DRAFT INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

WILMINGTON HARBOR NAVIGATION IMPROVEMENTS

June 2014

US Army Corps of Engineers

Wilmington District

Executive Summary

The Wilmington Harbor Navigation Improvements Study is being conducted as a partial response to the Resolution of the Committee on Transportation and Infrastructure, Docket 2755, dated June 28, 2006.

Wilmington Harbor is an approximately 38 mile navigation channel which begins at the outer ocean bar at the mouth of the Cape Fear River in Brunswick County, NC, and extends up to the City of Wilmington in New Hanover County, NC, where it services the Port of Wilmington. The Port is a major contributor to the economic activity of both counties, moving about 3.5 million tons and $6.4 billion in goods in 2010, and providing $500 million in sales, property, and corporate and personal taxes. Commodities include bulk cargo and containers, with both imports and exports well-represented.

Problems associated with current channel width and alignment affecting navigation efficiency and ship safety were identified by the Port of Wilmington and users of the channel in three areas of Wilmington Harbor 1) the Entrance Channel 2) the Battery Island Turn, and 3) the Anchorage Basin, which is also used as a turning basin. These inefficiencies can result in vessel delays and the associated economic losses. Therefore, the goal of this study is to increase NED benefits at Wilmington Harbor by reducing navigation inefficiencies that are causing delays to current and projected future vessels using the harbor. Objectives were created specific to each of the three problem areas and preliminary alternatives were developed to address the stated problems. These measures underwent an initial screening process based on their viability and practicality, potential environmental impacts, and a rough order of magnitude cost and benefit evaluation. Three measures were carried forward. These measures underwent additional engineering analysis to form the final array of alternatives. They include the re-alignment of the Entrance Channel, Reach 1, the widening of the existing Battery Island Turn (Channel), and the Widening of the existing Anchorage Basin.

The System of Accounts defined by the Principles and Guidelines (para. 1.6.2(c)) was used to compare alternatives. The plans were further compared with the planning opportunities and four formulation criteria suggested by the U.S. Water Resources Council. The criteria are completeness, effectiveness, efficiency, and acceptability. The National Economic Development (NED) Plan was identified as only Alternative 2: the Battery Island Turn, with a benefit-cost ratio of 2.0. However, the Recommended Plan combines both Alternative 1 and 2. In this plan, Alternative 1, the re-alignment of the Entrance Channel, Reach 1, is only a one-time cost savings and thus is not part of the NED plan. Widening the Anchorage Basin was not recommended due to minimal benefits.

The Recommended Plan will realign the Entrance Channel, Reach 1 up to 150 ft to the west of the existing channel, away from the shoal that forms on the east side of the channel. This will result in a onetime reduction in volume dredged during the next regular O&M cycle of the Wilmington Harbor 96 Act, NC Project. The realignment will not reduce the littoral sediment flow into the channel or the rate at which the channel will shoal.

The Recommended Plan will also widen the Battery Island channel to 750 ft, provide a 750-ft wide by about 1,300-ft long cutoff between Battery Island and Lower Swash

channels, and provide additional tapers where Southport and Lower Swash channels join the widened Battery Island channel. These modifications to the existing channel will increase the available turning radius from~2,850 ft to ~3,900 ft.

The project first cost of the cost for the Recommended Plan is $14,652,000. Under current cost sharing requirements, the Federal and Non-Federal cost shares are $10,989,000 and $3,663,000, respectively. There is no cost associated with the modification to the entrance channel as the cost would fundamentally be the routine O&M cost already associated with the channel maintenance. For the first dredging cycle, there would be a onetime cost savings to the Wilmington Harbor 96 Act Project O&M of approximately $2,364,790 as a result of decreased quantities of sediment requiring removal to achieve authorized channel depth. As a result, there is no B/C ratio associated with the Entrance Channel, Reach 1. The Battery Island Turn increment of the Recommended Plan provides over $1.2 million in average annual benefits at an average annual preliminary cost of $631,289 for a B/C ratio of 2.0. There are no expected negative impacts to the environment or cultural resources resulting from the Recommended Plan, and no additional real estate required. Further, all Recommended Plan features would be maintained by the Federal government after construction.

It is the recommendation of the Wilmington District that both components be implemented under existing Wilmington Harbor 96 Act, NC authority.

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List of Acronyms

AB	Anchorage Basin
AIWW	Atlantic Intracoastal Waterway
APE	Area of Potential Effect
AST	Aboveground Storage Tank
BI	Battery Island
BH	Baldhead
BOEM	Bureau of Ocean Energy Management
B/C	Benefit/ Cost Ratio
CBRA	Coastal Barrier Resources Act
CBRS	Coastal Barrier Resources System
CCA	Chromated Copper Arsenate
CDF	Confined Disposal Facility
CERCLIS	Comprehensive Environmental Response, Cleanup, Liability Information System
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CY	Cubic Yards
CORRACTS	Corrective Action Sites
CSDR	Coastal Storm Damage Reduction
DMMP	Dredged Material Management Plan
DOI	Department of the Interior
DWT	Dead Weight Tons
EA	Environmental Assessment
EC	Entrance Channel
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
ENR	Engineering News Record
EM	Engineering Manual
EQ	Environmental Quality
ESA	Endangered Species Act
FMC	Fishery Management Council
FT	Foot or Feet
FUDS	Formerly Used Defense Site
HAPC	Habitat Areas of Particular Concern
HTRW	Hazardous, Toxic, and Radioactive Waste
IC	Institutional Controls
IDC	Interest During Construction
LPP	Locally Preferred Plan
LUST	Leaking Underground Storage Tank
MAFMC	Mid-Atlantic Fishery Management Council
MANLAA	May Affect Not Likely to Adversely Affect
Mg/l	Milligrams Per Liter
MLLW	Mean Lower-low Water
MLW	Mean Low Water
MMS	Minerals Management Service
MOTSU	Military Ocean Terminal Sunny Point
MPRSA	Marine Protection, Research, and Sanctuaries Act
MSFCMA	Magnuson-Stevens Fishery Conservation and Management Act

NA	No Action
NC	North Carolina
NCARP	North Carolina Artificial Reef Program
NCDEM	North Carolina Department of Environmental Management
NCDENR	North Carolina Department of Environmental and Natural Resources
NCDWR	North Carolina Division of Water Resources
NCNHP	North Carolina Natural Heritage Program
NCWRC	North Carolina Wildlife Resources Commission
NE	No Effect
NED	National Economic Development
NEPA	National Environmental Policy Act
NGVD	National Geodetic Vertical Datum
NMFS	National Marine Fisheries Service
NPL	Federal National Priorities
NS	Nonstructural
NTU	Nephelometric Turbidity Units
O&M	Operations and Maintenance
ODMDS	Ocean Dredged Material Disposal Site
OPA	Otherwise Protected Area
OSE	Other Social Effects
PCP	Pentachlorophenol
PAH	Polynuclear Aromatic Hyrdocarbon Compounds
PNA	Primary Nursery Areas
PSU	Practical Salinity Units
RCRA	Resource Conservation and Recovery Act
RED	Regional Economic Development
ROM	Rough Order of Magnitude
SAFMC	South Atlantic Fishery Management Council
SAV	Submerged Aquatic Vegetation
SIP	State Implementation Plan
SLC	Sea Level Change
SMART	Specific, Measurable, Attainable, Risk Informed, Timely
SMP	Sand Management Plan
SNHA	Significant Natural Heritage Area
SWL	Solid Waste Landfill
TBD	To Be Determined
TEU	Twenty Foot Equivalent Units
TOR	Top of Rock
TSP	Tentatively Recommended plan
UST	Underground Storage Tank
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service
VCP	Voluntary Cleanup Program
WOFES	Wilmington Offshore Fisheries Enhancement Structure

1. STUDY OVERVIEW

This Integrated Feasibility Report and Environmental Assessment (EA) presents the results of studies to reexamine the feasibility of making navigational improvements at Wilmington Harbor, a deep draft navigation channel serving the Port of Wilmington in North Carolina. Wilmington Harbor is shown in Figure 1.1.

1.1 Study Authority

This study is being conducted as a partial response to the Resolution of the Committee on Transportation and Infrastructure, Docket 2755, dated June 28, 2006, which reads as follows:

> *Resolved by the Committee on Transportation and Infrastructure of the United States House of Representatives, that the Secretary of the Army is requested to review the report of the Chief of Engineers on Cape Fear – Northeast (Cape Fear) River, published as House Document 164, 105th Congress, and other pertinent reports to determine whether any modifications of the recommendations contained therein are advisable in the interest of navigation improvements and associated water resource development opportunities for Wilmington Harbor, North Carolina.*

1.2 Study Area

The study area includes Wilmington Harbor, the Eagle Island dredged material disposal site, the Wilmington Ocean Dredged Material Disposal Site (ODMDS), and the surrounding affected environment (Figure 1.1). Wilmington Harbor is an approximately 38 mile navigation channel which begins at the outer ocean bar at the mouth of the Cape Fear River in Brunswick County, NC, and extends upwards to the City of Wilmington in New Hanover County, NC, where it services the Port of Wilmington. A full description of the Port of Wilmington is contained in the Economics Appendix (A) of this report. The Port is a major contributor to the economic activity of both counties, moving about 3.5 million tons and $6.4 billion in goods in 2010, and providing $500 million in sales, property, corporate and personal taxes (http://files.www.ncmaritimestudy.com/outreach/NC_Maritime_Strategy_working_draft_2012-02-15.pdf). Commodities include bulk cargo and containers, with imports and exports both well-represented. The authorized depth of the channel is 44 ft (MLLW) at the ocean bar and entrance channel, then 42 ft for the channel up to the Cape Fear Memorial Bridge. In the last couple miles of the project, upstream of the bridge, the authorized depth decreases to 38 ft and then 34 ft. This final upstream segment is the only portion of the channel that has not been constructed (dredged) to the authorized depth, due to lack of users. Channel widths outside of the Anchorage Basin range from 200 ft at the north end of the project, to 900 ft at the entrance channel. The Anchorage Basin has a maximum width of 1,200 ft.

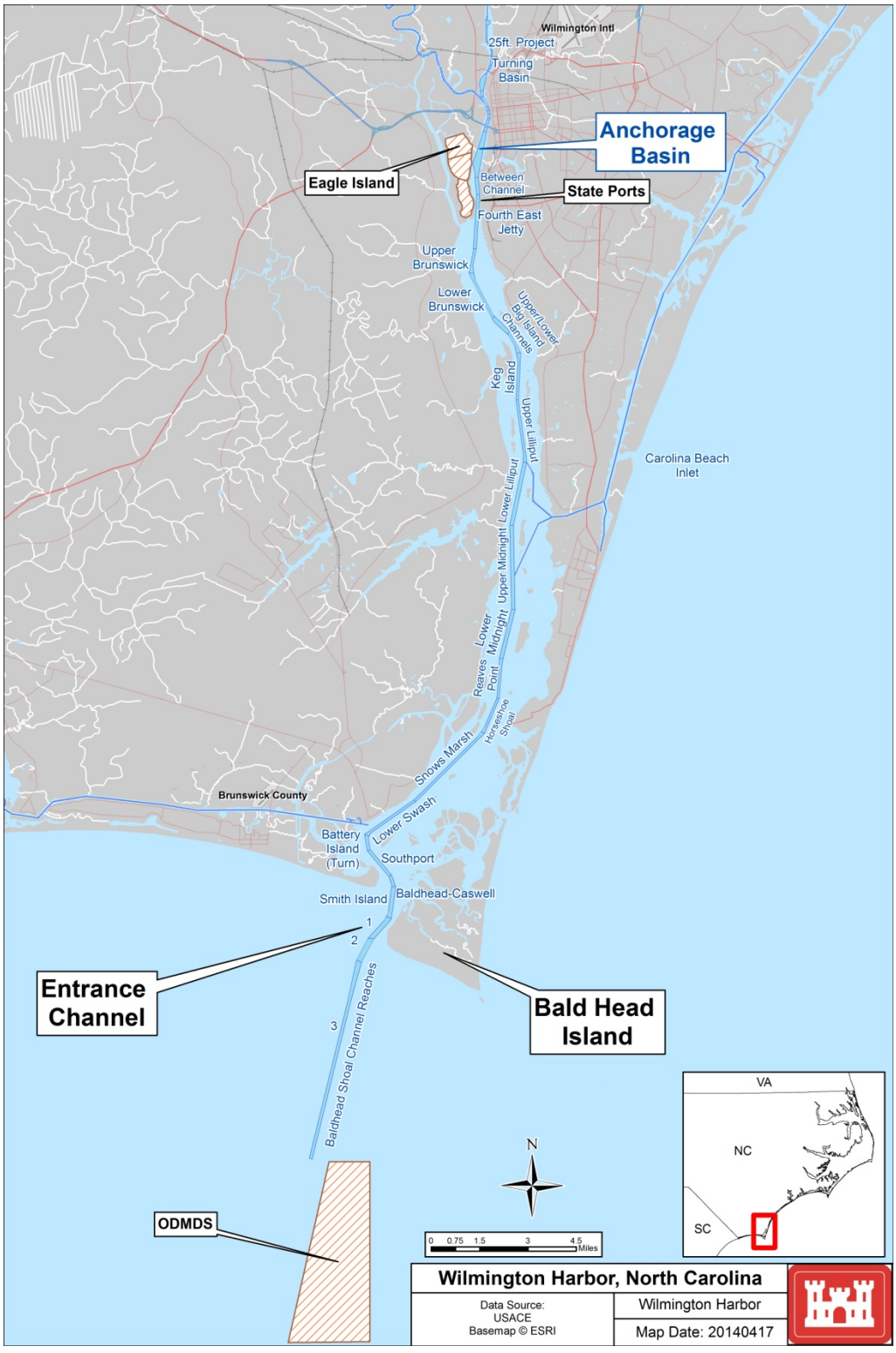

Figure 1.1. Study Area Map

1.3 Study Purpose and Need

Deep draft navigation channel improvements are needed to achieve economic efficiencies and safety for ships currently calling and projected to call on the Port. Three areas for improvement have been identified and are being addressed in this study: the Entrance Channel, Battery Island Turn, and the Anchorage Basin (Figure 1.1).

1.4 Scope of Study

This study consists of the analysis of measures and alternatives to select the plan with the highest net National Economic Development (NED) benefits for deep draft navigation improvements at Wilmington Harbor that is consistent with protecting the nation's environment, or otherwise determine that no plan of improvement is justified under current planning criteria and policies. The study focuses on improvements at three specific areas of Wilmington Harbor: the Entrance Channel, Reach 1 located near Bald Head Island, the Battery Island Turn, and the Anchorage Basin at Wilmington. These areas are discussed in more detail later in this report.

1.5 Design Vessel

The term "Design Vessel" refers to the largest vessel considered likely to call at the Port of Wilmington on a regular basis. In order for the Port to operate safely and efficiently, channel dimensions must accommodate this vessel with adequate clearances. In considering this plan for the improvement to the Wilmington Harbor channel, a vessel 965 ft in length, with a beam of 106 ft, and a draft of 38-40 ft was considered; this is the same design vessel used in the Wilmington Harbor 96 Act Project.

1.6 Study Process

The USACE studies for water and related land resources follow detailed guidance provided in the Planning Guidance Notebook (Engineer Regulation 1105-2-100). This guidance is based on the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies that were developed pursuant to section 103 of the Water Resources Planning Act (P.L. 89-80) and Executive Order 11747, which were approved by the U.S. Water Resources Council in 1982 and by the President in 1983. A defined six-step process is used to identify and respond to problems and opportunities associated with the Federal objective and specific state and local concerns. The six steps are as follows:

Step 1: Identify Problems and Opportunities

Step 2: Inventory and Forecast Conditions

Step 3: Formulate Alternative Plans

Step 4: Evaluate Alternative Plans

Step 5: Compare Alternative Plans

Step 6: Select Recommended Plan

The process involves an orderly and systematic approach to making evaluations and decisions at each step so that the public and the decision makers can be informed of basic assumptions made, the data and information analyzed, risk and uncertainty, the reasons and rationales used, and the significant implications of each alternative plan. The process concludes with the selection of a Recommended Plan. Specific aspects of the process are described in more detail in other sections of this document.

This study is being conducted utilizing the USACE SMART Planning principles and process (http://planning.usace.army.mil/toolbox/smart.cfm).

1.7 Prior Studies and Reports

The USACE has conducted a number of prior studies in the Wilmington Harbor area, and has prepared numerous supporting engineering, economic, and environmental reports. Some of the more pertinent reports are listed below:

Wilmington Harbor, Northeast Cape Fear River, General Design Memorandum, Wilmington, District, April 1990. Improvements recommended in this design memorandum were authorized by the Water Resources Development Act of 1986 (P.L. 99-662). The General Design Memorandum recommended widening the Fourth East Jetty Channel on the Cape Fear River from the width of 400 ft to a width of 500 ft, and deepening a portion of the project on the Northeast Cape Fear River from the depths of 32 and 25 ft to 38 ft.

Wilmington Harbor Ocean Bar – General Design Memorandum, Supplement and Environmental Assessment, Wilmington District, September 1993. This report recommended removal of rock in the Wilmington Harbor Ocean Bar (Baldhead Shoal) Channel. The authorized, 40-ft depth was not achieved at the time of project construction (1973).

Final Feasibility Report and Environmental Impact Statement on Improvement of Navigation, Cape Fear – Northeast Cape Fear Rivers Comprehensive Study, Wilmington, North Carolina, June 1996. This report was prepared in final response to a resolution adopted 8 September 1988 by the United States House of Representatives, which directed that the existing Federal project for Wilmington Harbor be reviewed and improvements considered.

Environmental Assessment, Preconstruction Modifications of Authorized Improvements, Wilmington Harbor, North Carolina, February 2000. This EA addressed preconstruction modifications to harbor improvements including Ocean Bar Channel realignment, disposal of dredged sand onto area beaches, rock blasting without air curtains, and a comprehensive dredging and disposal plan. Appendix A of the 2000 EA was a Sand Management Plan (EA SMP), which

addressed disposal issues associated with the Wilmington Harbor Entrance Channel.

Section 905(b) Analysis, Wilmington Harbor Navigation Improvements, New Hanover and Brunswick Counties, North Carolina. This 905(b) (reconnaissance) report was approved by the USACE South Atlantic Division in April 2011, and identifies the federal interest in pursuing this current feasibility study.

These reports, as well as several others, can be accessed from the Wilmington District website, at http://www.saw.usace.army.mil/Wilmington-Harbor/Main.htm.

1.8 Environmental Operating Principles

The USACE Environmental Operating Principles (EOP) were developed to ensure that USACE's missions include totally integrated sustainable environmental practices. The Principles provide corporate direction to ensure the workforce recognized the USACE's role in, and responsibility for, sustainable use, stewardship, and restoration of natural resources across the Nation and, through the international reach of its support missions. More information in the USACE Environmental Operating Principles can be found at: http://www.usace.army.mil/Mission/Environmental/EnvironmentalOperating Principles.aspx.

The Wilmington District is committed to implementing the USACE environmental operating principles. Specifically during the planning process, the project considered the sustainability of both the existing deep-draft navigation project in Wilmington and the natural resources located within and around the channel; the project PDT worked closely with environmental agencies, both State and Federal, to review proposed project requirements and how those requirements will impact the environment and what can be done to mitigate or prevent this from happening, and the USACE considered cumulative impacts in its assessment of the ecological and social value of resources that the project would impact. The project features were designed recognizing the present and expected future status of specific environmental resources, how those resources function in the estuary, and how those resources are influenced by man's activities.

1.9 Existing Federal Projects

The Wilmington Harbor Navigation Channel is a federally authorized and maintained navigation channel. Table 1.1 shows the authorized and currently maintained dimensions of the channel.

Table 1.1. Dimensions of Wilmington Harbor Navigation Channel.

Channel Name From Ocean to Upstream	Channel Length (ft)	Channel Width (ft)	Width[1] at Turning Basin	Maintained Channel Depth[2, 3] (ft)	Authorized Channel Depth + Overdepth
Baldhead Shoal Reach 3	26,658	500 - 900		44	46
Baldhead Shoal Reach 2	4,342	900		44	46
Baldhead Shoal Reach 1	4,500	700 - 785		44	46
Smith Island	5,100	650		44	46
Baldhead-Caswell	1,921	500		44	46
Southport	5,363	500		44	46
Battery Island	2,589	500		44	46
Lower Swash	9,789	400		42	44
Snows Marsh	15,775	400		42	44
Horseshoe Shoal	6,102	400		42	44
Reaves Point	6,531	400		42	44
Lower Midnight4	8,241	600		42	44
Upper Midnight4	13,736	600		42	44
Lower Lilliput4	10,825	600		42	44
Upper Lilliput	10,217	400		42	44
Keg Island	7,726	400		42	44
Lower Big Island	3,616	400		42	44
Upper Big Island	3,533	510 - 700		42	44
Lower Brunswick	8,161	400		42	44
Upper Brunswick	4,079	400		42	44
Fourth East Jetty	8,852	500		42	44
Between	2,827	400		42	44
Anchorage Basin Station 8+00 to 84+81	7,681	550 - 1200	1,200	42	44
Anchorage Basin Station 0+00 to 8+00	3,970	450 - 550		38	44
Memorial Bridge – Isabel Holmes Bridge	9,573	400	850	32	40
Isabel Holmes Bridge - Hilton RR Bridge	2559	200 - 300		32	40
Hilton RR Br. - Project Limit	6,718	200	700	25	36
Total Length in Feet	200,984				
Total Length in Miles	38.1				

[1] Width shown is widest point at basins, and includes the channel width.

[2] Channel depths are at mean lower low water.

[3] Allowable Overdepth is 2 ft

[4] This channel reach included the Passing Lane

2.0 AFFECTED ENVIRONMENT

Although this study is focused on limited areas of Wilmington Harbor, the discussion of the affected environment presented in this Section includes the entirety of Wilmington Harbor (Figure 1.1) and the surrounding area. The existing conditions of significant marine and terrestrial resources of the area are described below.

2.1 Sediments and Erosion

Sediments

Riverine: Sediments of the Wilmington Harbor generally consist of sands, silts, and clays occurring in various mixtures. From the Lower Midnight Channel upstream, the sediments are predominantly silts and clay, and from Reaves Point Channel downstream are predominantly sand, except for the outer Baldhead Shoal Channel which is predominantly silts and clays (Figure 1.1). Occasionally, gravel, shell fragments, limestone fragments, and organic material may also be present. Historically, the silt and clay dredged material has been place in diked upland disposal areas, or placed in the EPA designated Wilmington ODMDS. Sandy materials from the lower harbor are normally placed on nearby beaches. On average, about 2.5 million cubic yards of sediment are removed annually from Wilmington Harbor channel.

The sediments overlie carbonate rocks having different degrees of cementation and hardness. Rock formations that occur in this area, from youngest to oldest, include thin layers tentatively identified as the Waccamaw Formation and the Trent Formation, the extensive Castle Hayne Limestone, and the Peedee Formation. While all these strata are not generally present at any single location, they are represented within the harbor area. The Castle Hayne Limestone is one of the regional groundwater sources for southeastern North Carolina.

The depth of the top of the rock (TOR) varies depending upon the location. Inside the authorized USACE navigation channel (the Anchorage Basin range), the approximate TOR ranges from elevations -44.0 to -55.8 ft MLLW. The assumed TOR values outside of the authorized USACE navigation channel (between the east side of Eagle Island and the west side of the Anchorage Basin range), ranges from elevations -16.1 to -50.9 ft MLLW.

Littoral: The active beach profile, or portion of the nearshore ocean bottom affected by wave action, is comprised of sediments that consist of fine to medium quartz sand, shell hash, silt, and clay. The silt/clay component of the active profile ranges from about 2% to 5% down to about -24 ft NGVD. The predominantly mud bottom seaward of the littoral zone provides valuable habitat for shrimp, which support an important fishery in these waters.

Erosion

Erosion is occurring along Baldhead Island and Oak Island/Caswell beaches. Shoaling patterns in the navigation channel reveal that sediment depositing within the Baldhead Shoal Channel Reaches 1 & 2, nearest to Bald Head Island, comes from that island. Likewise, the shoaling within the Smith Island Range comes from Jay Bird Shoals with its primary source being the Oak Island/Caswell Beaches (USACE 2011). In essence these two littoral systems can be thought of as largely independent. Furthermore, the

shoaling quantities, as measured, are comparable to those originally estimated by the EA SMP (2000) being on the order of 1.0 million cubic yards every two years.

