurred between June and October when water temperatures were above 20°C (Cummings et al. 2014). The use of hopper dredges would be limited to the outermost Baldhead Shoal 3 to the ocean entrance channel reaches where manatees would be unlikely to occur. Cutterhead dredging may occur any time of year in the channel reaches south of Horseshoe Shoal and limited to 1 August to 31 January for all cuts north, thus coinciding with warmer periods when manatees could be present. Bucket dredge operations in the Keg Island to Lower Brunswick reaches would also occur year-round. Cutterhead and bucket dredges operate from anchored barges and would present only a minimal collision risk during brief periods of barge repositioning. As noted in Section 2.2, the amount of vessel traffic of AA1 as compared to the NAA would decrease, reducing the potential of vessel strikes. As a measure to reduce the risk of collisions, all dredging and placement operations proposed as part of AA1 would implement Guidelines for Avoiding Impacts to the West Indian Manatee: Precautionary Measures for Construction Activities in North Carolina Waters (USFWS 2003).

Confined blasting operations in the roughly 4.4-mile reach from Keg Island to Lower Brunswick channel would occur from August 1 to January 31, thus coinciding with warmer periods when manatees could be present. Blasting operations under Alternative 1 could employ stemmed charges and charge delays to reduce the magnitude of potentially injurious blast shock waves. Drill holes containing the individual charges would be stemmed (capped) with angular rock or other suitable material for the purpose of containing blast energy within the rock. Studies indicate that the use of stemmed charges with confined blasting can reduce shock wave peak pressure by 60 to 90% in relation to unconfined open water blasts (Nedwell and Thandavamoorthy 1992, Hempen et. al. 2005). The use of delays between individual charge detonations limits the development of cumulative blast pressure. Blasting operations would implement protective measures for marine mammals similar to those previously approved by NMFS (2000, 2012) for proposed blasting operations under the Wilmington Harbor 96 Act Project. See Appendix L for additional information on blast mitigation measures. Protective measures would include the establishment of blast zones of influence and the development of a Watch Program in accordance with NMFS Southeast Region guidance for mitigating the effects of marine blasting on protected species, including marine mammals and sea turtles (Baker 2008). The development and implementation of a site-specific blast protection mitigation program would be coordinated with the USFWS, NMFS, and other resource agencies. Cummings et al. (2014) identified just two reported manatee sightings in the Cape Fear River estuary above Snow’s Cut (river mile 13), thus indicating that manatee occurrences are rare in the vicinity of the proposed blasting areas (river mile 18 to river mile 22). Based on the use of stemmed charge confined blasting methods, the proposed watch program and other blast mitigation measures, and the apparent rarity of manatee occurrences in the vicinity of the blasting areas, it is determined that confined underwater blasting under AA1 may affect, not likely to adversely affect (MANLAA) the Florida manatee.

Environmental Consequences of AA2

The potential for vessel strikes and other dredging impacts would be reduced overall as compared to AA1 due to the decreased total work time. Therefore, impacts of this alternative would be similar to, but slightly less than AA1.

3.16.2 Piping Plover

Affected Environment

The piping plover (*Charadrius melodus*) was listed as endangered and threatened under the ESA on 10 January 1986 (50 FR 50726 – 50734). The final listing rule recognized three demographically independent populations that breed in three separate regions: the Atlantic Coast from NC to Canada, the Great Lakes watershed, and the Northern Great Plains region. Birds that breed along the Atlantic Coast are recognized as the subspecies *C. m. melodus*, while birds belonging to the interior Great Lakes and Northern Great Plains breeding populations are recognized as the subspecies *C. m. circumcinctus* (Miller et al. 2010). The piping plover is classified as endangered within the Great Lakes watershed and as threatened throughout the remainder of its breeding, migratory, and wintering range. The shared migratory and wintering range of the three breeding populations encompasses the Atlantic and Gulf Coasts from NC to northern Mexico, as well as the Bahamas and the West Indies. Outside of their breeding range, birds belonging to the endangered Great Lakes breeding population are indistinguishable from those belonging to the threatened Great Plains and Atlantic coast populations, and consequently, all piping plovers are classified as threatened within their shared migratory and wintering range (USFWS 2009). The 2009 status update identified the principal continuing threats to the recovery of the species as habitat loss attributable to beach stabilization and inlet management projects, human disturbance associated with vehicular and pedestrian recreational activities, and predation attributable to native wildlife and free-roaming and feral domestic animals (USFWS 2009).

Annual NC breeding pair estimates from 2000-2017 averaged 47 pairs. Annual estimates ranged from a low of 20 pairs in 2004 to a high of 70 pairs in 2012. Annual estimates since 2012 have ranged from 43 to 65 pairs. The vast majority of all breeding activity in NC occurs along the barrier islands of Cape Lookout National Seashore (CALO) and Cape Hatteras National Seashore (CAHA), which have accounted for 90% of all estimated breeding pairs in NC since 2000. Annual 2000-2017 estimates for the southern NC coast (south of CALO) ranged from two to nine breeding pairs (average = five pairs). Breeding activity along the southern NC coast is essentially restricted to the Lea-Hutaff Island/New Topsail Inlet complex and the north end of Bear Island. Collectively, these areas account for 89% of all southern NC coast breeding pair observations since 2000. Since 2000, 97% of all NC breeding pair observations and nest sites have occurred on undeveloped barrier islands. Furthermore, 79% of all breeding activity has occurred on undeveloped barriers that are also unstabilized, including North Core Banks (NCB), South Core Banks (SCB), Bear Island, Onslow Beach, and Lea-Hutaff Island. The accreting south end of Topsail Island along New Topsail Inlet is the only site associated with a developed island that supports any notable breeding activity in NC. Since 2000, all other developed islands in NC combined have accounted for just four breeding pair observations (Table 3-46). Breeding pair observations in the Cape Fear region from 2000-2017 include just two pairs at Fort Fisher, one each during 2002 and 2005.

Piping plovers from all three breeding populations use barrier islands along the NC coast as migratory stopover and/or wintering sites during the non-breeding season. The habitat use patterns of non-breeding plovers in NC are characterized by movements between different inlet complex habitats (Cameron 2006). Some sites are used exclusively for foraging while others are used for loafing.

Wintering plovers at Oregon Inlet primarily used back-barrier tidal flats and dredged material placement placement islands (i.e. bird islands) for foraging, while the ocean beach within one mile of the inlet was the primary site used for roosting, preening, and being alert (Cohen et al. 2008). Foraging habitat use was influenced by tidal stage, with plovers exhibiting a preference for the dredged material placement islands as the associated intertidal zones were exposed on the falling tide. The habitat preferences of wintering and migratory plovers are generally similar; however, there are some sites that are more important for migrating plovers (e.g., Ocracoke Inlet) and some that are more important for wintering plovers (e.g., Shackleford Banks and Bird Shoals) (Cameron 2006).

Comprehensive survey data for spring and fall migration periods along the southern NC coast are lacking, and consequently, patterns of migratory distribution and abundance along some portions of the southern coast remain poorly understood. However, data compiled by the North Carolina Wildlife Resources Commission (NCWRC) show that piping plovers use stopover sites at nearly all of the southern region inlets during migration

(Cameron 2006). Efforts to monitor wintering plovers along the southern NC coast have primarily been limited to the International Piping Plover Winter Census (IPPWC) - a range-wide survey of all known wintering sites conducted every five years. The results of the IPPWC surveys indicate that the distribution of wintering plovers along the southern NC coast is highly similar to that of the breeding population. Wintering plovers are highly concentrated at the Lea-Hutaff/New Topsail Inlet/South Topsail complex and the Bear Island/Bogue Inlet complex. Small numbers of winter residents have been observed along Fort Fisher and on the east end of Ocean Isle Beach at Shallotte Inlet (Table 3-46).

Piping Plover Wintering Critical Habitat

The breeding and nesting habitat requirements of piping plovers in NC are highly restricted to wide, sparsely vegetated sand flats along the most dynamic and unstable reaches of barrier islands. Although NCB and SCB encompass ~48 miles of unstable ocean beach habitat, breeding sites are restricted to the dynamic inlet-influenced ends of the islands, the similarly dynamic cape point, recently deposited overwash fans, and recently closed inlets. In the southern region, breeding sites are essentially restricted to the inlet-influenced ends of a few undeveloped barriers and natural overwash deposits on Lea-Hutaff Island. The highly restricted habitat use pattern in NC is consistent with the overall pattern of habitat use in the southern recovery unit, which is similarly restricted in comparison with the northern recovery units (USFWS 2009). During the breeding season, adults and broods forage primarily on low-energy inlet and back-barrier intertidal sand and mud flats. At CALO, pre-nesting adults spend less than ten percent of their foraging time along ocean beaches (National Park Service 2014). A 1990 study reported that 96% of brood observations occurred on sound-side tidal flats, even though broods had access to both back-barrier and ocean beach habitats (McConnaughey et al. 1990).

A total of 18 winter critical habitat units encompassing ~19,707 acres have been designated along the NC coast from Oregon Inlet south to Mad Inlet along the NC/South Carolina boundary. There are four designated units in the study area (Figure 3-16). NC 14 covers the northern end of Carolina Beach and the southern end of Masonboro Island. The term “wintering” as used in the listing final rule refers to all non-breeding season piping plover occurrences, including both migrating and wintering birds. Units have been designated at 15 of the state’s 20 inlets. The primary constituent elements (PCE) of critical habitat are those habitat components that are essential for the foraging, sheltering, and roosting requirements of piping plovers. Foraging habitat PCEs encompass elements of intertidal beaches and flats, including sand and mud flats, algal flats, and washover fans. Sheltering and loafing habitat PCEs include supratidal dune systems and flats that are associated with foraging habitat PCEs. High quality intertidal foraging habitats include sand and mudflats with little or no emergent vegetation. Adjacent exposed or sparsely vegetated sand, mud, and algal flats above high tide are also important, especially for roosting plovers. Other important habitat elements include sparsely vegetated sound-side habitats, salterns, sand spits, washover fans, and surf cast algae.

Environmental Consequences of NAA

Under without-project conditions, maintenance of the currently authorized federal navigation channel and associated beach placement of navigation dredged material would continue in accordance with existing practices. Piping plover breeding activity has not been documented at Cape Fear Inlet. Therefore, no effects on breeding activity would be expected. Beach placement operations may disrupt the foraging and/or roosting activities of migratory and wintering plovers. However, construction-related disturbance would be temporary and confined to a relatively short section of the beach at any given point during beach placement operations. Beach placement would result in the temporary loss of intertidal benthic invertebrate infauna within the beach fill templates, thereby reducing the availability of benthic prey for piping plovers. However, most benthic recovery studies have reported rapid recovery within one year of the initial impact when highly compatible beach fill sediments were used and larval recruitment periods were avoided (Jutte et al. 1999a, Burlas et al. 2001, Van Dolah et al. 1994, Van Dolah et al. 1992, Gorzelany and Nelson 1987, Salomon and Naughton 1984, Parr et al. 1978, and Hayden and Dolan 1974). It is anticipated that the Wilmington District USACE would continue to conduct maintenance dredging and beach placement on Bald Head Island and Oak Island in accordance with the terms and conditions of the SPBO (USFWS 2017), including adherence to a November 16 – April 30 beach placement environmental work window, beach fill compatibility standards, and the use of onshore delivery pipeline routes that avoid high value inlet habitats for shorebirds. Adherence to a November 16 – April 30 beach placement environmental work window would avoid peak benthic invertebrate recruitment periods (May – September) in North Carolina (Hackney et al. 1996, Diaz 1980, and Reilly and Bellis 1978). Therefore, it is expected that effects on the piping plover would be short-term and localized. There is no designated piping plover critical wintering habitat at Cape Fear River Inlet. Therefore, the without-project condition would not be expected to have any effects on critical habitat.

Environmental Consequences of AA1

Under AA1, the potential direct effects of beach placement on piping plovers and wintering critical habitat for the piping plover would be similar to those of continuing beach placement operations under the NAA, but with the addition of dredged material placement of beach quality sand on Carolina Beach, Masonboro Island and subtidal beneficial use sites. These additions would add long-term beneficial foraging sites but would cause a temporary loss of intertidal benthic invertebrate infauna. Potential effects on piping plovers would be minimized through adherence to all terms and conditions of the 2017 USFWS SPBO (Appendix G). Therefore, the project may affect, likely to adversely affect the piping plover.

As described in Appendix B, the XBeach model results indicate that deepening would have minimal effects on sediment transport and shoreline erosion rates along the beaches adjacent to Cape Fear River Inlet. Back barrier intertidal flats that comprise critical wintering habitat for the piping plover at Fort Fisher are located approximately 1 mile east of the navigation channel; therefore, no effects on critical habitat are expected to occur. However, critical habitat is located in the intertidal flats along Masonboro Island. Material placed here to reduce erosion would be placed during the November 16 to March 31 allowed critical habitat dredge placement window or environmental window and would impact about 131 acres. Material would be placed to tie into existing shoreline elevation and would be constructed no higher than the MHW projection. Work in the area would displace foraging birds short-term, but it would provide a long-term benefit to piping plover critical habitat. Therefore, the project may affect, likely to adversely affect piping plover wintering critical habitat. Table 3-46 and Table 3-47 below show known piping plover populations.

Environmental Consequences of AA2

Impacts of this alternative would be similar to AA1.

Table 3-46: Annual NC Piping Plover Breeding Pair Estimates 2000-2024 (from NCWRC Annual Piping Plover Reports).

		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	Total
NORTHERN REGION																											
CAHA[1]		4	3	2	3	3	3	5	6	11	9	12	15	15	9	14	12	12	7	3	5	3	3	4	5	2	170
PINWR[2]		2	1	2	1	0	0	0	0	0	0	1	1	1	0	2	5	6	2	1	1	0	2	1	1	1	31
CALO[3] NCB/SCB		16	16	15	14	13	26	33	46	46	37	42	41	51	45	47	43	30	27	22	24	22	32	27	32	28	776
CALO[3] Shackleford		-	-	-	-	-	1	0	0	0	0	0	0	0	0	0	0	0	0								
Regional Subtotal		22	20	19	18	16	30	38	52	57	46	55	57	67	54	63	60	48	36	26	30	25	37	32	38	31	977
SOUTHERN REGION																											
Bear Island/Bogue Inlet		0	0	0	0	0	0	1	1	1	1	1	1	2	0	0	2	2	0	0	0	0	0	0	1	1	14
Onslow Beach		0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	1	2	2	1	2	3	3	4	2	23
North Topsail/New River Inlet		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	3
South Topsail/New Topsail Inlet		0	1	1	1	1	2	2	2	2	1	0	1	0	1	0	0	1	1	1	2	1	1	0	1	0	23
Lea-Hutaff		2	2	2	5	3	4	5	5	4	4	5	2	0	1	1	0	0	0	0	0	0	0	0	1	1	47
Figure-8 Island		0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	1	1	1	1	1	0	1	0	0	9
Fort Fisher		0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Ocean Isle		0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Sunset Beach		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
Regional Subtotal		2	3	4	6	4	7	8	9	7	7	6	5	3	2	2	4	5	7	5	4	4	4	4	7	4	123
STATEWIDE TOTAL		**24**	**23**	**23**	**24**	**20**	**37**	**46**	**61**	**64**	**53**	**61**	**62**	**70**	**56**	**65**	**64**	**53**	**43**	**31**	**34**	**29**	**41**	**36**	**45**	**35**	**1100**
Average Annual Breeding Pair Total																											**94**

[1]Cape Hatteras National Seashore
[2]Pea Island National Wildlife Refuge
[3]Cape Lookout National Seashore

Table 3-47: International Piping Plover Winter Census.

Site Name	Year				Total
	2001	2006	2011	2016	
Fort Fisher to Bald Head	2	3	0	0	5
Oak Island	0	0	0	0	0
Holden Beach	0	0	0	0	0
Ocean Isle	0	4	1	0	5
Sunset Beach/Bird Island	0	0	0	0	0
Total	2	7	1	0	10

Figure 3-16: Critical Habitat for Wintering Piping Plovers.

3.16.3 Red Knot

Affected Environment

The rufa red knot (*Calidris canutus rufa*, hereinafter referred to as "red knot") was listed as threatened under the ESA on 12 January 2015 (79 FR 73705 73748). The USFWS has not approved a recovery plan for the red knot, and no critical habitat has been designated for the species. Red knots migrate between breeding grounds in the central Canadian High Arctic and wintering areas that are widely distributed from the southeastern US coast to the southern tip of South America. Migration occurs primarily along the Atlantic coast, where red knots use key stopover and staging areas for feeding and resting. Departure from the Arctic breeding grounds occurs from mid-July through August, and the first southbound birds arrive at stopover sites along the US Atlantic coast in July. Numbers of southbound birds peak along the US Atlantic coast in mid-August, and by late September, most birds have departed for their wintering grounds. Major fall stopover sites along the US Atlantic coast include the coasts of Massachusetts and New Jersey, and the mouth of the Altamaha River in Georgia. Principal wintering areas include the southeastern US Atlantic Coast from NC to Florida, the Gulf Coast from Florida to northern Mexico, the northern Atlantic coast of Brazil, and the island of Tierra del Fuego along the southern tip of South America. Smaller numbers of red knots also winter along the central and northeastern US Atlantic coast and in the Caribbean. The core southeastern US Atlantic wintering area is thought to shift from year to year between Florida, Georgia, and South Carolina (USFWS 2014a).

Red knots typically arrive at southeastern US and Caribbean wintering sites in November but may arrive as early as September. Birds wintering along the US Atlantic coast and in the Caribbean typically remain on their wintering grounds through March, and in some cases as late as May. Northbound birds from both North and South American wintering areas use stopover sites along the US mid-Atlantic coast from late April through late May/early June (USFWS 2014a). Important spring stopover sites in the US include Delaware Bay and the Atlantic Coast from Georgia to Virginia; however, small to large groups of northbound red knots may occur in suitable habitats along all of the Atlantic and Gulf Coast states. Unknown numbers of non- breeding red knots, many consisting of one-year-old subadult birds, remain south of the breeding grounds throughout the year (USFWS 2014a).

The principal factors affecting red knots within the study area are the same as those affecting non-breeding piping plovers, including habitat loss and modification attributable to shoreline stabilization and inlet dredging and human disturbance associated with pedestrian and vehicular recreational activities.

Migrating and wintering red knots use similar habitats, generally expansive intertidal sand and mud flats for foraging and sparsely vegetated supratidal sand flats and beaches for roosting. The red knot is a specialized molluscivore, feeding on hard-shelled mollusks that are swallowed whole and crushed in the gizzard. The diet is sometimes supplemented with softer invertebrate prey such as shrimp- and crab-like organisms, marine worms, and horseshoe crab eggs. Both high-energy oceanfront intertidal beaches and sheltered estuarine intertidal flats are used for foraging. Preferred habitats include sand spits and emergent shoals associated with tidal inlets, and habitats associated with the mouths of bays and estuarine rivers. Access to quality high-tide roosting habitat in close proximity to foraging areas is an important constituent of high-quality stopover and wintering sites (USFWS 2014a).

Systematic survey efforts have been relatively limited along the southern NC coast, and consequently, patterns of red knot distribution and abundance along some portions of the southern coast remain poorly understood. Systematic surveys along the southern NC coast have primarily been limited to the coordinated aerial surveys, which are conducted annually during the peak spring migration period of mid to late May. The aerial survey data suggest that Emerald Isle, Lea Hutaff Island, Figure 8 Island, Masonboro Island, and Bald Head Island are important stopover sites for northbound red knots during the spring; however, the data also indicate that red knots make wide use of habitats along many of the southern region barriers, including habitats associated with both developed and undeveloped islands (Table 3-48). As indicated by the results of surveys at CALO and CAHA, peak annual spring migration numbers can occur from mid-April to late May; thus, the short-window aerial surveys likely underestimate the distribution and abundance of red knots along the southern coast. Systematic survey coverage of the fall migration period along the southern coast has been limited to a few site-specific studies. Systematic shorebird surveys conducted by the NCWRC at Bogue Inlet following the 2005 ebb channel relocation project recorded peak annual red knot counts ranging from 17 to 204 individuals (Rice and Cameron 2009). The three highest peak counts, ranging from 68 to 204 individuals, occurred during May. However, two of the five annual peak counts occurred in February and March, and were limited to relatively small numbers of individuals (43 birds in February and 17 in March). Consistent monitoring by Audubon NC has provided comprehensive information on red knot migration patterns at Rich Inlet (Addison and McIver 2015). Peak counts at Rich Inlet ranging from approximately 60 to 250 individuals have occurred during May, and few red knots have been observed during fall migration.

Table 3-48: Red Knot Aerial Survey Counts 2006-2023[1]

Survey Area Name	2006[2]	2007[2]	2008[2]	2009[2]	2010[2]	2011[2]	2012[2]		2022[3]	2023[3]
Fort Fisher				81	4	20	8		2	6
Bald Head Island	78	67		21	5	26	40		2	
Oak Island			0		0	22	0		128	12
Lockwood Folly Inlet		0	25	18					*	*
Holden Beach					0	15	56		76	
Ocean Isle Beach					0	23	112		2	6
Tubbs Inlet		0		11					*	*
Sunset Beach				0	0	35	75		66	16

[1]Note: No Rufa Red Knot data was obtained between 2013 and 2021.
[2]Source: NCWRC, 2013
[3]Source: Watts, 2017
* Count included in adjacent beaches

Environmental Consequences of NAA

Under without-project conditions, maintenance of the currently authorized federal navigation channel and associated beach placement of navigation dredged material would continue in accordance with existing practices. The red knot is a non-breeding species in NC. Therefore, no effects on breeding activity would be expected. Beach placement operations may disrupt the foraging and/or roosting activities of migratory red knots. However, maintenance-related disturbance would be temporary and confined to a relatively short section of the beach at any given point during beach placement operations. Beach placement would result in the temporary loss of intertidal benthic invertebrate infauna within the beach fill templates, thereby reducing the availability of benthic prey. However, most benthic recovery studies have reported rapid recovery within one year of the initial impact when highly compatible beach fill sediments were used and larval recruitment periods were avoided (Jutte et al. 1999a, Burlas et al. 2001, Van Dolah et al. 1994, Van Dolah et al. 1992, Gorzelany and Nelson 1987, Salomon and Naughton 1984, Parr et al. 1978, and Hayden and Dolan 1974). It is anticipated that the Wilmington District USACE would continue to conduct maintenance dredging and beach placement on Bald Head Island and Oak Island in accordance with the terms and conditions of the USFWS Biological Opinion, including adherence to a 16 November - 30 April beach placement environmental work window, beach fill compatibility standards, and the use of onshore delivery pipeline routes that avoid high value inlet habitats for shorebirds. Adherence to a 16 November - 30 April beach placement environmental work window would avoid peak benthic invertebrate recruitment periods (May – September) in NC (Hackney et al. 1996, Diaz 1980, and Reilly and Bellis 1978). Therefore, it is expected that effects on the piping plover would be minor, short-term and localized.

Environmental Consequences of AA1

Under AA1, the potential direct effects of beach placement on red knots would include heavy machinery and equipment (e.g., trucks and bulldozers operating in Action Area) disturbing and disrupting of normal activities such as roosting and foraging. Beach placement would result in the temporary loss of intertidal benthic invertebrate infauna within the beach fill templates, thereby reducing the availability of benthic prey. Impacts are similar to the NAA, but with the addition of Carolina Beach, Masonboro Island and subtidal beneficial use sites. These additions would add long-term beneficial foraging sites but would cause a temporary loss of intertidal benthic invertebrate infauna. Potential effects on red knot would be minimized through adherence to all terms and conditions of the 2017 USFWS SPBO. Therefore, the project may affect, likely to adversely affect the piping plover.