2.2 Water Resources

Hydrology

Tides in the area are semidiurnal and the mean tidal range varies from about 4.9 ft at Bald Head Island to about 1 ft as far upstream as Lock & Dam 1, which is located about 65 miles above the river mouth. Regular reversals of flow occur with each tidal cycle except during periods of high freshwater flow. The salinity of the area varies due to many factors including freshwater inflow, tidal action, and wind. Salinity may range from fresh (0 practical salinity units (psu)) in the upper harbor to seawater (35 psu) in the lower river and nearshore ocean. A psu is a measure of salt content, similar to parts per thousand based on electrical conductivity. The daily average discharge of the Cape Fear River at its mouth is about 9,500 cubic feet per second.

Prior to the last deepening of Wilmington Harbor (2000-2006) there was concern that deepening (by an average of 4 ft) could increase the tidal range and salinity near Wilmington and upstream (USACE 2000). Because of this issue, a 10-year monitoring plan was implemented and included pre, during, and post dredging monitoring. The results indicated no apparent difference in tidal range or salinity as a result of the deepening (USACE 2011).

Water Quality

Three water quality classifications of the State of North Carolina apply to the waters of Wilmington Harbor. The Cape Fear River from the mouth of the Northeast Cape Fear River downstream to a line across the river from Snows Point to Federal Point is classified as "SC"; from this line downstream to the Atlantic Ocean is "SA" (except for an area in the vicinity of Southport that is classified "SC"); and waters of the Atlantic Ocean in the vicinity of the Cape Fear River mouth are classified "SB." "SC" waters are suitable for fishing, fish and wildlife propagation, secondary recreation, and other uses requiring water of lower quality. "SB" waters are suitable for primary recreation in addition to "SC" uses. "SA" waters are suitable for shellfishing for market purposes, as well as "SB" and "SC" uses (15 NC Administrative Code 2B .0311).

According to the NC Division of Water Quality latest ambient monitoring report for the Cape Fear River (NCDWQ 2009), the water quality in Wilmington Harbor generally meets state standards. However occasionally near the mouth of the Brunswick River (Cape Fear River Channel Markers 54, 56, and 61) dissolved oxygen values are below 5 mg/l and pH values are below 6.8.

Groundwater

In the Wilmington Harbor vicinity, groundwater is supplied primarily by two aquifers. In descending order of elevation, they are the water table aquifer of the undifferentiated surficial sands and the Castle Hayne Limestone. Most domestic water wells are set in the surficial sands. Locally, vertical groundwater movement may occur downward through the surficial sand to the Castle Hayne Limestone. Regionally, the horizontal groundwater

movement is eastward with some southeast movement. The resultant groundwater movement is toward the coast.

2.3 Air Quality

The Wilmington Regional Office of the North Carolina Department of Environment and Natural Resources (NCDENR) has air quality jurisdiction for the project area. New Hanover is in "attainment" for all criteria pollutants (Newland per comm. May 22, 2012).

2.4 Marine and Estuarine Resources

Nekton

Nekton collectively refers to aquatic organisms capable of controlling their location through active movement rather than depending upon water currents or gravity for passive movement. Nekton of the nearshore Atlantic Ocean along southeastern North Carolina can be grouped into three categories: estuarine dependent species; permanent resident species; and seasonal migrant species. The most abundant nekton of these waters is the estuarine dependent species which inhabit the estuary as larvae and the ocean as juveniles or adults. This group includes species which spawn offshore, such as the Atlantic croaker (*Micropogon undulatus*), spot (*Leiostomus xanthurus*), Atlantic menhaden (*Brevoortia tyrannus*), star drum (Stellifer lanceolatus), southern kingfish (Menticirrhus americanus), flounders (*Paralichthys* spp.), mullets (*Mugil* spp.), anchovies (*Anchoa* spp.), blue crab (*Callinectes sapi*dus), and penaeid shrimp (*Penaeus* spp.), as well as species which spawn in the estuary, such as red drum (*Sciaenops ocellatus*) and weakfish (*Cynoscion regalis*). Species which are permanent residents of the nearshore marine waters include the black sea bass (*Centropristis striata*), longspine porgy (*Stenotomus caprinus*), Atlantic bumper (*Chloroscombrus chrysurus*), inshore lizardfish (*Synodus foetens*), and searobins (*Prionotus* spp.). Common warm water migrant species include the bluefish (*Pomatomus saltatrix*), Spanish mackerel (*Scomberomorus maculatus*), king mackerel (*Scomberomorus cavalla*), cobia (*Rachycentron canadum*), Florida pompano (*Trachinotus carolinus*), and spiny dogfish (*Squalus acanthias*).

The surf zone along the area beaches provides important fishery habitat. Surf zone fisheries are typically diverse, and 52 species have been identified from North Carolina (Ross 1996, Ross and Lancaster 1996, Hackney et al. 1996). Some species may be dependent upon surf zone habitat. Studies indicate that juveniles of certain species may have high site fidelity and extended residence time in the surf zone suggesting its function as a nursery area (Ross and Lancaster 1996). Two species in particular, the Florida pompano and gulf kingfish (*Menticirrhus littoralis*) seem to use the surf zone exclusively as a juvenile nursery area.

Anadromous species such as blueback herring (*Alosa aestivalis*), American shad (*Alosa sapidissima*), hickory shad (*Alosa mediocris*), alewife (*Alosa pseudoharengus*), striped bass (*Morone saxatilis*), the endangered Atlantic sturgeon (*Acipenser oxyrhynchus*), and the endangered shortnose sturgeon (*Acipenser brevirostrum*), pass through the nearshore ocean and Cape Fear estuary en route to upper river spawning and nursery areas (Walburg and Nichols 1967, Nichols and Louder 1970, Moser and Ross 1993). Anadromous fish use is highest from mid-winter to mid-spring. The catadromous

American eel (*Anguilla rostrata*), is widely distributed in the Cape Fear River estuary and migrates through the area of the bar channel (Schwartz et al. 1981).

Marine mammals also occur in North Carolina's coastal waters. The Federally-endangered right whale (*Eubaleana glacialis*) and humpback whale (*Megaptera novaeangliae*) are spring and fall migrants off the coast; and the right whale often occurs in shallow water. A number of other whale and dolphin species normally inhabit deeper waters offshore, while the bottlenose dolphin (*Tursiops truncatus*) and the harbor porpoise (*Phocoena phocoena*) utilize nearshore waters. The bottlenose dolphin is common in the project area. The Federally-endangered manatee (*Trichechus manatus*) is a rare visitor, and several sightings have been documented in the project area.

Three species of sea turtles are known to nest on the beaches of North Carolina near the mouth of the Cape Fear River and also, occasionally, enter the lower Cape Fear estuary. These include the Federally-endangered Kemp's ridley sea turtle (*Lepidochelys kempii*) and the Federally-threatened green (*Chelonia mydas*) and loggerhead (*Caretta caretta*) sea turtles. These are discussed in Section 2.08 Endangered and Threatened Species.

Eight artificial reefs that provide habitat for fish, are located off Brunswick County. These reefs are managed by the State of North Carolina Artificial Reef Program (NCARP). Six of these reefs occur within about 15 miles of the existing Baldhead Shoal Channel. However, all these sites are located between 1 and 10 miles offshore and are in water about 30 to 53 ft deep. None are in proximity to the proposed work.

Primary Nursery Areas

The State of North Carolina defines Primary Nursery Areas (PNAs) as tidal saltwaters which provide essential habitat for the early development of commercially important fish and shellfish. It is in these estuarine areas that many fish species undergo initial post-larval development. PNAs are designated by the North Carolina Marine Fisheries Commission. Neither the ocean bar channel nor the navigation channel near Southport are located within a designated PNA (15 NC Administrative Code 3B .1405). Within the Cape Fear River portion of the harbor, PNAs occur from Upper Lilliput Channel upstream to the end of the project. They are located from the shoreline to 300 yards outside the harbor channel from Upper Lilliput Channel to Upper Brunswick Channel, inclusive. Upstream from that point, PNAs extend from the river shoreline to the edge of the harbor channel. This is the case adjacent to the existing Anchorage Basin near the State Ports.

Benthos

Aquatic organisms that live in close association with the bottom, or substrate, of a body of water, are collectively called the benthos. Benthic communities of the project area exhibit a wide range of organism composition and density, and community structure may vary considerably depending on substrate type and salinity regime.

Benthic organisms in this area of the nearshore ocean were reported by Birkhead et al. (1979) at densities ranging from about 90 individuals per square meter on sand bottom to over 500 per square meter on mud substrate. This study found the tube dwelling polychaete, *Spiophanes bombyx*, to be the dominant component of the benthos collected from a spot off the eastern end of Oak Island and other locations where substrates were predominantly mud or mud-sand mixtures. Other dominants reported from this marine area

included several polychaete worms (*Magelona* sp., *Heteromastus filiformis*, and *Paraprionospio pinnata*); the sea pansy (*Renilla reniformis*); and an unidentified brittlestar (amphiurid). Additional taxa reported in high numbers included the sand dollar (*Mellita quinquiesperforata*) and other polychaete worms (*Diopatra cuprea* and *Nephtys picta*). Similar findings were reported by Versar, Inc (2002).

Lawler, Matusky & Skelly Engineers (1975) conducted a benthic investigation at six stations ranging from near the mouth of the Cape Fear River up to the mouth of Smith Creek in the Northeast Cape Fear River. Polychaetes dominated the benthic fauna below Military Ocean Terminal Sunny Point (MOTSU). Of the 21 species collected, only five species occurred above Lower Lilliput channel and only one species at Smith Creek. Species included *Scolecolepides virdis, Capitella capitata, Branchioasylis americana, Drilonerea longa* and *Nerea succinea*. Oligochaetes were the most abundant group in the entire river, comprising 35 percent of all collected fauna. They were most abundant from Campbell Island upstream to the Anchorage Basin. Amphipods (*Gammarus* spp.) occurred in all samples but were most abundant near MOTSU, the Anchorage Basin and at Smith Creek. Other common species collected were Cumaceans and Isopods. Similar results were found by Ray (1996).

The NC Division of Environmental Management performed benthic sampling at Snows Marsh in 1985. Of the 38 species collected, polychaetes, molluscs, amphipods, and decapods dominated the site (NCDEM unpublished data). Sediments ranged from coarse sand to fine silty clays. Common species collected were polychaete worms (*Leitoscoloplos variabilis* and *Paraprionospio pinnata*) and molluscs (*Ilyanassa obsoleta* and *Crassostrea virginica).*

Shellfish beds are present in the Cape Fear Estuary, primarily south of Snows Cut (Woodward-Clyde Consultants 1980). All significant beds are in shallow water east of the navigation channel. The dominant species are the eastern oyster (*Crassostrea virginica*) and the clam (*Mercenaria mercenaria*).

Intertidal Macrofauna

Intertidal portions of ocean beaches are inhabited by a number of invertebrate species which are ecologically important. These include mole crabs (*Emerita talpoida*) and coquina clams (*Donax* spp.), as well as various species of polychaete worms and amphipods. Mole crabs and coquinas represent the largest component of the total macrofaunal biomass of North Carolina intertidal beaches, and they are consumed in large numbers by important fish species such as flounders, pompanos, mullets, and kingfish (Reilly and Bellis, 1978, Hackney et al. 1996, Versar 2002). Beach intertidal macrofauna are also a seasonally important food source for numerous shorebird species. Abundance of intertidal macrofauna can be influenced by man's alteration of the beach environment through activities such as (1) beach scraping and dune shaping with heavy equipment and (2) beach placement of dredged sand.

2.5 Essential Fish Habitat and State Managed Fish Species

Table 2.1 lists, by life stages, fish species which may occur in the vicinity of Wilmington Harbor, and for which Fishery Management Plans (FMPs) have been developed by the

South Atlantic Fishery Management Council (SAFMC), Mid-Atlantic Fishery Management Council (MAFMC), and NMFS. These fish species and habitats require special consideration to promote their viability and sustainability.

Table 2.2 list categories of EFH and Habitat Areas of Particular Concern (HAPC) for managed species that were identified in the FMP Amendments affecting the South Atlantic area. HAPC's are subsets of EFH which are rare, particularly susceptible to human-induced degradation, especially ecologically important, or located in an environmentally stressed area. No HAPCs are located in the vicinity of Wilmington Harbor. EFH categories in Wilmington Harbor are indicated by an * in Table 2.2.

Table 2.1. Essential Fish Habitat species in the Wilmington Harbor

Common Name	Scientific Name	Life Stage
INVERTEBRATES		
Brown shrimp	*Farfantepenaeus aztecus*	LJA
White shrimp	*Litopenaeus setiferus*	LJA
Pink shrimp	*Farfantepenaeus duorarum*	LJA
COASTAL DEMERSALS		
Red drum	*Sciaenops ocellatus*	ELJA
Bluefish	*Pomatomus saltatrix*	JA
Summer flounder	*Paralichthys dentatus*	LJA
COASTAL PELAGICS		
Spanish mackerel	*Scomberomorus maculatus*	JA
King mackerel	*Scomberomorus cavalla*	JA
Cobia	*Rachycentron canadum*	JA
SNAPPERS/GROUPERS		
Black sea bass	*Centropristis striata*	J
Rock sea bass	*Centropristis philadelphica*	J
Gag grouper	*Mycteroperca microlepis*	J
Red grouper	*Epinephelus morio*	J
Black grouper	*Mycteroperca bonaci*	J
Lane snapper	*Lutjanus synagris*	J
Mutton snapper	*Lutjanus analis*	J
Gray snapper	*Lutjanus griseus*	J
Yellow jack	*Carangoides bartholomaei*	J
Blue runner	*Caranx crysos*	J
Crevalle jack	*Caranx hippos*	J
Bar jack	*Caranx ruber*	J
Atlantic spadefish	*Chaetodipterus faber*	J
Sheepshead	*Archosargus probatocephalu*	JA
SHARKS		
Smooth dogfish	*Mustelus canis*	J
SMALL COASTAL SHARKS		
Atlantic sharpnose shark	*Rhizoprionodon terraenovae*	JA
Finetooth shark	*Carcharhinus isodon*	JA
Blacknose shark	*Carcharhinus acronotus*	JA
Bonnethead shark	*Sphyrna tiburo*	JA
LARGE COASTAL SHARKS		
Silky shark	*Carcharhinus falciformis*	JA
Tiger shark	*Galeocerdo cuvieri*	JA
Blacktip shark	*Carcharhinus limbatus*	JA
Spinner shark	*Carcharhinus brevipinna*	JA
Bull shark	*Carcharhinus leucas*	JA
Lemon shark	*Negaprion brevirostris*	JA
Nurse shark	*Ginglymostoma cirratum*	JA
Scalloped hammerhead	*Sphyrna lewini*	JA
Great hammerhead	*Sphyrna mokarran*	JA
Smooth hammerhead	*Sphyrna zygaena*	JA

Legend: E, Egg; L, Larval; J, Juvenile; A, Adult
Source: Habitat Protection Division, Pivers Island, NC

Table 2.2. Categories of EFH and HAPC identified in FMP Amendments affecting the South Atlantic.

EFH	GEOGRAPHICALLY DEFINED HAPC
Estuarine Areas	**Area-wide**
Estuarine Emergent Wetlands*	Council-designated Artificial Reef Special Management Zones
Estuarine Scrub/Shrub Mangroves	Hermatypic (reef-forming) Coral Habitat & Reefs
Submerged Aquatic Vegetation (SAV)	Hard Bottoms
Oyster Reefs & Shell Banks*	Hoyt Hills
Intertidal Flats*	*Sargassum* Habitat
Palustrine Emergent & Forested Wetlands	State-designated Areas of Importance for Managed Species
Aquatic Beds	Submerged Aquatic Vegetation
Estuarine Water Column*	
Seagrass	
Creeks	
Mud Bottom	
Marine Areas	**North Carolina**
Live/Hard Bottoms	Big Rock
Coral and Coral Reefs	Bogue Sound
Artificial/Man-made Reefs	Pamlico Sound at Hatteras/Ocracoke Islands
Sargassum	Capes Fear, Lookout, & Hatteras (sandy shoals)
Water Column*	New River
	The Ten Fathom Ledge
	The Point

In addition, the state of North Carolina has prepared Fishery Management Plans (FMP's) for several fish species that utilize resources within the study area. These species include striped mullet, spotted trout, southern flounder, sea mullet (kingfish) (3 species), striped bass, and red drum. Of these species, the red drum is also federally managed by the SAFMC. All of these species use the study area during a portion of their life cycle.

2.6 Terrestrial Resources

Terrestrial areas that may be influenced by the new proposed actions include the Eagle Island Confined Disposal Facility (CDF), Battery, Ferry Slip, South Pelican, and Striking Islands, and ocean beaches of Bald Head Island and Oak Island/Caswell Beach (Figure 2.1).

Figure 2.1 Lower Wilmington Harbor.

The Eagle Island CDF (Figure 1.1), located across the river from downtown Wilmington, is the largest existing upland disposal site for Wilmington Harbor. The portion used for disposal is approximately 880 acres and is dominated by a monoculture of common reed (*Phragmites australis*). This portion has marginal value to wildlife, but surrounding areas with tree and shrub cover provide important habitat for small mammals and songbirds. Linear borrow pits along the dike interior provide fresh water during most of the year, and are utilized by waterfowl, migrating shorebirds, and alligators. Along the Cape Fear and Brunswick Rivers, mixed marsh and expanses of smooth cordgrass (*Spartina alterniflora*) are common.

Battery Island is a natural island in the Cape Fear River near Southport. The location provides nesting habitat for wading birds in the red cedars (*Juniperus virginiana*), yaupon (*Ilex vomitoria*), and other shrubs on the island. Battery Island supports North Carolina's largest colony of wading birds, including approximately 10 percent of North America's White Ibises. The riverside beachfront provides nesting habitat for American Oystercatchers (*Haematopus palliatus*), and the grassy uplands support nesting for willets (*Catoptrophorus* sp.). The island is managed by the Audubon and is posted and patrolled throughout the nesting season to prevent disturbance to nesting birds. Human disturbance can result in egg or chick loss, nest abandonment, and colony abandonment.

Ferry Slip and South Pelican Islands are small dredged material disposal areas in the lower river that are not diked and are also managed by Audubon 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. As with Battery Island, 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. Most of this information on these Audubon managed islands was obtained from their webpage http://iba.audubon.org.

Striking Island is an important foraging site for wading birds from the nearby Battery Island Audubon Sanctuary. The site supports nesting Laughing Gulls (*Leucophaeus atricilla*), American Oystercatchers, Willets, and Clapper Rails (*Rallus longirostris*). Striking Island is a natural marsh island and consists primarily of intertidal and high saltmarsh with small islands of upland washed oyster shell banks, shrubs and grassy areas. (http://iba.audubon.org.)

Among North Carolina's upland habitats, the beach and dune community could be considered depauperate in both plants and animals. 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*).

North Carolina beaches offer valuable habitat for shorebirds, and use by these birds can be extremely heavy during migration periods. However, the value of project area beaches for shorebirds may have declined over time due to continued development, high public use, and man's disturbance through activities such as beach scraping with heavy equipment, which may deplete supplies of intertidal invertebrates that are important food sources for shorebirds. Dunes of the project 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.

2.7 Wetlands and Flood Plains

Coastal wetlands of the vicinity include tidal salt marshes which occur along the shorelines and the island fringes of the lower Cape Fear River. These marshes are comprised mainly of smooth cordgrass and are generally more extensive where they are more protected from wind and wave action. Intertidal wetlands of the area are very important ecologically due to their high primary productivity, their role as nursery areas for larvae and juveniles of many marine species, and their refuge/forage value to wildlife. In addition, they provide esthetically valuable natural areas. Non-tidal wetlands consisting of monotypic stands of the invasive plant, *Phragmites*, occur within some of the diked island disposal areas. Wetlands that may be affected by the proposed project would be found in the vicinity of the anchorage basin which is mainly fringed by smooth cordgrass.

2.8 Threatened and Endangered Species

Federal

Updated lists of threatened and endangered (T&E) species for the project area were obtained from the NMFS and U.S. Fish and Wildlife Service webpages (http://sero.nmfs.noaa.gov/pr/endangered%20species/specieslist/PDF2012/North%20Carolina.pdf and http://www.fws.gov/nc-es/es/countyfr.html). These were combined to develop the composite list shown in Table 2.3, 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.

Table 2.3. Federally listed endangered and threatened species that may be in or near the project area.

MAMMALS		
Blue whale	(*Balaenoptera musculus*)	Endangered
Finback whale	(*Balaenoptera physalus*)	Endangered
Humpback whale	(*Megaptera novaeangliae*)	Endangered
North Atlantic right whale	(*Eubaleana glacialis*)	Endangered
Sei whale	(*Balaenoptera borealis*)	Endangered
West Indian manatee	(*Trichechus manatus*)	Endangered
BIRDS		
Piping plover	(*Charadrius melodus)*	Threatened
Red-cockaded woodpecker	(*Picoides borealis*)	Endangered
Wood stork	(*Mycteria Americana)*	Endangered
REPTILES		
Hawksbill sea turtle	(*Eretmochelys imbricata*)	Endangered
Kemp's ridley sea turtle	(*Lepidochelys kempii*)	Endangered
Green sea turtle	(*Chelonia mydas*)	Endangered
Leatherback sea turtle	(*Dermochelys coriacea*)	Endangered
Loggerhead sea turtle	(*Caretta caretta*)	Threatened
FISHES		
Atlantic sturgeon	(*Acipenser oxyrhynchus oxyrhynchus*)	Endangered
Shortnose sturgeon	(*Thalictrum cooleyi*)	Endangered
PLANTS		
American chaffseed	(*Schwalbea americana*)	
Cooley's meadowrue	(*Thalictrum cooleyi*)	Endangered
Golden Sedge	(*Carex lutea*)	Endangered
Rough-leaved loosestrife	(*Lysimachia asperulaefolia*)	Endangered
Pond berry	(*Lindera melissifolia*)	Endangered
Seabeach amaranth	(*Amaranthus pumilus*)	Threatened
[1]The American alligator is listed as threatened only because of its similarity of appearance to crocodilians which are endangered or threatened and which are tracked for illegal commercial trade in hides or other products. The status of the American alligator is not actually threatened		

State

The North Carolina Natural Heritage Program (NCNHP), by letter dated August 9, 2012 (NCNHP 2012), listed the state rare plant and animal species and natural communities near the project area. These lists included the federal species indicated above. Also, the following information was excerpted from that letter:

The Lower Cape Fear River Aquatic Habitat Significant Natural Heritage Area (SNHA) comprises the active channel of the Cape Fear River from Eagle Island downstream to Bald Head Island and supports populations of two Federally and State Endangered animals: manatee (*Trichechus manatus*) and shortnose sturgeon (*Acipenser brevirastrum*). Also supported is the Federal and State Threatened American alligator (*Alligator mississippiensis*). The site also provides important habitat for other animal species that are rare in North Carolina, including Carolina diamondback terrapin (*Malaclemys terrapin centrata*). This portion of the river is considered to be of State significance due to the habitat provided to these rare species.

The shortnose sturgeon occurs in the lower Cape Fear River, swimming well upriver to spawn; its abundance is poorly known, though it is likely a resident in this lower part of the river. The manatee is a rare but possibly annual visitor during the warmer months, from the Florida and West Indies area.

The State Significantly Rare Black-necked Stilt (*Himantopus mexicanus*) breeds sporadically in the vicinity of the Anchorage Basin, depending on the availability of some standing water in diked areas of Eagle Island.

The Lower Cape Fear River Bird Nesting Islands SNHA, Brunswick River/Cape Fear River Marshes SNHA, and Battery Island SNHA are also in the vicinity of the proposed project. The Lower Cape Fear River Bird Nesting Islands are mostly dredge spoil islands located within the lower and salty tidal region of the Cape Fear River from Snows Cut to Island near Southport. These islands are one of the most important colonial waterbird nesting areas in North Carolina and provide critical feeding and breeding habitat for many waterbird species, including two special animal habitats: Gull-Tern-Skimmer Colony and Wading Bird Rookery.

The Brunswick River/Cape Fear River Marshes SNHA contains the largest area of tidal freshwater marsh habitat in North Carolina, occurring from the northern portion of Eagle Island and along the south end of the sand ridge traversed by US Highway 421. This site supports shortnose sturgeon and American alligator, the rare skipper (*Problema bulenta*), Dukes' skipper (*Euphyes dukesi*), and contains the only known occurrences of ribbed bishopweed (*Ptilimnium costatum*), and two of only four known North Carolina occurrences of Carolina bishopweed (*Ptilimnium* sp.)

2.9 Cultural Resources

The following section describes the historical setting and cultural, historic, and archaeological resources of the lower Cape Fear River project area within the North Carolina Coastal Plain.

Evidence of Paleo-Indian period (12,000 – 10,000 B.P.) occupation in the Coastal Plain is mostly limited to a small number of surface finds of fluted projectile points (Ward and Davis 1999). While the dearth of evidence suggests the region was sparsely populated, late Pleistocene and early Holocene sea levels were lower than today, and many Paleo-Indian sites are likely miles offshore from the present-day coastline (Lewis 2000, Phelps 1983). Warming trends melted glaciers and produced a rise in sea level to within a few meters of present levels by 9,000 B.P. and reached present sea level ca. 2,000 to 5,000 B.P. (Anderson et al. 1996, Lewis 2000).

The archaeological record of the Archaic period (10,000 – 3,000 B.P.) reflects new technologies and lifestyles as Archaic peoples adapted to climatic and environmental changes and mega-fauna extinctions that occurred during the Paleo-Indian period. Early Archaic sites in the Coastal Plain are mainly surface finds and are also likely inundated by early Holocene sea level rise (Phelps 1983, Ward and Davis 1999).

The Archaic period was an important foundation upon which later, more complex societies would grow during the Woodland period (3,000 B.P. – A.D. 1600). The early Woodland period people, in particular seem to have inhabited the same riverside locations and followed much the same lifestyle as their Archaic period predecessors. Coastal Archaic and Early Woodland period sites and artifact finds appear to be scattered and significant occupations tend to occur during Middle and Late Woodland periods (Ward and Davis 1999). An increasing reliance on horticulture, semi-sedentary villages, and pottery-making becomes more widespread during the Early Woodland period (Ward and Davis 1999).

Coastal, regional cultures begin to appear in the Late Archaic subperiod and into the Early Woodland period as agriculture, large population increase, and more permanent settlements occurred (Phelps 1983). An increased focus on estuarine resources during the Middle and Late Woodland periods is evident by shell middens (Millis 2011). Other cultural features include sand burial mounds, secondary cremations, platform pipes, and large triangular projectile points (Phelps 1983).

Two main tribes, the Cape Fear and Waccamaw, were settled in the southeastern North Carolina coastal area at the time of European contact (A.D. 1600 – 1710) (Jackson 1996). Little is known of these tribes, although they were most likely affiliated with Siouan peoples to the south (Jackson 1996). Cultural traits such as subsistence and settlements patterns do not appear to have changed much from the Late Woodland period during the early contact period (Ward and Davis 1999). Continued contact with European settlers would result in drastic cultural changes for these tribes.

The Cape Fear River has a long and active history as one of the earliest and most significant waterways in North Carolina. Spanish explorers sighted the river at least as early as the first quarter of the 16th century and European settlement began in 1664 with the establishment of Charles Town near the mouth of Town Creek (Angley 1983). Brunswick Town was a significant pre-Colonial settlement that survived for 60 years as the administrative center for North Carolina's five ports of entry (Angley 1983). By 1733, the town of New Carthage, later renamed Wilmington, had been laid out and within a few decades it would outstrip Brunswick Town as a cultural and maritime center (Reaves 1988).

Numerous confrontations took place between the American patriots and British loyalists and troops during the years leading up to the Revolution. Perhaps one of the most significant was the escape of Royal Governor Josiah Martin from his home in New Bern to Fort Johnston. Local patriots had been harassing Fort Johnston for some time, and Martin was eventually forced from Fort Johnston onto the British vessel Cruizer (Reaves 1988). Despite this success of the patriots, the English remained in control of the Cape Fear, conducting sporadic raids on plantations and mills, with Wilmington itself being occupied by the British in October of 1781 (Reaves 1988).

During the 19th century, up to 40 ships per month were visiting Wilmington's harbor from distant ports such as South America, Norway, and China (Reaves 1988). The importance of Wilmington to the Confederacy is reflected in the fortifications used to protect the city and her approaches (Jackson 1996). Fort Fisher, Fort Holmes, Zekes Island Battery, Camp Wyatt, Fort Hendrick, Fort Campbell, Fort Johnston, Fort Caswell, Battery Buchanan, Fort Anderson, Shaw Battery, Mound Battery, and Battery Lamb were located on the Cape Fear River at and below Wilmington, or faced the ocean and river in Brunswick County. All of these fortifications were important elements in the coastal defense. The defenses at Wilmington were not defeated until late in the war when Fort Fisher finally fell in the largest amphibious assault then known (Angley 1983, Reaves 1988).

After the Civil War, Wilmington's major water courses began to reflect the transition from plantation and agrarian economies to the commercial agriculture and industrial enterprises that would dominate throughout the 20th century. By 1905, ship building, fertilizer and brick factories, shipping terminals, and other capital intensive industries began to replace commercial fishing, hunting, forestry, and agriculture as economically dominant businesses (Angley 1983, Reaves 1988).

Archaeologically, the importance of the area as a maritime center is shown by the large number of shipwrecks and abandoned shipyards. Given this importance, numerous historical and archaeological investigations have been conducted and the Cape Fear River from Wilmington to the sea is the best-documented body of water in North Carolina (Overton et al. 1996).

2.10 Aesthetic and Recreational Resources

A scenic setting is provided by the ocean and river, coastal beaches, and the numerous vessels common to these waters, including commercial and recreational boats as well as ships calling on the port. The marine environment provides opportunities for boating and fishing, as well as an escape from the faster pace of land-based activities.

The Atlantic Intracoastal Waterway (AIWW) is collocated with the navigation channel from Snows Cut through Southport and provides recreation access for many boaters and also provides a safe north or south passage for non-oceangoing vessels. Beaches generally offer extensive recreational opportunities for activities such as swimming, sunbathing, walking, surfing, bird watching, and fishing.

2.11 Recreational and Commercial Fishing

Recreational and commercial fishermen extensively utilize the nearshore marine and riverine waters of North Carolina's southeast coast. Primary species sought include red drum, flounder, trout, spot, croaker, bluefish, Spanish mackerel, king mackerel, penaeid shrimp, and blue crabs. Traditional fishing grounds, primarily for shrimp, occur in the project vicinity off Bald Head Island and Oak Island (Figure 1.1). These areas are of prime importance to the local fishing industry. In addition, sport and commercial fishing is being conducted in the vicinity of a reef-like community that was developed at the Wilmington Offshore Fisheries Enhancement Structure (WOFES), a feature formed by the USACE placement of dredged rock at a location about 4 miles off Bald Head Island.

2.12 Coastal Barrier Resources System

Coastal barriers are unique landforms that provide protection for diverse aquatic habitats and serve as the mainland's first line of defense against the impacts of coastal storms and erosion.

The Coastal Barrier Resources System (CBRS) consists of the undeveloped coastal barriers and other areas located on the coasts of the United States that are identified and generally depicted on a series of maps entitled “John H. Chafee Coastal Barrier Resources System.” These maps are controlling and dictate which lands are affected by the CBRA. The maps are maintained by the Department of the Interior through the Fish and Wildlife Service (http://www.fws.gov/CBRA/index.html).

In the lower Cape Fear River, the Cape Fear Unit NC-07P is present. Maps for this unit can be viewed at http://www.fws.gov/CBRA/Maps/CBRS/index.html. The "P" following the unit number means Otherwise Protected Area (OPA). OPAs are undeveloped coastal barriers that are within the boundaries of an area established under Federal, State, or local law, or held by a qualified organization, primarily for wildlife refuge, sanctuary, recreational, or natural resource conservation purposes. NC-07P includes Carolina Beach State Park, Military Ocean Terminal Sunny Point buffer zone, and Zeke’s Island Coastal Estuarine Reserve. Portions of the existing Wilmington Harbor navigation border or lines within NC-07P, but none of the potential disposal areas or channel realignment areas for the project are present within the CBRS. Maintenance of federal navigation channels is exempted from CBRA.

2.13 Socio-Economic Resources

Population

North Carolina had an estimated population of 9,535,475 in 2010, an increase of 15.6 percent since 2000. North Carolina is presently growing about 1.3 percent annually, and is one of the fastest growing states in the nation.

The project area includes New Hanover and Brunswick counties and had an estimated 2010 population of 310,098 which is an increase of 33 percent since 2000. While the state is presently growing at 1.3 percent a year, the 2-county area is growing at 2.0

percent per year. Brunswick County has been among the fastest growing counties in the state, presently growing at 2.5 percent per year.

Employment

The latest economic data from 2012 indicate that North Carolina has a labor force of about 465,000, and an employment rate of about 420,000 giving an unemployment rate of 9.6 per cent. New Hanover and Brunswick Counties have a labor force of 156,452, and an employment of 141,006 giving an unemployment rate of 10.0 percent. The 2010 per capita income was $24,733 for Brunswick county and $25,776 for New Hanover County. The per capita income for the state was $24,745 compared to the national average of $27,334.

The 3-county region has a large resort population located along the sounds and beaches. Tourism is one of the largest economic factors in the area, along with retirement and vacation home development. Building along the beaches is beginning to slow. The influx of retired persons is a large component of the population and economic growth of the region.

Wilmington Harbor

Wilmington Harbor and the Port of Wilmington provide significant economic benefits to the region and the nation. The economics of the harbor and Port will be discussed in greater detail in Chapter 3 of this report and Appendix A - Economics.

2.14 Hazardous and Toxic Wastes.

Several Federal and State databases/lists were reviewed as part of this hazardous, toxic, and radioactive waste (HTRW) evaluation and include:

- Federal National Priorities (NPL)
- Federal Delisted NPL
- Federal Comprehensive Environmental Response, Cleanup, Liability Information System (CERCLIS)
- Federal CERCLIS-No Further Remedial Action Planned (NFRAP)
- Federal Resource Conservation Act (RCRA) Corrective Action Sites (CORRACTS)
- Federal RCRA-Generator
- Federal Institutional Controls (IC) and Engineering Controls (EC)
- Formerly Used Defense Site (FUDS)
- State/Tribal Superfund Registry
- State/Tribal Solid Waste Landfill (SWL)
- State/Tribal Underground Storage Tank (UST)/Aboveground Storage Tank (AST)
- State/Tribal Leaking Underground Storage Tank (LUST)

- State/Tribal Voluntary Cleanup Program (VCP)
- State/Tribal IC and EC
- State/Tribal Brownfields
- Tribal Lands

Based on results of the regulatory database review, there is one high priority release site within the study area and it is located near the anchorage basin. High priority release sites are those sites where there is no clear indication that the case/release has been closed by regulatory agency. Not included in high priority sites are those sites where the regulatory agency has not closed the case if the reported or suspected amount of material(s) release was less than 100 gallons.

The high priority site is the Southern Wood Piedmont Company site at the foot of Greenfield Street. The site was operated as a wood-treating facility from 1935 to 1983. Wood-treating products used on site included pentachlorophenol (PCP), chromated copper arsenate (CCA), and creosote. Creosote contains polynuclear aromatic hydrocarbon compounds (PAH). On-site investigations from 1985 to 1993 documented creosote contamination in soil and groundwater beneath the site. Groundwater investigations also identified a multi-acre pool of liquid creosote in the surficial aquifer beneath the central portion of the site. Historical site activities also caused extensive creosote contamination in an on-site drainage ditch, which leads south to lower Greenfield Creek. Historical use of PCP at the site had resulted in soil and sediment contamination by dioxins and furans. More details on this site and other nearby sites are included in the Geotechnical Appendix (C).

3.0 PROBLEMS, NEEDS, AND OPPORTUNITIES

Problems associated with current channel alignments and width affecting navigation efficiency and ship safety have been identified by the Port of Wilmington and users of the channel in three areas of Wilmington Harbor (Figure 3.1); 1) the Entrance Channel, Reach 1, 2) the Battery Island Turn (channel), and 3) the Anchorage Basin, which is used as a turning basin. These inefficiencies can result in vessel delays and the associated economic losses. The problems in these areas and opportunities to address them are discussed in more detail in the sections below.

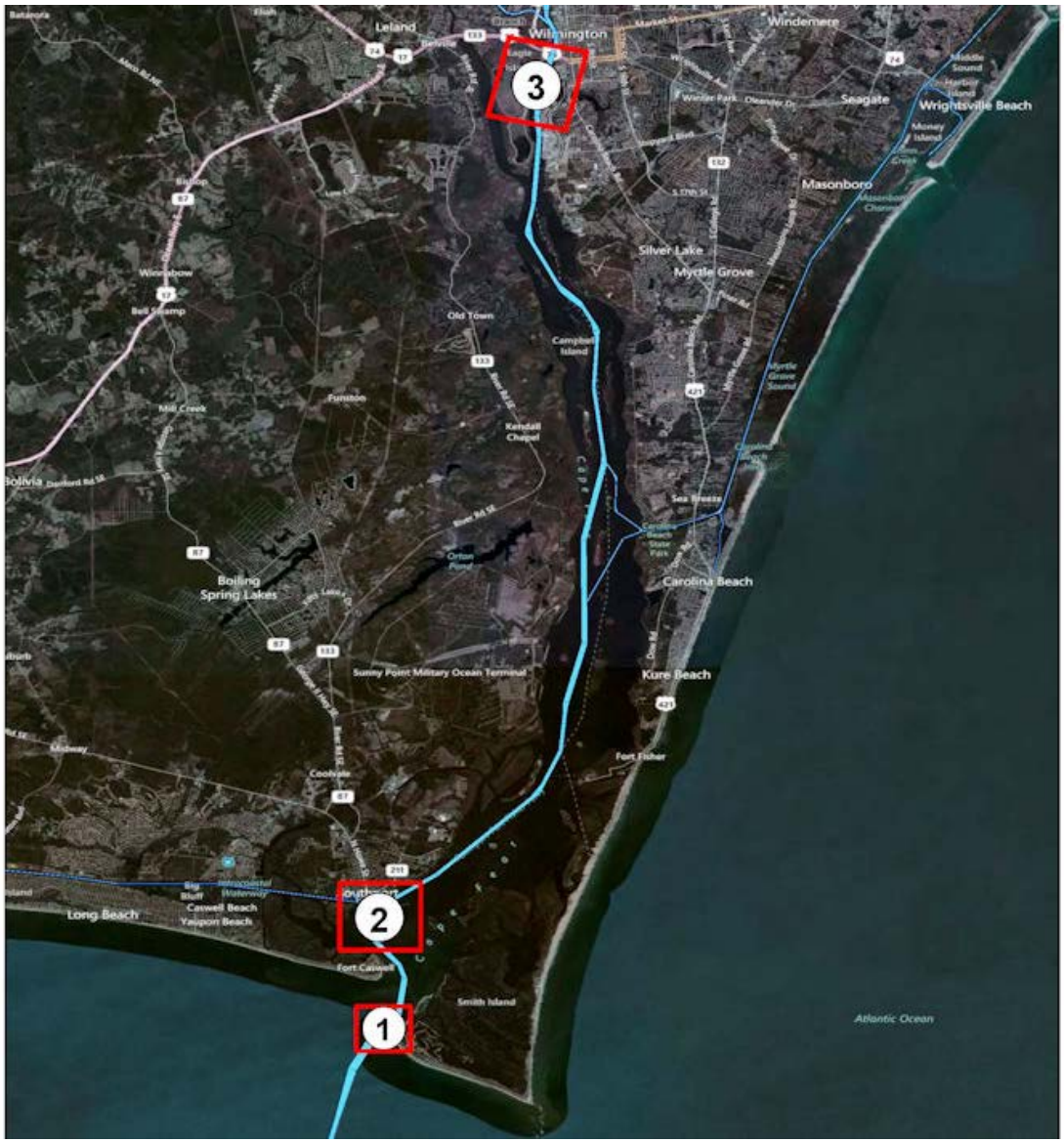

Figure 3.1. Location of problem areas in Wilmington Harbor – (1) Entrance Channel near Bald Head Island, (2) Battery Island Turn, and (3) Anchorage Basin.

3.1 Entrance Channel, Reach 1

In this report, the Entrance Channel includes the Baldhead Shoal Channel Reach 1. The current channel alignment in this area (Figure 3.2) has proven susceptible to rapid and persistent shoaling. The EA SMP, presented in Appendix H, Environmental Assessment Preconstruction Modifications or Authorized Improvements, Wilmington Harbor, NC, Appendix A (2000), proposes dredging of the reach every other year for this area; however, the actual dredging schedule has been more intermittent due to funding limitations. Figure 3.2 depicts the shoaling that occurred prior to dredging in 2013, when three years had elapsed since the previous maintenance dredging. As seen in that figure, the navigable width of part of the reach has been reduced by about half.

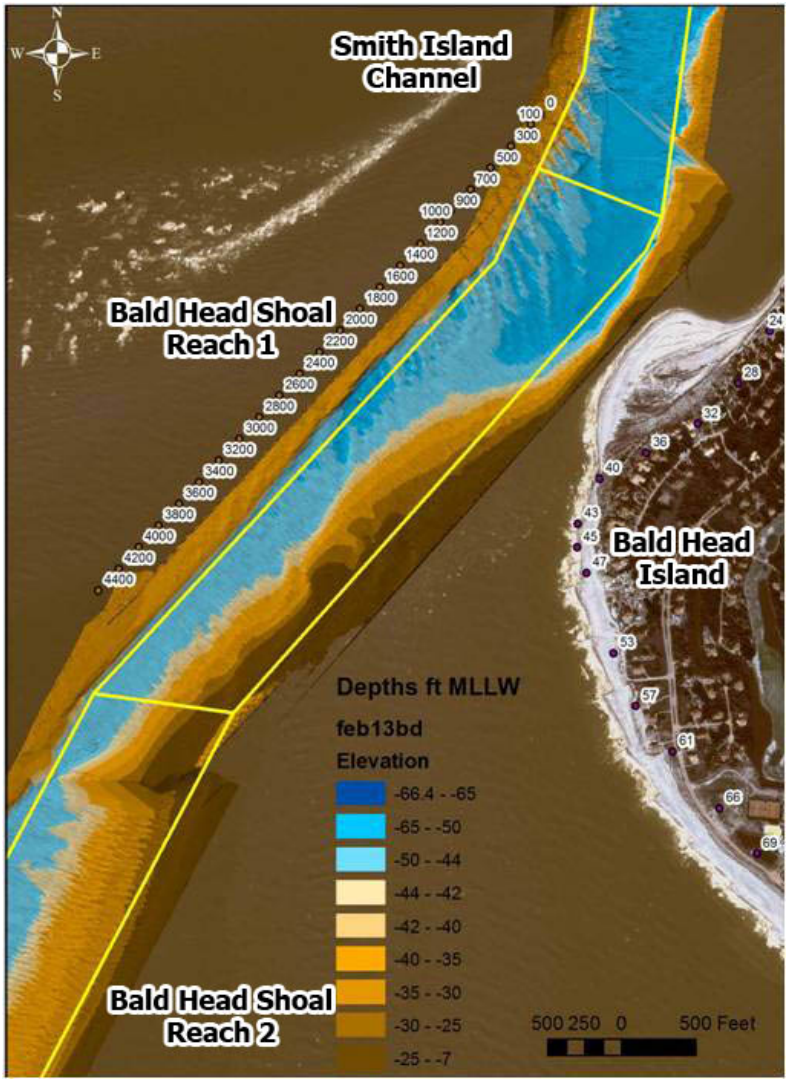

Figure 3.2. Entrance channel alignment near Bald Head Island, showing 3 years of shoaling that occurred prior to it being dredged in 2013.

Because of the shoaling and reduced channel width in Baldhead Shoal Channel Reach 1, ships that normally could pass each other will not do so in this area, leading to transit delays. Additionally, the reduced channel width resulting from shoaling on the eastern side of the channel places vessels on the less advantageous western side of the channel for safely navigating the bend between the Baldhead Shoal Channel-Reach 1 and Smith Island Channel reaches. This problem could be addressed by either increasing the distance from the channel edge of the Baldhead Shoal portion of the study area to Bald Head Island or increasing the frequency of dredging in the area. Both could potentially improve overall channel reliability and availability. The prior could be accomplished by using a hardened shoreline structure to reduce sand loss from Bald Head Island.

3.2 Battery Island Turn

The Battery Island Turn (Figure 3.3) is problematic for some of the larger container vessels currently calling on the Port of Wilmington. Vessels are at times being forced to delay their transit and wait for favorable tides. Specifically, the 965 ft Yang Ming New Jersey and Los Angeles class and 905 ft Ming East/North/South/West ships have to wait for favorable tide before making the turn if they are drafting deeper than 36 ft. There are opportunities for realigning or widening the Battery Island Turn, which would potentially improve navigation safety and efficiency and reduce delays for the impacted vessels.

Figure 3.3. Channel alignment at Battery Island.

In this report, the Battery Island Turn includes the Battery Island Channel and the adjacent channels, Lower Swash Channel to the north and Southport Channel to the

south. The potential improvement for the Battery Island Turn includes widening of the Battery Island Channel, a longer cutoff between Battery Island Channel and Lower Swash Channel, and tapers between the widened Battery Island Channel and the adjacent channels (Figure 3.3

3.3 Anchorage Basin

The existing maximum width (1,200 ft) of the Anchorage Basin (Figure 3.3) is not adequate for the larger container vessels calling on the Port of Wilmington to easily turn, and is not wide enough to allow any post-Panamax vessels to call in the future. Ships longer than 900 ft are being slowed by several minutes and require the assistance of two tugs during the turn. There are potential opportunities to either increase the dimensions of the existing Anchorage Basin or to create a new Anchorage Basin elsewhere in the Harbor. Widening of the Basin to better accommodate the existing fleet calling on the Port could also allow some of the smaller post-Panamax ships (although larger than the design vessel) to call on the Port in the future, whereas they could not call if the basin was kept at its current width.

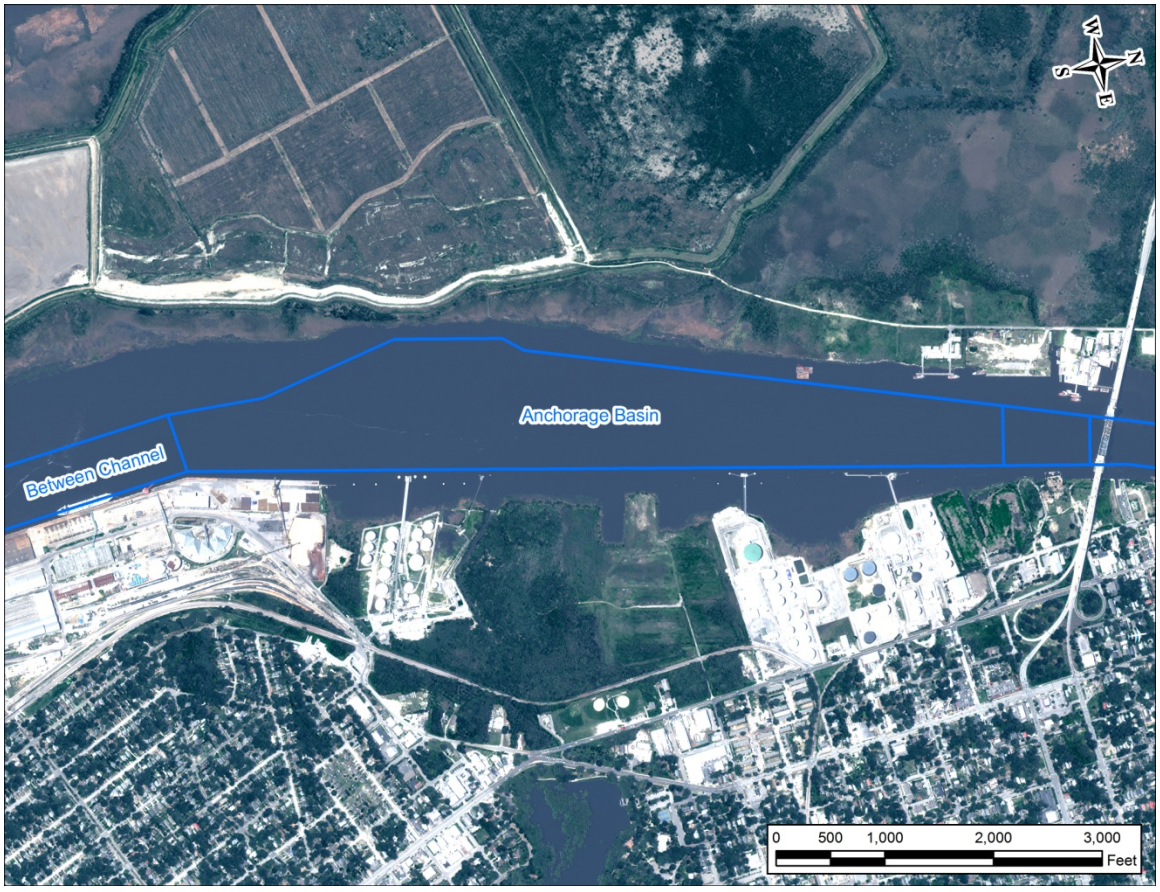

Figure 3.4. Navigation channel at the Anchorage Basin.