Environmental Consequences of AA2

Impacts of this alternative would be similar to AA1.

3.16.4 Sea Turtles

Affected Environment

This section addresses the affected environment and environmental effects of AA1 to sea turtle nesting beaches. For more information regarding sea turtles in the marine environment, see subsection 3.17.1.

Green Sea Turtle

The green sea turtle (*Chelonia mydas*) was initially listed as endangered and threatened under the ESA on 28 July 1978 (43 FR 32800). Breeding populations in Florida and along the Mexican Pacific Coast were listed as endangered, while all other populations throughout the species' range were listed as threatened. In 2011, the green sea turtle's ESA status was revised to threatened and endangered based on the recognition of eight Distinct Population Segments (DPS) (81 FR 20057). All green sea turtles in the North Atlantic were listed as threatened under the North Atlantic Ocean DPS. Additional DPSs in the South Atlantic, Southwest Indian, North Indian, East Indian-West Pacific, Southwest Pacific, Central North Pacific, and East Pacific were listed as threatened, while DPSs in the Mediterranean, Central West Pacific, and Central South Pacific were listed as endangered. Nesting in the US is primarily limited to Florida, although nesting occurs in small numbers along the southeast coast from Georgia to NC and the Gulf Coast of Texas. Nesting turtles appear to prefer high wave energy barrier island beaches with coarse sands, steep slopes, and prominent foredune, with the highest nesting densities occurring on sparsely developed beaches that have minimal levels of artificial lighting (Witherington et al. 2006). Nesting in Florida has increased exponentially over the last 20 years, with record highs of 36,195 and 37,341 nests recorded in 2013 and 2015, respectively [Florida Fish and Wildlife Conservation Commission (FWC)/Fish and Wildlife Research Institute (FWRI) 2016].

Green sea turtles nest in relatively small numbers along the NC coast, with reported nesting from 2000-2016 averaging 18 nests per year. Annual NC nest totals from 2000-2012 ranged from four to 26 nests. Nesting has increased since 2012, with the two highest nest totals on record occurring during 2013 (n=39) and 2015 (n=38). Annual average of 27 nests from 2013-2018. Green sea turtle nesting records span the entire NC coast, but are concentrated along the barrier islands of CALO and CAHA. Together, CALO and CAHA accounted for 63% of all reported nesting in NC from 2000 to 2016. Areas supporting consistent nesting in small numbers include Bald Head Island, Masonboro Island, Topsail Island, and Onslow Beach, which collectively account for 22% of all reported nesting in NC from 2000-2016. Nesting along the remainder of the NC coast has generally occurred sporadically in very small numbers. Nesting data show a peak in activity from the last week of June through the third week of August, with 79% of all nesting occurring during this period. A total of 43 green sea turtle nests were recorded on Masonboro Island from 2009-2024, while just one nest was recorded on Oak Island (Table 3-49).

Table 3-49: Cape Fear Region Sea Turtle Nests 2009-2024.

Shoreline Reach	Green	Leatherback	Kemp’s Ridley	Loggerhead
Masonboro Island	43	0	0	515
Carolina Beach	2	1	0	138
Fort Fisher	14	1	1	1,090
Bald Head Island	16	1	1	1,432
Caswell Beach	2	1	4	977
Oak Island	1	1	0	1,434
Holden Beach	3	1	1	849
Total:	**81**	**6**	**7**	**6,435**

In US waters, green sea turtles are distributed along the Atlantic and Gulf Coasts from Massachusetts to Texas (NMFS and USFWS 2007a). Post-hatchlings migrate to oceanic waters and begin an oceanic juvenile phase of development. Oceanic phase juveniles appear to move with the predominant ocean gyres for several years before returning to neritic waters where juvenile development continues to adulthood. Neritic phase juveniles inhabit shallow estuarine waters and nearshore continental shelf waters that are rich in seagrasses and/or marine macroalgae. Adults generally remain in relatively shallow foraging habitats with abundant seagrasses and macroalgae but may enter the oceanic zone when migrating between foraging grounds and nesting beaches. No critical habitat has been designated in the continental US.

Leatherback Sea Turtle

The leatherback sea turtle (*Dermochelys coriacea*) was listed under the ESA as endangered throughout its range on 2 June 1970 (35 FR 8491). The leatherback has a circumglobal oceanic distribution that extends north and south into sub-polar regions. During the summer and fall, the highest densities of adult and subadult leatherbacks in the North Atlantic have been reported in Canadian waters (James et al. 2005). However, little is known of the distribution and developmental habitat requirements of leatherbacks from hatchling to adulthood (NMFS and USFWS 2013). Adults undertake extensive migrations between northern foraging grounds and nesting beaches that are distributed throughout the tropical and subtropical regions of the Atlantic, Pacific, and Indian Oceans. Nesting in the US is primarily restricted to Florida, Puerto Rico, and the US Virgin Islands, but nesting occurs in small numbers along the Gulf Coast of Texas and the southeastern US Atlantic Coast from Georgia to NC. Nesting in Florida has increased substantially over the last 20 years, with the two highest nest totals on record occurring during 2009 (n=1,747) and 2012 (n=1,712). Leatherback nesting is rare in NC, with just 33 nests reported from 2000-2016. Of the eight years that had reported nesting events, statewide annual totals ranged from one to nine nests. Leatherback nesting records are heavily concentrated along the barrier islands of CALO and CAHA, which accounted for 82% of all reported leatherback nesting in NC from 2000-2016. Leatherback nesting along the remainder of the NC coast from 2000-2016 was limited to two nests along Bogue Banks and one nest each along Carolina Beach, Bald Head Island, and Holden Beach. Reported nest establishment dates in NC range from 16 April to 30 July. The potential for leatherbacks to nest as early as late February (Meylan et al. 1995) suggests the possibility that some early nests in NC may be missed by monitoring efforts that generally begin in May.

Kemp's Ridley Sea Turtle

The Kemp's ridley sea turtle (*Lepidochelys kempii*) was listed as endangered throughout its range on 2 December 1970 (35 FR 18320). Kemp's ridley sea turtles occur primarily in coastal waters of the Gulf of Mexico and the western North Atlantic Ocean. Data indicate that adults utilize coastal habitats of the Gulf of Mexico and the southeastern US. Adults inhabit nearshore waters and are commonly found over crab-rich sandy or muddy bottoms (NMFS and USFWS 2007b). Nesting is primarily restricted to coastal beaches along the Mexican states of Tamaulipas and Veracruz, nesting in small numbers occurs consistently along the Gulf Coast of Texas (Turtle Expert Working Group 1998). Rare nesting events occur along the Gulf Coast of Alabama and the southeastern US Atlantic Coast from Florida to NC. A total of 80 Kemp's ridley nests were documented in Florida from 1979 to 2013 (FWC/FWRI 2016). Kemp's ridley nesting is extremely rare in NC, with just 12 nests reported from 2000-2016. Of the 12 nests, eight were reported north of Cape Lookout along the Outer Banks. Reported nest establishment dates range from 25 May to 23 June. Kemp's ridley nesting records since 2009 for the Cape Fear region are limited to one nest at Fort Fisher, Bald Head Island and Holden Beach and four at Caswell Beach. Hatchlings migrate to the oceanic zone where they are carried by currents into various areas of the Gulf of Mexico and the North Atlantic Ocean. At approximately two years of age, juveniles leave the oceanic zone and move to coastal benthic habitats in the Gulf of Mexico and the Atlantic Ocean along the eastern United States. During this stage, juveniles occupy protected coastal waters such as bays, estuaries, and nearshore waters that are less than 165 feet deep. Juveniles utilize a wide range of bottom substrates but apparently depend on an abundance of crabs and other invertebrates (NMFS and USFWS 2007b). No critical habitat has been designated for the Kemp's ridley sea turtle.

Loggerhead Sea Turtle

The loggerhead sea turtle (*Caretta caretta*) was initially listed under the ESA as threatened throughout its range on 28 July 1978 (43 FR 32800). In 2011, the loggerhead's ESA status was revised to threatened and endangered based on the recognition of nine DPSs. Distinct population segments encompassing populations in the Northwest Atlantic Ocean, South Atlantic Ocean, Southwest Indian Ocean, and Southeast Indo-Pacific Ocean were reclassified as threatened, while the remaining five populations in the Northeast Atlantic Ocean, Mediterranean Sea, North Pacific Ocean, South Pacific Ocean, and North Indian Ocean were reclassified as endangered. Nesting in the US occurs along the Atlantic and Gulf coasts from southern Virginia to Texas but is concentrated from NC through Alabama (NMFS and USFWS 2008). Nesting populations along the southeastern US coast from southern Virginia to the Florida-Georgia border comprise the Northern Recovery Unit, one of five designated recovery units within the Northwest Atlantic DPS (USFWS 2009). Nesting in the Northern Recovery Unit had been declining at an annual rate of 1.3% through 2007; however, nesting has increased substantially since 2008. Similar nesting increases throughout the Northwest Atlantic DPS since 2007 indicate that the population may be stabilizing (USFWS 2015).

Adult female loggerheads return to their natal region to nest and show a high degree of site fidelity to the nesting beach selected during their initial reproductive season, typically nesting during subsequent years within zero to three miles of the initial nesting site (Miller et al. 2003). A variety of different substrates and beach slopes are used for nesting, but loggerheads appear to prefer relatively narrow, steeply sloped, coarse-grained beaches (Provancha and Ehrhart 1987). Slope has been found to have more influence on nest-site selection than temperature, moisture, and salinity, and nest sites along a given beach are typically located on the steepest slopes, which generally correspond to the highest elevations on the beach (Wood and Bjorndal 2000). Loggerheads require deep, clean, relatively loose sand above the high-tide line for successful nest construction (Hendrickson 1982). Embryonic development requires a high-humidity substrate with sufficient gas exchange (Mortimer 1990, Miller 1997, and Miller et al. 2003). Hatchlings emerge from their nests en masse almost exclusively at night, and initial emergences are sometimes followed by secondary emergence events on subsequent nights (Carr and Ogren 1960, Witherington 1986, Ernest and Martin 1993, and Houghton and Hays 2001). Hatchlings use light cues to guide their movement from the nest to the surf zone, relying on the contrast between the relatively bright ocean horizon and the relatively dark dune line (Daniel and Smith 1947, Limpus 1971, Salmon et al. 1992, Witherington and Martin 2003, and Witherington 1997).

Loggerhead nesting occurs along the entire NC coast, but is concentrated along three sections of the coast, including the Cape Fear region from Holden Beach to Fort Fisher, Topsail Island, and Onslow Beach, and the barriers that comprise Cape Lookout National Seashore (CALO) and Cape Hatteras National Seashore (CAHA). Collectively, these three sections of the coast accounted for 83% of all loggerhead nesting in NC from 2000-2016. Nesting in NC is typically restricted to the period of 1 May to

15 September. Relatively few nests are recorded during the first three weeks of May, but nesting increases rapidly from late May onward, peaking from mid-June through the end of July. Nesting declines abruptly after July, and few nests are recorded after the third week of August. The Cape Fear region from Holden Beach to Fort Fisher supports the highest concentration of loggerhead nesting in NC, accounting for 30% of all loggerhead nests recorded in the state from 2000-2016. The average annual nest density for the region was 7.5 nests per mile from 2000-2016. A total of 1,432 loggerhead nests were recorded on Bald Head Island from 2009-2024, while 138 nests were recorded on Carolina Beach (Table 3-49).

The USFWS and NMFS have designated terrestrial (79 FR 39756) and marine (79 FR 39855) critical habitat units for the loggerhead sea turtle along the US South Atlantic and Gulf Coasts from NC to Mississippi. In NC, eight loggerhead terrestrial critical habitat units encompassing approximately 96 miles of nesting beaches have been designated along the southern coast from Beaufort Inlet to the Shallotte River in Brunswick County (79 FR 39756). Designated marine critical habitat units along the NC coast include areas containing nearshore reproductive habitat, wintering habitat, breeding areas, and migratory corridors. More information regarding marine critical habitat can be found in Section 3.17.

In the Cape Fear region, four terrestrial critical habitat units encompass all of ocean-facing beaches from Carolina Beach Inlet to Shallotte Inlet, including Pleasure Island/Fort Fisher, Bald Head Island, Oak Island, and Holden Beach (Figure 3-17). Terrestrial critical habitat units encompass the dry ocean beach from the MHW line landward to the toe of the secondary dune or the first developed structure. The units represent beaches that are capable of supporting a high density of nests or those that are potential expansion areas for beaches with high nest densities. Critical nesting habitat primary constituent elements (PCEs) include unimpeded ocean-to-beach access for adult females and unimpeded nest-to-ocean access for hatchlings, substrates that are suitable for nest construction and embryonic development, a sufficiently dark nighttime environment to ensure that adult females are not deterred from nesting and that hatchlings are not disoriented and delayed or prevented from reaching the ocean, and natural coastal processes that maintain suitable nesting habitat or artificially maintained habitats that mimic those associated with natural processes (79 FR 39756).

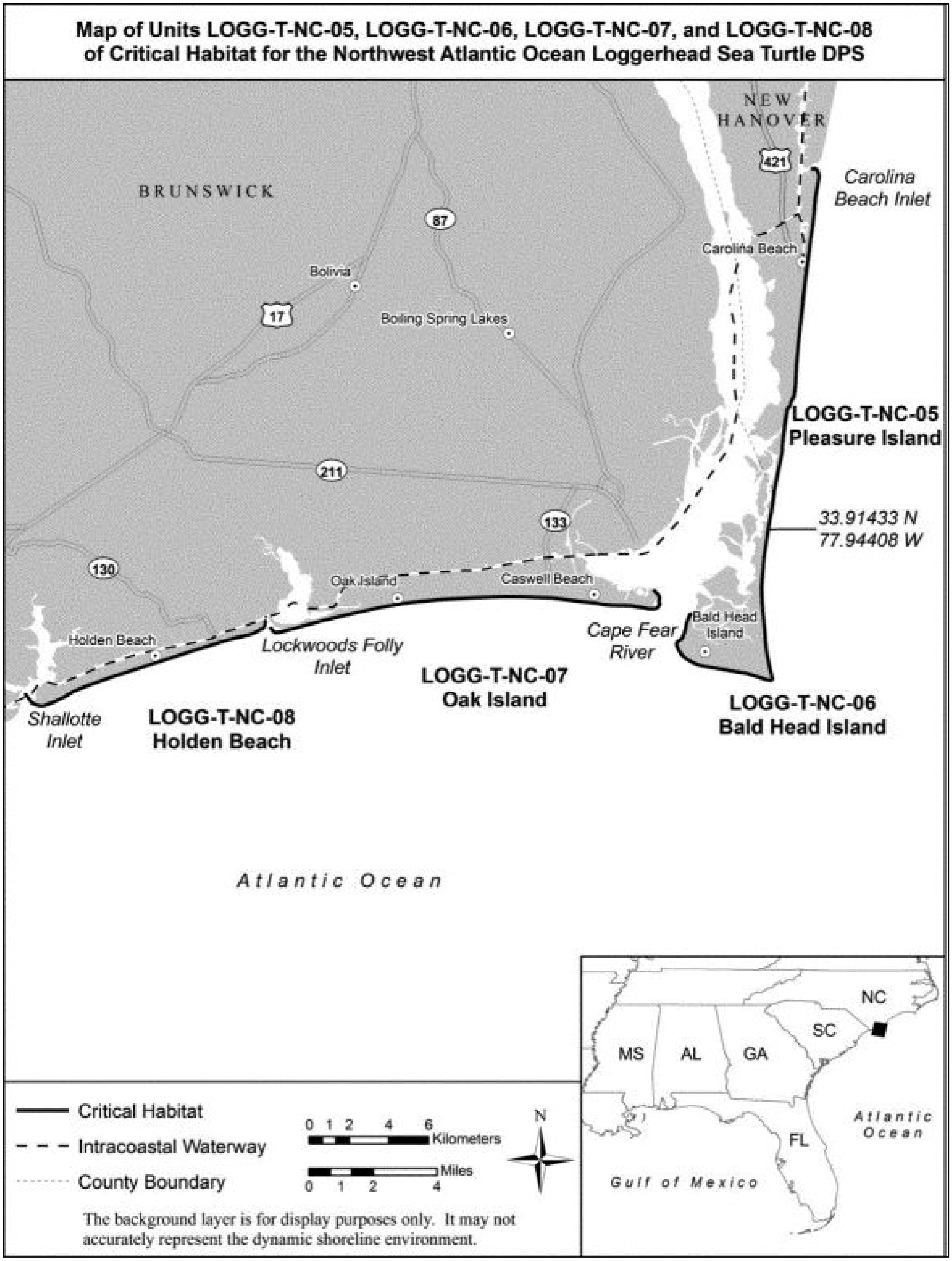

Figure 3-17: Loggerhead Terrestrial Critical Habitat

Environmental Consequences of NAA

Under without-project conditions, it is anticipated that the Wilmington District would continue to conduct maintenance dredging operations in accordance with the terms and conditions of the 2017 USFWS SPBO. Continuing beach placement may have minor, short-term effects on the dry beach nesting habitat for sea turtles. However, it is anticipated that habitat effects would be minimized through continued adherence to the terms and conditions of the USFWS Biological Opinion, including adherence to the to the NC sea turtle nesting environmental work window (16 November to 30 April), beach fill compatibility standards, and compaction and escarpment monitoring.

Environmental Consequences of AA1

Direct impacts of sand placement can potentially modify beach nesting habitats in ways that reduce nesting attempts and/or nesting success. Observed declines in nesting on nourished beaches have been attributed to modification of the natural beach profile, substrate compaction, and escarpment formation (Crain et al. 1995, Steinitz et al. 1998, Ernest and Martin 1999, Herren 1999, Rumbold et al. 2001, Byrd 2004, and Brock et al. 2009). By design, sand placement projects construct a flat berm that gradually steepens to the natural equilibrium profile over time through natural sediment transport processes. The initial post-construction reduction in slope can deter nesting females from emerging onto the beach or increase the proportion of false crawls on the affected beaches. Furthermore, the beach profile equilibration process can induce the formation of escarpments that prevent adult females from accessing upper dry beach nesting habitats, and the compaction of sediments by construction activities can impede the ability of adult females to excavate nests. Under AA1, the potential effects of beach placement on sea turtles would be similar to the NAA alternative but with the addition of Carolina Beach and Masonboro Island. These additions add 11,000 LF of potential beach placement within nesting habitat or potential nesting habitat for all four species of sea turtles. Beach placement operations would adhere to the established sea turtle nesting environmental work window (16 November – 31 April); thereby, avoiding direct impacts on nesting adult females, nests, and hatchlings. Monitoring for sea turtle nesting activity will be implemented throughout the construction area including the placement area and beachfront pipeline routes, in accordance with guidelines provided by the NCWRC and USFWS, so that nests laid in a potential construction zone can be bypassed and/or relocated outside of the construction zone prior to project commencement. A Sea Turtle Monitoring and Nest Relocation Plan will be developed and implemented by the contractor to minimize impacts for the duration of the project (until all equipment is removed from the beach). Despite implementing the conservation measures to the maximum extent practicable (i.e., beach quality sand and nest monitoring), the chance of impacting turtles and their incubating environment still exists. Measures to minimize beach placement effects on sea turtle nesting habitat would include adherence to beach fill compatibility standards and the implementation of escarpment and compaction monitoring in accordance with established Wilmington District practices. If it is necessary to place material outside of the sea turtle nesting window, the USACE will reconsult with the USFWS. Only compatible material that is similar in grain-size composition and color to native beach sediments would be placed on the beach. Therefore, the project may affect, likely to adversely affect all four species of nesting sea turtles. Beach placement would occur within an additional 11,000 LF designated terrestrial critical habitat for the loggerhead sea turtle compared to the NAA. Measures to minimize potential effects on beach nesting habitat would include adherence to the established sea turtle nesting environmental work window (Nov 16 – April 30), the placement of only compatible material that is similar in grain-size composition and color to native beach sediments, and the implementation of escarpment and compaction monitoring. Therefore, the project may affect, likely to adversely affect loggerhead terrestrial critical habitat.

Environmental Consequences of AA2

Impacts of this alternative would be similar to AA1.

3.16.5 Magnificent Ramshorn

Affected Environment

The magnificent ramshorn is an aquatic air-breathing gastropod mollusk. It has a coiled shell in the shape of a ram's horn. Its brown coiled shell, often with leopard-like spots-grows to the size and weight of a U.S. dollar coin, is just under 1.5 inches and less than 1 inch in height. The snail is adapted to still or slow-flowing aquatic habitats, and lays eggs on spatterdock and lily pads. The snail prefers freshwater bodies with pH within the range of 6.8–7.5. The magnificent ramshorn eats submerged aquatic plants, algae, and detritus.

The magnificent ramshorn is believed to be found only in southeastern North Carolina. The species was historically known from only four sites in the lower Cape Fear River Basin in North Carolina — the snail appears to be extinct at all four sites. Magnificent ramshorn snails were last seen in the wild in 2004. The loss of pond habitats and impaired water quality from saltwater intrusion, pollution and human alteration of aquatic vegetation communities posed significant threats to the species.

In the summer of 2023, the USFWS finalized the listing of the magnificent ramshorn as endangered. The Service also designated 739 acres in Brunswick County, North Carolina, as critical habitat for magnificent ramshorn. Two ponds are within the critical habitat designation - Orton Pond and Big Pond (also known as Pleasant Oaks Pond). The NCWRC has reintroduced small batches of captively raised magnificent ramshorn into Brunswick County in 2023.

Environmental Consequences of NAA

Under the NAA, SLC analysis presented in Appendix B-1 has estimated the tidal increase is estimated at an increase of 3.77 feet over the next 50 years using the high SLC scenario at the Wilmington gauge station. The dam elevation at Big Pond is estimated at 8 feet and at the Orton Pond Dam about 6 feet. Therefore, saltwater intrusion is not expected into either Orton Pond or Big Pond and would have no effect on the magnificent ramshorn.

Environmental Consequences of AA1

No direct or indirect impacts are expected from AA1. Tidal modeling indicated AA1 would add approximately 0.04 feet to the estimated increase under the Mean-High, High-Water 50-year scenario, well below the dam heights at each pond. Regional groundwater modeling (Appendix B) indicates that both surface water and groundwater flow toward the river, moving from higher to lower elevations, removing the chance of salinity impacts. Saltwater intrusion into the two lakes, whether through tidal, surface flow or groundwater, is unlikely and therefore there would be no impact to the magnificent ramshorn or critical habitat.

Environmental Consequences of AA2

Impacts of this alternative would be the same as AA1.

3.16.6 Seabeach Amaranth

Affected Environment

Seabeach amaranth (*Amaranthus pumilus*) was listed as threatened throughout its range in 1993 (58 FR 18035 18042). Historically, this species occurred on coastal barrier island beaches from Massachusetts to South Carolina. Extant populations are currently known from South Carolina, NC, Virginia, Delaware, Maryland, New Jersey, and New York. Although the historical range included Rhode Island and Massachusetts, seabeach amaranth has not been found in these states for over a century. Range-wide population numbers increased substantially during the 1990s, reaching a record high population estimate of 244,608 plants in 2000. However, the range-wide trend since 2000 is characterized by a dramatic decline to just 1,308 plants in 2013. All of the state-specific populations have experienced similar declines, with record or near record lows recorded in all states by 2013.

Primary habitats include overwash flats on the accreting ends of islands, lower foredunes, and the upper strand on non-eroding beaches. Seabeach amaranth is an annual, meaning that the presence of plants in any given year is dependent on seed production and dispersal during previous years. Seeds germinate from April through July, flowering begins as early as June, and seed production begins in July or August. Seeds are dispersed by wind and water; flowering and seed production both continue until the end of the growing season. Seabeach amaranth is intolerant of competition; consequently, its survival depends on the continuous creation of newly disturbed habitats. Prolific seed production and dispersal enable the colonization of new habitats as they become available. A continuous supply of newly created habitats is dependent on dynamic and naturally functioning barrier island beaches and inlets.

Although variable from year to year, the distribution of seabeach amaranth encompasses the entire barrier island coast of NC. Annual state-wide surveys from 1995 to 2014 recorded an average of 6,726 plants per year. Long-term population trends in NC have been similar to those of the overall range-wide population. After a record high annual count of 39,933 plants in 1995, annual survey totals from 1996 through 2002 fluctuated between approximately 200 and 14,000 plants. Beginning in 2003, the NC population increased substantially over three consecutive years, reaching 25,885 plants in 2005. The NC population has since been in rapid decline, reaching a record low annual total of 154 plants in 2012. Numbers remained low in 2013 and 2014, with surveys recording just 166 and 526 plants, respectively. The largest numbers of plants have been found along the southern NC coast, with concentrations occurring along Topsail Island and Bogue Banks. However, smaller numbers of plants occur consistently along much of the NC coast. Annual numbers in the study area have varied considerably from a low of just 22 plants in 2000 to a high of 2,420 in 2006. Since 2010, the population trend within the study area has mirrored the statewide and range-wide trend of steadily declining plant numbers, with annual totals from 2016 to 2023 ranging show just three plants over the all the area of potential effect (Table 3-50).

Table 3-50: Sea Beach Amaranth Surveys in North Carolina.

Survey Area	2016	2017	2018	2019	2020	2021	2022	2023	Total
Masonboro Island	*	*	*	*	0	0	0	0	**0**
Carolina Beach	0	0	0	0	0	0	0	0	**0**
Fort Fisher	0	0	0	0	0	0	0	0	**0**
Bald Head Island	0	0	0	0	0	0	0	0	**0**
Oak Island	0	0	0	0	0	0	0	0	**0**
Holden Beach	3	0	0	0	0	0	0	0	**3**
Total	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

*Not surveyed

Environmental Consequences of NAA

Under without-project conditions, it is anticipated that the Wilmington District USACE would continue to conduct beach placement on Bald Head Island and Oak Island in accordance with the terms and conditions of the SPBO BO (USFWS 2017), including adherence to a 16 November - 30 April beach placement environmental work window and beach fill compatibility standards. These measures would minimize the potential for adverse effects by avoiding the seabeach amaranth growing season and minimizing the potential for adverse substrate changes. Some seeds that are redistributed by sand placement and grading operations may be redeposited in unsuitable habitats; thereby, preventing successful germination or growth. Conversely, some seeds that are banked in unsuitable habitats may be redistributed to suitable dry beach habitats. Beach placement would contribute to the maintenance of wider vegetation-free dry beach habitats, thereby enhancing habitat conditions for seabeach amaranth along the erosional shorelines that adjoin the inlet. It is expected that any adverse effects on seed germination would be minor and localized.

Environmental Consequences of AA1

Under AA1, the potential effects of beach placement operations on seabeach amaranth would be similar to those of the NAA but with the addition of Carolina Beach and Masonboro Island adding 11,000 LF. Beach placement would be conducted in accordance with all terms and conditions of the SPBO BO (USFWS 2017). Therefore, the project may affect, likely to adversely affect the seabeach amaranth.

Environmental Consequences of AA2

Impacts of this alternative would be similar to AA1.

3.17 Protected Species – National Marine Fisheries Service

A Biological Assessment of Threatened and Endangered Species (BA) has been prepared in accordance with Section 7 of the Endangered Species Act, as amended (ESA) [16 United States Code (USC) 1531 *et seq.*] to address the effects of the proposed project on threatened and endangered species and critical habitats under the jurisdiction of the NMFS. The species listed in Table 3-51 includes federally listed threatened and endangered species that could be present in the area based on their geographic range and the designated critical habitat units (Table 3-52) that fall within the boundaries of the action area. However, the actual occurrence of a species in the area would depend upon the availability of suitable habitat, the season of the year relative to a species' temperature tolerance, migratory habits, and other factors. For these reasons, the two highly pelagic species on the NMFS list (sei and fin whales) were excluded from analysis based on their restriction to deep oceanic waters beyond the limits of the action area.

A summary of proposed effect determinations for Threatened and Endangered Species is in Table 3-51 and more detail is provided in the sections below. This section summarizes the BA; more detailed information, including analysis of impacts to critical habitat, can be found in Appendix F: Biological Assessment of Threatened and Endangered Species (NMFS).

Table 3-51: Summary of Effect Determinations for Threatened and Endangered Species and Critical Habitat.

Listed Species within the Study Area	Status	Proposed Effect Determination[1]
Sea Turtles		
Green sea turtle (North Atlantic [NA] DPS)	Threatened	MALAA
Hawksbill sea turtle	Endangered	MANLAA
Kemp's ridley sea turtle	Endangered	MALAA
Leatherback sea turtle	Endangered	MALAA
Loggerhead sea turtle (Northwest Atlantic [NWA] DPS)	Threatened	MALAA
Fish		
Atlantic Sturgeon (SA DPS)	Endangered	MALAA
Shortnose sturgeon	Endangered	MALAA
Elasmobranchs		
Giant Manta Ray	Threatened	MALAA
Oceanic Whitetip Shark	Threatened	NE
Whales		
Blue Whale	Endangered	NE
Fin Whale	Endangered	NE
North Atlantic Right Whale	Endangered	MANLAA
Sei Whale	Endangered	NE
Sperm Whale	Endangered	NE

[1]MANLAA = May Affect, Not Likely to Affect; MALAA= May Affect, Likely to Adversely Affect; NE = No Effect

Table 3-52. Critical Habitats that Overlap with Project Area

Species	Critical Habitat in the Action Area	Critical Habitat Rule/Date
Loggerhead sea turtle (Northwest Atlantic Ocean DPS)	LOGG-N-05 Nearshore Reproductive Habitat LOGG-N-02 Winter Habitat	79 FR 39856/ July 10, 2014
Atlantic sturgeon (Carolina DPS)	Unit 4. Cape Fear River and Northeast Cape Fear River	82 FR 39160/ August 17, 2017
North Atlantic right whale	Unit 2. Southeastern U.S. Calving Area	81 FR 4837/ January 27, 2016

The oceanic white tip, blue whale, fin whale, sei whale, and sperm whale are not addressed in this document or the BA due to a lack of suitable habitat for the species within the proposed project area.

3.17.1 Sea Turtles

Affected Environment

Five species of sea turtles are present within the project area: Green, Kemp's Ridley, Loggerhead, Hawksbill, and Leatherback. North Carolina's sounds and estuaries provide important developmental and foraging habitats for post-pelagic juvenile loggerhead, green, and Kemp's ridley sea turtles. All three species are represented primarily by juveniles, with few reported captures of older juveniles and adults and move inshore during the spring and disperse throughout the sounds during the summer (Epperly et al. 2007). They then leave the sounds and move offshore during the late fall and early winter. Juvenile loggerhead, green, and Kemps ridley sea turtles utilize the lower Cape Fear River estuary during the warmer months. Sea turtles have been observed in the Cape Fear River estuary as far upstream as river mile 15 (NMFS 1996). The leatherback sea turtle is primarily a pelagic species preferring deep, offshore waters. Leatherbacks may be present in nearshore ocean waters during certain times of the year; however, they rarely enter estuarine waters. Epperly (1995b) reported the appearance of significant numbers of leatherback turtles in nearshore ocean waters during May, coincident with the appearance of jellyfish prey. Hawksbill sea turtles are rare in North Carolina waters, and they rarely enter estuarine waters (Epperly et al. 1995a).

Environmental Consequences of NAA

For continued maintenance and operation of the FNS, environmental impacts of the NAA would remain consistent with the determinations made in the 2020 SARBO (NMFS) or the most recent version of the document.

Environmental Consequences of AA1 & AA2

Potential effects to sea turtles were evaluated through six identified actions associated with the action alternatives: construction of the channel modifications, long-term impacts due to the channel modifications, dredged material placement, construction of mitigation measures, geophysical and geotechnical (G&G) surveys, and maintenance dredging. No route of effect exceeded a may affect, not likely to adversely affect determination for sea turtles other than the construction elements of hopper dredging and relocation trawling. Hopper dredging is likely to adversely affect green, Kemp's ridley, and loggerhead sea turtles from entrainment or impingement due to hopper dredging. Based on the lack of reported interactions and expected avoidance of hopper dredging activities by leatherback and hawksbill sea turtles, hopper dredging will have no effect on these species. Relocation trawling is likely to adversely affect green, Kemp's ridley, leatherback, and loggerhead sea turtles inferenced by the historic capture of these species during relocation trawling. There will be no effect to hawksbill sea turtles from relocation trawling due to the hawksbill association with reef habitat.

Routes of effect from dredged material placement and geophysical and geotechnical (G&G) surveys would result in a may affect, not likely to adversely affect determination for sea turtles.

Long-term impacts due to the channel modifications and construction of mitigation measures would result in no effect to sea turtles.

Impacts from maintenance dredging would remain consistent with the determinations made in the 2020 SARBO (NMFS) or the most recent version of the document.

3.17.2 Giant Manta Ray

Affected Environment

Giant Manta Rays inhabit a variety of marine habitats, including estuarine waters, oceanic inlets, bays and intercoastal waterways. They are highly migratory and undertake long-distance movements to foraging and breeding grounds. Known aggregation sites exist globally, but their migration patterns are still being researched. A study conducted by Farmer et al. 2022, predicted that the highest nearshore occurrence of Giant Manta Ray occurs off northeastern Florida during April, with the distribution extending northward along the shelf-edge as temperatures warm, leading to higher occurrences north of Cape Hatteras, North Carolina from June to October, and then south of Savannah, Georgia from November to March as temperatures cool. However, Giant Manta Rays are not considered a common resident species in the Cape Fear River or near Wilmington, North Carolina. Sightings are infrequent and generally opportunistic. Any presence is likely seasonal, coinciding with warmer water temperatures and plankton blooms (late spring – fall).

Giant Manta Rays are filter feeders, primarily consuming zooplankton, including copepods, euphausiids (krill), and larval fish. The Cape Fear River estuary could provide some limited foraging habitat for manta rays, particularly during periods of high plankton blooms. The estuary receives freshwater input and has areas of upwelling, which can create favorable conditions for plankton growth. However, the lower salinity levels in the upper estuary may limit their use of that portion of the river. The nearshore waters off Wilmington, particularly around artificial reefs and ledges, are more likely to be used by manta rays. These areas can attract prey (plankton and small fish) and provide cleaning stations (areas where they visit to have parasites removed by smaller fish). The proximity of the Gulf Stream to the North Carolina coast can bring warmer waters and increased plankton abundance, potentially attracting manta rays to the area.

Environmental Consequences of NAA

Environmental impacts of the NAA would remain consistent with the determinations made in the 2020 SARBO (NMFS), or the most recent version of the document, for continued maintenance and operation of the FNS.

Environmental Consequences of AA1 & AA2

Potential effects to giant manta ray were evaluated through six identified actions associated with the action alternatives: construction of the channel modifications, long-term impacts due to the channel modifications, dredged material placement, construction of mitigation measures, geophysical and geotechnical (G&G) surveys, and maintenance dredging. No route of effect exceeded a may affect, not likely to adversely affect determination for giant manta ray other than relocation trawling. Per the SARBO there are “anecdotal records of giant manta ray captures in relocation trawling associated with dredging in the Gulf of Mexico prior to listing of this species”. As relocation trawling in the action area has been limited. Therefore, relocation trawling is likely to adversely affect giant manta ray.

Routes of effect from dredged material placement and would result in a may affect, not likely to adversely affect determination for giant manta ray

Routes of effect from assessed from long-term impacts due to the channel modifications, dredged material placement, geophysical and geotechnical (G&G) surveys, and construction of mitigation measures would result in no effect to giant manta ray.

Impacts from maintenance dredging would remain consistent with the determinations made in the 2020 SARBO (NMFS) or the most recent version of the document.

3.17.3 North Atlantic Right Whale

Affected Environment

The North Atlantic right whale (NARW) is highly migratory with a range from wintering and calving areas of the coast of the southeastern United States to summer feeding and nursery areas that extend northward from New England to Nova Scotia. The coastal waters of the Carolinas are part of the migratory corridor for the NARW, and NARW typically occur in the project area from November 1 - April 15. In the fall, a portion of the western North Atlantic population consisting primarily of pregnant females, females with young calves, and some juveniles migrate through the Carolinas southward to nearshore continental shelf waters off the coast of southern Georgia and northern Florida. The breeding and calving grounds for the NARW were designated as critical habitat under the ESA in 1994. Designated critical habitats for the NARW include northeastern feeding grounds in the Gulf of Maine/Georges Bank region, and southeastern nearshore ocean calving habitats from central Florida to Cape Fear, NC (81 FR 4838). In addition to being critical habitat for calving areas, the Cape Fear River mouth and adjacent nearshore waters provide potential foraging habitat for the NARW, particularly when copepod blooms occur. The presence of the Gulf Stream influences copepod distribution and can attract right whales to the area.

NARW are highly vulnerable to vessel strikes due to their slow swimming speed, tendency to feed near the surface, and preference for heavily trafficked areas. In order to reduce the risk of right whale deaths and injuries from ship collisions, the NMFS has established speed restrictions that limit vessels ≥65 ft in length to speeds of ten knots or less in designated Seasonal Management Areas (SMAs) along the US east coast (73 FR 60173). Seasonal Management Areas in the Mid-Atlantic migratory corridor encompass waters within 20 nautical miles (nm) of shore around the entrances to major ports, including the Port of Wilmington, along the NC coast.

Environmental Consequences of NAA

Environmental impacts of the NAA would remain consistent with the determinations made in the 2020 SARBO (NMFS), or the most recent version of the document, for continued maintenance and operation of the FNS.

Environmental Consequences of AA1 & AA2

Potential effects to the NARW were evaluated through six identified actions associated with the action alternatives: construction of the channel modifications, long-term impacts due to the channel modifications, dredged material placement, construction of mitigation measures, geophysical and geotechnical (G&G) surveys, and maintenance dredging. No route of effect exceeded a may affect, not likely to adversely affect determination for NARW. Vessel strikes from construction vessels was identified as extremely unlikely to occur with incorporation of protective measures and therefore resulted in the may affect, not likely to adversely affect determination.

Routes of effect assessed from long-term impacts due to the channel modifications, dredged material placement, G&G surveys, and construction of mitigation measures would result in no effect to NARW.

Impacts from maintenance dredging would remain consistent with the determinations made in the 2020 SARBO (NMFS) or the most recent version of the document.

3.17.4 Sturgeon

Affected Environment

Atlantic Sturgeon inhabit coastal waters and rivers along the Atlantic coast of North America. They are anadromous, meaning they migrate between saltwater and freshwater to spawn. The Cape Fear River is a known historical spawning river for Atlantic Sturgeon, and recent monitoring indicates successful spawning activity. Juvenile and subadult sturgeon utilize estuarine habitats for foraging and growth. The Cape Fear River estuary provides potential foraging habitat, particularly in areas with soft bottoms and moderate currents. Nearshore waters off Wilmington may also be utilized for foraging, especially during migrations.

The Cape Fear River and Northeast Cape Fear River contain critical habitat for Atlantic sturgeon. Lock and Dam 1 (LD1), Lock and Dam 2 (LD2), and Lock and Dam 3 (LD3) on the Cape Fear River prevent access to historic spawning grounds for Atlantic sturgeon. However, adults still utilize the Cape Fear River for spawning migration in the spring; a fall migration has not been confirmed despite monitoring efforts. The area just below LD1 has been confirmed as a successful spawning site, and young-of-year and juvenile sturgeon are known to use the Cape Fear River. A rock ramp was built at LD1 as mitigation for previous harbor modifications, but successful passage of Atlantic sturgeon via the rock ramp has not yet been documented. Habitat use within the Northeast Cape Fear River is less understood, and significant barriers to fish migration are not present.

Shortnose sturgeon spawn in the coastal rivers along the east coast of North America from Canada to the St. Johns River in Florida. Unlike Atlantic sturgeon that migrate more freely between freshwater, estuarine, and marine waters, shortnose sturgeon spend most of their adult life in fresh and brackish water. However, they venture into the lower coastal reaches and the ocean on rare occasions. There is no known resident population of shortnose sturgeon in the study area though transient adults have been recorded in the system. No critical habitat has been designated for the shortnose sturgeon within the project area.

Environmental Consequences of NAA

Environmental impacts of the NAA would remain consistent with the determinations made in the 2020 SARBO (NMFS), or the most recent version of the document, for continued maintenance and operation of the FNS.

Environmental Consequences of AA1 & AA2

Potential effects to sturgeon were evaluated through six identified actions associated with the action alternatives: construction of the channel modifications, long-term impacts due to the channel modifications, dredged material placement, construction of mitigation measures, geophysical and geotechnical (G&G) surveys, and maintenance dredging. No route of effect exceeded a may affect, not likely to adversely affect determination for sturgeon other than hopper dredging and blasting. Hopper dredges are known to cause mortality to sturgeon by entrainment and impingement, and blasting may result in injurious effects may include a temporary or permanent change in hearing (threshold shift), lung or gastrointestinal tract injury (from pressure waves), or direct injury or mortality. Therefore, construction of the channel modifications would result in a may affect, likely to adversely affect determination.

Routes of effect from assessed from long-term impacts due to the channel modifications, dredged material placement, G&G surveys, and construction of mitigation measures would result in a may affect, not likely to adversely affect determination for sturgeon.

Routes of effect assessed from dredged material placement and construction of mitigation measures would result in no effect to sturgeon.

Impacts from maintenance dredging would remain consistent with the determinations made in the 2020 SARBO (NMFS) or the most recent version of the document.

3.17.5 Marine Mammals

Take of marine mammals is prohibited under the Marine Mammal Protection Act (MMPA), with certain exceptions. Provided certain findings are made, NOAA Fisheries may issue incidental take authorizations allowing the unintentional "take" of marine mammals incidental to specified activities, including construction projects, scientific research projects, oil and gas development, and military exercises. This subsection addresses the marine mammals present in the project area and potential for takings. An Incidental Take Authorization (ITA) will be obtained in the PED phase of the project, when more information regarding construction methodology is available, if necessary.

Affected Environment

Multiple bottlenose dolphin stocks may occur in the project area year-round (i.e., Southern North Carolina Estuarine Stock, Northern North Carolina Estuarine Stock, North Atlantic Northern Migratory Coastal Stock, North Atlantic Southern Migratory Coastal Stock).

Environmental Consequences of NAA

The operation and maintenance of the existing FNS is unlikely to result in unintentional take of marine mammals.

Environmental Consequences of AA1 and AA2

Either Action Alternative may require confined underwater blasting to remove rock. Confined underwater blasting and associated blast mitigation measures could result in incidental take of marine mammals. Bottlenose dolphins are at risk of take from blast barotrauma, entanglement in blasting mitigation devices, and potentially other activities. If blasting is required, an Incidental Take Authorization (ITA) will be obtained in the PED phase of the project, when more information regarding construction methodology is available.

3.18 Aquatic Habitat

Proposed modifications to the harbor are likely to result in changes to hydrodynamics and water quality. To assess how these changes may impact aquatic habitat and species, habitat suitability index (HSI) models were applied to quantify habitat impacts to a variety of species under each alternative and various sea level change and flow conditions. The HSI models calculate a suitability index value, from 0 to 1, where 1 indicates optimal suitability. HSI scores are multiplied by the area assessed to provide habitat units (HUs). For this assessment, habitat units are expressed as acres. A representative selection of aquatic species with was identified by an interagency technical working group (TWG) for this assessment. The selected species were: Atlantic Sturgeon, Southern Flounder, Eastern Oyster, Spot, American Shad, Blueback Herring, and Striped Bass. More information on HSI modeling is available in Appendix I: Aquatic Habitat Suitability.

3.18.1 Affected Environment

The Cape Fear River estuary is an important nursery area for many estuarine-dependent fish and invertebrate species that spawn offshore and use estuarine habitats for juvenile development. Ocean-spawned larvae are transported shoreward by the prevailing currents and eventually pass through tidal inlets and settle in estuarine nursery habitats. Juveniles remain in the estuarine nursery areas for one or more years before moving offshore and joining the adult spawning stock (NCDEQ 2016). Rozas and Hackney (1984) and Ross (2003) indicate that oligohaline marshes of the upper estuary are also important nursery habitats for estuarine dependent species. These studies indicate that densities of juvenile spot, Atlantic croaker, flounder, and other estuarine dependent species in the upper oligohaline marshes and creeks are comparable to or higher than densities in the salt marshes and mesohaline to polyhaline creeks of the mid to lower estuary. In the specific case of spot and croaker, Ross (2003) reported that the upper oligohaline nursery areas were the most valuable for juvenile development. Rozas and Hackney (1984) reported three seasonal peaks in numerical abundance in oligohaline marsh rivulets; including a spring peak associated with the influx of juvenile spot, Atlantic menhaden, Atlantic croaker, and southern flounder; a summer peak attributable to high numbers of grass shrimp; and fall peak attributable to high numbers of bay anchovy and grass shrimp.

Anadromous species that undertake annual migrations from coastal waters to spawning grounds in the upper freshwater reaches of the Cape Fear River include Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*), striped bass (*Morone saxatilis*), American shad (*Alosa sapidissima*), hickory shad (*A. mediocris*), blueback herring (*A. aestivalis*), and alewife (*A. pseudoharengus*). Additionally, elvers of the catadromous American eel (Anguilla rostrata) migrate upriver to freshwater juvenile nursery areas in the upper Cape Fear River system (USACE 2010). The North Carolina Marine Fisheries Commission and the North Carolina Wildlife Resources Commission (NCWRC) have designated the middle to upper portions of the Cape Fear River estuary from Lilliput Creek northward as Anadromous Fish Spawning Areas (AFSAs). Anadromous Fish Spawning Areas are defined as areas where evidence of spawning of anadromous fish have been documented through direct observation of spawning, capture of running ripe females, or capture of eggs or early larvae (15A NCAC 03N .0106, 15A10C .0602).

3.18.2 Environmental Consequences of NAA

Under the NAA, total habitat units increase with sea level change for all assessed species and life stages. Increases vary between 50 and 342% under high sea level change projections. Increases are primarily due to increase in open water available throughout the project area due to sea level change, visualized in Figure 3-18. Typical flow conditions (50th percentile of long-term flows) were used for Table 3-53, but all modeled scenarios and results are available in Appendix I.