4.0 EXISTING CONDITIONS AND FUTURE WITHOUT-PROJECT

The existing condition of significant resources in the area was described in Chapter 2 of this report. This chapter focuses on further quantifying the existing and future without-project conditions, which will form the primary basis for the comparison of benefits of project alternatives. The future without-project condition refers to a most likely future that would occur without additional changes being made by the USACE to the currently authorized channel, but would incorporate any actions planned to be undertaken by other entities in the future.

4.1 Navigation

4.1.1 Current Fleet

A thorough analysis the existing fleet data for vessels calling at Wilmington Harbor in 2009 revealed six typical vessel types: (1) Containerships, (2) Bulk Carriers, (3) General Cargo Vessels, (4) Petroleum Tankers, (5) Chemical Tankers, and (6) Ro-Ro Vessels (includes Vehicle Carriers).

Containerships made up nearly 35% of the deep-draft vessel calls at Wilmington Harbor in 2009. The largest vessels that call at Wilmington Harbor at the present time are containerships of 62,000 to 65,000 deadweight tons (DWT). They are between 950 and 965-ft long, 106 ft in beam and have design drafts of between 42 and 44 ft. Their actual sailing drafts were 38 ft or less when calling at Wilmington Harbor in 2009. Containerships maintain an underkeel clearance of at least 10 percent of sailing draft in the channel at all times. They can carry up 4,400 to 4,800 Twenty Foot Equivalent Units (TEUs); however they generally transfer less than 1,500 TEUs at the port, which are split between imports and exports. These larger ships typically travel between the Far East and East Coast of the US.

Additional Container subclasses that call in Wilmington include smaller vessels in the 50,000 DWT class. These are generally about 850-ft long, have design drafts of about 41-42 ft, and can carry up to about 4,000 TEU's. An even smaller sub-class of container vessel typically service Europe and Central/South America. These vessels are generally between 20,000 DWT and 22,000 DWT. They are typically 525 to 550 ft in length, with beams ranging from 82 to 93 ft and design drafts between 32 and 35 ft. They can carry up to approximately 1,300 TEUs.

The largest Bulk Carriers were rated at about 55,000 DWT with a length of 656 ft, a beam of 106 ft and a design draft of 38 ft. The largest General Cargo vessels were rated at about 47,000 DWT with a length of 656, a beam of 102 ft and a design draft of 40.4 ft.

The largest non-container vessels that call at the Port are Oil Tankers. These vessels are range in size from 70,000 DWT to 76,000 DWT with a length of 700 to 750 ft, with beams of 106 to 131 ft and design drafts ranging from 40 to 46 ft. The actual sailing drafts of these vessels in Wilmington Harbor were 38 ft or less in 2009.

4.1.2 Current Port Practices

Nearly 200,000 loaded TEU's were handled at Wilmington Harbor in 2010, making it the 17th largest container Port in the United States and the 8th largest container port on the U.S. Atlantic coast. Imports at Wilmington accounted for almost 114,000 loaded TEU's (57%) and exports accounted for about 86,000 loaded TEU's (43%). Empty containers account for an additional 13% of import containers and 25% of export containers at Wilmington. Historically, exports have increased at a faster pace than imports. In 2005 exports made up only about 33% of total shipments.

4.1.3 Potential Limits to Navigation

Turns and bends within the navigation channel have been an area of concern to vessel pilots in the Wilmington Harbor since the 38-ft project was completed. The 96 Act Project addressed some of these concerns but the introduction of containerization has led to the introduction of longer and wider vessels. Identified issues include:

- Shoaling on the east side of the navigation channel at Bald Head Island and the resultant reduced width is problematic to navigation under typical wind and tide conditions. This shoaling places vessels on the less advantageous side of the channel to navigate the bend within the Smith Island Channel reach. In order to avoid the shoaling in Baldhead Shoal Channel Reach 1, vessels are required to decrease speeds to navigate the S-shaped useable channel. Current vessel restrictions are for a 38-ft "anytime" draft (State Port Pilots; USACE communication, Feb 2011).
- The turn at Battery Island is problematic for certain (950 ft by 106 ft and 965 ft by 106 ft) container vessels under specific wind and tide conditions.
- Vessels are being forced to delay their transit and await favorable tide conditions in order to serve the harbor. These delays are expensive and result in increased transportation costs. Certain vessels are also subject to draft restrictions as a result of this turn. Contributing factors, including ship handling characteristics and size, channel configuration, tide conditions, and inbound or outbound transit operation could influence safe maneuvering of these ships through the channel.
- Current Anchorage Basin dimensions are not adequate to properly accommodate turning of some of the larger container vessels currently calling at the North Carolina State Ports Authority. Concerns regarding current Anchorage Basin dimensions have been expressed by the North Carolina States Ports Authority and the shipping industry. Currently vessels are being turned on high tides, executing turning more slowly than normal, and requiring extra tug assistance to perform turning maneuvers.

4.2 Environmental Resources

- The Future Without-project Condition of Environmental Resources is expected to be the same as the existing condition described in Section 2.

5.0 PLAN FORMULATION AND EVALUATION OF ALTERNATIVES

The planning process used for this study and detailed in this section followed the 6 steps indicated earlier in Section 1.6. Alternatives were formulated and then screened, evaluated, and compared in an iterative process with increasing levels of detail at each sequence to finally identify the Recommended Plan. Although various analysis parameters may change at each sequence, within each sequence the parameters used to compare alternatives are kept identical.

5.1 Goals and Objectives

As outlined in the 1983 *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies*, the Federal objective in water resources planning is to contribute to national economic development (NED) consistent with protecting the Nation's environment. The Federal objective leads to the general overall goal of this study:

Goal

Increase NED benefits at Wilmington Harbor by reducing navigation inefficiencies that are causing delays to vessels currently using the harbor.

Identifying and considering the problems, needs, and opportunities of the study area in the context of federal authorities, policies, and guidelines resulted in the establishment of the following specific objectives, which are all to be considered over a 50 year period of analysis:

Objectives

1. Reduce vessel transit times and potentially future dredging costs through the Entrance Channel, Reach 1.

2. Reduce the transit times needed for larger vessels to negotiate the Battery Island Turn portion of the navigation channel.

3. Reduce the time it takes for larger vessels currently calling on the Port to turn in the Anchorage Basin.

5.2 Constraints

The planning process is subject to the limitations imposed by the following general constraints:

a. Geographic limits of the study authority.

b. Conformance to USACE policies for the project purpose.

c. All applicable Federal laws, regulations, and Executive Orders.

d. Current limits of knowledge, information, and predictive ability.

No other specific planning constraints have been identified for this study that would further limit the planning process. Although there are many factors that may ultimately affect the implementability of a particular alternative and be used throughout the screening process, these do not necessarily qualify as planning constraints.

5.3 Formulation and Evaluation Criteria

Alternative plans are evaluated by applying numerous, rigorous criteria. Four general criteria are considered during alternative plan screening: completeness, effectiveness, efficiency, and acceptability.

- *Completeness*: Completeness is the extent that an alternative provides and accounts for all investments and actions required to ensure the planned output is achieved. These criteria may require that an alternative consider the relationship of the plan to other public and private plans if those plans affect the outcome of the project. Completeness also includes consideration of real estate issues, O&M, monitoring, and sponsorship factors. Adaptive management plans formulated to address project uncertainties also have to be considered.
- *Effectiveness:* Effectiveness is defined as the degree to which the plan will achieve the planning objective. The plan must make a significant contribution to the problem or opportunity being addressed.
- *Efficiency*: The project must be a cost-effective means of addressing the problem or opportunity. The plan outputs cannot be produced more cost-effectively by another institution or agency.
- *Acceptability*: A plan must be acceptable to Federal, state, and local government in terms of applicable laws, regulation, and public policy. The project should have evidence of broad-based public support and be acceptable to the non-Federal cost sharing partner.

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

Engineering Criteria:

- The design of a safe, efficient, and reliable project which incorporates best engineering principles/practices in support of an NED plan.

Economic Criteria:

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

Environmental Criteria:

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

- The plan should represent an appropriate balance between economic benefits and environmental sustainability.
- The plan should be developed in a manner that is consistent with the USACE's Environmental Operating Principles (EOPs). (see-http://www.usace.army.mil/Missions/Environmental/EnvironmentalOperating Principles.aspx)
- Adverse impacts to the environment should be avoided. In cases where adverse effects cannot be avoided, mitigation of impacts and then mitigation must be provided to minimize impacts to at least a level of insignificance.

5.4 Design Vessel

The design vessel for this study is 965 ft in length, with a beam of 106 ft, and a draft of 38-40 ft .This is the same design vessel used in the Wilmington Harbor 96 Act Project. The projected future vessels calling on the Port are consistent with this design vessel

5.5 Identification, Examination, and Screening of Measures

Several different potential measures were initially considered for addressing the stated problems in each of the three areas of Wilmington Harbor being studied. These measures underwent an initial screening process based on their viability and practicality, potential environmental impacts, and a rough order magnitude (ROM) cost and benefit evaluation. Generally, measures were screened out at this stage if they either would not be effective in adequately addressing the problem from a technical or implementability standpoint, if another measure could provide equivalent benefits at a lower cost, or if the measure was better pursued outside of the scope of this feasibility study. These initial measures are discussed in more detail in the following subsections. Note that the discussions below are preliminary and appropriate only for this stage of the planning process. Measures that are forwarded on for further consideration would undergo additional analysis as it relates to technical viability, environmental impacts, costs, and benefits as part of this study. In addition, a "No Action" measure at each location is still being carried forward at this point. "No Action" consists of continuance at status-quo and no additional or new measures being implemented by the USACE in these areas.

5.5.1 Initial Measures – Entrance Channel, Reach 1

<u>Measure EC1 - Channel Realignment</u>

One potential measure for reducing the shoaling rates within the channel is to shift Baldhead Shoal Channel – Reach 1 westward. Channel dimensions (width and depth) would remain the same, as no widening or deepening was deemed necessary.

a) *Technical and implementability considerations*: The optimal location and effectiveness of the realignment would need to be determined, and would largely be based on an analysis of the historical movement of sand in the area. Any impacts to areas on the western side of the channel resulting from the realignment would also need to be considered. However, there are no obvious technical or implementability issues with this measure.

b) *Environmental considerations*: A new area of the Cape Fear River would be dredged, although it would be adjacent to the area currently being dredged. There are historic shipwrecks in the area that may require mitigation depending on final location of the realignment, but there are no other major expected environmental impacts from this measure that would require mitigation.

c) *Preliminary costs and benefits:* There would be an initial construction cost related to dredging the new channel alignment. Analysis done during the reconnaissance phase of this study estimated the cost of this dredging to be around $2.2 million, based on dredging 200,000 cubic yards of sand and a 20% contingency (based on historic bid information). It was assumed that the dredging would occur during the normal maintenance cycle of the reach, thereby not incurring an additional mobilization cost. Preliminary benefits were not calculated but would be based on reduced future O&M costs for dredging the channel. Although vessel transit times could also be reduced with full availability of the channel, this is not a claimable economic benefit since the economic baseline presumes full channel capacity.

d) Conclusion: Because the measure appears technically viable and implementable, and there are no obvious environmental or economic issues, the measure was forwarded on for further analysis.

Measure EC2 – Hardened Structure

A hardened structure could take the form of a feature perpendicular to the shoreline (i.e., a groin or jetty) or parallel to the shoreline (i.e. a breakwater feature). Groins are generally only a few hundred feet long. A jetty for the Wilmington Harbor Improvements Project would need to be several thousand feet long. A preliminary jetty alignment for the project is shown in Figure 5.1. The alignment shown in Figure 5.1 is only meant to be illustrative of the potential size and location of the structure that might be needed in order to have any substantial effect on the movement of sand into the channel. The jetty alignment is offset from the eastern edge of the Reach 2 channel by 1,000 ft to allow for a safety margin for vessels navigating past the structure. This margin is reduced to 800 ft along Reach 1, where the jetty is anchored within the sand spit along the southwestern corner of Bald Head Island. This alignment results in an overall jetty length of approximately 8,200 ft.

a) *Technical and implementability considerations*: With the construction of a single jetty along the eastern margin of the channel, there will be a strong tendency for the channel to migrate towards the structure over time. This in fact occurred at Masonboro Inlet when the north jetty was constructed in advance of the south jetty and has likewise been observed at other project locations with single structures (as documented by Kieslich 1981).With this channel shift there will also be the likely change in shoaling patterns along the entrance channel. As noted above, the present shoaling patterns along Baldhead Shoals Channel (Reach 1 & 2) is from the Bald Head side of the channel. Very little shoaling has been observed along the western side coming from Jay Bird Shoals, except for the Smith Island Channel reach. With the migratory response to the eastern single jetty, a likely scenario will be the encroachment of Jay Bird Shoals along the western margin of the Bald Head Shoal channel. Such a reversal in shoaling patterns will essentially render the eastern jetty ineffective and would result in a need for maintenance

dredging along the opposite side of the channel .As with Masonboro Inlet (and most stabilized inlets), a second jetty was necessary to properly exclude sediment from entering the channel from each side. Adding a second structure along the Oak Island/Caswell Beach side would be quite costly. A final consideration is the impact of a jetty (or jetties) to the overall sediment management plan of the project. Additional detailed analysis is necessary to determine what impact such a feature would have on the adjacent beaches. For example would sand bypassing be needed for operation of such a plan to mitigate for any project induced erosion? If necessary, the inclusion of a sand bypassing plan would be an additional cost of the jetty plan.

Figure 5.1. Conceptual alignment for a Bald Head Island jetty feature.

b) *Environmental considerations*: The two major concerns with a jetty are the potential to reduce larval transport from the ocean to the Cape Fear River estuary, and alteration of beach habitat. Modeling would be required to determine the impact on larval transport. Beach habitat would not only be altered by sand accumulating behind the jetty, but the jetty would be anchored by a revetment extending 2,600 ft into the island (per the conceptual plan). Depending on the final revetment alignment and length, several acres of terrestrial habitat would be altered. These environmental impacts of the jetty would likely be higher than that of realigning the channel, and could potentially require substantial mitigation.

c) Preliminary costs and benefits: In the absence of a detailed design for this measure, a rough cost estimate was prepared by comparing the cost of a jetty at nearby Masonboro Inlet. The south jetty at Masonboro Inlet was constructed over the period of 1978-80 at a cost of $5,614,000. Given the overall south jetty length of 3,500 ft the resulting cost-per-foot is $1,604 at 1978 price levels. This unit cost escalated to 2012 price level amounts to

$5,418/foot, based on ENR Construction Cost Indexing. This per ft cost is applied directly to the 8,200 ft conceptual length of the Wilmington Harbor Jetty and is taken as one-half of this value (i.e. $2,709/foot) for the 2,600 ft-long revetment. The cost of both structures, after applying a contingency factor of 25% to account for the uncertainties of this conceptual level plan, results in a total estimated cost of $64,000,000. A summary of the cost calculation is contained in Table 5.1.

The projected $64 million dollar cost is likely an underestimate, for a few reasons. First, given the relatively greater channel depths at Cape Fear (40-60 ft) versus those of Masonboro Inlet (20-30 ft), additional costs that are not accounted for would likely be incurred to prevent undermining of the jetty from channel migration. Also, based on recent (2012) bids received for repairs of the Masonboro South Jetty, actual unit prices for armor stone are substantially higher than the escalated cost based on the ENRConst Cost Index. Finally, the cost does not include any environmental mitigation which might be required.

Preliminary benefits were not calculated but would be based on reduced future O&M costs for dredging the channel. Although vessel transit times could also be reduced with full availability of the channel, this is not a claimable economic benefit since the economic baseline presumes full channel capacity. Benefits with regards to reduced O&M would likely be higher than that of measure EC1, but not by the orders of magnitude needed to justify the substantially higher cost.

d) Conclusion: The purpose of a jetty is to stabilize an inlet. While one of the means by which the inlet stabilization is achieved is by controlling the littoral transport into the inlet, in this case the inlet is stable. Therefore, due to the relatively high costs and the relative stability of the inlet, a hardened structure was screened from further consideration.

Example jetties which were constructed by the USACE Wilmington District are located at Masonboro Inlet, NC.

Table 5.1. Cost estimate calculation for conceptual jetty feature for Bald Head Island.

	Length	**Year Built**	**Cost**	**Cost per Foot**
Masonboro Inlet South Jetty	3500	1978-80	$5,614,000	$1,604
Price Level	1978	2012	Price Level	2012 Cost per ft
ENRConst Cost Index	2776	9376	3.378	$5,418
Structure	**Length**	**Cost**	**Cost per Foot**	
Wilmington Harbor Jetty	8200	$44,423,866	$5,418	
Revetment	2600	$7,042,808	$2,709	
Subtotal	10800	$51,466,674		
Contingency	25%	$12,533,669		
Total		**$64,000,000**		

Measure EC3 – Increase Dredging Frequency

a) Technical and implementability considerations: This measure would involve dredging the current channel alignment every year, instead of every two years as is currently authorized, thus increasing full channel availability. Maintenance dredging as part of the current authorization occurred in 2005, 2007, 2009, and 2013 but did not occur in 2011 due to lack of funding. Since consistent funding is not available to dredge on the current two year cycle, it is unlikely that funding for an even higher dredging frequency would be realistic.

b) Environmental considerations: This measure would not impact any new areas within the Cape Fear River; however, the existing channel would be impacted more frequently and the associated placement of sand on the beach would occur more often. If this dredging and disposal activity was performed during the colder months, the extent of environmental impact would probably be minimal, and would not likely require any mitigation.

c) Preliminary costs and benefits: This measure would involve an increase in O&M costs. Although the total volumes to be dredged and disposed over a given period of time would remain roughly the same as compared to current conditions, dredge mobilizations/demobilizations would occur every year instead of every two years. This is opposed to measures EC1 and EC2, which would be expected to reduce O&M costs. Although vessel transit times could also be reduced with full availability of the channel, this is not a claimable economic benefit since the economic baseline presumes full channel capacity.

d) Conclusion: Considering current and anticipated future funding constraints, it is unlikely that this measure could ever be fully implemented. In addition, it does nothing to address the objective of reducing future O&M costs, and would in fact increase those costs. For these reasons, this measure was screened from further consideration.

Measure EC4 – Advanced Maintenance Dredging of Channel Width

This measure would involve, during the normal maintenance cycle, dredging additional channel width thus potentially increasing channel availability prior to the next dredging. Advanced maintenance could occur on the existing channel alignment, or on a new alignment.

a) Technical and implementability considerations: Under certain circumstances, implementation of advanced maintenance for the currently authorized channel width could be approved at the USACE South Atlantic Division and would not require further congressional authorization. Hence, this measure could potentially be analyzed and implemented outside the purview of this current feasibility study. However, limited advanced maintenance of the channel width is not likely to be very effective, due to the rapid shoaling that occurs in the channel, and the limited area in which the advanced maintenance could occur. Further, dredging to the east of the channel towards Baldhead Island could possibly lead to shoreline impacts. Substantial dredging to the west (which would be necessary to effectively keep up with the shoaling) could cause impacts to Oak Island and would also cause problems with tying the reach back into the rest of the channel.

b) Environmental considerations: Because of the technical and implementability issues discussed above, environmental considerations were not assessed in detail. A new area of the Cape Fear River would be dredged, although the dredging area would be adjacent to the channel currently being dredged. There are historic shipwrecks in the vicinity that may require mitigation depending on final location of an advanced maintenance area, but there are no other major expected environmental impacts from this measure that would require mitigation.

c) Preliminary costs and benefits: Preliminary costs and benefits have not been determined for this measure.

d) Conclusion: Because of the technical and implementability issues discussed above, it is being screened from further consideration from this feasibility report.

Measure EC5 – Alteration of Sand Disposal Location

Some of the shoaling in the channel may be attributable to where the dredged material is currently being placed on Bald Head Island. This measure would involve altering where the sand is being placed on the island.

a) Technical and implementability considerations: This measure could be implemented without additional Congressional authorization but would require a new Sand Management Plan. A SMP is an advisory document, not a decision document, authorization, or appropriation document, although it may advise future decisions on dredged material disposal. An updated SMP has been drafted which puts 2/3 of the dredged sand onto Bald Head Island and 1/3 onto Oak Island/Caswell Beaches every dredging cycle, but to date that plan has not been evaluated or approved nor does it have the required NEPA Compliance documentation.

b) *Environmental considerations*: An Environmental Assessment would be required for the new Sand Management Plan.

c) *Preliminary costs and benefits:* See the Sand Management Plan in Appendix H.

d) Conclusion: Placement of suitable material on Bald Head Island would follow recommendations contained in the SMP (Appendix H). A new SMP has been drafted but has not evaluated or approved and a new EA has not been drafted.

5.5.2 Initial Measures – Battery Island Turn

Ship simulations, done in the 1990's indicate that the passage around Battery Island (Lower Swash thru Southport channels) required an average channel width of about 750 ft along 8,000 ft of channel. Currently, Lower Swash channel is 400-ft wide, Battery Island channel is 500 ft wide and Southport channel is 500-ft wide. An existing cutoff at Lower Swash/Battery Island widens the channel to about 700-ft wide along the apex of the turn.

Measure BI1 – Widen the Existing Turn

This measure would reduce the existing sharp turn angle at Battery Island by widening the channel in that area. The channel could potentially be widened to the east, west, or a combination of both.

a) *Technical and implementability considerations*: The optimal area to locate the channel widener would still need to be determined, and would be based on cost and environmental considerations, as well as the current path of vessels through the turn (some vessels currently utilize natural deepwater outside of the existing channel when making the turn). There are number of underwater cultural resource targets in the area immediately to the east of the current turn, and impacts to the Battery Island shoreline from locating the channel closer to it would need to be considered. The area to the west of the turn is shallower water as compared to the east, and thus would require additional dredging volumes.

b) *Environmental considerations*: There are number of underwater cultural resource targets in the area immediately to the east of the current turn, and erosion to the Battery Island shoreline from locating the channel closer to it would also need to be considered. The area to the west of the turn is shallower water as compared to the east, and thus would require additional dredging volumes. Widening on the west side does not involve any Primary Nursery Areas, areas less than 10 ft deep or known cultural resources. Thus, mitigation would probably not be required for dredging there. However if the channel was widened on the east side, the Battery Island shoreline may need to the stabilized to preclude erosion and mitigation would be required for cultural resource concerns. Measures would also be required to preclude blasting impacts on fisheries, marine mammals, and sea turtles.

c) *Preliminary costs and benefits:* Benefits have not been quantified at this stage, but would be gained from the 965 ft and 905 ft vessels currently calling on the Port not having to be delayed by waiting for fair tide when they are drafting greater than 36 ft. Analysis done during the reconnaissance phase of this study estimated the cost of this dredging (with the widening occurring entirely to the east) to be around $4 million dollars, based on dredging 157,900 cubic yards of sand or silt, blasting 7,100 cubic yards of rock, plus mobilization and equipment costs and a 25% contingency. This estimate does not include the cost of any potential cultural resources mitigation.

d) Conclusion: Because the measure appears technically viable and implementable and there are no obvious economic or prohibitive environmental issues, it was forwarded on for further analysis.