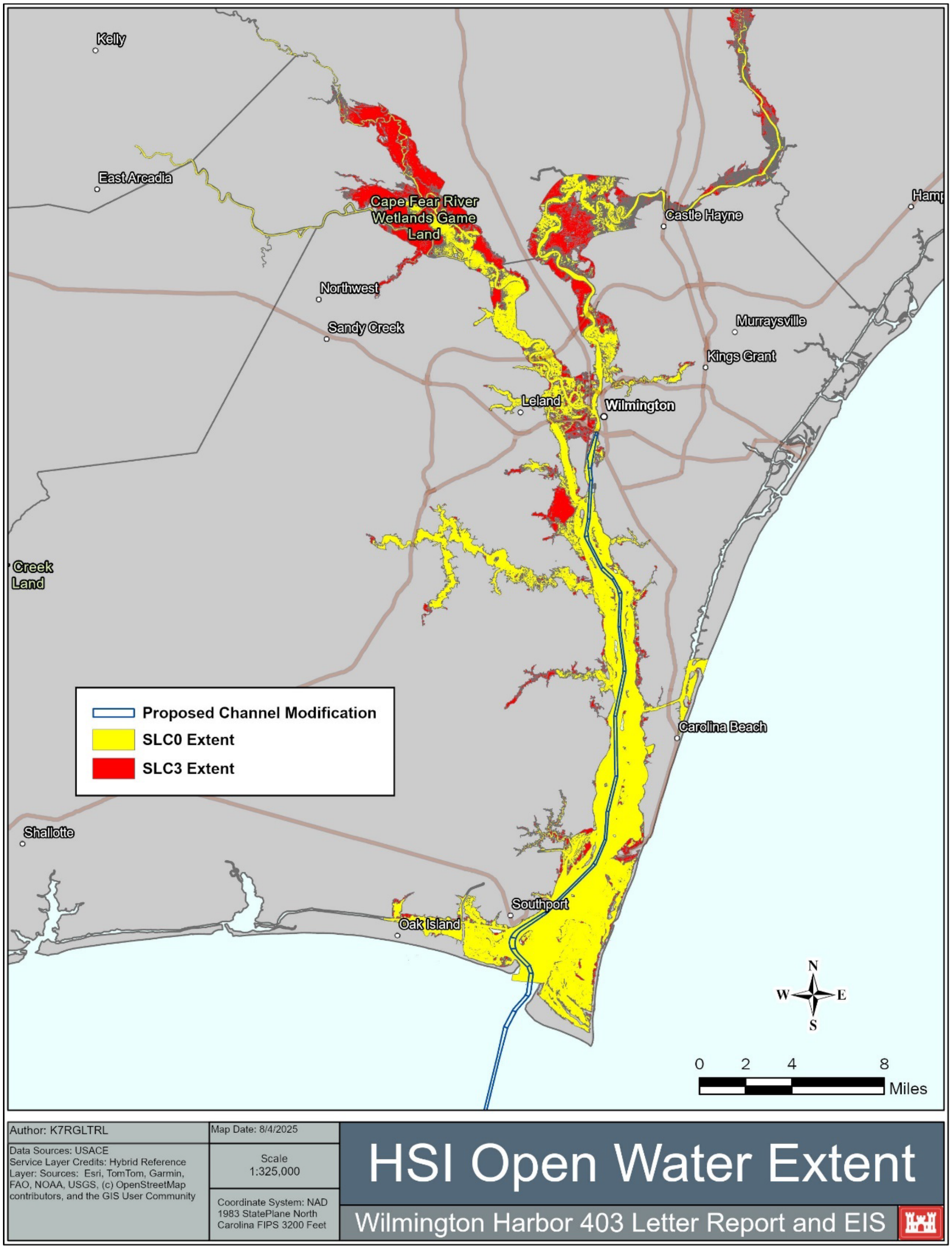

Figure 3-18. Open Water Extents Used for Habitat Unit Calculations. Note that the SLC3 extent contains additional area of open water.

Table 3-53: No Action Alternative Habitat Unit Impacts.

Species (life stage)	SLC0	SLC3	Percent Change
Atlantic Sturgeon (adult)	36379	59782	64
Atlantic Sturgeon (juvenile)	32804	60147	83
Atlantic Sturgeon (spawning)	4234	16451	289
Atlantic Sturgeon (young of year)	6367	28126	342
Blueback Herring (juvenile)	23882	39541	66
Blueback Herring (sael)	11525	22257	93
Eastern Oyster	10984	17668	61
Shad (estuarine)	55828	83534	50
Shad (riverine)	9554	20868	118
Southern Flounder	47013	75742	61
Spot	32609	55399	70
Striped Bass (adult/juvenile)	23403	30746	31
Striped Bass (egg)	7252	24909	243
Striped Bass (larval)	13696	21857	60
Striped Bass (spawning)	12760	27524	116

3.18.3 Environmental Consequences of AA1 & AA2

AA1 and AA2 result in similar impacts to aquatic habitat Table 3-54. These alternatives result in decreased habitat units for anadromous fish in their spawning and early life stages. This loss of habitat units ranges from 1.9 to 6.3% in SLC0 conditions. SLC3 conditions would reduce the range of impacts to anadromous fish spawning and early life stages to losses between 1.1 and 4.7%. All other species and life stages (estuarine) show increased habitat units in SLC0 conditions, and impacts ranging from slightly positive to less than significant (+.1% to -1.7%). Additional detail and analyses are available in Appendix I. Overall, changes to hydrodynamics and water quality due to channel modifications would result in increased habitat quantity/quality for some species, and decreases to other species, though all habitat unit losses would be less than 8% in all modeled scenarios.

Table 3-54. Percent Change of Habitat Units due to AA1 and AA2 under existing and high sea level change conditions.

Species (life stage)	SLC0		SLC3	
	AA1	AA2	AA1	AA2
Atlantic Sturgeon (adult)	1.3	1.3	-0.7	-0.7
Atlantic Sturgeon (juvenile)	2.0	2.3	-1.4	-0.9
Atlantic Sturgeon (spawning)	-2.6	-1.9	-4.0	-3.3
Atlantic Sturgeon (young of year)	7.0	7.8	-4.1	-3.2
Blueback Herring (juvenile)	-5.9	-4.6	-4.0	-3.0
Blueback Herring (spawning and early life)	-3.7	-3.0	-2.8	-2.4
Eastern Oyster	5.5	3.8	4.9	3.5
Shad (estuarine)	0.0	0.0	0.0	0.0
Shad (riverine)	-2.9	-2.4	-1.5	-1.1
Southern Flounder	0.3	0.3	0.1	0.1
Spot	0.6	0.5	-0.3	-0.3
Striped Bass (adult/juvenile)	0.1	0.2	-1.7	-1.6
Striped Bass (egg)	-6.3	-4.9	-4.7	-3.6
Striped Bass (larval)	-4.3	-3.2	-4.0	-2.5
Striped Bass (spawning)	-7.7	-6.4	-3.6	-2.7

The mitigation plan included in AA1 and AA2 includes fish passage structures for the first two dams on the Cape Fear River, Lock and Dam 1 and Lock and Dam 2. These fish passage structures would mitigate for significant impacts to spawning and early life stage habitat for anadromous fish by allowing fish to pass to historic spawning grounds. Performance of the fish passage structures would be monitored, and adaptive management would be employed to ensure success. More information on the mitigation plan, including monitoring and adaptive management measures, is available in Appendix M.

Overall, indirect impacts to aquatic habitat for anadromous fish from AA1 and AA2 would be negligible with implementation of the mitigation plan. Impacts to estuarine species are limited and often positive. Minor negative impacts are likely to be offset by increases in aquatic habitat due to sea level change.

3.19 Essential Fish Habitat

3.19.1 Affected Environment

The Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. § 1801 *et seq.*) of 1976 defines essential fish habitat (EFH) as those waters and substrate necessary for fish spawning, breeding, feeding, or growth to maturity. The MSA is the primary law responsible for governing marine fisheries management in U.S. federal waters and aims to promote conservation, reduce bycatch, and rebuild overfished industries. Additionally, Habitat Areas of Particular Concern (HAPC) comprise a more specific subset of EFH that are considered to be especially critical due to factors such as rarity, susceptibility to human-induced degradation, and/or high ecological importance. The project area is completely within the boundaries designated as EFH. Appendix L is the detailed EFH assessment pursuant to MSA. The following information summarizes that analysis.

The project footprint includes the Cape Fear River Estuary and the ODMDS. If any activities could potentially affect EFH adversely, the applicable Federal agency must consult with the NMFS to develop measures to conserve EFH and support management of sustainable marine fisheries. Managed species occurring in the project area are included in Table 3-55.

Table 3-55: NMFS, South Atlantic Fisheries Management Council (SAFMC), Mid-Atlantic Fisheries Management Council (MAFMC), and New England Fisheries Management Council (NEFMC) Managed Species.

Common Name	Scientific Name	Life Stage Use(s)	Fisheries Management Plan[1]
Atlantic Sharpnose Shark	*Rhizoprionodon terraenovae*	Adult, Juvenile, Neonate	NMFS Highly Migratory Species
Blacknose Shark	*Carcharhinus acronotus*	Juvenile/Adult	NMFS Highly Migratory Species
Blacktip Shark	*Carcharhinus limbatus*	Juvenile/Adult	NMFS Highly Migratory Species
Bluefish	*Pomatomus saltatrix*	Adults, Eggs, Juvenile, Larvae	MAFMC Bluefish
Bonnethead Shark	*Sphyrna tiburo*	Juvenile/Adult	NMFS Highly Migratory Species
Clearnose Skate	*Raja eglanteria*	Juvenile	NMFS Highly Migratory Species
Coastal Migratory Pelagics-Spanish Mackerel	*Scomberomorus maculatus*	ALL	SAFMC Coastal Migratory Pelagics
Penaeid Shrimp	*Penaeus aztecus* (Brown Shrimp) *Penaeus duorarum* (Pink Shrimp) *Penaeus setiferus* (White Shrimp)	ALL	SAFMC Shrimp
Sand Tiger Shark	*Carcharias taurus*	Adult, Neonate/Juvenile	NMFS Highly Migratory Species
Sandbar Shark	*Carcharhinus plumbeus*	Adult, Juvenile	NMFS Highly Migratory Species
Scalloped Hammerhead Shark	*Sphyrna lewini*	Juvenile/Adult	NMFS Highly Migratory Species
Smoothhound Shark Complex	*Mustelus sp.*	ALL	NMFS Highly Migratory Species
Snapper Grouper -Gray snapper	*Lutjanus griseus*	ALL	SAFMC Snapper Grouper
Spinner Shark	*Carcharhinus brevipinna*	Juvenile/Adult, Neonate	NMFS Highly Migratory Species

Common Name	Scientific Name	Life Stage Use(s)	Fisheries Management Plan[1]
Summer Flounder	*Paralichthys dentatus*	Adult, Juvenile, Larvae	MAFMC Summer Flounder, Scup, Black Sea Bass
Tiger Shark	*Galeocerdo cuvier*	Juvenile/Adult, Neonate	NMFS Highly Migratory Species
Windowpane Flounder	*Scophthalmus aquosus*	Juvenile	NEFMC Northeast Multispecies

[1]NMFS = National Marine Fisheries Service;
MAFMC = Mid-Atlantic Fisheries Management Council;
SAFMC = South Atlantic Fisheries Management Council; and
NEFMC = New England Fisheries Management Council

3.19.2 Environmental Consequences of NAA

Under the NAA, continuing maintenance dredging and placement activities would affect EFH and federally managed fisheries primarily through sediment suspension and soft bottom habitat disturbance. The water column and soft bottom habitats are components of multiple EFH and/or HAPC habitats within the study area including unconsolidated bottom, subtidal and intertidal non-vegetated flats, primary nursery areas (PNA), and coastal inlets.

Continuing maintenance operations would have recurring temporary direct impacts on soft bottom habitats and benthic infaunal prey communities in the existing navigation channel. Temporary losses of benthic invertebrate infauna would reduce the availability of benthic prey for federally managed species such as summer flounder and estuarine-dependent snapper-grouper species. Recurring periods of infaunal depression would reduce total benthic infaunal productivity over the 50-year assessment period. Maintenance dredging events would temporarily affect the water column through sediment suspension and increases in turbidity. Increases in suspended sediment concentrations and turbidity can affect the behavior (e.g., feeding, predator avoidance, habitat selection) and physiological functions (e.g., gill-breathing) of federally managed fisheries such as summer flounder, estuarine dependent snapper-grouper species, bluefish, coastal migratory pelagics, and shrimp. Additionally suspended sediments that are dispersed and redeposited outside of the existing channel can impact adjacent soft bottom EFH habitats and associated benthic invertebrate prey communities. However, Wilmington Harbor monitoring studies indicate that suspended sediments are narrow and confined to the navigation channel, with significant settlement to the bottom layer occurring with 300 meters of the source (Reine et al., 2002). Therefore, it is expected that the effects of dredging-induced sediment suspension and redeposition on EFH and federally managed species would be localized and short-term.

Continuing beach placement operations would have recurring direct impacts on intertidal and subtidal soft bottom habitats along Bald Head Island and Oak Island. Temporary losses of soft bottom benthic infauna would reduce the availability of benthic prey for federally managed species that utilize nearshore unconsolidated bottom EFH habitats, including summer flounder and bluefish. Beach placement would occur in accordance with the established sea turtle nesting environmental work window (November 16 – April 30) and beach fill compatibility standards; thereby increasing the likelihood of relatively rapid benthic infaunal recovery. Temporary increases in suspended sediment concentrations and turbidity along the beach placement areas would have short-term and localized effects on managed species that utilize nearshore unconsolidated bottom and ocean high salinity surf zone EFH habitats, including coastal migratory pelagic species, bluefish, and summer flounder.

3.19.3 Environmental Consequences of AA1 & AA2

The effects of AA1 and AA2 would be similar across the EFH habitats. The effects are summarized in Table 3-56 and in more detail in the EFH Assessment report in Appendix L. Table 3-56 and text below provide a summary of the anticipated effects of the alternatives on EFH, HAPC, and federally managed fisheries.

Table 3-56: Type and Quantity of Habitat Impacted by Action Alternatives.

Essential Fish Habitats	Potential Presence		Potential Impacts	
	Project Impact Area (direct)	In/Near Project Vicinity (indirect)	Dredging Activities	Sediment Placement Activities
Estuarine and Marine Water Column	☑	☑	Adverse but not substantial	Adverse but not substantial
Estuarine Emergent Wetlands	☑	☑	Adverse but not substantial	No Adverse Effect
Palustrine Emergent Wetlands	☑	☑	Adverse but not substantial*	No Adverse Effect
Submerged Aquatic Vegetation		☑	No Adverse Effect	No Adverse Effect
Subtidal and Intertidal Non-Vegetated Flats	☑	☑	Adverse but not substantial	Adverse but not substantial
Oyster Reefs and Shell Banks	☑	☑	Adverse but not substantial	Adverse but not substantial
Unconsolidated Bottom	☑	☑	Adverse but not substantial	Adverse but not substantial
Hardbottom and Artificial Reefs		☑	No Adverse Effect	No Adverse Effect
Coastal Inlets	☑	☑	Adverse but not substantial	Adverse but not substantial
State-Designated Nursery Areas	☑	☑	Adverse but not substantial	Adverse but not substantial
Sandy Shoals of Capes	☑	☑	Adverse but not substantial	No Adverse Effect

*Impact minimized due to mitigation

Construction Impacts

Under AA1 and AA2, dredging and placement operations would have direct effects on EFH/HAPC and federally managed species that are similar to those described above for the NAA. However, the extent of dredging and placement operations and the magnitude of resulting effects would increase. Temporary losses of benthic invertebrate infauna would reduce the availability of benthic prey for federally managed species such as summer flounder and estuarine-dependent snapper-grouper species. Temporary losses of benthic invertebrate infauna are expected to be short-term as infauna would migrate from the abundant nearby unconsolidated sediments and be transported via slumping of non-dredged sediments into the channel (Wilber and Clarke 2007). Alternative 2 (46 ft) would result in slightly less impacts than Alternative 1 (47 ft) due to shorter construction period and lesser potential extent of side slope sloughing.

The use of confined blasting as a pretreatment measure to break up areas of hard rock would not have any additional direct impacts on softbottom habitats beyond those already described for existing dredging activities. The development of a site-specific blasting plan would be coordinated with federal and state resource agencies to ensure that the potential effects of blasting on fisheries are mitigated to the maximum extent practicable. See Appendix L for information on blasting mitigation.

Indirect Impacts

AA1 would have negligible effects on temperature and dissolved oxygen (DO) concentrations. DO concentrations in the estuary are projected to decrease by an average of 0.03 mg/L in surface waters and .05 mg/l in bottom waters relation to the NAA. Hydrodynamic model results indicate that channel deepening under AA1 would also increase surface and bottom salinities in relation to the NAA. Under typical flow conditions, the maximum relative increases in average annual salinity occur between the downstream confluence of the Cape Fear and Brunswick Rivers and US Highway 17 with average increases of 1.28 psu in surface waters and 2.51 psu in bottom waters. Projected increases at all depths are rapidly reduced in the reaches above and below Wilmington. Impacts under AA2 are similar but slightly reduced. Indirect impacts such as reduced water quality due to temporary increases in turbidity levels for activities such as feeding or spawning may also occur however these impacts would be short-term (within 12-24 hours) and minor in nature as the Cape Fear River estuary is a naturally turbid area due to tidal influences. Once construction activities are completed, any turbidity will quickly dissipate given the tidal currents. Short-term increases in turbidity will not have a measurable effect on the water temperature or dissolved oxygen concentrations.

Impacts from Placement of Beneficial Use Material

Four types of beneficial use of dredged material are included in the action alternatives: beach placement, bird island enhancement, intertidal flat/marsh creation and enhancement, and artificial rock reef enhancement. Beneficial use of dredged materials would result in minor and temporary impacts to the water column due to turbidity during construction events. The beneficial use activities will also result in the conversion of benthic habitat as listed in Table 3-57 and detailed in-depth in Appendix L. The proposed project will place fill in areas of the Cape Fear Estuary’s subtidal and intertidal flats burying some organisms, while other organisms that are more motile will likely avoid and survive the dispersal event. Impacts to subtidal and intertidal areas due to sedimentation and burial are expected to be temporary and minor in nature. Although intertidal will experience some negative effects, the intertidal habitat will increase in size due to the beneficial use of dredged material resulting in an overall long-term benefit. The additional fill will provide substrate for intertidal flat habitat, and it is expected that species will colonize the new fill and be comparable to other nearby intertidal habitats within two years of construction (Wilber and Clarke 2007).

Table 3-57: Net project impacts based on the beneficial use efforts.

Habitat Type	Net Loss/Gain (Acres)
Subtidal	-1459
Intertidal	+1182

Habitat Type	Net Loss/Gain (Acres)
Supratidal	+276

Placement would cause losses of soft bottom benthic infauna and reduce the availability of benthic prey for federally managed species that utilize unconsolidated bottom and habitats. Placement operations would adhere to the established environmental work windows thereby avoiding peak infaunal recruitment periods and increasing the likelihood of relatively rapid benthic infaunal recovery. Additionally, natural disturbances are common in coastal environments so infaunal communities are resilient to many kinds of periodic disturbances. Recovery is normal for healthy salt marsh habitats if the disturbance event is under the critical threshold and if there are adjacent unaffected habitats that can serve as a source for colonists (McCall 2012). This direct impact would be minor and long-term (approximately 2 years); however, these effects are balanced with the benefits that beneficial use provides to species and the overall system. The Action Alternatives are expected to have the similar impacts due to placement of beneficial use material.

Impacts from Proposed Mitigation Plan

The proposed mitigation measures are primarily occurring in freshwater systems where EFH species are unlikely to inhabit, therefore, only minor and temporary adverse, indirect impacts to EFH from the proposed mitigation measures would be anticipated. The impacts may include increased turbidity due to construction activities; however, temporary increases in turbidity would have negligible effects on EFH species in the system. The restoration of estuarine wetlands near Eagle Island would likely result in beneficial incidental impacts to EFH species with removal of approximately 24 acres of low quality, invasive phragmites stands and replacement with tidal pools and native vegetation. Additional ecosystem benefits, which have been measured across multiple salt marsh restoration projects, may be achieved over various temporal scales including improved habitat provisioning for increased floral and faunal diversity, enhanced hydrodynamic attenuation and sediment accretion, increased nutrient cycling and carbon sequestration (Billah et al., 2022). More information on the mitigation plan, including monitoring and adaptive management measures, is available in Appendix M.

3.20 Recreation

3.20.1 Affected Environment

The coastal waterways, ocean and beaches of New Hanover and Brunswick Counties provide a scenic and enjoyable setting for the general public, which also includes the numerous recreational and commercial vessels. The estuarine and marine environment within the study area provides a wealth of opportunities for recreational fishing, diving, and boating, both by tourists and the public at large. The beaches present in the study area offer numerous recreational opportunities, including swimming, surfing, walking, diving, fishing, and other ecotourism activities. Public beaches within Brunswick and New Hanover counties have active shore protection programs to maintain their beaches for both shore protection of properties and to maintain public beaches. The total study area includes areas outside of the two counties, encompassing inland areas containing public parks and other recreational areas. Recreational and commercial fishermen have used the river/estuarine and marine waters within the study area extensively for many generations. Primary species sought include oysters, penaeid shrimp, blue crab, spot, flounder, trout, croaker, red drum, bluefish, Spanish mackerel, and king mackerel. The existing WOFES artificial reef provides fishing habitat and is utilized by hundreds of recreational fishermen.

3.20.2 Environmental Consequences of NAA

Under the NAA, continuing maintenance dredging and beach placement activities would be short-term and localized effects on recreation. Construction safety zones would restrict public beach access and recreational activities in the immediate vicinity of the active beach placement; however, effects on recreation would be short-term and limited to a relatively small segment of the beach at any given point during the construction process. Public exposure to recreational impacts would be limited, as adherence to the sea turtle nesting environmental timeframe for beach placement (November 16 to April 30) would limit operations to the colder months when recreational beach use is at its lowest point. Maintenance dredging would not restrict recreation vessel traffic in the Cape Fear River, and any effects on recreational fishing would be short-term and localized to a small portion of the estuary. The existing WOFES site, as it currently stands, will likely continue to be used by fishermen during its lifespan.

3.20.3 Environmental Consequences of AA1

Under AA1, it is expected that channel deepening and beach placement operations would have short-term and localized effects on recreation that are similar to those of the NAA. Confined blasting would result in additional restrictions on vessel traffic and recreational activities such as fishing; however, these restrictions would be indirect and short-term and would not restrict recreational vessel passage through the Cape Fear River estuary. The public's access to recreational areas may be limited during dredging and placing, as heavy equipment and vessels are requited for beach placement. The expected duration for each individual placement action is not expected to go over 90 days. Beach placement would occur on the off-seasons, and would not affect the entirety of the beach, leaving portions open for beachgoers.

Some beneficial use sites, particularly the islands in the Cape Fear River, are used to dock boats and fish. Placement at these sites would temporarily prohibit recreation; there would be no long term or permanent effects to recreation in these areas as the available recreation areas would still be accessible after initial construction and minor O&M events.

The proposed wetland mitigation plan would not impact recreation as the proposed sites are relatively secluded; however, the fish passage mitigation sites could impact fishermen at Lock and Dam 1 and 2 as they are used for recreational fishing of freshwater species. These impacts would be temporary and minor as the proposed mitigation is a one-time event that will not decrease the ability to fish.

3.20.4 Environmental Consequences of AA2

The effects to recreation under AA2 are similar to those of AA1 in respect to beneficial use placement and mitigation. In respect to recreation, dredging days would be less under the second alternative, and would limit indirect impacts from dredging vessels and equipment in placement areas affecting the public's access to recreational resources.

3.21 Historical and Cultural Resources

3.21.1 Affected Environment

The earliest evidence of human occupation in the American Southeast dates to more than 10,000 years before present (bp) – an era known as the Paleoindian period. Paleoindian cultures are general assumed to have been nomadic, with subsistence focused primarily on gathering and hunting large game. Sites dating to this period are generally characterized by a distinctive tool set consisting of fluted lanceolate projectile points/knives (PP/Ks). Few Paleoindian sites have been located in the Wilmington/Cape Fear River region; however, sea levels during the period were between 60 and 30 meters (roughly 200 to 100 ft) below current levels (Ferguson, 1986), thus sites relating to coastal Paleoindian populations would likely be located in submerged and offshore underwater contexts today.

Following the Paleoindian period, the North Carolina Coastal Plain saw continued habitation through the Archaic (ca. 10,000 to 3,000 bp) and Woodland (ca. 3,000 to 350 bp) periods into the Historic and Modern day. Hunter gatherer subsistence strategies continued from the Paleoindian into the Archaic period, with a diversification of lithic tools, and seemingly less reliance on hunting large game as evidenced by Archaic archaeological assemblages containing smaller and simpler PP/Ks as compared to the larger, fluted tools in use during the Paleoindian period. The transition from the Archaic into the Woodland period was marked by increased sedentism, larger villages and camp sites (as opposed to the more nomadic resource procurement sites abundant during earlier periods), and the development of pottery (Ward and Davis, 1999).

The move into the Woodland period saw a shift to subsistence strategies that coupled with a sedentary lifestyle, such as horticulture and even the domestication of some plants. This period also saw increased interactions between distinct linguistic groups. In the study region, the Algonquian speaking groups who dominated the more southern regions of the North Carolina Coastal Plain appear to have experienced a decline in territorial presence that coincides both with the arrival of early English explorers as well as an expansion of Iroquoian and Siouan speaking cultures (Mathis, 1995).

The Historic period coincides with European exploration of the North Carolina Coastal Plain by the English in the late 16th century, followed by more regular contact between Native American groups and European settlers moving south from Virginia in the mid-17th century. The very early colonial period did not see much activity or European exploration of the Cape Fear River, however, by 1664, English settlers had set up a colony at the confluence of the Cape Fear River and Town Creek. This colony did not last long due to difficulties with supply lines, hostilities with native groups, and internal disputes over land use policies, and by the early 18th century, North and South Carolina colonists had established permanent settlements along the lower Cape Fear River (Jackson, 1996).

Due to a shoal at the mouth of Town Creek that prevented larger vessels from navigating further upstream, the town of Brunswick was established just down river of the shoal in 1726. Subsequent to the founding of Brunswick Town, the town of Wilmington was formally incorporated in 1740, after being originally established as “New Town” in 1733. Following the founding of Brunswick and Wilmington, the Cape Fear region saw continued growth. Following the American Revolutionary War, Wilmington grew in prominence over Brunswick Town as the region’s primary port, with the first major navigational improvements to the river coming in the early 19th century (Lee, 1971).

Due to its deep water channel and having two access points to the Atlantic Ocean (New Inlet, and the mouth of the Cape Fear River), Wilmington served as the one of the most important seaports during the American Civil War (Pleasants, 1979). Furthermore, due to the local geology and bathymetry of dangerous navigational hazards, such as the Frying Pan Shoals, Wilmington served as the favored port for vessels running through the Union blockade (James, et al, 2018). To protect the two inlets, and maintain the efficacy of the blockade runners, Confederate forces constructed Forts Fisher and Anderson (the latter being located on the site of former Brunswick Town), as well as numerous smaller batteries and fortifications along the river (Jackson, 1996).

Following the Civil War, industry and commerce began returning to the Cape Fear River, resulting in deeper draft vessels calling on the Port of Wilmington (James, et al, 2018), which brought needs for additional navigational improvements, such as dredging a deeper channel, and the 1881 construction of a rock dam, known as the Rocks, between Fort Fisher and Zeke's Island. During the more than 140 years between the construction of "the Rocks" and today, numerous incremental changes aimed at improving navigation along the Cape Fear River. As a result of these changes, several cultural resources studies investigations have already taken place.

The most recent of these studies came in 2018, when Panamerican Consultants, Inc. conducted cultural resource remote sensing surveys of limited areas potentially affected by harbor channel expansion; including a 250-ft-wide zone along either side of the approximate 26-mile inner harbor channel reach between the Cape Fear River mouth and Wilmington, a 500-ft-wide zone along either side of the existing Bald Head Shoals ocean entrance channel, and a 1,000-ft-wide by 8-mile zone encompassing the proposed ocean entrance channel extension reach. The remote sensing surveys identified seven potentially significant targets, all within the inner harbor survey areas. Subsequent diver investigations identified three of the seven targets as modern debris; one as an old wooden revetment; one as a natural ridge; one as the remains of a navigation buoy; and one as the paddlewheel shaft of the shipwreck *CSS Kate*, a Confederate blockade runner previously identified by the NC Underwater Archaeological Branch (UAB). Remote sensing surveys conducted at the time did not identify any potentially significant targets within the ocean channel survey areas. No subbottom paleofeatures potentially representing prehistoric sites were identified in either the inner or ocean survey areas (James, et al, 2018).

As a result of the long, commercially, and militarily significant history of the Cape Fear River, a number of vessels have been reported lost, abandoned, or scuttled within the river's waters, in the vicinity of the project's study area. Many of these wrecks have been located and recorded by the North Carolina State Historic Preservation Office (SHPO) and Office of State Archaeology (OSA). Three such wrecks that lie within the proposed dredging footprint are recorded by SHPO as 31CFR0050, 31CFR0082, and 31CFR0084, details of which are highlighted as:

- 31CFR0050 is a late 17th to early 18th century cannon that was recovered in May of 1985 from the western edge of the existing Cape Fear River FNS. The dates of the cannon coincide roughly with the time period when a Spanish privateer, the *Fortuna,* exploded and sank in the same vicinity. The previously mentioned 2018 cultural resources remote sensing survey did not locate anything indicative of a shipwreck; however, numerous, smaller magnetic anomalies were picked up in the area (James, et al 2018).

- 31CFR0082 is the Confederate blockade runner *CSS Kate*. *CSS Kate* ran upon unmarked obstructions in the river in November 1862 and has remained in the river, near the western edge of the federal navigation channel ever since. The 2018 cultural resources remote sensing survey did not locate *CSS Kate,* but did identify that her paddlewheel shaft had sloughed into the channel margins and would likely be in the path of direct impacts from any of the dredging associated with this navigation improvements project.

- 31CFR0084 is the potential remains of the tugboat *Fayetteville* lost in May 1853 when one of her boilers exploded. The previously mentioned 2018 cultural resources remote sensing survey did not locate anything indicative of a shipwreck; however, additional surveys are needed to ensure coverage of the entire extent of potential project impacts.

Additionally, a number of historic sites that are listed in the National Register of Historic Places (NRHP) occur along the banks of the Cape Fear River; including the Wilmington Historic District, Brunswick Town/Fort Anderson State Historic Site, Orton Plantation, Fort Fisher State Historic Site, Southport Historic District, Fort Caswell Historic District, and the Bald Head Island Lighthouse. Additionally, the NRHP-listed *USS North Carolina* is berthed in the Cape Fear River opposite downtown Wilmington.

3.21.2 Environmental Consequences of NAA

Under the NAA, continuing maintenance dredging operations would be limited to the removal of alluvial material from the existing disturbed channel prism. Forecast modeling suggests that erosive forces to shorelines and riverbanks would continue and potentially increase under the NAA, which would likely lead to continued and increased adverse impacts to historical and cultural resources located in these areas.

3.21.3 Environmental Consequences of AA1 & AA2

The Section 203 Report completed by the NCSPA mentioned in Section 1.1 (Background) did not address the inherently governmental function of consultation with the NC SHPO or pertinent federally recognized Tribal Nations under section 106 of the National Historic Preservation Act (NHPA) regarding potential effects to historic properties and other cultural resources. Budget and schedule constraints for the Section 403 effort prevent the USACE from conduct all of the necessary surveys to sufficiently identify and evaluate cultural resources, understand the potential adverse effects of each action alternative on historic properties, or establish methods to avoid, minimize, or mitigate potential adverse effects, prior to completion of this feasibility study. As such, USACE is deferring final identification and evaluation of historic properties until the pre-construction, engineering, and design (PED) phase), when additional funding becomes available, and prior to construction by executing a Programmatic Agreement (PA) with the North Carolina SHPO, and the General Services Administration (GSA) , pursuant to 36 CFR § 800.4(b)(2). The draft PA, presented in Appendix E, details additional historic property inventories to be completed during the study's pre-construction, engineering, and design phase to identify and assess the eligibility of historic properties and determine effects of the study on these properties.

Although additional surveys are needed to determine the presence of additional historic properties within the study's area of potential effects, and potential effects to historic properties, initial research indicates that the action alternatives have the potential to adversely affect three known cultural resources within or adjacent to the channel: 31CFR0050, 31CFR0082, and 31CFR0084.

The discussion of effects above is preliminary based on known resources and should not be considered final. The PA outlines the process by which additional historic property surveys would be conducted, effects determined, and avoidance, minimization, and/or mitigation strategies are implemented. The draft

PA also describes monitoring requirements, minimization and mitigation procedures, and procedures in case adverse effects to historic properties occur inadvertently.

3.22 Socioeconomics

3.22.1 Affected Environment

The project area boasts a diverse economy with the Port of Wilmington being a primary driver. New Hanover County, with a population around 285,000 and growing rapidly, has a relatively strong economy but still experiences income inequality with approximately 12% of residents below the poverty line. New Hanover County's high quality of life, fostered by its riverfront development, accessible beaches, and the presence of the University of North Carolina Wilmington, contributes to its attractiveness as a place to live and work. Brunswick county has a lower population, but is still seeing significant population increases, and relies heavily on the port for economic prosperity.

3.22.2 Environmental Consequences of NAA

If the channels connecting the Atlantic Ocean to the Port of Wilmington are not deepened and widened, economic activity and growth would likely continue. Based on available information and trends, cargo volumes would be expected to continue to increase. Due to the current channel's configuration, light loading practices would continue as the least-cost alternative to intermodal shifts in cargo. Vessels would continue to call at the Port of Wilmington, as opposed to shifting their cargo to an alternate port nearby, such as Charleston, SC or Norfolk, VA, to access their hinterlands via landside transport. Over time, modest increases in costs for goods imported and exported through Wilmington, relative to locations where the need to light load vessels is lower, may result from the transportation inefficiencies as the feet that serves the east coast continues to shift towards larger and more efficient vessels.

3.22.3 Environmental Consequences of AA1 & AA2

AA1 and AA2 would not have significant indirect effects on population, employment, or income for several reasons. Modifications to existing navigation channels are not expected to induce landside population growth or development as other social and economic factors (e.g. economy, jobs) influence this, and the study area is already highly developed. Therefore, associated significant indirect impacts to population, employment, and income would not occur.

There would be direct economic benefits in terms of reduced transportation costs, as detailed in the economic attachment (Attachment 5) to the Letter Report. Both bulk and container vessels would experience a time savings in the form of the reduction in transit time delays. Another source of savings would be the elimination of voyages over the year by loading the existing fleet deeper with a deeper channel in place. The ability to load deeper allows the existing fleet to move the same volume of cargo in fewer trips. This would result in cost savings to the shippers and generates nationwide benefits. Other costs and practices, such as land side costs, would not change because of the project and are assumed to remain constant.

Both action alternatives would have minimal direct impacts to human environment resources because work would primarily be located in the open water of the Cape Fear River and uninhabited manmade dredged material placement sites. The only impacts to land, described in previous sections, are minimal, and do not involve any displacement of occupied structures, residences, facilities or businesses.

3.23 Public Health and Safety

3.23.1 Affected Environment

Public and health safety considerations are a key focus due to the proximity of the project to populated areas and the potential for risks associated with construction activities from dredging and blasting. The project area is a major shipping corridor with high levels of vessel logy. The addition of construction equipment, dredging vessels, and blasting activities introduces potential hazards that require coordinated emergency response planning. Collaboration with the U.S. Coast Guard and local authorities will ensure the implementation of contingency plans to address potential accidents, spills, or other emergencies promptly and effectively.

Portions of the navigation channel contain consolidated materials, such as soft and hard rock, that will require blasting to achieve the proposed channel depth. Blasting activities introduce potential risks to public safety, including noise, vibration, and the potential for unintentional impacts on nearby infrastructure, vessels, and marine life. To minimize risks, safety buffers, public notifications, and controlled blasting protocols will be implemented in accordance with federal and state safety standards (Appendix L). Continuous monitoring during blasting will also ensure compliance with safety and environmental regulations. Blasting operations will adhere to its the blasting mitigation plan and the Unified Facilities Guide Specifications for confined Underwater Blasting (UFGS, 2023).

Dredging through pipelines, hopper and mechanical dredge, is the primary means of construction of the project, which presents public health and safety concerns. The operation involves the removal of significant volumes of sediment over several years. Dredging equipment and support vessels increase traffic on the Cape Fear River, heightening navigational risks for commercial, recreational, and fishing vessels. Dredging operations would be carefully planned and conducted to minimize impacts on water quality and navigational safety. Measures such as traffic management protocols and communication with the U.S. Coast Guard will help mitigate risks to the public and waterway users.

Construction activities, include both dredging, blasting, and placement of material in designated locations, may affect nearby communities. Noise, vibration, and emissions from heavy equipment and vessels have the potential to disturb residents and contribute to temporary air quality concerns. Public notifications will be issued and work would adhere to local noise ordinances. Additionally, the transportation and placement of dredged material, whether in the ODMDS or at beneficial use locations, could temporarily increase road or waterborne traffic near the project area, requiring construction safety measures according to USACE EM-385-1-1 to reduce risks to workers and the public who utilize these recreational areas.

3.23.2 Environmental Consequences of NAA

While this alternative avoids immediate safety risks tied to construction activities for new work, it would not eliminate ongoing and future public and health safety concerns related to O&M dredging. O&M dredging takes place on a yearly basis in the Anchorage Basin and Outer Ocean Bar reaches while other reaches are done as needed.

While the NAA avoids construction-related risks, it fails to address long-term public and health challenges associated with using and maintaining a restricted navigation channel. These include increased risks of vessel incidents, disruptions to critical supply chains, and prolonged maintenance-related hazards.

3.23.3 Environmental Consequences of AA1

AA1 would involve extensive and continuous construction activities, including blasting or other pretreatment, dredging, and the movement of large volumes of sediment across multiple locations. AA1 would remove approximately 35.1 million cubic yards of sediment, consisting of unconsolidated materials (i.e., sand, silt, and clay) and consolidated materials (i.e., soft and hard rock). While this alternative offers significant long-term benefits, such as improved navigational safety, enhanced vessel efficiency, and increased flexibility, it also introduces several public and health safety risks during the construction phase, which is expected to span approximately six years. Safety measures and mitigation strategies to address risks associated with blasting, dredging, and increased construction activity would be implemented in the project area.

3.23.4 Environmental Consequences of AA2

AA2 would also involve extensive and continuous construction activities, including blasting or other pretreatment, dredging, and the movement of large volumes of sediment across multiple locations. However, the scope of work would be slightly less compared to AA1. This alternative would remove approximately 29.6 million cubic yards of sediment, consisting of unconsolidated materials (i.e., sand, silt, and clay) and consolidated materials (i.e., soft and hard rock). Public and health safety risks remain a concern under this alternative but are expected to be slightly lower due to the reduced scope of work and shorter construction duration. However, the construction phase is still anticipated to span approximately six years, requiring safety measures and mitigation strategies to address risks associated with blasting, dredging, and increased construction activity in the project area.

3.24 Invasive Species

3.24.1 Affected Environment

The project area, encompassing the Cape Fear River and adjacent estuarine environments, supports a diverse range of native flora and fauna, but is also susceptible to the introduction and establishment of invasive species. Recreational boating, aquarium releases, live bait introduction, and the commercial shipping industry are a few examples of existing pathways for invasive species introduction in the project area.

Harbor operations can be primary vectors for invasive species introduction via ballast water discharge from vessels and hull fouling. The establishment of CFR § 151.2025 to mandate the management of ballast water, technological advances in anti-fouling coatings, and more efficient vessel operations have likely reduced the risk of invasive species introduction due to commercial navigation, but some risk remains.

Disturbed areas from dredging operations, such as placement areas and newly created habitat, are particularly vulnerable to colonization by invasive species.

Existing mitigation efforts, such as monitoring programs and targeted removal projects, are ongoing, but the risk of new introductions and further spread remains a significant concern. The health and biodiversity of the estuarine ecosystem are directly threatened by the continued presence and expansion of invasive species, impacting native species populations, habitat structure, and overall ecosystem function.

3.24.2 Environmental Consequences of NAA

Existing risk from the commercial shipping industry would continue. Without channel modifications, vessel calls are projected to increase by 127% by 2085. Increased vessel calls would result in increased risk due to increases in total hull surface area entering the harbor and ballast water discharge, along with increased connectivity to other ports.

Vulnerability of existing beneficial use sites would continue to be present under existing maintenance operations.

3.24.3 Environmental Consequences of AA1 and AA2

Risk from the commercial shipping industry would continue but is likely to be reduced. Channel modifications are projected to reduce vessel calls by 22% by 2085. Decreased vessel transit would result in decreased risk of invasive species introduction due to decreases in total hull surface area entering the harbor and reduced ballast water discharge. Connectivity to other ports would also be reduced.

The expansion of beneficial use sites would increase the area of disturbed sites vulnerable to invasive species during maintenance operations.

Both action alternatives include wetland restoration measures which would remove the invasive species Phragmites australis from a coastal wetland, reducing the spread of the species in that area.

SECTION 4 – ALTERNATIVES SUMMARY AND SELECTION OF ALTERNATIVE, "TENTATIVELY SELECTED PLAN" INFORMATION, AND ANALYSES

4.1 Comparison of Alternatives' Impacts

As discussed in Section 3, impacts to resources from the NAA and two action alternatives were evaluated. The following (Table 4-1) summarizes these findings.

Table 4-1. Impacts to resources under each alternative.

Resource		Alternatives		
		No Action (NAA)	Action Alternative 1 (Proposed, -47 feet) (AA1)	Action Alternative 2 (-46 feet) (AA2)
Hydrology and Hydraulics	Channel Morphology	The channel would continue to shoal and keep its shape at its historic rate depending on SLC, reflecting the ongoing natural processes of sediment deposition under the NAA.	Under AA1, channel depths would change from -42 feet to -47 MLLW feet from Anchorage Basin to Lower Swash, while from Battery Island to the Entrance Channel would change from -44 to -49 MLLW feet with varying degrees of channel width. Shoaling rates are expected to add 351,299 cy/yr of material to be removed under the no SLC scenario.	Under AA2, channel depths would change from -42 feet to -46 MLLW feet from Anchorage Basin to Lower Swash, while from Battery Island to the Entrance Channel would change from -44 to -48 MLLW feet with varying degrees of channel width. Shoaling rates are expected to add 238,039 cy/yr of material to be removed under the no SLC scenario.
Hydrology and Hydraulics	Beach Shoreline	Oak Island, Caswell Beach, and Bald Head Island would continue to experience shoreline change driven primarily by natural longshore sediment transport processes and wave conditions under the NAA.	Under typical wave conditions, the maximum deviation in shoreline position is 1.3 feet at Oak Island/Caswell Beach and 4.2 feet at Bald Head Island, with changes in mean annual sediment transport of less than 1% for both locations. Change in significant wave height across the alternatives rarely reaches 1 cm or 0.1% for AA1.	Under typical wave conditions, the maximum shoreline deviation is 0.9 feet at Oak Island/Caswell Beach and 3.2 feet at Bald Head Island, with changes in mean annual sediment transport of less than 1% for both locations. Change in significant wave height across the alternatives rarely reaches 1 cm or 0.1% under AA2.
Hydrology and Hydraulics	River Shorelines	Under the NAA, increased vessel traffic from 534 to 1,214 over time would continue to elevate sediment disturbance and increase river shoreline vulnerability throughout Wilmington Harbor. The maximum bed shear stress (MBSS) would increase by approximately 19.8% due only to	Under AA1, there would be a decrease in yearly passages from 1,214 to 949, reduce bottom stress which in turn would reduce river shoreline erosion throughout the project area The maximum bed shear stress (MBSS) would be approximately 9.8%.	Under AA2, there would be a decrease in yearly passages from 1,214 to 979, reduce bottom stress which in turn would reduce river shoreline erosion throughout the project area The maximum bed shear stress (MBSS) would be approximately 9.8%.

Resource	Alternatives		
	No Action (NAA)	Action Alternative 1 (Proposed, -47 feet) (AA1)	Action Alternative 2 (-46 feet) (AA2)
	the higher number of vessel transits.		
Water Quality	DO levels tend to decrease under SLC3 compared to SLC0, suggesting that rising sea levels may lead to greater stratification or altered flow patterns that reduce oxygen availability in shallower or more enclosed areas. Impacts to temperature were negligible. Salinity will increase up to 5.94 psu, and TSS is expected to decrease in future conditions.	Impacts to DO, temperature, and TSS are negligible. Salinity impacts are localized with increases up to 2.51 psu, and bottom waters are impacted more than surface waters.	Impacts to DO, temperature, and TSS are negligible. Salinity impacts are localized with increases up to 2.01 psu, and bottom waters are impacted more than surface waters.
Wetlands	Sea level change would result in the conversion of 9,627 acres of tidal freshwater wetlands into brackish wetlands through the 50-year period of analysis.	AA1 would not eliminate wetlands but would cause wetland class conversions. 1,071 acres of tidal freshwater wetlands would be converted to brackish wetlands due to the increase of salinity. Wetlands may experience accretion with the placement of beneficially used dredged material adjacent to wetlands on riverbanks and islands within the Cape Fear River.	Type of impacts to wetlands under AA2 would be similar to AA1. 972 acres of tidal freshwater wetlands would change to brackish wetlands with due to the increase of salinity.
Flooding and Tidal Impacts	Under the NAA, tidal processes remain relatively stable, but SLC significantly influences both tidal datums and storm surge impacts. Inundations from tides and storms would follow current trends.	The MHW would increase by 0.11 feet (5.3%) and MLW would drop by 0.15 feet (6.6%) under AA1 compared to NAA, resulting in a tidal range increase of 0.26 feet (5.9%). The land area inundated by storms, on average, would increase by 12,236,984 ft^2 (0.61%).	Under AA2, the MHW would increase by 0.09 feet (4.3%) and the MLW would decrease by 0.12 feet (5.2%), resulting in a tidal range increase of about 0.21 feet (4.8%). The land area inundated by storms, on average, would be slightly smaller than AA1.