<u>Measure BI2 – Relocate Channel to the East of Battery Island</u>

This measure would relocate and straighten the channel to the east side of Battery Island (Figure 5.2), thus eliminating any issues with the current turn. The new channel would be dug to existing authorized depth (44 ft) and width (500 ft).

a) *Technical and implementability considerations*: There is not much data regarding the new channel area (i.e., amount of rock, cultural resources, and environmental surveys), so there is uncertainty with regards to this measure. Additional hydrodynamic modeling would also need to be conducted to ascertain whether the river would follow this new alignment.

b) *Environmental concerns:* There would be many environmental concerns and issues related to this measure, including probable impacts to cultural resources, shellfish beds, marsh, shallow water habitat, and to Battery and Striking Islands (to the east of the

alignment). Surveys for cultural resources, shellfish beds would be required before an assessment on impact could be made, but these resources are likely to be present. Based on preliminary information gleaned during the reconnaissance phase of this study, about 13 acres of marsh would be lost from Battery and Striking Islands and about 202 acres of shallow water habitat (less than 10 ft deep) would be lost. Also the channel would be located between Battery and Striking Islands which are important colonial waterbird nesting areas managed by The Audubon Society. Shoreline stabilization would probably be required to protect these islands from ship wakes. If blasting within the channel is required due to the presence of rock, measures would also be required to preclude blasting impacts on fisheries, marine mammals, and sea turtles.

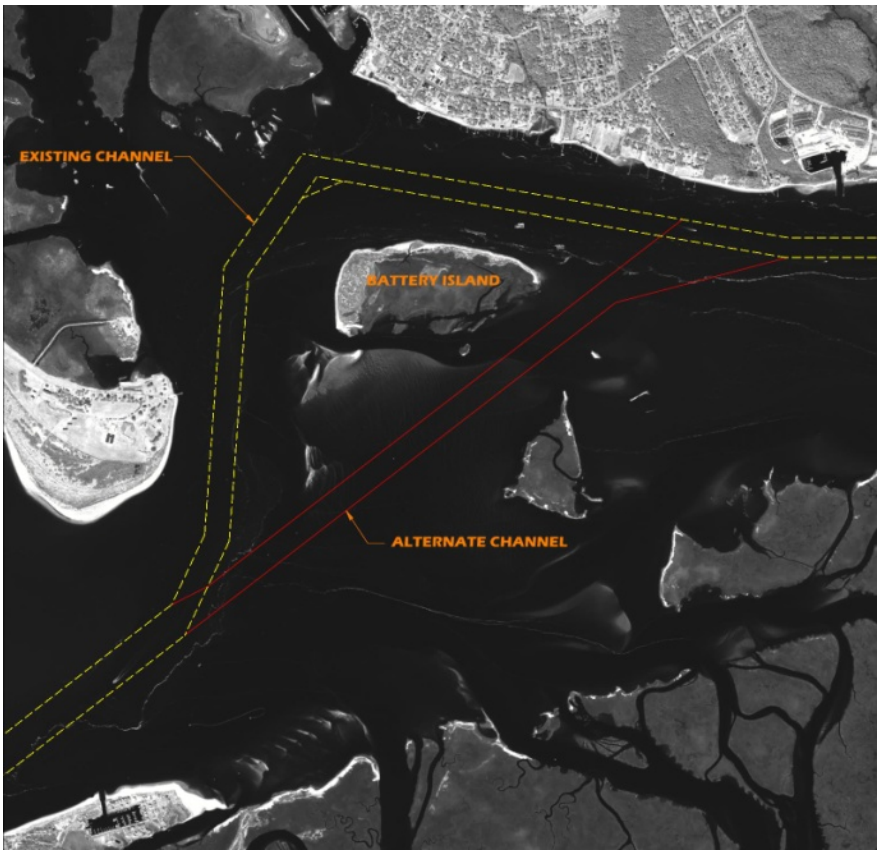

Figure 5.2. Potential alignment for measure BI2.

c) Preliminary costs and benefits: Analysis done during the reconnaissance phase of this study estimated that this measure would involve dredging approximately 12,368,000 cubic yards of material. A cost was not developed because it is unknown how much rock is in the area and rock blasting, if required, would significantly affect the cost. However, approximately 75 times the material as compared to alternative BI1 would need to be dredged. Additionally, environmental mitigation costs alone would be around $46 million, based on estimates developed during the reconnaissance phase of this study. Thus, the cost of this measure would be substantially higher than measure BI1. On the benefits side, similar to BI1, vessel delays based on waiting for fair tide would be

eliminated. Additionally, vessels could likely shorten total transit times because the new alignment would require a shorter distance to be traveled. These benefits have not been quantified, but it is highly unlikely that, as compared to measure BI1, the additional transit time benefits gained from the new alignment would exceed the additional costs for construction and mitigation.

d) Conclusion: This measure is almost certain to be less cost effective for achieving the study objectives than BI1, while also incurring substantially more environmental impacts. For these reasons, this measure was screened from further consideration.

5.5.3 Initial Measures – Anchorage Basin Widening

Measure AB1 – Widen the Existing Location to 1,450 ft

This measure would widen the existing Anchorage Basin to 1,450 ft. This is the minimum recommended Anchorage Basin design width (1.5 x ship length) for the largest ship currently calling on the port, which is the 965-ft long Panamax size vessel.

a) *Technical and implementability considerations*: Because of existing infrastructure, which includes the Eagle Island Dredged Material Disposal site to the west and Port facilities to the east, there is limited room for the existing anchorage basin to be widened. Figure 5.3 shows the potential locations where this widening could occur.

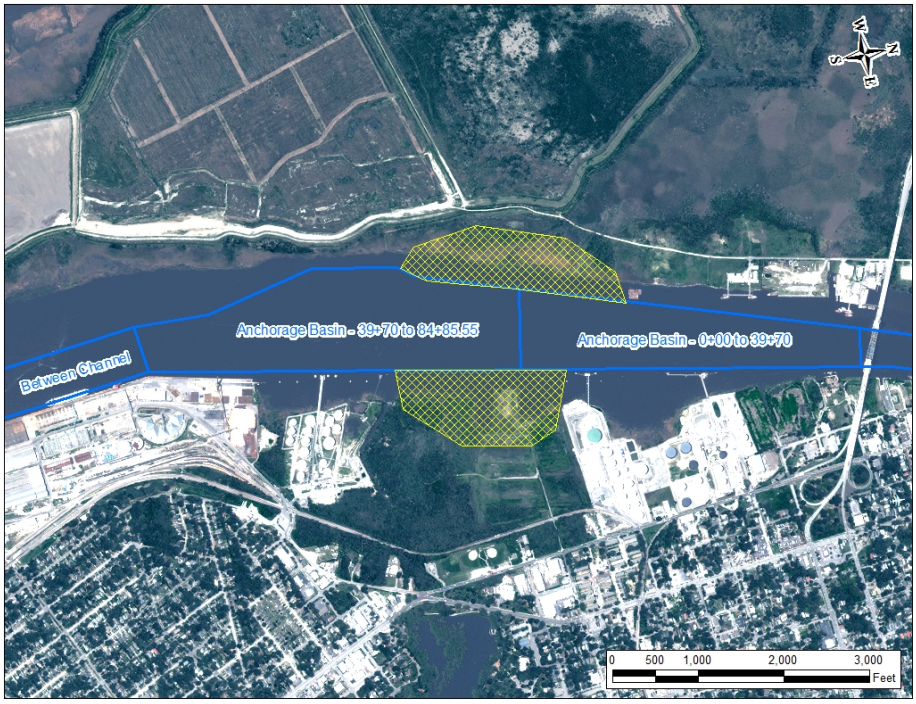

Figure 5.3. Approximate potential areas (yellow hatched) for widening the existing anchorage basin.

The widening could be towards the east, west, or some combination of the two. Expansion to the west (towards Eagle Island) could potentially cause stability issues with the Eagle Island dike. The land to the east has HTRW issues and any dredging past the

shoreline would require HTRW cleanup. Any HTRW cleanup required would be at 100% non-Federal cost.

b) *Environmental considerations*: In addition to the HTRW issues to the east, the area to the west in front of the Eagle Island dike and the shoreline adjacent to the HTRW area are wetlands and all areas outside of the existing channel and Anchorage Basin are designated Primary Nursery Areas. Analysis during the reconnaissance phase of the study indicated that 28 acres of primary nursery would potentially be impacted including about 13 acres of marsh. The mitigation costs associated with this impact would be about $11 million. If blasting is required due to the presence of rock, measures would also be required to preclude blasting impacts on fisheries, marine mammals, and sea turtles. However, marine mammals and sea turtles are not likely present this far from the ocean.

c) *Preliminary costs and benefits:* Discussion with the Port pilots indicate that expansion of the Anchorage Basin to 1,450 ft would save several minutes on turning ships greater than 900 ft in length, or that the turn could be made with the use of only one tug, rather than two (although in this case the turning time would be the same as the existing condition). A very preliminary benefits analysis based on savings from turning time alone indicates benefits of a few hundred thousand dollars over a 50-year period of analysis. These benefits do not include any relating to post-Panamax ships being able to call on the Port with the expanded Anchorage Basin width, as they cannot call under current conditions. Although a 1,450-ft wide basin does not meet the minimum recommended design criteria for any vessel longer than 965 ft, longer ships would not be prohibited from calling. Based on the ratio of a 965 ft ship turning in a 1200 ft basin (0.80), a 1,160 ft ship could theoretically turn in a 1,450 ft basin.

Analysis done during the reconnaissance phase of this study estimated the cost of widening (towards Eagle Island only - similar to recent deepening of this area in 2013) to be around $25.5 million dollars, based on dredging 1,441,000 cubic yards of sand or silt, blasting 89,000 cubic yards of rock, plus mobilization and equipment costs and a 25% contingency. This cost includes about $11 million dollars in estimated environmental mitigation costs. However, the costs did not factor in any costs associated with the stabilization of the Eagle Island dike if that were to be necessary.

d) Conclusion: Because the measure appears technically viable and implementable and there are no obvious economic or prohibitive environmental issues, it was forwarded on for further analysis.

<u>Measure AB2 – Create a new Anchorage Basin at the Mouth of the Brunswick River</u>

This measure would involve creating a new 1,450-ft wide Anchorage Basin approximately 2 miles south of the existing one, at the mouth/confluence of the Brunswick and Cape Fear Rivers. A preliminary engineering drawing of the new Anchorage Basin is shown in Figure 5.4.

a) *Technical and implementability considerations*: Further investigations/surveys would need to be conducted to adequately characterize the sediment outside of the existing channel. There are buried utility lines that would also likely have to be relocated. Larger ships that docked north of the Anchorage Basin would have to back up for 2 miles before they could turn.

b) *Environmental considerations*: Based on the preliminary alignment, all new areas to be dredged would include 54 acres of PNA, including about 5 acres of marsh. The impact would require mitigation. If blasting is required due to the presence of rock, measures would also be required to preclude blasting impacts on fisheries, marine mammals, and sea turtles. However, marine mammals and sea turtles are not likely present this far from the ocean.

c) *Preliminary costs and benefits:* It is estimated that this alternative would require the dredging of 2,460,200 cubic yards of sand or silt and 25,400 cubic yards of rock, or about twice the dredging volume of alternative AB1. Also, if similar mitigation costs per acre are used as for Measure AB1, mitigation costs would be about $21 million for AB2. The costs of relocating buried utility lines would also need to be investigated and factored into the total cost for the alternative. Although not quantified at this stage, the benefits from this alternative would also likely be somewhat lower than that of AB1 as larger ships would have to back up 2 miles from the Port before they could turn, thus increasing transit times as compared to AB1.

d) Conclusion: Because this alternative is substantially more than alternative AB1, with fewer benefits, it is screened from further consideration.

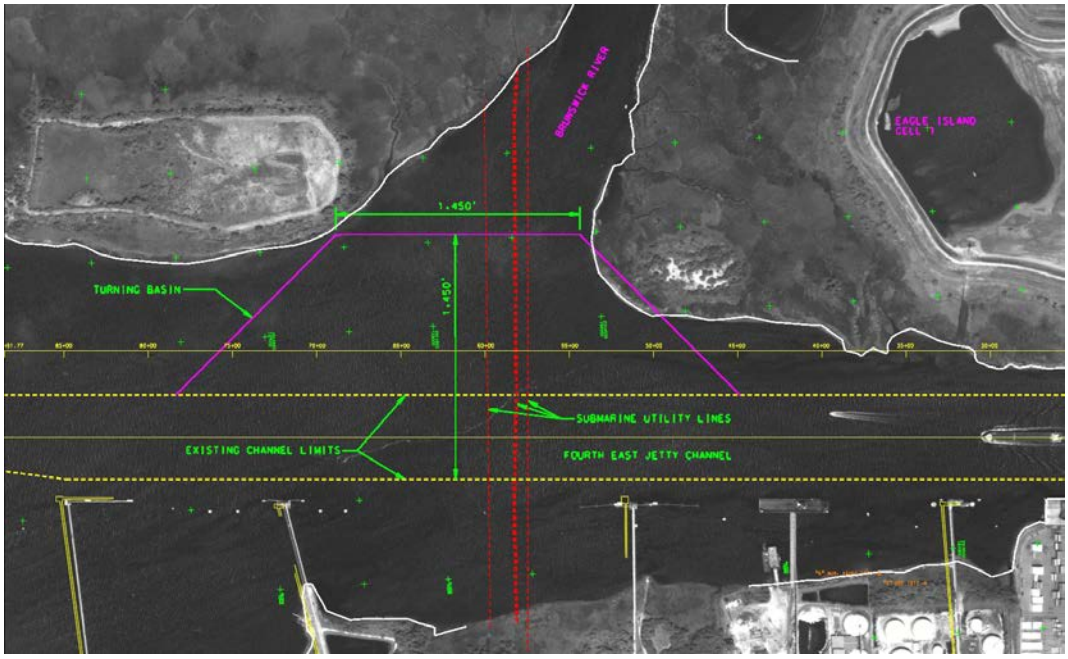

Figure 5.4. Approximate location and design (purple line) of a new Anchorage Basin.

5.5.4 Nonstructural Measures

Nonstructural measures (NS) as they relate to navigation projects can include such things actions as vessel lightering, tug assistance, vessel operating practices, traffic management, underkeel clearance restrictions, and utilization of the tide. Nonstructural measures are already being fully utilized for operating vessels as safely and efficiently as possible in the channel given the current conditions. Hence, additional nonstructural

measures for addressing the problems outlined in this study do not need to be considered further.

5.5.5 Initial Measures – Summary

Table 5.2 contains a summary of the measures screening process and results.

In addition to No Action (NA), the measures moved forward for more detailed analysis were EC1 (realigning the Entrance Channel, Reach 1), BI1 (widening the existing Battery Island Turn), and AB1 (Widening the existing Anchorage Basin to 1450 ft).

Table 5.2. Summary of measures considered.

Measure Code	Location	Description	Preliminary Cost	Benefits	Status	Reason for Screening out
EC1	Entrance Channel, Reach 1	Realign Channel	$3 million	TBD	Forwarded for further analysis	N/A
EC2	Entrance Channel, Reach 1	Hardened Structure	$64 million	TBD, probably comparable to EC1	Screened out	Cost
EC3	Entrance Channel, Reach 1	Increase Dredging Frequency	TBD but likely higher than EC1	TBD, probably lower than EC1	Screened out	Does not meet study objectives
EC4	Entrance Channel, Reach 1	Advanced Maintenance	Unknown	Unknown	Screened out	Potential unacceptable impacts to adjacent shores
EC5	Entrance Channel, Reach 1	Alteration of Sand Disposal Location	Unknown	Unknown	Screened out	To be considered under existing Wilmington Harbor 96 Act Project.
BI1	Battery Island Turn	Widen Existing Turn	$4 million	TBD	Forwarded for further analysis	N/A
BI2	Battery Island Turn	Relocate Channel	Several hundred million	TBD, probably slightly higher than BI1	Screened out	Cost, Environmental impacts
AB1	Anchorage Basin	Widen at Existing Location to 1450'	$26 million	TBD	Forwarded for further analysis	N/A
AB2	Anchorage Basin	Create new 1450' Anchorage Basin two miles south	At least twice as much as AB1	TBD, but lower than AB1	Screened out	Potential costs are higher and benefits are lower than AB1
NA	No Action	None	None	None	Forwarded for further analysis	N/A
NS	Non-Structural	None	None	None	Screened out	Fully implemented in existing and future without-project condition

5.6 Detailed Development of Final Array of Alternatives

The measures that were carried forwarded after the initial screening underwent additional engineering analysis. Discussions and input from the Cape Fear River pilots were also used to help inform the design of these alternatives. These measures became the final array of alternatives. These alternatives can provide benefits alone or can be combined with one or both of the other alternatives. The engineering analyses are discussed in more detail in Appendix B, and are summarized below.

5.6.1 Alternative 1 – Re-align Entrance Channel, Reach 1

Re-aligning the channel was analyzed as a way of obtaining a one-time reduction in the volume dredged. The reduction is a one-time occurrence since moving the channel does not reduce the littoral sediment flow into the channel or the rate at which the channel will shoal. The volume contained in three new alignments for Baldhead Shoal Channel Reach 1 was compared to the volume contained in the existing alignment for the February 2013 before dredging survey. A volume reduction can be obtained by moving the channel to the west away from the shoal that forms on the east side of the channel until the channel starts to cut into the bank on the west side of the channel which offsets reductions obtained from the move away from the shoal on the east side of the channel. The three alignments analyzed are shown in Figure 5.5 along with a table of volume reductions. While there is very little difference amongst the volume reductions for all three alignments, alignment 2 has the greatest volume reduction.

The dredged material from the relocation of the Entrance Channel, Reach 1 will be used to return beach compatible sediment back to adjacent beach system where compatible in accordance to the 2000 EA Sand Management Plan (Appendix H). Dredged material not suitable for beach disposal will be placed in the Wilmington ODMDS.

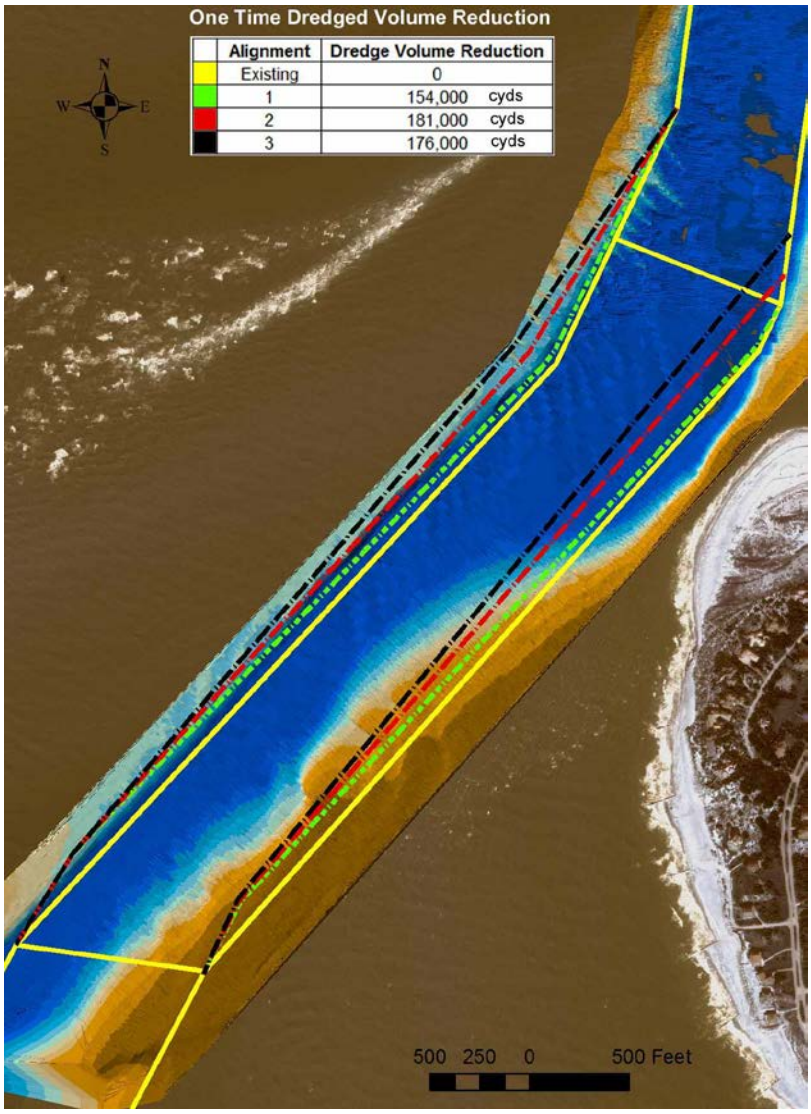

Figure 5.5. Entrance Channel, Reach 1 Relocation alternatives.

5.6.2 Alternative 2 – Widen existing Battery Island Turn (Channel)

The following improvements are proposed: (1) widen Battery Island channel to 750 ft; (2) provide 750 ft by 1,300 ft cutoff between Battery Island and Lower Swash channels; and (3) provide additional tapers where Southport and Lower Swash channels join the widened Battery Island channel. These geometric changes increase the available turning radius from about 2,850 ft to about 3,900 ft; a 37% increase (Figure 5.6).

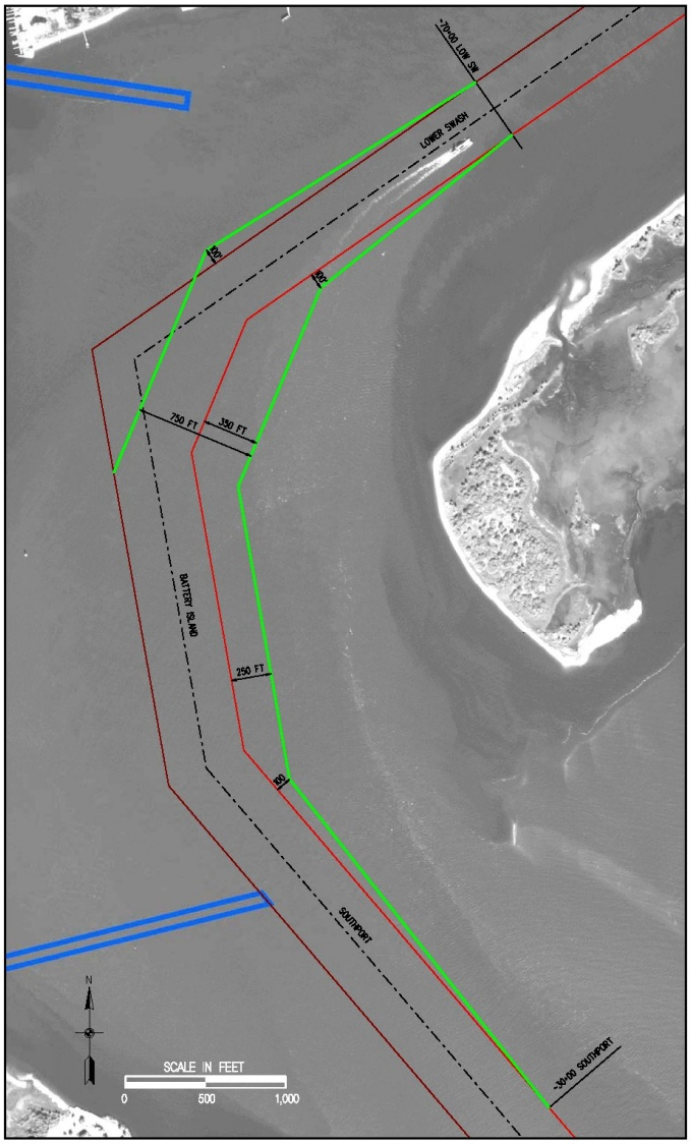

Figure 5.6. Alignment for Battery Island Turn widening.

Existing and new washprobe data collected for this study were used to determine TOR depths in the expansion area. Construction of the widened Battery Island Turn would potentially require removal of rock, although the quantities are minimal. Initial construction dredging quantities are shown in Table 5.3. The authorized depth of the channel changes from 44 ft to 42 ft at Station 30+00. Depending on the channel section, quantities were calculated to 47 ft or 45 ft, which allows for 1 ft of required overdepth and 2 ft of allowable overdepth in addition to the authorized depth. Calculation of these quantities is detailed in the Engineering Appendix (B). Dredged material from the Battery Island turn may contain silt, clay and rock which is not suitable for beach disposal. Therefore it is recommended that Battery Island turn dredged material be transported and disposed of in the ODMDS.

Proposed channel improvements are based on a combination of engineering manual (EM) guidance, previous ship simulations and input from ship pilots.

Table 5.3. Initial construction dredging quantities for the widened Battery Island Turn.

Battery Island Dredging Quantities			
Part 1			
Station 70+00 Lower Swash Channel to Battery Island Channel Intersection			
Depth (ft)	**Sediment (cy)**	**Rock (cy)**	**Total Volume (cy)**
-42*	66,122	4	66,126
-43	82,233	171	82,404
-44	100,364	838	101,202
-45	119,982	2,401	122,383
Part 2			
Battery Island Channel Intersection to Station 30+00 Southport Channel			
Depth (ft)	**Sediment (cy)**	**Rock (cy)**	**Total Volume (cy)**
-44*	263,859	24	263,883
-45	299,130	214	299,344
-46	336,292	660	336,952
-47	374,786	1,469	376,255
* Authorized depth. Additional depths are to account for required and allowable dredging overdepth.			

5.6.3 Alternative 3 – Widen Existing Anchorage Basin to 1450 ft

Figure 5.7 shows the location of the widened Anchorage Basin. The Anchorage Basin length and side slopes would remain unchanged, but it would have a maximum width of 1450 ft, which would meet the recommended design standards outlined in EM 1110-2-1613 for a 965-ft long ship. This alternative relocates the widest portion of the Anchorage Basin approximately 700 ft north of its current location. This shift northward is necessary to allow for adequate room for the widening. The factor of safety analysis is detailed in the Geotechnical Appendix (C). Two O&M scenarios were also considered for the widened Anchorage Basin. Scenario 1 would continue to maintain a portion of the existing Anchorage Basin (the area shown in orange in Figure 5.7). This would allow smaller ships that do not need the full 1450 ft width to continue to turn in the existing location, rather than having to travel the additional distance north. The river pilots indicated that maintaining this existing area would be desirable from their perspective. Scenario 2 would no longer maintain this area and thus reduce total O&M costs as compared to Scenario 1.

Existing and new washprobe data collected for this study were used to determine TOR depths in the expansion area. Construction of the widened Anchorage Basin would require removal of rock. Initial construction dredging quantities are shown in Table 5.4. The quantities are calculated to 45 ft, which allows for 1 ft of required overdepth and 2 ft

of allowable overdepth on top of the 42 ft authorized depth. Calculation of these quantities is detailed in the Engineering Appendix (B). Material would be disposed of in the Eagle Island containment area.

In terms of O&M, Scenario 1 would require approximately 218,000 cy per year of additional dredging as compared to the without-project condition. Scenario 1 would also reduce the amount of environmental mitigation required for the widening, since mitigation credits could be claimed for allowing that portion of the existing Anchorage Basin to fully shoal back in. Scenario 2 would require approximately 288,000 cy per year of additional dredging as compared to the without-project condition. The calculation of these shoaling rates/O&M dredging quantities is discussed in detail in the Engineering Appendix (B).

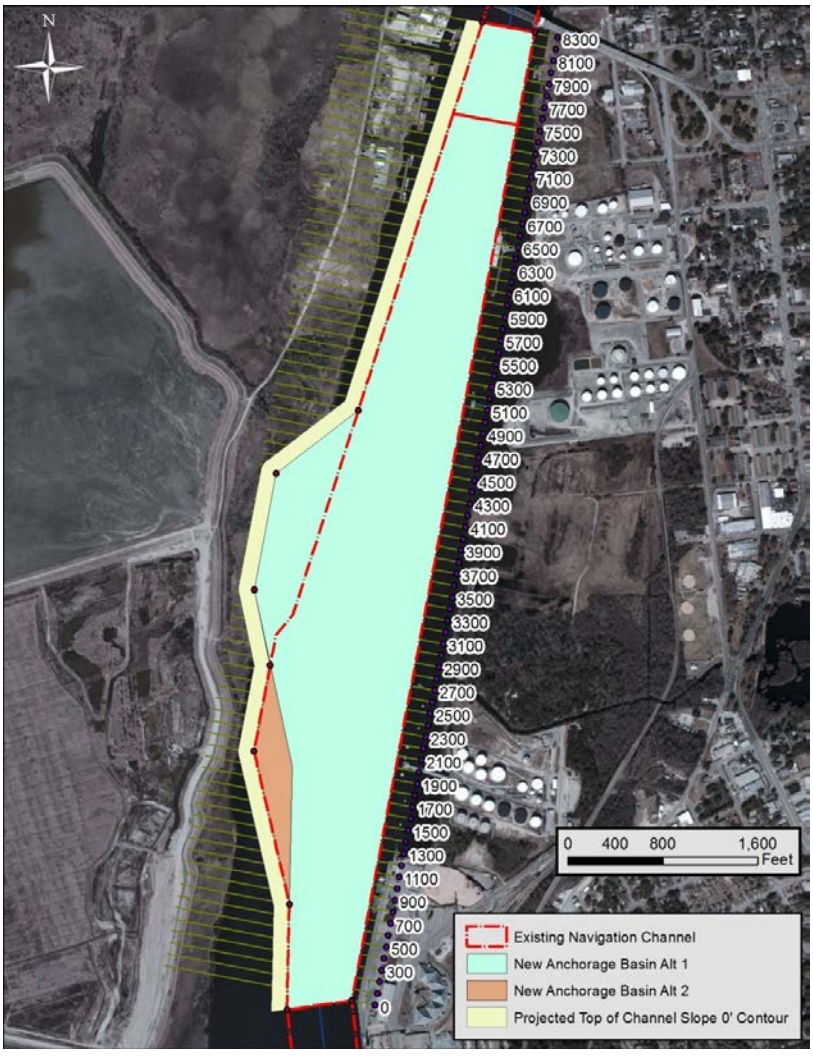

Figure 5.7. Location of widened Anchorage Basin, with different O&M scenarios.

Table 5.4. Initial construction dredging quantities for the widened Anchorage Basin at various elevation.

Elevation (ft) MLLW	Sediment (cy)	Rock (cy)	Total Volume (cy)
-42*	1,099,547	123,837	1,223,384
-43	1,118,177	144,960	1,263,137
-44	1,135,762	167,457	1,303,219
-45	1,151,145	192,484	1,343,629
* Authorized depth. Additional depths are to account for required and allowable dredging overdepth.			

5.7 Screening and Evaluation of Final Array of Alternatives

Evaluation of the final array of alternatives was used to demonstrate the positive and negative effects of each alternative. The System of Accounts defined by the Principles and Guidelines (para. 1.6.2(c)) was used to compare alternatives. The four accounts used to compare proposed water resource development plans are the national economic development (NED), environmental quality (EQ), regional economic development (RED), and other social effects (OSE) accounts.

The plans were further compared with the planning opportunities and four formulation criteria suggested by the U.S. Water Resources Council. The criteria are completeness, effectiveness, efficiency, and acceptability.

Completeness. Completeness is the extent to which an alternative plan provides and accounts for all necessary investments or other actions to ensure the realization of the planned effects. That could require relating the plan to other types of public or private plans if the other plans are crucial to achieving the contributions to the objective.

Effectiveness. All the plans in the final array provide some contribution to the planning objectives. Effectiveness is defined as a measure of the extent to which a plan achieves its objectives.

Efficiency. All the plans in the final array provide net benefits. Efficiency is a measure of the plan's cost-effectiveness expressed in net benefits.

Acceptability. All the plans in the final array must be in accordance with Federal law and policy. Acceptability is defined in terms of acceptance of the plan by the non-Federal sponsor and the concerned public.

Table 5.5 presents a comparison of the system of accounts, planning opportunities, and formulation criteria for each of the alternatives in the final array.

Table 5.5. System of accounts, planning opportunities, and formulation criteria for each of the alternatives in the final array.

Criteria	No Action Alternative	Entrance Channel, Reach 1 Alternative	Battery Island Turn Alternative	Anchorage Basin Alternative
1. Planning objectives				
Meets planning objective(s) specific for that location	No	Yes - Reduces vessel transit times and potentially future dredging costs through the Entrance Channel, Reach 1.	Yes - Reduces the transit times needed for larger vessels to negotiate the Battery Island Turn portion of the navigation channel.	Yes - Reduces the time it takes for larger vessels currently calling on the Port to turn in the Anchorage Basin and create adequate width in the Anchorage Basin to allow for the turning of even larger vessels (post-Panamax) which may call on the Port in the future.
2. System of Accounts				
National Economic Development				
Average Annual Cost	N/A	$0	$631,171	$3,627,500
Average Annual Benefits	N/A	$0	$1,251,000	$194,841
B/C Ratio	N/A	N/A	2.0	0.05
Total First Cost	N/A	Onetime $2,364,790 reduction in O&M costs in first dredging cycle	$14,652,000	$37,901,000

Criteria		No Action Alternative	Entrance Channel, Reach 1 Alternative	Battery Island Turn Alternative	Anchorage Basin Alternative
Environmental Quality					
Estuarine & Marine Environment	*Dredging Impacts on Benthic Resources*	Impacts similar to proposed actions except no new areas will be dredged.	Short term impacts to benthic macro-invertebrates associated with dredging new and existing channel area. Risk of demersal fish entrainment by dredging activities.	Short term impacts to benthic macro-invertebrates associated with dredging new and existing channel area. Risk of demersal fish entrainment by dredging activities.	Short term impacts to benthic macro-invertebrates associated with dredging new and existing channel area. Risk of demersal fish entrainment by dredging activities.
	Disposal Impacts on Benthic Resources-Beach and Surf Zone	Impacts similar to proposed actions.	Short term and localized impact to surf zone benthic macro-invertebrate community from direct burial and turbidity associated with beach placement of sediment. *	Disposal will be in the ODMDS. Impacts associated with disposal in the ODMDS have been addressed in EPA's Final EIS (USEPA 2001).	NA. Disposal in Eagle Island
	Turbidity	Impacts similar to proposed actions.	Short term impacts to adult, larval, and juvenile surf zone fishes from elevated turbidity levels associated with dredging and beach placement. *	Short term impacts to adult, larval, and juvenile fishes from elevated turbidity levels associated with dredging. Disposal will be in the ODMDS.	Short term impacts to adult, larval, and juvenile fishes from elevated turbidity levels associated with dredging. Disposal will be in Eagle Island.

* The portion of the Entrance Channel, Reach 1 sediments not suitable for beach disposal will be disposed into the ODMDS. Impacts of that disposal action will be similar to the impacts of disposal of the Battery Island Turn sediments into the ODMDS.

Criteria		No Action Alternative	Entrance Channel Alternative	Battery Island Turn Alternative	Anchorage Basin Alternative
Environmental Quality (cont.)					
	EFH-HAPC	Impacts similar to proposed actions except no new areas will be impacted	Short term impacts to water column due to elevated turbidity level from dredging and disposal.	Short term impacts to water column due to elevated turbidity level from dredging and disposal.	Loss of 4.8 acres of primary nursery area (PNA) and 12.6 acres of vegetated wetlands due to dredging of expanded basin.
Terrestrial Environment	*Beach and Dune*	Impacts similar to proposed actions.	Short term impacts to portions of the existing dune vegetation during construction. Long term sustainability of dune habitat for nesting sea turtles and other dependent mammal and avian species. Short term impacts to ghost crabs and their beach and dune habitat with long term sustainability of habitat.*	N/A. Disposal in the ODMDS	N/A. Disposal in Eagle Island.
	Shorebird Habitat	Impacts similar to proposed actions	Short term impacts to shorebird foraging due to a temporary reduction in surf zone macro-invertebrate forage base associated with construction and maintenance. Prevention of overwash fan habitat for shorebirds from constructed dune.*	N/A. Disposal in the ODMDS	N/A. Disposal in Eagle Island.

* The portion of the Entrance Channel, Reach 1 sediments not suitable for beach disposal will be disposed into the ODMDS. Impacts of that disposal action will be similar to the impacts of disposal of the Battery Island Turn sediments into the ODMDS

Criteria		No Action Alternative	Entrance Channel Alternative	Battery Island Turn Alternative	Anchorage Basin Alternative
Environmental Quality (cont.)					
Threatened and Endangered Species Terrestrial Environment	*Sea Turtles*	Impacts similar to proposed actions.	Short term decrease in sea turtle nest success associated with changes to the physical characteristics of the beach. Long term sustainability of sea turtle nesting habitat due to preservation of the beach berm Long term reduction of beach lighting impacts to sea turtles from constructed dune. Risk of sea turtle entrainment from hopper dredge.*	N/A. Disposal in the ODMDS Except risk of sea turtle entrainment from hopper dredge.	Low probability of sea turtles being in the vicinity of the Anchorage Basin.
	Sea Beach Amaranth	Impacts similar to proposed actions.	Deep burial of seeds during construction and maintenance may slow germination and population recovery over the short-term. Long term benefits of increased available sea beach amaranth habitat.*	N/A. Disposal in the ODMDS.	N/A. Disposal in Eagle Island

* The portion of the Entrance Channel, Reach 1 sediments not suitable for beach disposal will be disposed into the ODMDS. Impacts of that disposal action will be similar to the impacts of disposal of the Battery Island Turn sediments into the ODMDS

Criteria		No Action Alternative	Entrance Channel Alternative	Battery Island Turn Alternative	Anchorage Basin Alternative
Environmental Quality (cont.)					
Threatened and Endangered Species Terrestrial Environment (cont.)	*Atlantic Sturgeon*	Impacts similar to proposed actions.	Risk of Atlantic sturgeon entrainment from hopper dredged.	Risk of Atlantic sturgeon entrainment from hopper dredged.	Risk of Atlantic sturgeon entrainment from hopper dredged.
	Piping Plover	Impacts similar to proposed actions.	Short term impact to piping plover foraging, sheltering, and roosting areas. Long term preservation of these areas *.	N/A. Disposal in the ODMDS.	N/A. Disposal in Eagle Island
	Red Knot	Impacts similar to proposed actions.	Short term impact to Red Knot foraging, sheltering, and roosting areas. Long term preservation of these areas*.	N/A. Disposal in the ODMDS.	N/A. Disposal in Eagle Island
Cultural Resources		Impacts unlikely since no new areas will be dredged.	Slight risk of encountering resources associated with dredging areas since they have been surveyed.	Slight risk of encountering resources associated with dredging areas since they have been surveyed.	High risk of encountering 3 historic properties associated with expansion of the Anchorage Basin.
Mitigation		No mitigation required.	No mitigation anticipated.	No mitigation anticipated.	Mitigation required for the loss of 4.8 acres of PNA and 12.6 acres of vegetated wetlands and probably 3 historic properties due to dredging.
Water Quality		Impacts similar to proposed actions except no new areas will be dredged	Short term and localized elevated turbidity and suspended solid levels near the dredging equipment and in the surf zone.*	Short term and localized elevated turbidity and suspended solid levels near the dredging equipment. Disposal in the ODMDS.	Short term and localized elevated turbidity and suspended solid levels near the dredging equipment. Disposal will be in Eagle Island.

* The portion of the Entrance Channel, Reach 1 sediments not suitable for beach disposal will be disposed into the ODMDS. Impacts of that disposal action will be similar to the impacts of disposal of the Battery Island Turn sediments into the ODMDS

Criteria	No Action Alternative	Entrance Channel Alternative	Battery Island Turn Alternative	Anchorage Basin Alternative
Environmental Quality (cont.)				
Air Quality	Impacts similar to proposed actions.	Temporary air pollutant increase associated with dredging and heavy equipment use during initial construction and during maintenance events.	Temporary air pollutant increase associated with dredging and heavy equipment use during initial construction and during maintenance events.	Temporary air pollutant increase associated with dredging and heavy equipment use during initial construction and during maintenance events.
Noise Quality	Impacts similar to proposed actions.	Temporary noise increase associated with dredging and heavy equipment use during initial construction and during maintenance events.	Temporary noise increase associated with dredging and heavy equipment use during initial construction and during maintenance events.	Temporary noise increase associated with dredging and heavy equipment use during initial construction and during maintenance events.
Recreation and Aesthetic Resources	Impacts similar to proposed actions.	Improved appearance of beach would enhance recreational experience, and wider berm would increase recreational area. Temporary inconvenience to beach users during initial construction and future maintenance, although these would occur during low visitation months (Winter).*	N/A. Disposal in the ODMDS.	N/A. Disposal in Eagle Island.

* The portion of the Entrance Channel, Reach 1 sediments not suitable for beach disposal will be disposed into the ODMDS. Impacts of that disposal action will be similar to the impacts of disposal of the Battery Island Turn sediments into the ODMDS.

Criteria	No Action Alternative	Entrance Channel Alternative	Battery Island Turn Alternative	Anchorage Basin Alternative
Other Social Effects (OSE)				
Health and Safety	Same as existing condition	Same as existing condition	May reduce difficulty of turn	May reduce difficulty of turn
Job security and Economic Vitality	No benefit to job security as fleet forecast is the same for with and without action	No benefit to job security as fleet forecast is the same for with and without action	No benefit to job security as fleet forecast is the same for with and without action	No benefit to job security as fleet forecast is the same for with and without action
Effects on education, cultural, and recreational opportunities	No benefits to education, cultural, and recreational opportunities	No benefits to education, cultural, and recreational opportunities	No benefits to education, cultural, and recreational opportunities	No benefits to education, cultural, and recreational opportunities
Regional Economic Development				
Impact on Gross Regional Product	N/A	N/A	$11,978,900	$35,015,300
Impact on Income	N/A	N/A	$9,064,000	$26,494,700
Impact on Employment	N/A	N/A	180 jobs	526 jobs

Criteria	No Action Alternative	Entrance Channel Alternative	Battery Island Turn Alternative	Anchorage Basin Alternative
3. Evaluation Criteria				
Acceptability	The No Action Plan would continue to be acceptable to state and local entities and is compliant with existing laws, regulations, and policies. This plan is the least satisfactory to the local maritime community	The alternative is acceptable to state and local entities and is compliant with existing laws, regulations, and policies. As a result of a onetime cost savings, this alternative is preferred over the No Action plan.	The alternative is acceptable to state and local entities and is compliant with existing laws, regulations, and policies. As a result of reduced wait times for vessels calling on the Port of Wilmington, this alternative is preferred over the No Action plan.	The alternative is acceptable to state and local entities and is compliant with existing laws, regulations, and policies. However, there will be environmental impacts that would require mitigation and benefit/cost ratios are unacceptable.
Completeness	No Action would not be complete solution to navigation problem identified in the navigation corridor.	This alternative is considered a complete solution for the investment at this location (Entrance Channel, Reach 1). It does not however provide a solution for navigation issues in the other problem areas.	This alternative is considered a complete solution for the investment at this location (Battery Island Turn). It does not however provide a solution for navigation issues in the other problem areas.	This alternative is considered a complete solution for the investment at this location (Anchorage Basin). It does not however provide a solution for navigation issues in the other problem areas.
Effectiveness	The No Action Plan would maintain current level of effectiveness.	This alternative is considered an effective solution for the investment at this location (Entrance Channel, Reach 1). It does not however provide a solution for navigation issues in the other problem areas.	This alternative is considered an effective solution for the investment at this location (Battery Island Turn). It does not however provide a solution for navigation issues in the other problem areas.	This alternative is considered an effective solution for the investment at this location (Anchorage Basin). It does not however provide a solution for navigation issues in the other problem areas.
Efficiency	The No Action Plan is does not contribute to planning objectives	Most cost effective alternative for meeting the planning objective for this area. This alternative provides a onetime cost savings.	Most cost effective alternative for meeting the planning objective for this area. This alternative has a benefit-cost ratio above unity.	Most cost effective alternative for meeting the planning objective for this area. This alternative does not have benefit cost ratio above unity.

5.8 National Economic Development (NED) Plan

The National Economic Development (NED) Plan consists of Alternative 2: the Battery Island Turn (Section 5.5.2). This alternative has a benefit-cost ratio of 2.0 (table 5.5).

5.9 Locally Preferred Plan (LPP)

The Locally Preferred Plan (LPP) is the plan that differs from the NED plan and, in the opinion of the state best meets the needs of the local community. To date, the State of North Carolina has not identified an LPP.

5.10 Recommended Plan

The Recommended Plan is a combination of two alternatives; the Entrance Channel, Reach 1 (Alternative 1) (Section 5.5.1) which provides a onetime O&M cost savings to the Wilmington Harbor 96 Act, NC Project, and the Battery Island Turn (Alternative 2) (Section 5.5.2) which is the NED plan.

6.0 THE RECOMMENDED PLAN

6.1 Plan Description and Components

The Recommended Plan contains both the Entrance Channel, Reach 1 (alternative 1) and the Battery Island Turn (alternative 2) alternatives described above (Section 5).

The Recommended Plan would realign the entrance channel up to 150 ft to the west of the existing channel, away from the shoal that forms on the east side of the channel. This would result in a onetime reduction in volume dredged during the next regular O&M cycle. The realignment would not reduce the littoral sediment flow into the channel or the rate at which the channel will shoal.

The Recommended Plan would also widen the Battery Island channel to 750 ft, provide a 750-ft wide by about 1,300-ft long cutoff between Battery Island and Lower Swash channels, and provide additional tapers where Southport and Lower Swash channels join the widened Battery Island channel. These modifications to the existing channel would increase the available turning radius from approximately 2,850 ft to approximately 3,900 ft.

The project first cost for the Recommended Plan is $14,652,000. There is no cost associated with the modification to the Entrance Channel as the cost would continue to be the routine O&M cost already associated with the channel maintenance. For the first dredging cycle, there would be a onetime cost savings to the Wilmington Harbor Deep Draft Navigation Project O&M of approximately $2,364,790 as a result of decreased quantities of sediment requiring removal to achieve authorized channel depth. As a result, there is no B/C ratio associated with the Entrance Channel. The Battery Island Turn increment of the Recommended Plan provides over $1,251,000 in average annual benefits at an average annual cost of $631,829 for a B/C ratio of 2.0.

6.2 Design and Construction Considerations

The Recommended Plan would be constructed by private contractors under contract to the Federal Government. Estimated construction period is 6 months for the Battery Island Turn. The Entrance Channel, Reach 1 relocation would occur during the first dredging cycle after the completion of plans and specification (Table 11.1). For the Battery Island Turn, all sediments dredged during initial construction and maintenance would be placed in the Wilmington ODMDS (Figure 1.1) because of the high percentage of fine grain sediments and because the dredged material may contain some rock and cemented sand. The rock and cemented sand is not hard enough to require blasting (Figure 1.1). The schedule (Table 11.1) is subject to change if it is determined that the Recommended Plan can be constructed under the existing authorization for Wilmington Harbor.

6.3 Real Estate Considerations

No additional acquisition of real estate interest is required for the realignment of the Entrance Channel, Reach 1 or for widening of the turn at Battery Island. As the project has a nexus to commerce and navigation, the Government will exercise its rights under navigation servitude to construct the project. No staging or temporary work areas are

required. Real Estate considerations for areas designated for beach disposals were addressed under the Wilmington Harbor 96 Act Project.

6.4 Operation and Maintenance Considerations

Federal O&M of the Entrance Channel, Reach 1 and the Battery Island Turn is expected to be accomplished under the Wilmington Harbor 96 Act, NC Project.

6.5 Disposal Areas

Dredged material from construction of the Battery Island Turn will be placed in the EPA designated Wilmington ODMDS. The use of the site will be in accordance with the current Wilmington ODMDS Site Management and Monitoring Plan (SMMP). The site is located approximately 5 nautical miles (nmi) offshore Bald Head Island, North Carolina. The Wilmington ODMDS has an area of about 9.4 square nautical miles (nmi^2). Depths within the ODMDS range from about -35 to -52 feet local MLLW. The dredged material from the relocation of the Entrance Channel, Reach 1 will be used to return beach compatible sediment back to adjacent beach system where compatible in accordance to the 2000 EA Sand Management Plan (Appendix H). Dredged material not suitable for beach disposal will be placed in the Wilmington ODMDS.

6.6 Plan Accomplishments

Entrance Channel, Reach 1

There will be a onetime reduction in maintenance dredging. The reduction in maintenance dredging is achieved by moving the channel away from a recurring shoal into naturally deep water.

Battery Island Channel Improvements

There will be improved channel geometry at the Battery Island channel. The proposed plan effectively increases the radius of the turn by providing a widener in the Battery Island channel reach and tapers that extend into the adjacent channel reaches.

6.7 Without and With-project

The without-project condition consists of those future conditions most likely to prevail in the absence of the proposed project. The base year for this project is 2019 when the proposed alternatives will be fully functional and start generating benefits and continues to year 2069.

6.7.1 Environment

The future without project condition of environmental resources is expected to be the same as the existing condition described in Section 2.

6.7.2 Economics

It is assumed that the commodity flows and the fleet composition is the same in the without project and the with project condition.

Entrance Channel

The proposed movement of the entrance channel to follow deep water will reduce maintenance costs by approximately amount of $2,364,790 during the first dredging cycle through a reduction in quantity of material that will require dredging.