Resource	Alternatives		
	No Action (NAA)	Action Alternative 1 (Proposed, -47 feet) (AA1)	Action Alternative 2 (-46 feet) (AA2)
Sediment	This alternative would maintain the navigation channel at its current depth (-42/-44 ft) with no deepening, widening, or realignment. Routine maintenance dredging would continue to ensure safe navigation at existing authorized depths and widths. Annual O&M dredging would remove about 2.5 million cubic yards per year and place it at Eagle Island, Brunswick County beaches, or the ODMDS.	AA1 would require the removal and placement of approximately 35.1 million cubic yards of sediment, including consolidated and unconsolidated materials. The sediment would largely stay within the riverine system.	AA2 would require dredging approximately 29.6 million cubic yards of sediment, consolidated and unconsolidated materials. Slightly less dredging would be required compared to AA1.
Groundwater	Under the NAA, groundwater conditions continue to follow normal trends with the groundwater flow field continuing to go toward the river. In addition, groundwater conditions would remain largely influenced by groundwater pumping (usage) and SLC.	Under AA1, groundwater conditions are expected to remain largely unchanged. While the existing flow field may experience slight alterations, these are within the model's margin of error. The changes are localized and minor, especially when compared to the broader impacts of SLC and groundwater pumping.	Under AA2, groundwater conditions are expected to remain largely unchanged. While the existing flow field may experience slight alterations, these are within the model's margin of error and would likely be smaller than AA1. The changes are localized and minor, especially when compared to the broader impacts of SLC and groundwater pumping.
Air Quality	No impacts to air quality under the NAA. Regular O&M of the current FNS has minor and temporary emissions.	Overall long-term decrease in emissions is anticipated. There would be more dredging and placement days (~655 additional days compared to AA2), but emission from heavy equipment would be minor and temporary and would not affect regional air quality.	Impacts to air quality under AA1 are similar to those under AA2. Initial construction, placement, and mitigation measures would increase emissions; however, regional air quality would not be impacted.
Climate Variability	Future climate and SLCs could increase sedimentation in the navigation channel, requiring	More extreme droughts and rain could increase sediment in the Cape Fear River channel, raising dredging	More extreme droughts and rain could increase sediment in the Cape Fear River channel, raising dredging

Resource	Alternatives		
	No Action (NAA)	Action Alternative 1 (Proposed, -47 feet) (AA1)	Action Alternative 2 (-46 feet) (AA2)
	more dredging under the NAA. SLC may also cause overtopping of structures, greater shoreline erosion, and flooding of low-lying areas. More extreme droughts and rain could increase sediment in the Cape Fear River channel, raising dredging needs. However, deeper channels from rising seas could reduce dredging needs. Overall, both changes would lessen the area's navigability resilience.	needs. AA1 would improve navigability resilience compared to taking NAA.	needs. AA2 template would improve navigability resilience over the NAA, though less than the AA1.
Visual Resources (Aesthetic)	Existing planned beach placement operations would have temporary indirect impacts on aesthetics and beach recreational opportunities under the NAA. Large commercial vessels would continue to temporarily affect viewshed in river as they come to port.	Under AA1, beach placement operations would have temporary indirect impacts on aesthetics and beach recreational opportunities. Restrictions on vessel traffic in the immediate vicinity of possible confined blasting operations would have short term indirect impacts on water recreational activities. Blasting would not restrict recreational vessel passage through the Cape Fear River estuary.	Similar to AA1. Dredging operations and impacts to viewshed would be slightly less than AA1 with less dredging days required.
Noise	Noise impacts would be minimal during O&M and placement. The NAA would not increase noise significantly in the existing project area; impacts would be temporary and minor in dredging and placement areas.	AA1 impacts to noise would be minor during construction, placement, and mitigation. Most areas of disturbance are in relatively secluded areas outside of tourist season, and would not elevate the overall noise level of the region.	Same as AA1.
Vegetation	Under the NAA, vegetation throughout the study area would show varying degrees of change depending on the rate of SLC.	Under AA1, additional relative upstream shifts in the freshwater to oligohaline salinity isopleths as compared to the NAA, but not	Vegetation would have slightly reduced salinity impacts as compared to AA1 under AA2. Overall, there would be minor long-

Resource	Alternatives		
	No Action (NAA)	Action Alternative 1 (Proposed, -47 feet) (AA1)	Action Alternative 2 (-46 feet) (AA2)
	Potential impacts to overtopping of waterside structures, increased shoreline erosion, and increased flooding of low-lying areas.	expected to cause significant salinity impacts to a point where vegetation habitats would change considerably. Overall, there would be minor long-term negative impacts due to salinity change, minor short-term impacts to covered vegetation during bird island placement, and long-term positive impacts due to protecting the shoreline.	term negative impacts due to salinity change, minor short-term impacts to covered vegetation during bird island placement, and long-term positive impacts due to protecting the shoreline.
Wildlife	The NAA is not expected to cause significant salinity impacts to a point where wildlife habitats would change considerably. Short-term transient effect could occur to mammalian species using the dune and fore-dune habitat, but those species are mobile and would be expected to move to other, undisturbed areas of habitat during periodic nourishment events.	Additional relative upstream shifts in the freshwater to oligohaline salinity isopleths for AA1 as compared to the NAA, but not expected to cause significant salinity impacts to a point where vegetation habitats would change considerably. Short-term transient effect could occur to mammalian species using the dune and fore-dune habitat. Overall, the anticipated effects of AA1 are considered to be insignificant.	Similar impacts as compared to AA1 under AA2, but with slightly reduced relative upstream shifts in the freshwater to oligohaline salinity isopleths.
Coastal Birds	Beach construction activities would temporarily disrupt the foraging and/or roosting activities of coastal birds with O&M maintenance under the NAA. Beach placement would result in the burial and temporary loss of intertidal benthic invertebrate infauna within the beach fill templates.	Channel deepening would not be expected to result in impacts on intertidal or supratidal waterbird habitats under AA1. Beach placement for Oak Island, Caswell Beach, and Bald Head Island would be the same as the NAA. Carolina Beach and Masonboro Island placement would cause additional burial and	Same as AA1.

Resource		Alternatives		
		No Action (NAA)	Action Alternative 1 (Proposed, -47 feet) (AA1)	Action Alternative 2 (-46 feet) (AA2)
			temporary loss of intertidal benthic invertebrate infauna within the beach fill templates, thereby reducing the availability of benthic infaunal prey for shorebirds. The placement of material in and around important bird islands and Masonboro Island would have a short-term negative impact to feeding and roosting birds during construction but with a significant long-term improvement to overall bird habitat by providing resilience to ongoing shoreline erosion.	
Protected Species	Florida Manatee	Under the NAA, there is a low risk of vessel collisions during dredged material transport to ODMDS to the manatee species. Risk would be minimized through implementation of USFWS guidelines for avoiding impacts to manatees in NC waters.	Under AA1, there is risk of injury and/or behavioral effects from confined blasting operations. Risk would be minimized through implementation of a blast mitigation program. Low risk of vessel collisions during dredged material transport to ODMDS. Risk would be minimized through implementation of USFWS guidelines for avoiding impacts to manatees in NC waters.	Under AA2, there is risk of injury and/or behavioral effects from confined blasting operations. Risk would be minimized through implementation of a blast mitigation program. Low risk of vessel collisions during dredged material transport to ODMDS. Risk would be minimized through implementation of USFWS guidelines for avoiding impacts to manatees in NC waters.
Protected Species	Piping Plover and Red Knot	Under the NAA, beach placement would have recurring temporary direct impacts on 3 to 5 miles of intertidal beach foraging habitat and associated benthic infaunal prey resources every two years.	Under AA1, beach placement would have recurring temporary direct impacts on 3 to 5 miles of intertidal beach foraging habitat and associated benthic infaunal prey resources every two years. Minor relative increase in extent of habitat impact during the initial construction beach placement event.	Same as AA1.
Protected Species	Sea Turtles	Beach placement would have recurring temporary impacts on 3	Beach placement would have recurring temporary impacts on 3 to	Same as AA1.

Resource		Alternatives		
		No Action (NAA)	Action Alternative 1 (Proposed, -47 feet) (AA1)	Action Alternative 2 (-46 feet) (AA2)
		to 5 miles of dry beach nesting habitat every two years. Risk of entrainment by hopper dredges during channel maintenance operations. Risk would be minimized through adherence to established hopper dredge environmental work window.	5 miles of dry beach nesting habitat every two years. Minor relative increase in extent of habitat impact during the initial construction beach placement event. Low risk of injury and/or behavioral effects from confined blasting operations. Risk would be minimized through implementation of a blast mitigation program. Risk of entrainment by hopper dredges during construction and maintenance of outer entrance channel. Risk would be minimized through adherence to established hopper dredge environmental work window.	
Protected Species	Magnificent Ramshorn	No effect under NAA, has not been spotted in the study area in 21 years.	Under AA1, historic areas of habitat are not expected to be affected by salinity increase from proposed project. No effect under AA1.	Same as AA1.
Protected Species	Seabeach Amaranth	Recurring beach disposal every two years would have the potential for adverse effects on seabeach amaranth through burial.	Same as NAA.	Same as NAA.
Protected Species	Sea Turtles	The NAA may affect, not likely to adversely affect hawksbill sea turtles. The NAA may affect, likely to adversely affect green, Kemp's Ridley, leatherback, and loggerhead sea turtles.	AA1 may affect, not likely to adversely affect hawksbill sea turtles. AA1 may affect, likely to adversely affect green, Kemp's Ridley, leatherback, and loggerhead sea turtles.	Same as AA1.
Protected Species	Giant Manta Ray	The NAA may affect, not likely to adversely affect the giant manta ray.	AA1 may affect, not likely to adversely affect the giant manta ray.	Same as AA1.

Resource		Alternatives		
		No Action (NAA)	**Action Alternative 1 (Proposed, -47 feet) (AA1)**	**Action Alternative 2 (-46 feet) (AA2)**
Protected Species	North Atlantic Right Whale	The NAA may affect, not likely to adversely affect the NARW.	AA1 may affect, not likely to adversely affect the NARW.	Same as AA1.
Protected Species	Sturgeon	The NAA may affect and is likely to adversely affect shortnose and Atlantic sturgeon.	AA1 may affect, likely to adversely affect both shortnose and Atlantic sturgeon.	Same as AA1.
Aquatic Habitat		Habitat units increase up to 50 to 342% dependent upon sea level change conditions which increase aquatic habitat area.	Habitat units decrease for anadromous fish in their spawning and early life stages. This loss of habitat units ranges from 2.6 - 7.7% in current sea level conditions and 1.5 - 4.7% in future conditions.	Habitat units decrease for anadromous fish in their spawning and early life stages. This loss of habitat units ranges from 1.9 - 6.4% in current sea level conditions and 1.1 - 3.6% in future conditions.
Essential Fish Habitat		Under the NAA, continuing maintenance dredging and placement activities would affect EFH and federally managed fisheries primarily through sediment suspension and soft bottom habitat disturbance. The water column and soft bottom habitats are components of multiple EFH and/or HAPC habitats within the study area including unconsolidated bottom, subtidal and intertidal non-vegetated flats, PNA, and coastal inlets. Temporary increases in suspended sediment concentrations and turbidity along the beach placement areas would have short-term and localized effects on managed species that utilize nearshore unconsolidated bottom and ocean high salinity surf zone EFH habitats, including coastal migratory pelagic	Under the AA1, dredging would cause adverse but not substantial impacts to EFH, specifically estuarine and marine water columns, wetlands, non-vegetated flats, oyster reefs and shell banks, unconsolidated bottom, coastal inlets, and nursery areas. Sediment placement would cause adverse but not substantial effects to estuarine and marine water columns, non-vegetated flats, oyster reefs and shell banks, unconsolidated bottom, coastal inlets, and nursery areas. The proposed mitigation plan would mitigate impacts to wetlands. Benthic recovery in the Wilmington Harbor FNS is estimated to take 6 months to two years, which is relatively brief.	Impacts to EFH under AA2 are similar to those of AA1.

Resource	Alternatives		
	No Action (NAA)	Action Alternative 1 (Proposed, -47 feet) (AA1)	Action Alternative 2 (-46 feet) (AA2)
	species, bluefish, and summer flounder.		
Recreation	NAA would not affect recreation. Regular O&M places material at beaches during the off season, which causes negligible impacts to overall recreation.	AA1 may minorly and temporarily impact recreations at beaches during beach nourishment placement, which would take longer than a typical O&M placement event (under NAA). However, placement would occur on the off-season.	Impacts to recreation under AA2 are similar to AA1, with less impacts to recreation from decreased amount of beach nourishment during the six construction years.
Historical and Cultural Resources	Historic and cultural resources could be impacted by predicted increased erosion on shorelines and riverbanks under the NAA.	AA1 has the potential to adversely affect cultural/historic resources from both direct and indirect project impacts; however, additional surveys are needed to locate potentially significant historic/cultural resources, and to determine the nature and extent of potential effects to them.	Same as AA1.
Socioeconomic Impacts	Socioeconomics would not be impacted under the NAA.	Construction under AA1 would cause short term positive impacts to the local Wilmington economy, but would not impact employment, income, or poverty of the area.	Same as AA1.
Public Health and Safety	The NAA avoids immediate safety risks tied to construction activities for new work; it would not eliminate ongoing and future public and health safety concerns related to O&M dredging.	AA1 involves extensive and continuous construction activities, including blasting or other pretreatment, dredging, and the movement of large volumes of sediment across multiple locations. Construction during dredging and placement could post minimal and temporary threats to the public, but contractors and USACE would follow all safety standards.	Impacts to public health and safety under AA2 are similar to those under AA1 as construction during dredging and placement would occur under similar circumstances.
Invasive Species	Increased vessel calls would result in increased risk due to increases in total hull surface area entering the	Decreased vessel transit would result in decreased risk of invasive species introduction due to decreases in total	Similar to AA1, although reduction of risk due to decreased vessel traffic would be lesser since transportation

Resource	Alternatives		
	No Action (NAA)	**Action Alternative 1 (Proposed, -47 feet) (AA1)**	**Action Alternative 2 (-46 feet) (AA2)**
	harbor and ballast water discharge, along with increased connectivity to other ports. Vulnerability of existing beneficial use sites would continue to be present under existing maintenance operations.	hull surface area entering the harbor and reduced ballast water discharge. Connectivity to other ports would also be reduced. The expansion of beneficial use sites would increase the area of disturbed sites vulnerable to invasive species during maintenance operations. Mitigative wetland restoration measures which would remove the invasive species Phragmites australis from a coastal wetland, reducing the spread of the species in that area.	efficiencies are reduced in comparison.n

4.2 Plan Selection

The primary decision criteria for identifying the National Economic Development (NED) Plan includes reasonably maximizing net benefits while remaining consistent with the Federal objective of protecting the nation's environment. Contributions to NED are increases in the net value of the national output of goods and services, expressed in monetary units. For this analysis, the contributions to NED are the direct net benefits that accrue in the planning area and the rest of the nation. NED benefits were estimated by calculating the reduction in transportation cost at each alternative using the HarborSym Modeling Suite of Tools.

The results of the origin-destination (OD) transportation cost saving benefit analysis are displayed in Table 4-2. As shown, the 47-foot alternative maximizes net NED benefits, but both alternatives are justified based on benefits exceeding costs.

Table 4-2: Benefit Cost Analysis (FY 25Prices, 3.0% Discount Rate)

Cost/Benefit	AA2 -46 FEET	AA1 -47 FEET
AAEQ Benefits	$71,189,000	$83,278,000
AAEQ Costs	$53,561,000	$62,230,000
Incremental AAEQ Costs	$18,174,000	$8,669,000
Net Benefits	$17,628,000	$21,048,000
BCR @ 3.0%	1.3	1.3

Based on cost and benefits analysis, AA1 is the National Economic Development (NED) Plan. Based on the analysis presented earlier sections of this DEIS, no unacceptable environmental impacts were identified for either action alternative, and the environmental impacts are similar in nature and are not out of proportion in magnitude when compared with each other. Additionally, the costs associated with compensatory mitigation for adverse impacts that could not be avoided are included in the cost estimates used above. Considering these results along with the scope and intent of this analysis, as well as its existing conditional authorization, the 47-foot alternative is identified as the NED Plan and the Tentatively Selected Plan.

SECTION 5 – ENVIRONMENTAL LAWS, EXECUTIVE ORDERS AND PRIOR NEPA FINDINGS

In addition to the NEPA of 1969, the actions comprising the TSP are subject to consultation and compliance requirements under a number of other federal laws and their implementing regulations as well as certain Executive Orders (EOs). The following sections summarize relevant requirements and steps that have been or will be taken to meet them.

5.1 Relevant Laws

The following Table 5-1 described the laws relevant to this study and EIS document, and how the proposed plan is or will be in compliance with said law.

Table 5-1: Table of relevant laws.

Law	Relevancy to Project and Compliance
Abandoned Shipwrecks Act of 1987	The Abandoned Shipwreck Act (ASA) of 1987 establishes government ownership over the majority of abandoned shipwrecks located in waters of the United States and creates a framework within which shipwrecks are managed. Cultural resources surveys to determine the presence or absence of abandoned shipwrecks within the project will be conducted to ensure compliance with this Act.
Archaeological and Historic Preservation Act of 1974	This Act requires that Federal agencies provide for "...the preservation of historical and archeological data (including relics and specimens) which might otherwise be irreparably lost or destroyed as the result of...any alteration of the terrain caused as a result of any Federal construction project of federally licensed activity or program". Archaeological surveys will be conducted in order to determine effects to historical and archaeological data present within the project footprint, and to ensure compliance with this Act. Formal consultation with the North Carolina State Historical Preservation Office (SHPO) and North Carolina Office of State Archaeology (OSA) has been initiated and is ongoing. A Programmatic Agreement (PA) is being prepared to define the path forward to meet requirements for resources that have not yet been identified. A draft of the PA is included in in Appendix E.
Clean Water Act (CWA), Sections 404 and 401	Section 404 of the Clean Water Act (33 USC 1344) authorizes the USACE to regulate the discharge of dredged or fill material into waters of the US, including wetlands. Section 401 of the Clean Water Act (33 USC 1341) delegates federal authority to the state to issue 401 Water Quality Certifications for the discharge of dredged and fill material into Waters of the State. Extensive efforts have been undertaken to quantify and address the potential effects of the proposed project on wetlands; including the indirect effects of potential salinity increases in the CFR estuary. The analyses of wetland effects and potential mitigation measures have been coordinated with federal and state resource agencies through the formation of a Tidal Wetlands Technical Working Group.
Coastal Barrier Resources Act	The Coastal Barrier Resources Act (CBRA) of 1982 was enacted to discourage the development of hurricane prone, biologically sensitive coastal barrier islands. This act was later amended in 1990 by Coastal Barrier Improvement Act. The CBRA prohibits most new federal expenditures that encourage or subsidize barrier island development.

Law	Relevancy to Project and Compliance
	The CBRA established the John H. Chafee Coastal Barrier Resource System (CBRS) consisting of barrier islands that are either undeveloped or predominantly undeveloped. The CBRS includes two types of designated units; System Units and Otherwise Protected Areas (OPAs). The CBRS Cape Fear Unit OPA (NC-07P) encompasses the majority of the undeveloped Cape Fear peninsula from Snows Cut to the southern boundary of the Bald Head State Natural Area; including most of the east-facing oceanfront beach between Fort Fisher and Cape Fear and the estuarine marsh and dredged material islands that lie between the peninsula and the federal navigation channel. However, the developed south-facing ocean beaches of Bald Head Island and Oak Island that include beach placement areas are not part of the CBRS. Furthermore, the National Flood Insurance Program (NFIP) is the only type of prohibited federal spending that is applicable to OPAs. Therefore, the proposed action would not result in any federal spending that would affect the CBRS.
Coastal Zone Management Act of 1972	The Coastal Zone Management Act (CZMA) (16 USC 1451 et seq.) established a cooperative program between the federal government and the coastal states for the management and protection of coastal resources. The CZMA is carried out primarily by coastal states through the implementation of federally approved coastal management programs. North Carolina's coastal management program was established by the Coastal Area Management Act (CAMA) of 1974. Federal actions must demonstrate consistency with the key elements of the state's coastal management program; including state coastal management rules and policies established in Chapter 7 of Title 15A of North Carolina's Administrative Corde, the policies set forth in approved local Land Use Plans, and the North Carolina Dredge and Fill Law. The North Carolina Division of Coastal Management is the lead state agency responsible for implementing CAMA and conducting federal action consistency reviews. Compliance with the federal consistency requirements will be achieved through consultation with the North Carolina Division of Coastal Management.
Endangered Species Act	Pursuant to Section 7 of the ESA (16 USC 1536), federal agencies are required to consult with the USFWS and NMFS to ensure that actions they undertake, fund, or authorize are not likely to jeopardize the continued existence of any threatened or endangered species; or result in the destruction or adverse modification of designated critical habitat. The USFWS and NMFS have participated in the analyses of potential impacts on aquatic and terrestrial resources through the Aquatic Habitat and Wetlands/Uniform Mitigation Assessment Method (UMAM) TWGs. Biological Assessments have been prepared to evaluate potential effects of the proposed action on federally listed

Law	Relevancy to Project and Compliance
	threatened and endangered species. The Biological Assessments has been submitted to the USFWS and NMFS to initiate formal consultation pursuant to Section 7 of the ESA.
Fish and Wildlife Coordination Act	The Fish and Wildlife Coordination Act (FWCA) (16 USC 661 et seq.), as amended, requires federal agencies to incorporate fish and wildlife resource conservation into the planning process for water resources development projects that they undertake, fund, or authorize. Section 2(b) of the FWCA requires the federal action agencies for water resource projects to consult with the USFWS and the state fish and wildlife agency (i.e., the North Carolina Wildlife Resources Commission [NCWRC]) to ensure that conservation is fully incorporated. The USFWS and NCWRC are responsible for identifying adverse impacts on fish and wildlife resources and developing recommendations to avoid, minimize, and/or compensate for impacts, which are provided to the action agencies in FWCA reports. The USFWS and NCWRC have participated in the analyses of potential fish and wildlife impacts and the evaluation of potential mitigation measures through the Aquatic Habitat and Wetlands/UMAM, and Beneficial Use of Dredged Material TWGs.
Magnuson-Stevens Fishery Conservation and Management Act	The Magnuson- Stevens Fishery Conservation and Management Act (MSA) (16 USC 1801 et seq.) requires federal agencies to consult with the NMFS to ensure that actions they undertake, fund, or authorize incorporate Essential Fish Habitat (EFH) conservation into the planning process. Essential Fish Habitat is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." Analyses of potential effects on EFH have been coordinated with the NMFS through the Aquatic Habitat TWG. An EFH Assessment report has been prepared that evaluates the effects on EFH and federally managed fisheries (Appendix J). The EFH assessment has been submitted to the NMFS to initiate formal consultation pursuant to the MSFCMA.
Marine Mammal Protection Act of 1972	The Marine Mammal Protection Act (MMPA) (16 USC 1361 et seq.) prohibits the take of marine mammals in United States waters and authorizes programs to conserve, protect, and recover declining marine mammal populations. Although take is generally prohibited, the MMPA makes allowances for limited take through permits and incidental harassment authorizations. The responsibilities for implementing the MMPA are divided between the NMFS (cetaceans and pinnipeds) and the USFWS (manatees, sea otters, and walruses). Channel deepening under the proposed action may require the use of confined blasting as a pretreatment measure to prepare hard rock for removal by dredges. The areas of rock that may require confined blasting are located within an approximately 4-mile

Law	Relevancy to Project and Compliance
	reach of the channel that extends from a point approximately 18 miles above the estuary mouth up to a point approximately two miles below Eagle Island. Due to the potential for manatees and bottlenose dolphins to occur in the vicinity of the blasting areas, an incidental take authorization (ITA) may be required. The development of a site-specific blasting plan will be coordinated with the NMFS and the USFWS to ensure that the potential effects of blasting on marine mammals are minimized to the maximum extent possible. If the need for confined blasting is identified in the Pre-construction Engineering and Design Phase, the USACE will apply for the relevant ITA in that phase and obtain the authorization prior to commencing confined blasting activities.
Marine Protection, Research, and Sanctuaries Act	Under Section 103 of the Marine Protection, Research, and Sanctuaries Act (MPRSA), dredged material that is proposed for ocean placement at the Ocean Dredged Material Disposal Site (ODMDS) would require testing and concurrence from the USEPA prior to transport for disposal. All dredged material placement within the USEPA designated ODMDS would be conducted in accordance with the Wilmington Harbor ODMDS Site Management and Monitoring Plan (SMMP) (USEPA and USACE 2023).
Migratory Bird Treaty Act of 1918	The Migratory Bird Treaty Act (MBTA) (16 USC 703 et seq.) prohibits the take of migratory birds and authorizes the USFWS to implement programs to conserve, protect, and recover declining migratory bird populations. The MBTA does not impose any specific consultation requirements on the federal action agencies; however, compliance with the MBTA will be coordinated with the USFWS through the FWCA consultation process.
National Historic Preservation Act (NHPA) of 1966	Pursuant to Section 106 of the NHPA (16 USC 470 et seq.), federal agencies are required to consider the effects of actions they undertake, fund, or authorize on historic properties that are listed or may be eligible for listing in the NHPA. Federal action agencies are required to consult with the Advisory Council on Historic Preservation, either directly or through State Historic Preservation Offices for the purpose of identifying historic properties potentially affected by the action, assessing the effects, and mitigating adverse impacts. Formal consultation with the North Carolina State Historical Preservation Office (SHPO) and North Carolina Office of State Archaeology (OSA) has been initiated and is ongoing. A Programmatic Agreement (PA) is being prepared to define the path forward to meet requirements for resources that have not yet been identified. A draft of the PA is included in in Appendix E.