Battery Island Turn

The pilots indicated that vessels drafting over 36 ft must wait for high tide to navigate around Battery Island. It is expected this practice will continue and with the introduction of post-Panamax vessels in the fleet mix, and it is expected a tug will be required for the post-Panamax vessels in the without-project condition. It has been confirmed by Engineering there is a deficiency in the channel width for the larger vessels. Therefore, in the without-project condition it was modeled that vessels drafting greater than 36 ft would wait for tide to navigate Battery Island turn and post-Panamax vessels would require a tug to assist in the turn. Tidal availability is approximately four feet twice a day.

In the with-project condition, it is assumed vessels drafting greater than 36 ft do not have to wait for tide and post-Panamax vessels do not need tug assist around the bend because the bend will be widened to 750 ft. When taking the cost savings and multiplying by the vessel type, the transportation cost savings for the year are calculated. Using the FY14 discount rate of 3.5% over a 50 period of analysis the average annual transportation cost saving benefits are $1,106,000.

Tug Assist Benefits

The Battery Island bend easing has another benefit component. It is assumed in the Future Without Project Condition, post-Panamax vessels will need tug assistance navigating around Battery Island in addition to the tide. By widening the bend to 750 ft, tug assistance will no longer be needed for the post-Panamax vessels. It is not assumed the tug will be removed from the harbor for not being needed in the with-project condition, therefore, only variable operating costs of the tug will be used for benefit. The variable costs were calculated using the crew costs of one captain and two crew members, the number of crew members was provided by the tug company as well as the fuel cost.

An average fuel cost was calculated by using diesel fuel prices for the past five years. The tug company provided that six hours of time would be needed for a tug to help post-Panamax vessels around the Battery Island Bend, and uses 100 gallons of fuel per hour. Based on the vessel call lists, the maximum number of post-Panamax vessel transits is 63. The benefits by year were calculated by taking the crew cost for six hours ($375) plus the fuel cost for six hours ($1,932) times the number of transits of post-Panamax vessels (63). The average annual benefit for reduction in tug assistance is $145,000.

Table 6.2 shows the costs and benefits for the Battery Island Turn.

Table 6.2: Battery Island Costs and Benefits

Total Benefits	$29,341,000
Average Annual Transportation Cost Savings Benefits	$1,106,000
Average Annual Reduction in Tug Assist Benefits	$145,000
Total Average Annual Benefits	$1,251,000
Project Cost	$14,652,000
O&M	$45,000
IDC	$105,000
Average Annual Cost	$631,171
Net Benefits	$619,171
BCR	2.0

6.8 Cost Summary of Recommended Plan

The estimated project first cost for the Recommended Plan is $14,652,000 based on October 2014 price levels. The fully funded project cost is $16,189,000, escalated to an estimated construction mid-point date of 4th quarter 2019 (Table 6.3). This will be cost shared with the Non-Federal Sponsor under current cost sharing requirements (75% Federal and 25% Non-Federal). The Federal and Non-Federal cost shares are $10,989,000 and $3,663,000, respectively.

Table 6.3. Cost Summary

Item	**First Cost ($1,000s)**	**Fully Funded ($1,000s)**
PED	$ 740	$ 876
Construction	$ 13,378	$ 14,676
Construction Management	$ 534	$ 637
Total Project Cost	**$ 14,652**	**$ 16,189**

7.0 ENVIRONMENTAL EFFECTS

The following section discusses and compares the environmental effects of the Recommended Plan and the No Action alternative in the Wilmington Harbor project area. The Wilmington Harbor navigation channels are to be maintained to their authorized depth, but some widening and channel relocation is proposed to reduce ship transport and maintenance costs. A complete project description is found in Section 6.0, The Recommended Plan.

The affected environment of the project includes the area bordering the navigation channels around Battery Island, the Entrance Channel, the beaches and nearshore waters of Bald Head Island and Oak Island/Caswell Beach, and the Wilmington ODMDS.

Table 5.5 summarizes and compares the potential environmental effects of the Recommended Plan and the No Action alternative. Areas of no or inconsequential impact are not included in the table.

7.1 Sediments and Erosion

Wilmington Harbor Entrance Channel, Reach 1: Moving the channel westward was analyzed as a way of obtaining a one-time reduction in the volume dredged. The reduction is a one-time occurrence since moving the channel does not reduce the littoral sediment flow into the channel or the rate at which the channel will shoal. A volume reduction can be obtained by moving the channel to the west away from the shoal that forms on the east side of the channel until the channel starts to cut into the bank on the west side of the channel. That would offset reductions obtained from the move away from the shoal on the east side of the channel.

As described in Section 6.0, dredged material historically accumulated in the existing Entrance Channel – Reach 1 has been beach compatible and can be disposal there for future dredge cycles, as to offset ongoing erosion there. The material sampled within the proposed Entrance Channel - Reach 1, or “virgin” material, shall not be considered for beach disposal but rather the designated Wilmington ODMDS or other upland disposal sites.

Battery Island Turn: With the proposed alignment, the shoaling rate within the turn is expected to be similar to current rates because the forces that form the impeding shoals would continue to be similar. Projected shoaling rates for the turns thru the Battery Island channel (includes northern part of Southport channel and southern part of Lower Swash channel) are estimated at 12,000 cubic yards per year. The basis for the estimate is dredging pay quantities over the four dredging events that have taken place from 2004 to 2012.

As described in Section 6.0, all sediments dredged during initial construction and maintenance will be placed in the Wilmington ODMDS because the sediments contain a high percentage of silt and may contain some rock and cemented sand. The rock and cemented sand is not hard enough to require blasting. The ship-induced waves along the Southport shoreline are not expected to be significantly changed from the existing condition by implementing the proposed modifications. The southern shore of Battery Island could experience somewhat higher ship waves since the wider channel is closer

(increase wave heights by about 14%), however for existing vessel speeds, a 14% wave height increase is less than 1.5 inches and is considered negligible. See Appendix B for details.

No action: Impacts similar to proposed action except no new areas will be dredged.

7.2 Water Resources

7.2.1 Hydrology

Due to the relatively minor modifications in the channel alignment or width at the Battery Island Turn and the Entrance Channel, Reach 1, no appreciable change in hydrology is anticipated.

No appreciable change in the No Action Alternative.

7.2.2 Water Quality.

Entrance Channel, Reach 1: During construction, there would be elevated turbidity and suspended solids in the immediate area of dredging and sand deposition on the beaches when compared to the existing non-storm conditions of the surf zone. Significant increases in turbidity are not expected to occur outside the immediate construction/maintenance area (turbidity increases of 25 NTU or less are not considered significant). Turbid waters (increased turbidity relative to background levels but not necessarily above 25 NTUs) would hug the shore and be transported with waves either up-drift or down-drift depending on wind conditions. Because of the low percentage of silt and clay being pumped to the beach, turbidity impacts would not be expected to be greater than the natural increase in turbidity and suspended material that occurs during storm events and existing disposal events.

During dredging, there would be elevated turbidity and suspended solids in the immediate area of the dredge and in the overflow of scows or hopper dredges to obtain an economic load, if that type of equipment is used. Any increases in turbidity in the navigation channel during project construction and maintenance would be expected to be temporary and limited to the area surrounding the dredging. Turbidity levels would be expected to return to background levels in the navigation channel and surf zone when dredging ends.

Therefore, no appreciable change in water quality is anticipated in the navigation channel or adjacent beaches due to the proposed project. Maintenance dredging is occurring frequently in the navigation channel now along with disposal of beach quality sand on adjacent beaches in accordance with the EA SMP (2000).

No Action: Maintenance action will have similar impacts to the proposed action except no new areas will be dredged.

A Section 401 Water Quality Certificate under the Clean Water Act of 1977 (P.L. 95-217), as amended, is required for the proposed beach disposal and would be obtained from the NCDWR before construction begins. This project will use the North Carolina Division of Water Quality's March 19, 2012, Water Quality Certification No. 3908: General Certification for Projects Eligible for U.S. Army Corps of Engineers Regional General Permit 198000048 Involving Disposal of Dredged Material on Ocean Beaches

within North Carolina. It is not anticipated that there will be any issues in obtaining the certification.

Battery Island Turn: During dredging, there would be elevated turbidity and suspended solids in the immediate area of the dredge and in the overflow of scows or hopper dredges to obtain an economic load, if that type of equipment is used. For the dredging, any increases in turbidity in the navigation channel during project construction and maintenance would be expected to be temporary and limited to the area surrounding the dredging. Turbidity levels would be expected to return to background levels in the navigation channel when dredging ends.

For spider barge operation, a study was performed in Wilmington Harbor in 2002 (Reine et al. 2002) monitoring the fate of the overflow from a spider barge operation. This study was conducted in the Keg Island and Lower Big Island Channels about 16 miles upstream of the Battery Island Turn. The study was conducted during ebb and flood tide cycles and indicated that the elevated turbidity values from overflow of the scows were confined to the navigation channel. Turbidity values in the plume nearest spider barge operation reached a maximum of 128 NTU (nephelometric turbidity units) but decreased rapidly down current. Turbidity samples collected over shallow areas adjacent to the navigation channel during dredging averaged less than 30 NTU with a peak of 41 NTU at one station. These latter values were similar to background values in the shallow areas.

Based on this study (Reine et al. 2002), the Wilmington District has received all the required environmental clearances to use spider barge operations in Wilmington Harbor downstream of the mouth of the Brunswick River. The Battery Island Turn is about 19 miles downstream of the mouth of the Brunswick River. Use of spider barge operations in the Battery Island Turn should be similar to the Keg Island and Lower Big Island Channels since those latter channels average about 37% silt and the Battery Island Turn has comparable silt content.

7.2.3 Groundwater

Battery Island Turn: Dredging is not expected to adversely affect groundwater of the area. Saltwater intrusion into the groundwater is the only potential concern, but none of the dredging will be deeper than the existing navigation channel.

Entrance Channel, Reach 1: Dredging with beach placement of material would not be expected to adversely affect groundwater of the area. Saltwater intrusion into the groundwater is the only potential concern, but none of the dredging will be deeper than the existing navigation channel and disposal on the beaches will occur in an existing saltwater environment.

No Action: No Impacts.

7.3 Air Quality

Temporary increases in exhaust emissions from construction equipment are expected during dredging, dredged material disposal, and maintenance operations. The State of North Carolina does have a State Implementation Plan (SIP) approved or promulgated under Section 110 of the Clean Air Act, as amended. However, a conformity determination is not required because Brunswick County has been designated by the State

of North Carolina as an attainment area, and the direct and indirect emissions from the project fall below the prescribed de minimus levels (58 Fed. Reg. 93.153(c)(1)) and; therefore, no conformity determination would be required.

No Action: Impacts similar to the proposed action.

7.4 Marine and Estuarine Resources

7.4.1 Nekton

Surf Zone Fishes

Entrance Channel, Reach 1 (Battery Island Turn does not involve beach disposal): The surf zone is a dynamic environment, and the community structure of organisms that inhabit it (e.g., surf zone fishes and invertebrates) is complex. Representative organisms of both finfish and the invertebrate inhabitants they consume exhibit similar recruitment periods. In North Carolina, the majority of invertebrate species recruit between May and September (Hackney et al. 1996, Diaz 1980, Reilly and Bellis 1978), and surf zone fish species recruit from March through September (Hackney et al. 1996). The anticipated construction time frame for the project is from December 1 to March 31 and would avoid a majority of the peak recruitment and abundance periods of surf zone fishes and their benthic invertebrate prey source.

The surf zone represents a HAPC) for some species, including adult bluefish and red drum, which feed extensively in that portion of the ocean. The surf zone is suggested to be an important migratory area for larval/juvenile fish moving in and out of inlets and estuarine nurseries (Hackney et al. 1996). Disposal operations along the beach can result in increased turbidity and mortality of intertidal macrofauna, which serves as food sources for those and other species. However, during disposal operations, the dredged material slurry is managed through the construction of dikes to allow for a larger settling time and reduction of turbidity loads into the surf zone environment. Though mitigation efforts are undertaken to reduce turbidity loads, elevated NTU levels are still anticipated at the immediate disposal area sites. Therefore, feeding activities of the species could be interrupted in the immediate area of beach sand disposal. Mobile fish species are expected to temporarily relocate to other areas as the project proceeds along the beach. However, some species like Florida pompano and Gulf kingfish exhibit strong site fidelity during the middle portion (summer) of the nursery period (Ross and Lancaster 2002) and might not avoid secondary effects (turbidity) of disposal. Because the project would avoid impacts to the surf zone during the summer months, it is expected that the project would not affect this period of strong site fidelity. Although a short-term reduction in prey availability could occur in the immediate disposal area, only a small area is affected at a time, and once complete, organisms can recruit into the nourished area. Such a recovery would begin immediately after disposal activity if the material is similar to the native beach (see Benthic Resources—Beach and Surf Zone Section 7.4.2).

According to Ross (1996) some surf zone fishes exhibit prey switching in relation to prey availability. Therefore, during periods of low prey availability, as a result of short-term impacts to the benthic invertebrate population during beach disposal activities, surf zone fishes may temporarily use alternative food sources. Considering the dynamic nature of the surf zone, such opportunistic behavior of avoidance and prey switching might enable

some surf zone fishes to adapt to disturbances such as beach nourishment. A combination of short-term prey switching and temporary relocation capabilities may help mitigate short-term prey reductions during beach disposal operations. Once the placement operation is finished, physical conditions in the impact zone quickly recover and biological recovery soon follows. Surf-feeding fish can then resume their normal activities in the areas. That is supported in Ross and Lancaster's (2002) study in which Florida pompano and Gulf kingfish appeared to remain as long near a recently nourished beach as a beach that was not recently nourished.

Disposal and subsequent turbidity increases may have short-term effects on surf zone fishes and prey availability. However, the opportunistic behavior of the organisms within the dynamic surf zone environment enables them to adapt to short-term disturbances. Because of the adaptive ability of representative organisms in the area and the avoidance of peak recruitment and abundance time frames with a December 1 to March 31 construction time frame, such effects would be expected to be temporary and minor.

No Action: Impacts similar to proposed action.

Larval Fish Entrainment

Entrance Channel, Reach 1 and Battery Island Turn: For many marine fishes, spawning grounds are believed to occur on the continental shelf with immigration to estuaries during the juvenile stage through active or passive transport. According to Hettler and Hare (1998), research suggests two bottlenecks that occur for offshore-spawning fishes with estuarine juveniles: the transport of larvae into the nearshore zone and the transport of larvae into the estuary from the nearshore zone. During that immigration period from offshore to inshore environments, the highest concentration of larvae generally occurs in the inlets as the larvae approach the second bottleneck into the estuary. Once through the inlet, the shelter provided by the marsh and creek systems in the sound serve as nursery habitat where young fish undergo rapid growth before returning to the offshore environment.

Susceptibility to entrainment by a dredge is largely dependent on proximity to the cutter-head or drag arm, and the pumping rate of the dredge. Those larvae present near the bottom would be closer to the dredge area and would, therefore, be subject to higher risk of entrainment. Assessment of the significance of the entrainment is difficult. Assuming the very small volumes of water pumped by dredges relative to the total amount of water in the dredging vicinity, a small proportion of organisms are presumed to be affected. Potential reasons for low levels of impact include the extremely large numbers of larvae produced by most estuarine-dependent species and the extremely high natural mortality rate for early life stages of many fish species. Because natural larval mortalities might approach 99 percent (Dew and Hecht 1994, Cushing 1988), entrainment by a hydraulic dredge would not be expected to pose a significant additional risk in most circumstances.

An assessment of potential entrainment effects of the proposed dredging action may be viewed in a more site-specific context by comparing the pumping rate of a dredge with the amount of water present in the affected water body. For the purposes of this assessment, assumptions would be made that inlet bottlenecks would have the highest concentrations of larvae as they are transported into the estuarine environment from the nearshore zone. The distribution, abundance, seasonality, transport, and ingress of larval

fish at Beaufort Inlet, North Carolina, has been extensively studied (Blanton et al., 1999, Churchill et al. 1999, Hettler and Barker 1993, Hettler and Chester 1990, Hettler and Hare 1998). Therefore, it represents a good case study site for assessing larval entrainment of a hydraulic dredge. The largest hydraulic dredge likely to work in the navigation channel would have a discharge pipe about 30 inches in diameter and would be capable of transporting about 30,600 m3 of sand per day (assuming 1 mile of travel) if operated 24 hours (because of breakdown, weather, and the like, dredges generally do not work 24 hours a day, 7 days a week). The dredged sediment would be pumped as slurry containing about 15 percent sand and about 85 percent water by volume. The volume of water discharged would, thus, be about 173,000 m3 per day, or about 2.0 m3 per second. In contrast, the calculated spring tide flow through Beaufort Inlet is approximately 142,000,000 m3 × 2 = 284,000,000 m3 (i.e., two tides a day) of water and 264,000,000 m3 during neap tide. Thus, the dredge would entrain only 0.06 to 0.07 percent of the daily volume flux through the inlet. Under the worst-case scenario with the highest concentrations of larvae possible based on spatial and temporal distribution patterns, the maximum percentage entrained barely exceeds 0.1 percent per day. Although any larvae entrained would likely be killed, the effect at the population level would be expected to be insignificant.

Due to the mobility of fish beyond the larval stage, entrainment is not anticipated to be a significant issue either.

Entrainment is not anticipated to be an issue for a bucket dredge, since this type of dredge removes sediment and only small amounts of water.

No Action: Impacts similar to proposed action

Anadromous Species

As indicated in Section 2.4, anadromous species such as blueback herring, American and hickory shad, alewife, striped bass, and Atlantic and shortnose sturgeon pass through the project area to spawning areas in the upper river. Due to the mobility of these species, the dredging associated with the proposed project should not adversely impact these species. These species are not likely to be present along the beach disposal areas, but if they did occur there no impacts should occur due to their mobility.

No Action: Impacts similar to proposed action

Artificial Reefs

The NCARP manages 8 reefs that are located off Brunswick County. None are in proximity to the proposed work. The WOFES, is a reef-like community that was formed by the USACE placement of dredged rock at a location about 4 miles off Bald Head Island. None of these reefs will be impacted by the proposed dredging or disposal operations.

No Action: Impacts similar to proposed action

Primary Nursery Areas

There are no designated primary nursery areas (PNAs) in the Battery Island, navigation channel or beaches in the project area. PNAs would not be expected to be directly affected by implementing the proposed project since no PNAs are located in the project

area. The Molasses, Coward, and Smokehouse Creeks PNA is located west of the Battery Island Channel, but at least 3,500 ft away from its nearest point, and no widening is proposed on the west side of the channel.

No Action: Impacts similar to proposed action

7.4.2 Benthic Resources

Beach and Surf Zone

Entrance Channel, Reach 1 (Battery Island Turn does not involve beach disposal): Beach disposal may have negative effects on intertidal macrofauna through direct burial, increased turbidity in the surf zone, or changes in the sand grain size or beach profile. While beach disposal may produce negative effects on intertidal macrofauna, they would be localized in the vicinity of the disposal operation.

In a 1999 Environmental Report on the use of Federal offshore sand resources for beach and coastal restoration, U.S. Department of Interior (DOI), Bureau of Ocean Energy Management (BOEM, Previously Minerals Management Service (MMS)) provided the following assessment of potential effects on beach fauna from beach disposal.

> *Because benthic organisms living in beach habitats are adapted to living in high energy environments, they are able to quickly recover to original levels following beach nourishment events, sometimes in as little as three months (Van Dolah et al. 1994, Levisen and Van Dolah 1996). This is again attributed to the fact that intertidal organisms are living in high energy habitats where disturbances are more common. Because of a lower diversity of species compared to other intertidal and shallow sub tidal habitats (Hackney et al. 1996), the vast majority of beach habitats are re-colonized by the same species that existed before nourishment (Van Dolah et al. 1992, Nelson 1985, Levisen and Van Dolah 1996, Hackney et al. 1996).*

As a component of their review of the potential effects of beach disposal on surf zone fishes and invertebrates in the South Atlantic Bight, Hackney et al. (1996) identified nine fish species and five invertebrate species/groups that are important inhabitants of the intertidal and sub tidal beach environment. According to their literature review of associated impacts to these species and how best to protect the natural resources associated with beach disposal, they identified four management questions to address for each disposal project: (1) project timing, (2) sediment compatibility, (3) disposal duration, and (4) innovative ways to minimize effects (i.e., limiting the quantity of material placed on the beach at any one time). Those management questions were considered during planning efforts associated with the proposed dredging and beach construction efforts for this project. The proposed dredging window of December 1 through March 31 for initial construction and each disposal event avoids most of the identified peak recruitment periods for surf zone fish (March through September [Hackney et al., 1996]) and invertebrate species (May through September [Hackney et al. 1996, Diaz 1980, Reilly and Bellis 1978]) in North Carolina. Beach disposal would therefore be completed before the onshore recruitment of most surf zone fishes and invertebrate species. To assure compatibility of disposal material with native sediment characteristics and minimize impacts to benthic invertebrates from the placement of

incompatible sediment, all sediment identified for use for this project has gone through compatibility analysis and overfill ratio calculations to assure compatibility with the native sediment (Appendix B). Also disposal duration would be 4 months of less which should reduce impacts on recruitment. Finally limiting the quantity of material placed on the beach at any one time is not feasible since the maintenance material needs to be removed all at one time to allow the channel to be maintained to the proper width and depth for ship passage.

In summary, temporary effects on intertidal macrofauna in the immediate vicinity of the beach disposal project would be expected as a result of discharges of disposal material on the beach. While the proposed beach disposal may adversely affect intertidal macrofauna, with the implementation of environmental measures discussed above, such effects would be expected to be localized, short-term, and reversible. Any reduction in the numbers or biomass (or both) of intertidal macrofauna present immediately after beach disposal may have localized limiting effects on surf-feeding fishes and shorebirds because of a reduced food supply. In such instances, those animals may be temporarily displaced to other locations.

No Action: Impact similar to proposed action.

Entrance Channel, Reach 1 and Battery Island Turn

Entrance Channel, Reach 1: Benthic resources in and adjacent to the navigation channel are in a constant state of flux due the maintenance dredging and ship propeller wash. The proposed channel alignment will not appreciably alter that condition. Battery Island Turn: The widening of the Battery Island Turn will involve dredging about 35.9 acres of previously undredged river bottom, including side slopes (Figure 7.1). All but about 0.13 acres of this area is at or below the existing 25 ft contour at MLW. The 0.13 acre area is on the side slopes and the shallowest depth in this area is about 14 ft MLW. About 6.25 acres of the existing turn will be eliminated from future maintenance dredging.

While benthic resources in the maintained turn area are not likely to return to predredging conditions, the benthic resources in the 6.25 acres area should improve. However, there will be an overall reduction in the benthic resources in the Battery Island Turn. The resources in this area are not significant enough to required mitigation.

No Action: Impacts similar to proposed actions except no new areas will be impacted.