Law	Relevancy to Project and Compliance
Native American Graves Protection and Repatriation Act of 1990	This Act applies to federally owned and tribally owned lands, including Reservation lands. No applicable resources are anticipated to be impacted by the proposed action. Additional investigations will be performed during the preconstruction engineering and design phase. If any applicable resources are discovered, appropriate actions will be implemented.
Rivers and Harbors Act of 1899 Section 10	Section 10 of the Rivers and Harbors Act (33 USC 403) authorizes the USACE to regulate work in navigable waters; including construction, excavation, and the deposition of material. The proposed project would not adversely affect the navigable waters of the United States, and would improve the navigability of the existing Wilmington Harbor FNS.
Sunken Military Craft Act of 2004	The Sunken Military Craft Act (SMCA) serves the primary purpose of preserving and protecting all sunken military craft that are owned by the U.S. government, or sunken military craft of foreign governments within U.S. waters from unauthorized disturbance. Pursuant to the SMCA, sunken U.S. military craft remain the property of the U.S. government regardless of their location or the passage of time. In the case of military craft sunk while in service to the Confederate States of America (CSA), the U.S. government maintains ownership as well. Archaeological surveys will be conducted to determine the presence or absence of sunken military craft within the project footprint, and to ensure compliance with this Act.
Submerged Lands Act of 1953	The Submerged Lands Act recognizes the title of the states to submerged lands in navigable waters within their boundaries. Pursuant to North Carolina General Statute 146-12 (Easements in Lands Covered by Water), projects that place certain structures on state-owned submerged lands or place fill in navigable waters to raise state-owned submerged lands above the MHW line require an easement from the North Carolina Department of Administration. The proposed action would not encompass any actions that would require an easement from the NC Department of Administration.

5.2 Executive Orders

Executive Order 11988 (Floodplain Management)

EO 11988 requires federal agencies to avoid, to the extent possible, the long and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. In accordance with FEMA implementing regulations (44 CFR Part 9), the proposed project has undergone an evaluation for compliance with Executive Order 11988 through an 8-Step planning process. It is anticipated that the proposed action will not impact floodplain development or management.

Executive Order 11593 (Protection and Enhancement of the Cultural Environment)

EO 11593 applies to federally and non-federally owned sites, structures, and objects of historical, architectural, or archaeological significance. Archaeological surveys will be conducted to determine the presence or absence of sites, structures, and objects of historical, architectural, or archaeological significance, and to ensure compliance with this Executive Order.

Executive Order 13175 (Consultation and Coordination with Indian Tribal Governments)

EO13175 sets forth fundamental principles to guide agencies in formulating and implementing policies that have tribal implications. Pursuant to E.O. 13175, USACE, Headquarters developed a November 1, 2012, Tribal Policy Memorandum, which dictates Federal responsibilities, including Trust Responsibilities, to Federally recognized Tribes. Tribal consultation policy was updated in the December 5, 2023, Tribal Consultation Policy Memorandum signed by the Assistant Secretary of the Army (Civil Works). The Corps will continue to coordinate as required by the E.O. and as specified by Civil Works Tribal Policy Memoranda.

Executive Order 11990 (Protection of Wetlands)

EO 11990 directs all federal agencies to issue or amend existing procedures to ensure consideration of wetlands protection in decision making and to ensure the evaluation of the potential effects of any new construction proposed in a wetland. As described above, the potential effects of the proposed action on wetlands have been evaluated extensively in coordination with federal and state resource agencies.

Executive Order 13112 (Invasive Species)

Executive Order 13112 directs federal agencies to use their authorities to prevent the introduction, establishment, and spread of invasive species. The effects of the proposed action on invasive species have been evaluated. The principal mechanism that could potentially contribute to the introduction and spread of invasive species would be introductions via ship ballast water. However, the proposed action would result in fewer vessels calling on the Port of Wilmington. Therefore, the proposed action would not increase the potential for introductions and would be compliant with EO 13112.

Memorandum on Government-to-Government Regulations with Native American Tribal Governments

Memorandum signed by President Clinton April 29, 1994 directs the heads of executive departments and agencies to operate within a government-to-government relationship with federally recognized tribal governments; consult, to the greatest extent practicable and to the extent permitted by law, with tribal governments prior to taking actions that affect federally recognized tribal governments; assess the impact of Federal Government plans, projects, programs, and activities on tribal trust resources and assure that tribal government rights and concerns are considered during the development of such plans, projects, programs, and activities; take appropriate steps to remove any procedural impediments to working directly and effectively with tribal governments on activities that affect the trust property and/ or governmental rights of the tribes; and work cooperatively with other Federal departments and agencies to enlist their interest and support in cooperative efforts, where appropriate, to accomplish the goals of this memorandum.

Table 5-2 summarizes the proposed plan's regulatory compliance status for applicable statutes discussed above; Table 5-3 summarizes compliance with applicable Executive Orders.

Table 5-2: Status of Environmental Statutory Compliance

Title of Public Law	U.S Code	Compliance Status
Abandoned Shipwreck Act of 1987	43 USC 2101	In progress
Anadromous Fish Conservation Act of 1965, As Amended	16 USC 757 et seq.	Full Compliance
Archeological and Historic Preservation Act of 1974, As Amended	16 USC 469	In progress
Clean Air Act, As Amended	42 USC 7401 et seq.	Full Compliance
Clean Water Act, As Amended	33 USC 1251 et seq.	Full Compliance
Coastal Zone Management Act, As Amended	16 USC 1451 et seq.	Full Compliance
Endangered Species Act of 1973	16 USC 1531	Full Compliance
Estuary Program Act of 1968	16 USC 1221 et seq.	Full Compliance
Farmland Protection Policy Act	7 USC 4201 et seq.	Not applicable
Fish and Wildlife Coordination Act of 1958, As Amended	16 USC 661	Full Compliance
Historic and Archeological Data Preservation	16 USC 469	Full Compliance
Historic Sites Act of 1935	16 USC 461	Full Compliance
Magnuson Fishery Conservation and Management Act – Essential Fish Habitat	16 USC 1801	Full Compliance
Marine Mammal Protection Act	16 USC 1361	In Progress
Marine Protection, Research, and Sanctuaries Act of 1972	Section 103 MPRSA	In Progress
Migratory Bird Treaty Act of 1918	16 USC 7.II.703-723	Full Compliance

Title of Public Law	U.S Code	Compliance Status
*National Environmental Policy Act of 1969, As Amended	42 USC 4321 et seq.	Full Compliance
National Historic Preservation Act of 1966, As Amended	54 USC 306108	In Progress
American Indian Religious Freedom Act of 1978	42 USC 1996	Full Compliance
Native American Graves Protection and Repatriation Act	25 USC 3001 et seq.	In Progress
Submerged Lands Act of 1953	43 USC 1301 et seq.	Full Compliance
Sunken Military Craft Act	10 USC 113 section 1401-1408	In Progress

Table 5-3: Status of Compliance with Executive Orders

Executive Orders	EO Number	Compliance Status
Protection and Enhancement of Environmental Quality	11514	Full Compliance
Protection and Enhancement of the Cultural Environment	11593	Full Compliance
Floodplain Management	11988	Full Compliance
Protection of Wetlands	11990	Full Compliance
Implementation of the North American Free Trade Agreement	12889	Full Compliance
Invasive Species	13112	Full Compliance
Consultation and Coordination with Indian Tribal Governments	13175	In Progress
Memorandum on Government-to-Government Regulations with Native American Tribal Governments	Memorandum	In Progress

5.3 Prior NEPA Documents and Incorporation by Reference

The proposed work would be conducted by dredging and placement methods previously used for construction and maintenance dredging of federally authorized channels in the project area. The environmental acceptability of the work and methods has been addressed in previous NEPA documents that were circulated for public and environmental agency review between 1977 and 2022. These NEPA documents address actions within the greater “Wilmington Harbor” project, which describes the federal navigation channels between the Atlantic Ocean and the northern end of Eagle Island in the Lower Cape Fear River, as well as various placement sites in the surrounding areas. Incorporated by reference, these documents include the following:

a. Maintenance of Wilmington Harbor, North Carolina Final Environmental Impact Statement (FEIS) (U. S. Army Corps of Engineers April 1977)

b. Long-term Maintenance of Wilmington Harbor, North Carolina FEIS. (U. S. Army Corps of Engineers October 1989)

c. Improvement of Navigation, Cape Fear - Northeast Cape Fear Rivers Comprehensive Study, Wilmington, North Carolina, Volumes I, II, and III. Final Feasibility Report, Environmental Impact Statement and Record of Decision (ROD). (U. S. Army Corps of Engineers December 1996)

d. Wilmington Harbor Channel Widening, New Hanover and Brunswick Counties, North Carolina. Final Supplement I to the FEIS and ROD. (U. S. Army Corps of Engineers December 1996)

e. Preconstruction Modifications of Authorized Improvements, Wilmington Harbor, North Carolina. Environmental Assessment and Finding of No Significant Impact (FONSI). (U. S. Army Corps of Engineers February 2000)

f. New Wilmington Ocean Dredged Material Disposal Site Designation. FEIS and ROD. (U. S. Army Corps of Engineers and U.S. Environmental Protection Agency 2001).

g. Continued Construction of Authorized Improvements, Wilmington Harbor 96 Act, Wilmington Harbor. Environmental Assessment and FONSI. (U. S. Army Corps of Engineers August 2012)

h. Eagle Island Improvements, Dike Raise to Elevation 50 Feet, Brunswick and New Hanover Counties, North Carolina. Final Environmental Assessment and FONSI. (U. S. Army Corps of Engineers April 2017)

i. Wilmington Harbor Navigation Improvements, Wilmington, NC. Final Integrated Feasibility Report, Environmental Assessment, and FONSI. (U. S. Army Corps of Engineers October 2018).

SECTION 6 – SUMMARY OF ENVIRONMENTAL COMMITMENTS

To proceed with the proposed modifications of the FNS to AA1, the 47-foot alternative, the USACE will follow the environmental commitments listed below as coordinated with resource agencies:

1. The USACE will abide by the conditions of the resultant NMFS Biological Opinion, and relevant Project Design Criteria (PDC), which will be obtained before construction of the project.

2. The USACE will abide by the USFWS 2017 Statewide Programmatic Beach Placement Biological Opinion, or superseding BO, and 2017 Manatee Guidelines.

    - Beach placement and bird island placement would only occur during the appropriate timeframes for the protection of nesting sea turtles and birds. Work will follow the reasonable and prudent measures, and terms and conditions of the 2017 USFWS Statewide Programmatic BO for all dredging and placement activities. Specifically, an environmental timeframe of **November 16 to April 30** would be observed for all sand placement activities above the MHW line per the Reasonable and Prudent Measure A.3 of the 2017 USFWS Statewide Programmatic Biological Opinion (SPBO). Placement on bird islands will only occur between **September 1 to March 31** to protect bird nesting. Placement onto Masonboro Island beaches would occur only during the aforementioned bird nesting timeframe.

3. The USACE will follow the conditions listed outlined in the North Carolina Division of Coastal Management (NCDCM) Federal Consistency Concurrence, which will be obtained before the construction of the project.

4. The USACE will abide by the conditions of the Section 401 Water Quality Certification, which will be obtained before construction of the project.

5. The USACE will abide by the conditions of the Biological Opinion and Incidental Take Authorization, which will be obtained before the initiation of any underwater blasting activity.

6. The USACE is committed to avoiding impacts to and protecting cultural resources. As such, USACE will abide by the terms and conditions set forth in its *Programmatic Agreement among the USACE, Wilmington District, the North Carolina State Historic Preservation Office, and the General Services Administration Regarding the Wilmington Harbor Improvements Study.* As this agreement is not yet finalized, the terms and conditions are subject to future updates.

    Furthermore, all project specifications include a clause for unanticipated discoveries, consistent with 36 CFR 800.13. This clause states that if, during construction activities, items that may have historic or archaeological origin are observed, such observations are to be reported immediately to the Contracting Officer so that the appropriate Corps staff may be notified. Cease all activities adjacent to the discovery that may result in the destruction of these resources and prevent employees from further removing, or otherwise damaging, such resources. Once reported, Corps staff will initiate coordination with the appropriate federal, tribal and state agencies to determine if archaeological investigation is required. Additional work in the area of the discovery will be suspended at the site until all federal and state regulations have been successfully complied with and the Corps staff members provide further directive. Project activities in the vicinity of the discovery may not resume until the Contracting Officer approves work to proceed.

SECTION 7 – PUBLIC INVOLVEMENT AND COORDINATION

7.1 Summary of Public Outreach

In May 2023, USACE conducted early scoping in accordance with the NEPA; 42 US Code [USC] §4321 et seq. and the Council on Environmental Quality (CEQ) regulations implementing NEPA (40 Code of Federal Regulations [CFR] Part 1500-1508). The purpose of the early public scoping process was to provide information about the project to the public, narrow the scope of analysis to significant environmental issues, gather agency and public input on alternatives and issues of concern, and encourage full and open participation in early scoping for the Draft EIS. Scoping was not only an opportunity for USACE to explain project goals, but also the earliest chance for the public to provide input regarding the "scope" of the issues to be evaluated in the Draft EIS.

In accordance with 40 CFR 1502.4(5)e, the formal beginning of the EIS process began with the publication of the Notice of Intent (NOI) to prepare an EIS. USACE published the NOI for the Wilmington Harbor 403 Project in the Federal Register on June 7, 2024 (89 FR 48602-48603).[9] In compliance with NEPA and USACE policies, input on the proposed project was solicited from the public and other governmental agencies. The public was invited to comment during the scoping process and during public meetings, and comments were solicited during review of this Draft EIS. Appendix O contains public comment summaries and responses.

USACE hosted three (3) in-person public meetings and a series of virtual meetings to provide information to the public regarding the project to encourage and facilitate public participation in the project planning process. Numerous public outreach methods were utilized to advertise these meetings as listed in Table 7-1 Copies of these publications and information sharing tools can be found in Appendix O.

Table 7-1. Public Meetings, Outreach and Publications

Date	Outreach Method
February 16, 2023	Article about the project published in The Star News
March 10, 2023	Article published in WECT News
May 22, 2023	News release for the Early Scoping Public Meeting published and printed in The Star News.
May 23, 2023	Article published in Wilmington Biz
May 30, 2023	Public notice advertising the WH 403 Letter Report and EIS Early Scoping Public Meeting posted on project website and sent via email to over 400 stakeholders
May 30, 2023	Project covered by WECT News during its news hour
May 30, 2023	News release links posted on social media
May 31, 2023	Article published in Port City Daily
June 1, 2023	Article published by WHQR Public Media

[9] https://www.govinfo.gov/content/pkg/FR-2024-06-07/pdf/2024-12577.pdf

Date	Outreach Method
June 6, 2023	Article published in Coastal Review by the North Carolina Coastal Federation
June 13, 2023	Story on the project aired by WECT News
June 14, 2023	Article published in Port City Daily
June 21, 2023	Early Scoping Public Meeting photos and summary posted on social media
June 26, 2023	Notification of the end of the Early Scoping Public Meeting comment period posted on social media
July 20, 2023	Article published in Port City Daily
May 20, 2024	News release for Public Scoping Meeting sent to 14 media contacts, posted onto project website, and copied on Wilmington District's social media sites
June 4, 2024	First round of Virtual Public Meetings posted on social media
June 6, 2024	Media Advisory for Public Scoping Meeting sent to media list
June 7, 2024	NOI Publication
June 7, 2024	Public informational notice distribution via Wilmington District's Regulatory Division mailing list
June 11, 2024	Public Scoping Meeting information post on social media
June 12, 2024	Public Scoping Meeting information post on social media
June 13, 2024	Public Scoping Meeting
June 13, 2024	Video reel with Public Scoping Meeting highlights posted on social media
June 24, 2024	Second round of Virtual Public Meetings posted on social media
January 30, 2025	News release for Public Meeting sent to 14 media contacts, posted on website, and copied on Wilmington District's social media sites
January 31, 2025	Flyers sent to Boys and Girls Club parents to advertise the community meeting
February 13, 2025	Public Meeting at the Boys and Girls Club
February 18, 2025	Social media post about Meeting outcome

Note: Table includes outreach for Early Scoping Public Meeting (June 2023), Public Scoping Meeting (June 2024), Virtual Public Meetings (June 2024), and the Southeastern NC Boys and Girls Club Community Meeting (February 2025)

In addition to the engagement methods identified above, USACE also maintains a project email address and a publicly accessible website that provides project information as well as information about the NEPA process. The email address (WilmingtonHarbor403@usace.army.mil) was established so members of the public can send general inquiries and request to be added to the distribution list. The project email inbox was also used to collect public comments during the comment period.

The project website includes the NOI Public Scoping Meeting materials and provides an opportunity for the public to access information about the proposed project, to submit written comments throughout the preparation of the EIS, and to sign up for the project mailing list. The website will continue to be updated to provide information for the duration of the project. The project website address is: wilmington-harbor-usace-saw.hub.arcgis.com.

7.2 Public Meetings

7.2.1 Early Scoping Public Meeting

USACE hosted an open-house style Early Scoping Public Meeting at Cape Fear Community College on June 13, 2023. The purpose of this meeting was to engage with and inform the public on the development of the WH403 Letter Report and EIS, while also soliciting input and public comments. The venue was selected in part due to proximity to the project and the publics' existing familiarity with this location as the setting where USACE public meetings were historically held for previous projects. The meeting lasted from 4:00 pm to 7:00 pm and was attended by 49 guests who represented individual interests and various organizations.

Copies of the meeting materials such as the Informational Display Boards, Handout, Comment Card and Presentation are included Appendix O. A copy of the video presentation can be found at the following link:

https://www.saw.usace.army.mil/Missions/Navigation/Dredging/Wilmington-Harbor-403-Letter-Report-and-EIS/.

USACE accepted comments via comment card at the public meeting, the USACE Public Comment Tool online, email, U.S. Postal Service, and voicemail during the early scoping comment period, which lasted through June 30, 2023. In addition, USACE surveyed Early Public Scoping Meeting attendees on best practices for advertising in the local area. Results indicated that all forms of outreach (listed in Table 7-1) were effective in some capacity, with the advertisement of the Public Notice noted as the most popular method. Detailed results of this survey are listed in Appendix O.

7.2.2 Public Scoping Meeting

An in-person Public Scoping Meeting was held on June 13, 2024, at the Sunset Park Elementary School in Wilmington, North Carolina. This Americans with Disabilities Act (ADA) compliant venue is located close to the Port of Wilmington, has free parking, and is located approximately 400 feet from the closest transit stop on Carolina Beach Road. It is situated within a residential community surrounded by local commercial and retail sites, which provides convenient access for attendance. Providing local and residents and business access to project information. Accessibility was a specific consideration for this meeting given that six of the census tracts within the study area have greater than 50 percent of residents with income less than the federal poverty rate (U.S. Census ACS 2021 5-Year Estimates).

The open-house style meeting began at 3:00 pm, ended at 7:00 pm, and was attended by 37 guests. After signing in at the Welcome Station, the public received information about the proposed action through a video presentation and interactive stations where mapping exercises and displays were staffed by USACE subject matter experts. Verbal and written comments on the actions, alternatives, and impacts that the EIS should address were solicited. The comment period began June 7, 2024, and ended July 22, 2024. More information on the Public Scoping Meeting, including meeting boards, meeting brochure, virtual meeting presentation slides, public engagement video, and the news release, can be found on the project website and in Appendix O.

7.2.3 Virtual Public Meetings

A series of four topical Virtual Public Meetings were hosted by USACE through Webex from June 4 to June 7, 2024. The intent of the virtual meetings was to give the public a chance to learn about the project and provide feedback to the project team. Each virtual session included standard content relating to the engagement process, project background, and development of alternatives while focusing on one of the topics noted below:

- Plan Formulation, NEPA, Cultural Resources, Social Effects, and Economics
- Ecological Resources (Wetlands, Protected Species, and Habitat)
- Physical Resources (Design, Geotech, Groundwater, Geospatial, Hydrology, and Water Quality)
- Beneficial Use of Dredged Materials

The virtual meetings were scheduled for two hours, and the series was repeated a second time (June 24 to June 28, 2024) for those who could not attend the first series. Every session offered an opportunity for the public to ask questions and provide comments. In total, 133 members of the public participated in the Virtual Public Meetings offered. All meeting information can be reviewed further in Appendix O. Recordings of virtual meetings can be found here:

https://www.saw.usace.army.mil/Missions/Navigation/Dredging/Wilmington-Harbor-403-Letter-Report-and-EIS/

7.2.4 Southeastern NC Boys and Girls Club Community Meeting

On February 13, 2025, USACE partnered with NC State Ports Authority (NCSPA), UNC-Wilmington, and Cape Fear Community College to host a community outreach event at the Boys and Girls Club (BGC) of Southeastern North Carolina. This meeting provided approximately 50 students, who live in communities adjacent to the NCSPA Port of Wilmington, with an overview of the project and potential impacts from the proposed improvements. A secondary goal of the meeting was to introduce BGC students to the various career fields engaged in the planning, designing and constructing of the proposed Wilmington Harbor Channel Deepening Project. The final hour of this community outreach event was open to the public. This meeting was advertised via flyers to BGC parents, informational signage, the BGC website, and USACE social media outlets. Twelve members of the public attended. All meeting information can be reviewed further in Appendix O.

7.3 Agency Consultation and Coordination

As stated above, a NOI to prepare an EIS for the Wilmington Harbor 403 Project was published in the Federal Register June 7, 2024 (89 FR 48602-48603). A Regulatory Public Notice, dated June 7, 2024, was sent to federally recognized tribes, interested stakeholders, elected officials and federal, state, and local agencies. The purpose of the public notice was to inform agencies and other interested parties regarding the proposed action, information about the proposed project, and that an EIS that is being prepared by USACE.

Table 7-2 Scoping Letter Recipient Agencies

Type of Agency / Organization	Scoping Letter Recipient
Federally Recognized Tribe	The Catawba Nation
	United Keetoowah Band of Cherokee Indians
	Eastern Band of Cherokee Indian
State Recognized Tribe	Coharie Tribe
	Haliwa-Saponi Indian Tribe
	Meherrin Indian Tribe
	Occaneechi Band of the Saponi Nation
	Sappony
	Waccamaw Siouan Tribe
Federal Agency	BOEM
	Environmental Protection Agency
	National Marine Fisheries Service
	National Park Service
	U.S. Army Corps of Engineers
	U.S. Fish and Wildlife Service
State Agency **County Government**	NC Department of Environmental Quality (Division of Historical Resources, Division of Parks and Recreation, Division of Coastal Management, Division of Mitigation Services, Division of Water Resources, 401 & Buffer Permitting)
	NC DNCR- Division of Historical Resources
	NC National Heritage Program
	NC Wildlife Resources Commission
	NC Coastal Reserve
Municipality	City of Wilmington
	Fayetteville Public Works Commission
	New Hanover County
	Town of Carolina Beach
	Town of Caswell Beach
	Town of Kure Beach
	Town of Oak Island
	Town of Southport
	Village of Bald Head Island
Non-Profit / Municipality **Non-Governmental Organization**	American River
	Atlantic States Marine Fisheries Commission
	Audubon North Carolina
	Bald Head Island Conservancy
	Cape Fear River Pilots
	Cape Fear River Watch

Type of Agency / Organization	Scoping Letter Recipient
	Fort Caswell
	Moore Charitable Foundation
	NC Coastal Federation
	NC Wildlife Federation
	Southern Environmental Law Center
	The Ferguson Group
	Town of Caswell Beach

A Notice of Availability (NOA) will be published in the Federal Register to formally initiate review of the Draft EIS and Final EIS. USACE Wilmington District will forward local public notices to both the Wilmington's Regulatory Division mailing lists and the project-specific mailing list and will publish meeting announcements through various media outlets. Public meetings will be held during the public review period of the Draft EIS to present the Tentatively Selected Plan (TSP) and solicit comments. There will be a 45-day public review period and a public engagement meeting for the Draft EIS.

7.4 Summary of Agency and Public Input

7.4.1 Early Scoping Public Meeting

USACE received 82 comments from 45 members of the public during the Early Scoping Public comment period (June 13 to June 30, 2023). It should be noted that individuals were permitted to submit comments through multiple means, which resulted in a greater total number of comments compared to the number of commenters. The following federal, state, or local agencies were represented:

- US Environmental Protection Agency
- NC Wildlife Resources Commission
- NC Department of Natural and Cultural Resources
- Village of Bald Head Island
- Town of Kure Beach
- Town of Oak Island

In addition, the following organizations also submitted comments during the comment period:

- Cape Fear River Watch
- UNC Wilmington, Department of Physics & Physical Oceanography
- UNC Wilmington, Department of Biology & Marine Biology
- UNC Wilmington, Department of Earth and Ocean Sciences
- UNC Wilmington, Department of Environmental Sciences
- Audubon North Carolina
- Bald Head Island Conservancy
- North Carolina Coastal Federation
- Southern Environmental Law Center
- The Orton Foundation

As comments were received, USACE cataloged and recorded each one. All original copies, including transcripts of verbal comments, are incorporated into the administrative record for this project. All public comments received are posted in a redacted form to the USACE project website. An estimated 70 percent of comments focused on environmental impacts, with the most frequent comment subcategories including erosion (47 comments), habitat (37), fish and wildlife (36), and saltwater intrusion (28). Detailed information on comments left by the public can be found in the Early Public Scoping Summary Report, Appendix O.

7.4.2 Public Scoping Meeting

USACE received 65 comments from 54 members of the public during the NOI Public Scoping comment period (June 7 to July 22, 2024). The following federal, state, or local agencies attended

- US Fish and Wildlife Service
- National Oceanic and Atmospheric Administration
- Environmental Protection Agency
- Town of Kure Beach

In addition, the following organizations, neighborhoods, or businesses also submitted comments during the comment period:

- University of North Carolina (UNC) Wilmington, Department of Earth and Ocean Sciences
- UNC Wilmington, Department of Environmental Sciences
- Funston Company
- League of Women Voters Lower Cape Fear
- Del Webb Riverlights (neighborhood)
- Audubon North Carolina
- Coastal Plain Conservation Group and Center for Biological Diversity
- Southern Environmental Law Center on behalf of Audubon North Carolina, Cape Fear River Watch, Center for Biological Diversity, CleanAIRE NC, North Carolina Coastal Federation, North Carolina Conservation Network, North Carolina NAACP, and North Carolina Sierra Club
- Bald Head Island Conservancy
- North Carolina Wildlife Federation
- Brooks Law Firm
- Moore Capital Management, LP
- Lower Cape Fear Association

All public comments received were posted in a redacted form to the USACE project website. Similar to the comments from the Early Public Scoping period, an estimated 62 percent of comments focused on environmental impacts, with the most frequent comment subcategories including habitat (23 comments), fish and wildlife (20), saltwater intrusion (14), and erosion (11). Detailed information on comments left by the public can be found in the Public Involvement Summary Report, Appendix O.

7.4.3 Southeastern NC Boys and Girls Club Community Meeting

The following federal, state, or local agencies were represented:

- New Hanover County
- North Carolina Ports Authority

In addition, the following organizations, neighborhoods, or businesses also submitted comments during the comment period:

- Brooks Pierce Law Firm

- Historic Wilmington Foundation
- New Hanover County
- Village of Bald Head Island
- North Carolina Coastal Federation
- Local residents

The intent of the meeting was to increase awareness, provide opportunities for the public to engage with USACE, and to inform the public of upcoming public comment periods. Therefore, no public comments were received with this engagement.

7.5 Summary of Technical Working Groups

7.5.1 Aquatic Habitat Technical Working Group

Early in the study process, USACE along with other Federal, State, and local agencies participated as cooperating agencies based on their jurisdiction by law, or their special expertise with respect to any environmental issue evaluated in this EIS. From 2023-2025, USACE conducted Aquatic Habitat, Wetlands, and Beneficial Use of Dredged Materials technical working group meetings with these cooperating agencies to coordinate model inputs, outputs, and analysis.

A technical working group (TWG) was formed to select methodology for assessing potential project impacts to aquatic habitats. The technical working group contained members from various federal and state agencies and academia. The technical working group contained multiple subject matter experts who provided valuable feedback in ecological model selection and modifications to improve and verify accuracy within the project study area. The TWG contributed through numerous meetings and reviews. More details, including member affiliation and a timeline of coordination events, are available in Appendix N. Table 7-3 lists agency members of the Aquatic Habitat TWG. Table 7-4 lists dates of the TWG meetings, communication and workshops and the communication topics of discussion.

Table 7-3 Aquatic Habitat Technical Working Group Member Agencies and Organization

Type of Agency	Organization
Federal	NMFS Protected Resources Division
	Upper Harbor
	Upper Harbor
	NMFS Habitat Conservation Division
	United States Coast Guard
	US Fish and Wildlife Service
	USACE (SAS, SAW, and ERDC)
State Agency	NC Wildlife Resources Commission
	North Carolina Division of Marine Fisheries
Non-Profit, Municipality, or Non-Governmental Organization	UNC Wilmington

Table 7-4 TWG Meeting Dates and Topics

Date	Communication/ Meeting
October 31, 2023	Ecological Modeling Workshop
December 8, 2023	Atlantic Sturgeon Modeling Discussion
February 9, 2024	Proposed Species Coordination (Email)
May 6, 2024	Species list, model specifics, identification and functional assessment discussion for direct impacts
May 17, 2024	Aquatic Modeling Species Parameters Review (Email)
June 3, 2024	Water Quality model parameters for H.S.I. and Direct Impacts
August 5, 2024	Ecological Modeling Approach and Direct Impacts Methods
November 4, 2024	Habitat Suitability Index Draft Review Planning
November 14, 2024	Habitat Suitability Index Modeling Draft Results Review (In person)
December 2, 2024	Habitat Suitability Index Modeling Draft Results Review 2
January 13, 2025	Habitat Suitability Index Model Draft Results Review 3 and Mitigation Brainstorming Session
February 19, 2025	Mitigation Workshop

7.5.2 Wetlands Working Group

On February 28, 2024, USACE held a meeting with State and Federal agency stakeholders to discuss the use of the Uniform Mitigation Assessment Method (UMAM) to assess project impacts to wetlands and get buy-in on its use. At this time of this meeting, the Wetland TWG had not been established. The TWG Kickoff Meeting was held September 5, 2024, with various State and Federal agency representatives. The TWG meetings were held monthly, culminating in the field work to determine the current functional condition of specific wetland sites within the project area. These wetland sites were identified based on the potential impacts due to salinity changes in the river based on the proposed project. Table 7-5 provides agency members of the Wetlands TWG. Table 7-6 provides dates of the TWG meetings, communication and workshops and the communication topics of discussion.

Table 7-5 Wetlands Technical Working Group Member Agencies and Organization

Type of Agency	Organization
Federal	National Marine Fisheries Service
	Environmental Protection Agency
State Agency	NC Wildlife Resources Commission
	North Carolina Natural Heritage Resources Program
	North Carolina Division of Marine Fisheries
	NCDEQ Division of Water Resources

Table 7-6 Wetlands Technical Working Group meetings and coordination

Date	Communication/ Meeting
February 1, 2024	UMAM Support
February 28, 2024	Wetland Impact Assessment Methodology Discussion
June 13, 2024	Public Open House

Date	Communication/ Meeting
June 4, 2024	Wetland Discussion
September 5, 2024	Wetlands/UMAM TWG Kickoff Meeting
October 17, 2025	Monthly Wetlands/UMAM TWG Meeting
November 5, 2024	Wetlands/UMAM TWG Training Exercise
December 4, 2024	Wetlands/UMAM TWG Field Work
December 17, 2024	Field Work Discussion of UMAM Scores
January 8, 2025	Meeting to Reach Consensus on UMAM Scores
February 13, 2025	Discuss Wetland Impacts Due to Salinity Changes

7.5.3 Beneficial Use of Dredged Materials Technical Working Group

Various stakeholders, agencies, land managers, and beneficial use experts were consulted as a part of the beneficial use of dredged material (BUDM) plan creation for the Wilmington Harbor FNS project. Initial meetings explored types of BUDM opportunities and ideas for the project, whereas later meetings discussed various locations along the Cape Fear River, marshes, and beaches in the area that could benefit in some way from sediment placement. The sites were narrowed down due to feasibility, including cost considerations, environmental concerns, and distance from initial dredging. Participants in the TWG created polygons on an ESRI ArcGIS-maintained website created by USACE with the assistance of USACE members, adding additional details on type of beneficial use, site considerations, and why the site itself would be an appropriate location for BUDM. During the writing of the BUDM appendix, individual stakeholders were contacted for more information regarding specific sites on an as-needed basis. The TWG was consulted throughout the process of writing both the EIS and BUDM appendix (Appendix D) and may be consulted during construction of the various BUDM sites. Table 7-7 provides agency members of the BUDM TWG. Table 7-8 provides dates of the TWG meetings, communication and workshops and the communication topics of discussion.

Table 7-7 Beneficial Use TWG Member Agencies and Organization

Type of Agency	Organization
Federal	National Marine Fisheries Service-Habitat Conservation Division
	National Marine Fisheries Service-Protected Resources Division
	Environmental Protection Agency
	US Fish & Wildlife Service
State Agency	North Carolina (NC) Wildlife Resources Commission
	NC DEQ, Division of Marine Fisheries
	NC Department of Natural & Cultural Resources
	NC DEQ, Division of Water Resources
Non-Profit, Municipality, or Non-Governmental Organization	North Carolina Audubon
	Cape Fear River Watch
	Bald Head Island Conservancy
	North Carolina Coastal Federation
	University of North Carolina-Wilmington

Table 7-8 Beneficial Use TWG meetings and coordination conducted

Date	Communication/ Meeting[1]
May 1, 2024	Virtual workshop to collaborate on BUDM opportunities
May 21, 2024	Discussion on specific BUDM ideas
June 7, 2024	Virtual Meeting Session: BUDM
June 13, 2024	Public Open House
June 28, 2024	Virtual Meeting Session: BUDM
July 3, 2024	Informal resource agency guidance/discussion on BUDM
August 19, 2024	Discussion with NC Division of Marine Fisheries to address direct concerns
August 21, 2024	Discussion with National Marine Fisheries Service-Habitat Conservation Division to address direct concerns

[1]Conferences, meetings, and other collaborative workshops were attended by members of USACE where BUDM projects were discussed; however, the focus of the meetings were not solely for the proposed project.

7.5.4 Cultural Resources Technical Working Group

Multiple individuals representing the North Carolina State Historic Preservation Office (SHPO), the North Carolina Office of State Archaeology (OSA) including its Underwater Archaeology Branch, and North Carolina Historic Sites were consulted regarding potential effects to historic properties and participated in an informational meeting and field site visit on May 20, 2024 with several USACE project delivery team members. During this meeting the USACE briefly summarized study status and shared preliminary data regarding alternatives identification (e.g., proposed revised channel dimensions). The site visit included several historic properties along the banks of the Cape Fear River and in relatively close proximity to the navigation channel including: Brunswick Town / Fort Anderson, Southport Historic District, Fort Johnston, Price's Creek Beacon, Battery Buchanan, The Rocks. Nearby sunken vessels and relative locations were also identified (e.g., *CSS Kate*). Bank erosion and protective measures (e.g., wave attenuators) were observed and discussed in terms of severity, history, and effectiveness. Following this meeting and site visit, the SHPO / OSA provided marine GIS data to the USACE to inform study development and Section 106 considerations. Several locations were discussed as having potential for inclusion in the study's beneficial use of dredged material (BUDM) plan (e.g., Brunswick Town / Fort Anderson, Price's Creek Beacon, The Rocks). Table 7-9 provides agency members of the Cultural Resources TWG. Table 7-10 provides dates of the Cultural Resources TWG meeting.

Table 7-9 Cultural Resources TWG Member Agencies and Organization

Type of Agency	Organization
State Agency	North Carolina (NC) State Historic Preservation Office
	NC Office of State Archaeology
	NC Historic Sites

Table 7-10 Cultural Resources TWG meetings and coordination conducted

Date	Communication/ Meeting
May 20, 2024	Informational meeting and field site visit

SECTION 8 – LIST OF PREPARERS

Table 8.1 below describes the list of prepares of the Wilmington Harbor Deepening EIS and associated appendices. Teams from both USACE Wilmington District and Stantec contributed to the research, writing, and formulation of the project. In addition to the preparers from both entities, members of the TWGs (see Section 7.5) and other USACE members contributed to information gathering, reviewing, and other tasks associated with this EIS.

Table 8.1. List of preparers.

Name	Title	Years of Experience	Degree	Experience/Expertise	EIS Area(s) Authored
US Army Corps of Engineers South Atlantic Wilmington District (USACE SAW)					
Justin Bashaw	Biologist	>15 years	M.S. Marine Biology B.S. Environmental Sciences	Environmental analyses and effects, cultural resources, dredged material placement, public involvement	Cultural Resources, Sediment
Andrew Bazzle	Economist	>10 years	M.A. Economics B.A. Economics	Navigation Economics	Socioeconomics
Noah Clark, EI	Civil Engineer (Coastal)	<5 years	B.S. Coastal Engineering	Coastal Engineering, Wave Mechanics	Sub-appendix Vessel Wake
Stephen Fabian, P.G.	Geologist, Engineering Technical Lead	>5 years	M.S. Geoscience, B.S. Earth Science	Coastal Geologist	Geologic and Geotechnical Appendix, Affected Environments – Public Health and Safety, Sediment, Groundwater
Eric Gasch	Biologist	>20 years	B.S. Biology	NEPA Specialist	Alternatives Analysis
Jeff Groblewski, P.G.	Physical Scientist	>20 years	B.S. Geoscience / Earth Science	Environmental investigation and remediation of contaminated sites	Geologic and Geotechnical Sub-Appendix – HTRW, Affected Environment HTRW
Kurt A. Heckendorf, P.E.	Civil Engineer (Geotechnical)	>20 years	B.S. and M.S. in Civil Engineering	Geotechnical engineering (levees and dams), flood risk management project design, engineer technical lead	Geologic and Geotechnical Sub-Appendix – Cell 1 Slope Stability
Suzanne Hill	Environmental Section Chief	>20 years	M.S. Education, B.S. Watershed Science	NEPA Specialist, Environmental Compliance	Environmental Technical Lead reviewer

Name	Title	Years of Experience	Degree	Experience/Expertise	EIS Area(s) Authored
Trevor Lancaster	Geographer	>15 years	B.A. Geography, Environmental Studies	Geospatial Analysis, Modelling, Production Mapping	Mapping
Lauren Mazzola	Realty Specialist	>5 years	B.S. Economics	Real Estate Planning and Acquisition	Real Estate Plan Appendix, Mitigation
Ryan Mccadden, P.E.	Civil Engineer	>5 years	B.S. Civil Engineering	Dredging and Navigation	Introduction, Engineering Appendix
Grace Maze, PhD	Oceanographer	>10 years	Ph.D. Applied Marine Physics, B.S. Marine Science	Coastal Modeling	Affected Environment, Climate Analysis, Sub-appendix Climate Change
Alexander Metz	Biologist	>5 years	M.S. Environmental Science, B.S. Biology	Ecological modeling and monitoring, NEPA documentation, Geospatial Analysis	Aquatic Habitat, Essential Fish Habitat, EFH Appendix and Aquatic Habitat Appendix
Madison E. Monroe	Biologist	>5 years	M.S. Ecology, B.S. Ecology	NEPA Documentation, Essential Fish Habitat	Essential Fish Habitat
Michael Moran, P.E., T.C.C. E	Cost Engineer	>5 Years	B.S. and M.S. Mechanical Engineering	Costing Engineering - Dredging	Cost Engineering Appendix
Clarissa Murray, P.E.	Lead Civil Engineer (Hydraulics)	> 20 years	B.S., M.S. Civil & Environmental Engineering	Groundwater Modeling, Hydrogeology, Hydraulic Modeling	Groundwater within G&G Appendix and Sub-Appendix
John Policarpo	Physical Scientist	>20 years	B.S. Oceanography	Wetlands biology, NEPA, Beneficial Use of Dredged Materials	Affected Environment Wetlands, Beneficial Use
Mikaila Reynolds	Biologist	>5 years	M.S. Environmental Studies	NEPA, environmental impacts, Beneficial Use of Dredged Materials	Introduction, Alternatives, Affected Environment, Alternatives Summary, Beneficial Use

Name	Title	Years of Experience	Degree	Experience/Expertise	EIS Area(s) Authored
			B.S. Water: Resources, Policy and Management		
Dr. Emily Russ	Research Biologist	>5 years	PhD in Marine, Estuarine and Environmental Science	Ecological modeling, sediment vegetation interactions, coastal vegetation modeling, spatial models	Wetlands Appendix, Aquatic Habitat Appendix
Brian Seymour	Archaeologist	>20 years	M.S. Maritime Archaeology B.A. English	Cultural Resources	Cultural Resources, Programmatic Agreement
Skye Stockel	Biologist	>10 years	B.S. Biology	Environmental Compliance, Marine Biology	Biological Assessment
Andrea Stolba	Program Manager	>20 years	M.F.A. Urban Design, M.A. Historic Preservation, B.S. Veterinary Science	Planning, Urban Design, GIS, Project Management	Introduction, Affected Environment
Bret Walters	Chief of Planning and Environmental Branch	>20 years	B.S. Physics/ Chemistry	Planning, NEPA, and environmental compliance	Introduction, Alternatives, Affected Environment, Alternatives Summary, and Tentatively Selected Plan

Name	Title	Years of Experience	Degree	Experience/Expertise	EIS Area(s) Authored
Stantec					
Jared Anderson	Senior Air Quality Scientist	>20 years	M.S. Environmental Sciences; B. S. Meteorology	Air Quality Permitting	Air Quality
Taylor Asher	Coastal Engineer	10 years	PhD	Numeric Modeling / Coastal Engineering	Wave Transformation
Paul Carroll, PE	Senior Coastal Engineer	20 years	M.S., Civil Engineering	Numeric Modeling / Coastal Engineering	Hydrology, Hydraulics, Coastal Engineering
Emily Chapman	Coastal Engineering Specialist	2 years	M.S. Civil Engineering	Numeric Modeling / Coastal Engineering	Hydrology, Hydraulics, Coastal Engineering
Madison Clapsaddle	Marine Resources Specialist	9 years	B.A. Environmental Science; A.S. Science	Marine Resources, Underwater Acoustics, Permitting and Mitigation	Conceptual Blast Mitigation Plan
Todd DeMunda	Coastal Engineer	20 years	M.S. Coastal Engineering	Numeric Modeling / Coastal Engineering	Tidal and Flooding Impacts
LaTonya Derrick, PhD	Senior Transportation Planner	26 years	PhD, Philosophy - Public Policy & Administration	NEPA, Public Engagement	Public Engagement
Andrea Dvorak-Grantz, AICP	Senior NEPA Transportation Planner	28 years	B.S, Biology M.S., Biology	NEPA documentation, alternatives analysis, impact assessment, public involvement	EIS Compilation, NEPA documentation, Public Involvement Quality Assurance
Gina Geller	Environmental Scientist	8 years	B.S. Environmental Studies: Environmental Policy; Master of Environmental Law and Policy	Permitting compliance	504 Compliance

Name	Title	Years of Experience	Degree	Experience/Expertise	EIS Area(s) Authored
Sarah Kassem	Coastal Engineer	11 years	MS Coastal Engineering	Numeric Modeling / Coastal Engineering	Shoreline Evolution
Chris Lashley	Coastal Engineer	8 years	PhD	Numeric Modeling / Coastal Engineering	Water Quality
Miranda Maldonado	Environmental Project Manager	>20 years	B.S. Ecology and Natural Resource Management	Planning, NEPA, and environmental compliance	QC Review
Luis Maristany	Coastal Engineer	15 years	MS Coastal Engineering	Numeric Modeling / Coastal Engineering	Vessel Wake
Jim Moyer	Associate, Water Resources Engineer	12 years	B.S. Civil Engineering	Stream Restoration, Fish Passage Barrier Mitigation	Mitigation Plan
Todd DeMunda, PE	Principal, Coastal Engineer	20 years	B.S. Ocean Engineering; M.C.E. Coastal Engineering	Numerical modeling, hydrodynamics	Tide/flooding impacts
Melissa Ruiz	Principal, Environmental Scientist	>20 years	B.S. Environmental Studies; B.S. Biological Sciences; Master of Forestry	Natural Resources Assessment, Permitting and Mitigation	Mitigation Plan
Amy Sackaroff, AICP	Senior NEPA Practitioner	24 years	B.S. Environmental Engineering	NEPA documentation, alternatives analysis, impact assessment	EIS Compilation, Quality Assurance
Kelly Swindle	Senior Marine Biologist	18 years	B.S. Biology; Master of Professional Studies: Ecosystem Management and Administration	Natural Resources Assessment, Permitting, NEPA	Aquatic Impacts Assessment

Name	Title	Years of Experience	Degree	Experience/Expertise	EIS Area(s) Authored
Laura Tivilik, PE (KY)	Environmental Engineer	7 years	M.S. Civil and Environmental Engineering	Ecosystem Restoration, Fish Passage Barrier Mitigation	Mitigation Plan
Selina Vinski	Environmental Specialist	7 years	M.S. Environmental Engineering and Science; B.S. Meteorology	Air Quality Permitting	Air Quality
Amanda Voges	Environmental Scientist	10 years	B.S. Environmental Science: Natural Resources Management; M.S. Environmental Studies	Natural Resources Assessment, Permitting and Mitigation	Mitigation Plan
Barbara Wagner, PE	Senior Project Manager	29 years	M.S., Energy and Resources	NEPA documentation, alternatives analysis, impact assessment	EIS Compilation, Quality Assurance
Kun Yang	Coastal Engineer	6 years	PhD	Numeric Modeling / Coastal Engineering	Water Quality
Rachel Zastrow	Coastal Engineer	8 years	B.S. Civil Engineering; M.S. Civil Engineering	Coastal Habitat Restoration, Living Shorelines	Mitigation Plan

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