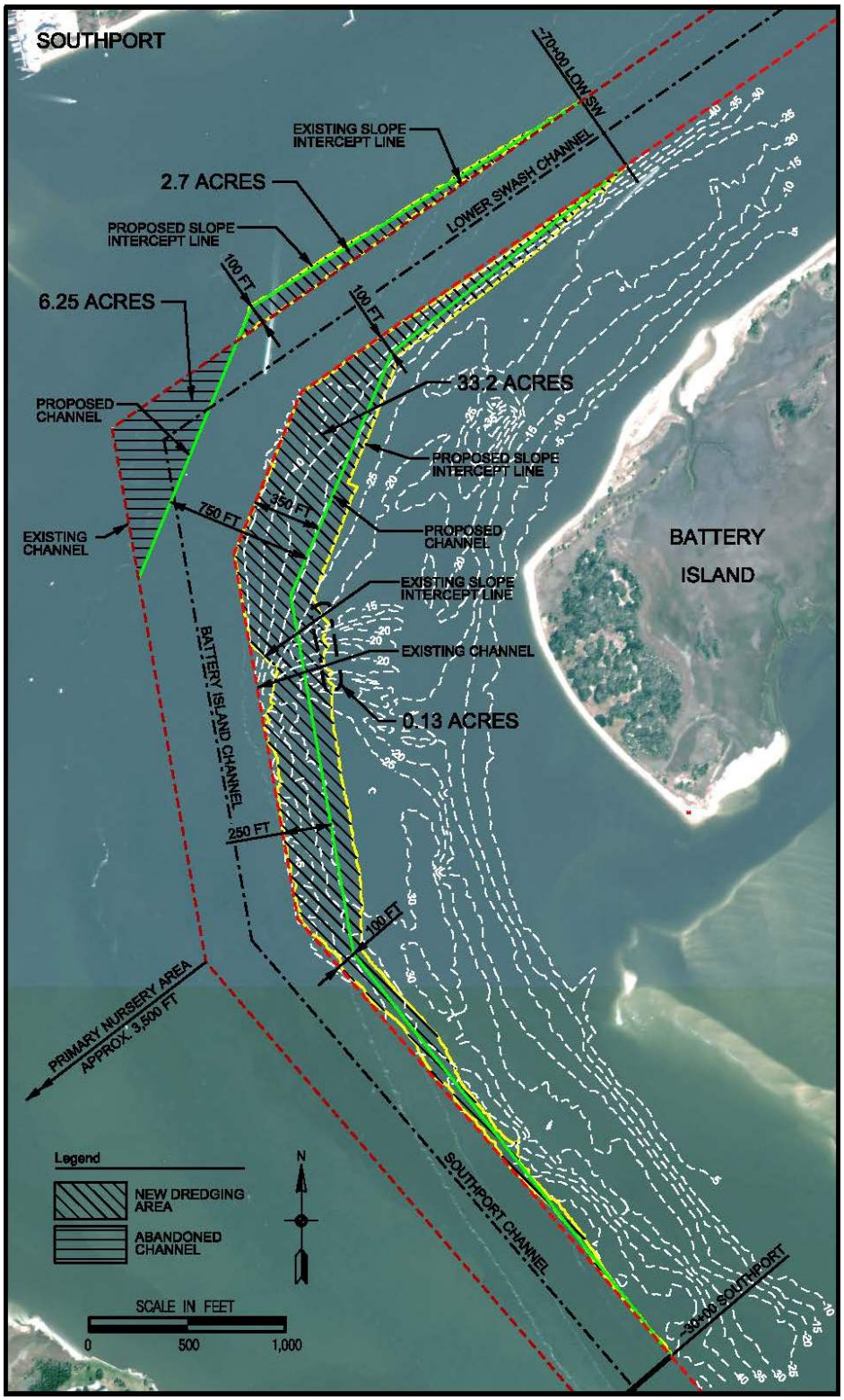

Figure 7.1. Area to be dredged at the Battery Island Turn

7.5 Essential Fish Habitat and State Managed Fish Species

Table 7.1 identifies more than 30 categories of EFH and HAPC. While all those habitat categories occur in waters of the southeastern United States, not all occur in the immediate project vicinity or the project impact zone. Effects on habitat categories potentially present in the project vicinity are discussed in the following subsections.

7.5.1 Effects on the Estuarine Water Column

Battery Island Turn and Entrance Channel, Reach 1: While the navigation channel is a part of the estuarine water column, dredging frequently occurs there and the impacts are the same as discussed in the previous section. However, the Wilmington Harbor Entrance Channel work involves beach fill. Short-term, elevated turbidity levels could occur during the placement operation and could be transported outside the immediate disposal area via longshore and tidal currents. Turbidity associated with the beach disposal operation could extend into the Cape Fear River inlet and the estuarine water column from longshore currents and tidal influx, but this turbidity should of short duration and minor due to the low percentages of silt and clay in the sand placed on the beaches.

No Action: Impacts similar to proposed action.

7.5.2 Effects on Live/Hard Bottoms

Battery Island Turn and Entrance Channel, Reach 1: Significant quantities of sand-sized sediments placed on the beach can be transported and deposited seaward as a result of short-term erosional events and the equilibration of beach fill. Over time, the evolving profile advances seaward into deeper water until it approaches equilibrium, however, sediment particles can be in motion at greater depths than those at which profile readjustment occurs. The seaward limit of effective profile fluctuation over long-term time scales is referred to as the closure depth. On the basis of the data reviewed to date, no hard-bottom features have been identified in the expected depth of closure for the study or in the dredging areas.

No Action: Impacts similar to proposed action.

7.5.3 Effects on Coral and Coral Reefs

Battery Island Turn and Entrance Channel, Reach 1: Similar to Live/Hard Bottoms discussion above, on the basis of the data reviewed to date, no coral of coral reefs have been identified in the expected depth of closure for the study or in the dredging areas.

No Action: Impacts similar to proposed action.

7.5.4 Effects on Artificial/Manmade Reefs

The NCARP manages 8 reefs that are located off Brunswick County. None are in proximity to the proposed work. The WOFES, is a reef-like community that was formed by the USACE placement of dredged rock at a location about 4 miles off Bald Head Island. None of these reefs will be impacted by the proposed dredging or disposal operations.

No Action: Impacts similar to proposed action

7.5.5 Effects on Sargassum

Battery Island Turn and Entrance Channel, Reach 1: *Sargassum filipendula* is a benthic species of *Sargassum* and is often the predominant macrophyte in nearshore areas where *Sargassum* beds grow subtidally in moderately exposed or sheltered rocky or pebble areas near hard bottom or coral reef communities (Schneider et al. 1991). No such habitat exists in the project area except possibly for the WOFES. However it is over 3 miles away from the proposed dredging and disposal operations.

Pelagic *Sargassum* sp. occur in large floating mats on the continental shelf, in the Sargasso Sea, and in the Gulf Stream. Most pelagic *Sargassum* circulates between 20° N and 40° N latitudes and 30° W longitude and the western edge of the Florida Current/Gulf Stream and forms a dynamic structural habitat with a diverse assemblage of marine organisms including fungi, micro- and macro-epiphytes, at least 145 species of invertebrates, 100 species of fishes, four species of sea turtle, and numerous marine birds. It is a major source of productivity in a nutrient-poor part of the ocean.

Pelagic *Sargassu*m is positively buoyant and, depending on the prevailing surface currents, would remain on the continental shelf for extended periods or be cast ashore. Therefore, pelagic *Sargassum* species could be transported inshore from the Gulfstream and drift through the vicinity of the dredge plant. Because *Sargassum* sp. occurs in the upper few ft of the water column, it is not subject to effects from dredging or sediment disposal activities associated with the proposed action (SAFMC 1998.) Thus, effects from the dredging or disposal operations would not be expected to be significant.

No Action: Impacts similar to proposed action.

7.5.6 Effects on the Marine Water Column

Battery Island Turn and Entrance Channel, Reach 1: The potential water quality effects of dredging and beach fill placement are addressed in Section 7.2. Dredging and beach fill placement conducted during project construction could create effects in the marine water column in the immediate vicinity of the activity potentially affecting the surf zone and nearshore ocean. Such effects could include minor and short-term suspended sediment plumes and related turbidity, and the release of soluble trace constituents from the sediment. The effects could be similar, on a smaller scale, to the effects of storms. Storm effects could include increased turbidity and sediment load in the water column and, in some cases, changes in fish community structure (Hackney et. al 1996). Storms of great severity, such as hurricanes, have been documented to create conditions resulting in fish kills, but such situations are not usually associated with beach placement. However, the impacts of the proposed action should be of short duration and minor due to the low percentages if silt and clay in the sand placed on the beaches.

No Action: Impacts similar to proposed action.

7.5.7 Effects on State-Designated Areas Important for Managed Species

Primary Nursery Areas are designated by the North Carolina Marine Fisheries Commission and are defined by North Carolina as tidal saltwaters that provide essential habitat for the early development of commercially important fish and shellfish (http://www.ncfisheries.net/rules.htm, 15 NC Administrative Code 3B .1405). Many fish

species undergo initial post-larval development in the areas. PNAs would not be expected to be directly affected by implementing the proposed project since no PNAs are located in the project area. The Molasses, Coward, and Smokehouse Creeks PNA is located west of the Battery Island Channel, but at least 3,500 ft away from its nearest point, and no widening is proposed on the west side of the channel.

7.5.8 Effects on Submerged Aquatic Vegetation (SAV)

There are no SAVs in the project area.

7.5.9 Ebb Tide Delta (Cape Fear River Inlet)

The Battery Island Turn is not located in the ebb tide delta.

The Entrance Channel, Reach 1 would be moved westward toward naturally deep water for a one time reduction in dredging cost, but the channel would be basically located near where it has been from over 150 years. No disposal will occur on the ebb tide delta. Therefore the Entrance Channel, Reach 1 will not adversely impact the ebb tide delta.

No Action: Impacts would be similar to proposed action except the Entrance Channel, Reach 1 would not be moved western toward naturally deep water.

7.5.10 Effects on Cape Fear Sandy Shoals

The sandy shoals off Cape Fear begin about 4 miles southeast of the Cape Fear River Inlet. No effects on these shoals are anticipated.

7.5.11 Effects on Big Rock and Ten Fathom Ledge

Big Rock and the Ten Fathom Ledge are north of Cape Fear, North Carolina. As such, they would not be expected to be affected by implementing the proposed project.

7.5.12 Impact Summary for Essential Fish Habitat

The proposed and No Action alternative would not be expected to cause any significant adverse impacts to EFH or HAPC for those species managed by the SAFMC and MAFMC.

Table 7.1. Categories of EFH and HAPC and potential impacts

Essential Fish Habitat	In/near project vicinity	Project impact area	Dredge plant operation	Sediment disposal activities
Estuarine areas				
Estuarine Emergent Wetlands	no	no	no	no
Estuarine Scrub/Shrub Mangroves	no	no	no	no
Submerged Aquatic Vegetation	no	no	no	no
Oyster Reefs & Shell Banks	no	no	no	no
Intertidal Flats	no	no	no	no
Palustrine Emergent & Forested Wetlands	no	no	no	no
Aquatic Beds	no	no	no	no
Estuarine Water Column	yes	yes	within acceptable limits	within acceptable limits
Seagrass	no	no	no	no
Creeks	no	no	no	no
Mud Bottom	no	no	no	no
Marine areas				
Live/Hard Bottoms	no	no	no	no
Coral and Coral Reefs	no	no	no	no
Artificial/Man-made Reefs	yes	no	no	no
Sargassum	yes	no	no	no
Water Column	yes	yes	within acceptable limits	within acceptable limits
Geographically Defined HAPC				
Area-wide				
Council-designated Artificial Reef Special Mgnt Zones	no	no	no	no
Hermatypic (reef-forming) Coral Habitat and Reefs	no	no	no	no
Hard Bottoms	yes	no	no	no
Hoyt Hills	no	no	no	no
Sargassum Habitat	yes	no	no	no
State-designated Areas of Importance of Managed Species (PNAs)	no	no	no	no
Submerged Aquatic Vegetation	no	no	no	no
Ebb Tide Delta (Cape Fear River)	yes	yes	yes	no
North Carolina				
Big Rock	no	no	no	no
Bogue Sound	no	no	no	no
Pamlico Sound at Hatteras/Ocracoke islands	no	no	no	no
Cape Fear sandy shoals	distant offshore	no	no	no
Cape Hatteras sandy shoals	no	no	no	no
Cape Lookout sandy shoals	no	no	no	no
New River	no	no	no	no
The Ten Fathom Ledge	no	no	no	no
The Point	no	no	no	no

7.6 Terrestrial Resources

Terrestrial areas that are in the vicinity of the proposed actions include the Battery Island and ocean beaches of Bald Head Island and Oak Island/Caswell Beach. However, no terrestrial resources, including vegetation, will be impacted by the proposed project except for the placement of dredging material on the beaches of Bald Head Island and Oak Island/Caswell Beach.

Entrance Channel, Reach 1: Project construction would not be expected to have an adverse effect on wildlife found along the beach or that uses foredune areas. However, short-term transient effects could occur to mammalian species and birds using the fore-dune habitat, but those species are mobile and would be expected to move to other, undisturbed areas of habitat during beach disposal.

The placement of sediment along the study area would be expected to directly affect ghost crabs through burial (USACE 2004, Lindquist and Manning 2001, Peterson et al. 2000, Reilly and Bellis 1983). Because ghost crabs are vulnerable to changes in sand compaction, short-term effects could occur from changes in sediment compaction and grain size. According to Hackney et al. (1996), management strategies are recommended to enhance recovery after beach disposal are (1) timing activities so that they occur before recruitment and, (2) providing beach sediment that favors prey species and burrow construction. Ghost crabs are present on the project beach year-round (Hackney et al. 1996), therefore, direct effects from burial could occur during the proposed construction time frame of December 1 to March 31. However, the peak larval recruitment time frame would be avoided, and because nourished sediment will be compatible with the native beach, it is expected that ghost crab populations would recover within one year post-construction (USACE 2004, Lindquist and Manning 2001, Peterson et al. 2000, Reilly and Bellis 1983). Because ghost crabs recover from short-term effects and because recommended management strategies to avoid long-term effects would be followed, no significant long-term impacts to the ghost crab population would be expected.

Although the project area is developed and sustains recreational use, migratory shorebirds could still use the project area for foraging and roosting habitat. Beach disposal activities could temporarily affect the roosting and intertidal macro-fauna foraging habitat, however, recovery often occurs within one year if disposal material is compatible with native sediments. A 2-year study in Brunswick County, North Carolina (USACE 2004) indicated that beach disposal had no measurable impact to shorebird use. Although temporary impacts to the shorebird prey base could occur in the affected areas, the entire length of the Bald Head Island and Oak Island/Caswell Beaches are impacted during each disposal event which would allow for availability of adjacent unaffected foraging habitat. Because (1) areas of diminished prey base are temporary and isolated, (2) recovery occurs within one year if material is compatible, and (3) adjacent unaffected foraging and roosting habitat would be available throughout the project, it would not be expected that foraging and roosting habitat would be significantly affected by implementing the proposed action.

Although it is possible that shorebird nesting could occur in the project area during the spring and summer months (April 1–August 31), most of the bird species have been displaced by development pressures and recreational use along the beach, thus, traditional nesting areas on the project beach have been reduced. Many of the bird species have retreated to the relatively undisturbed dredged material disposal islands that border the navigation channels in the area. Nonetheless, it is possible that shorebird species would still attempt to nest in the project area. To protect bird nesting, the NCWRC discourages beach work between April 1 and August 31. Beach disposal would usually be conducted from December 1 through March 31, but an extension into April may be required in rare cases.

On the basis of the following considerations, the proposed construction activities would not be expected to significantly affect breeding and nesting shorebirds or colonial waterbirds in the project area: (1) contractors would adhere to the April 1 to August 31 bird-nesting window except in rare cases, and (2) project construction timing and planning would allow for rapid recovery of intertidal foraging habitat in the project area.

No Action: Impacts similar to proposed action.

7.7 Wetlands and Flood Plains

Battery Island Turn and Entrance Channel, Reach 1: There are no wetlands in the project dredging footprint and beach placement operations would not be expected to adversely affect floodplains.

No Action: Impact similar to proposed action.

7.8 Endangered and Threatened Species

7.8.1 Federal

In accordance with Section 7(a)(2) of the Endangered Species Act (ESA) of 1973, as amended, the USACE initiated informal consultation with both the USFWS and NMFS for the proposed project.

A summary of effect determinations for all listed species identified in the project area relative to both the beach placement and in-water related activities for the project are provided in Table 7.2. All commitments to reduce impacts to listed species are provided below.

7.8.2 Summary of Effects Determinations

Sea Turtles—Loggerhead, Hawksbill, Kemp's Ridley, Green, and Leatherback

Entrance Channel, Reach 1: All five species are known to occur within oceanic waters adjacent to the project area; however, only the loggerhead, green, and leatherback sea turtles are known to nest within the limits of the project beach placement area. Therefore, species specific impacts may occur from the beach placement. Also, a hopper dredge may be used, and hopper dredges are known to take turtles. Considering the proposed dredging window (December 1-March 31) to avoid the presence of sea turtles and to avoid the sea turtle nesting season to the maximum extent practicable, the proposed project may affect but is not likely to adversely affect loggerhead, green and leatherback sea turtles. Re-establishment of a berm with a gradual slope can enhance nesting success of sea turtles by expanding the available nesting habitat beyond erosion and inundation prone areas.

Battery Island Turn: Hopper dredges may be used for the project, and these dredges are known to take sea turtles. However, considering the proposed dredging window (December 1-March 31) to avoid the presence of sea turtles, the proposed project may affect but is not likely to adversely affect loggerhead, green and leatherback sea turtles. No Action: Impacts similar to proposed action.

Table 7.2. Threatened and endangered species effects determination for beach placement and dredging activities associated with the proposed project area.

Listed Species w/in the Project Area		Effect Determination	
		Beach Placement Activities (USFWS)	In-Water Dredging Activities (NMFS)
Sea Turtles	***Leatherback***	MANLAA	MANLAA
	Loggerhead	MANLAA	MANLAA
	Green	MANLAA	MANLAA
	Kemp's Ridley	NE	NE
	Hawksbill	NE	NE
Large Whales	***Blue, Finback, Sei, and Sperm***	NE	NE
	NARW	NE	MANLAA
	Humpback	NE	MANLAA
West Indian Manatee		NE	MANLAA
Atlantic Sturgeon		NE	MANLAA
Shortnose Sturgeon		NE	MANLAA
Piping Plover and Red Knott		MANLAA	NE
Red-cockaded Woodpecker and Wood Stork		NE	NE
Seabeach Amaranth		MANLAA	NE
Cooley's Meadowrue and Rough-Leaved Loosestrife		NE	NE

Note: The American alligator is listed as threatened only because of its similarity of appearance to crocodilians which are endangered or threatened and which are tracked for illegal commercial trade in hides or other products. The status of the American alligator is not actually threatened
Notes: No Effect (NE = green), May Affect Not Likely to Adversely Affect (MANLAA = orange)

Large Whales—Blue Whale, Finback Whale, Humpback Whale, North Atlantic Right Whale, Sei Whale, and Sperm Whale

Battery Island Turn and Entrance Channel, Reach 1: Of the six species of whales being considered, only the North Atlantic Right whale and humpback whale would normally be expected to occur within the project area during the project construction period. Therefore, the proposed project will have no effect on the blue whale, finback whale, sei whale, and sperm whale. Conditions to reduce the potential for accidental collision (i.e. contractor pre-project briefings, large whale observers, slow down and course alteration procedures, etc.) will be implemented as a component of this project. Based on the implementation of these conditions, dredging activities associated with the proposed project may affect but are not likely to adversely affect the North Atlantic Right whale and humpback whale species.

No Action: Impacts similar to proposed project.

West Indian Manatee

Battery Island Turn and Entrance Channel, Reach 1: Since the habitat and food supply of the manatee will not be significantly impacted, overall occurrence of manatees in the project vicinity is infrequent, all dredging will occur in cold weather, and precautionary measures for avoiding impacts to manatees, as established by USFWS guidelines attached in Appendix J, will be implemented for transiting vessels associated with the project, the proposed action may affect by is not likely to adversely affect the manatee.

No Action: Impacts similar to proposed action.

Shortnose and Atlantic Sturgeon

Hopper dredges are known to take sturgeon, but the areas to be dredged are not likely to be feeding areas for sturgeon due to high velocity currents, generally sandy surface substrate, and frequent ship traffic. Therefore, it has been determined that the actions of the proposed project may affect by is not likely to adversely affect the shortnose and Atlantic sturgeon.

Piping Plover and Red Knot

There is no designated critical habitat for the wintering piping plover in the project area. The long-term effects of the project may restore some roosting, sheltering and foraging habitat areas through the addition of beach fill; however, short-term impacts to foraging, sheltering, roosting habitat may occur during project construction. Therefore, it has been determined that the project may affect, but is not likely to adversely affect the piping plover.

The Red Knot proposal for being listed as threatened was posted in the Federal Register on 30 September 2013 (Vol. 78, No. 189). If it is listed, potential impacts should be similar to the Piping Plover.

Red-cockaded Woodpecker and Wood stork

No feeding or nesting habitat exists in the project area for these species. For these reasons it has been determined that the project will have no effect on these species.

Seabeach Amaranth

Beach disposal will restore much of the existing habitat lost to erosion and is expected to provide long-term benefits to seabeach amaranth; however, construction and deep burial of seeds on a portion of the beaches during project construction may slow germination and population recovery over the short-term. Therefore, the project may affect, but is not likely to adversely affect seabeach amaranth.

No Action: Impacts similar to proposed project.

Cooley's Meadowrue and Rough-Leaved Loosestrife

No habitat exists in the project area for these species. For this reason it has been determined that the project will have no effect on these species.

American alligator

The American alligator is not likely to occur in the high salinity conditions, strong currents and high wave energy environment in the vicinity of Battery Island Turn and the Entrance Channel, Reach 1. Therefore this species should not be impacted.

No Action: Impacts similar to proposed project.

7.8.3 Consultation Summary

On January 8, 2014, the USACE initiated informal consultation under Section 7 of the ESA in with both NMFS and USFWS. Informal consultation is appropriate for the proposed action since none of species have a "May Affect Likely to Adversely Affect" determination.

7.8.4 State

As indicated in Section 2.8, the North Carolina Natural Heritage Program by letter dated August 9, 2012 (NCNHP 2012) listed the state rare plant and animal species and natural communities in the vicinity of the project area. That lists included the federal species indicated above. The Lower Cape Fear River Aquatic Habitat Significant Natural Heritage Area (SNHA) comprises the active channel of the Cape Fear River from Eagle Island downstream to Bald Head Island and supports populations of two Federally and State Endangered animals: manatee (*Trichechus manatus*) and shortnose sturgeon (*Acipenser brevirostrum*). Also supported is the Federal and State Threatened American alligator (*Alligator mississippiensis*). The site also provides important habitat for other animal species that are rare in North Carolina, including Carolina diamondback terrapin (*Malaclemys terrapin centrata*). See discussion above for manatee, sturgeon, and alligator. The Carolina diamondback terrapins generally inhabit tidal marshes and nest on sandy beaches in the estuary. None of these habits will be altered by the proposed project. The State Significantly Rare Black-necked Stilt (*Himantopus mexicanus*) breeds sporadically in the vicinity of the Anchorage Basin, depending on the availability of some standing water in diked areas of Eagle Island. Eagle Island is over 20 miles upstream of the proposed project. The Lower Cape Fear River Bird Nesting Islands SNHA, Brunswick River/Cape Fear River Marshes SNHA, and Battery Island SNHA are in the lower Cape Fear River. However Battery Island is the only site adjacent to the project. This only issue there is the slight increase in ship wakes since the widened channel would be closer to the island. However as indicated in Section 7.1, the increase in wave height is considered negligible.

Regarding the Brunswick River/Cape Fear River Marshes SNHA, no marshes will dredged, filled or otherwise impacted by the proposed project.

Based on the above discussion, the actions proposed at the Battery Island Turn and Entrance Channel, Reach 1 should not adversely impact the state indicated natural communities or species.

No Action: Impacts similar to proposed project.

7.9 Cultural Resources

Entrance Channel, Reach 1: There are no known historic properties east of the proposed entrance channel realignment within the project area of potential effects (Area of Potential Effect (APE), Figure 7.2). One historic property, a mid- to late-nineteenth century shipwreck (Target 1-14), lies approximately 730 ft west of the current entrance channel prism (Figure 7.3). Realignment of the channel 115 ft to the west is proposed at this location placing the top of slope approximately 570 ft from Target -14).

The wreck lies outside of the project's APE; however, potential project effects were assessed due to the large no impact zone around Target 1-14. The proposed project action will occur outside the 500 ft no impact zone for Target 1-14 and no effects are expected for the proposed Entrance Channel, Reach 1 realignment.

Battery Island Turn: Three shipwrecks and one engine boiler, state site numbers 0038CFR, 0052CFR, 0081CFR and 0085CFR respectively, are within the APE for the proposed realignment at Battery Island (Figure 7.4). The barge wreck (0038CFR) south of Battery Island is approximately 730 ft from the current channel prism. The proposed realignment would move the channel prism 250 ft closer, placing the top of slope approximately 420 ft from the wreck. The remains of the Confederate ironclad North Carolina (0052CFR) lie approximately 715 ft from the current channel prism. The proposed realignment would move the current channel prism 30 ft to the east and place the top of slope approximately 625 ft from site 0052CFR. The Belfast (0081CFR) is located approximately 865 ft from the existing channel prism. The proposed channel realignment would move the current channel prism 350 ft towards Battery Island and place the top of slope of the approximately 460 ft from site 0081CFR.

There are no known historic properties on the western shore of Battery Island. The current channel lies within the Southport Historic District approximately 1,300 to 1,650 ft southwest of the Southport waterfront where three historic properties have southern boundaries terminating at the river's edge (Figure7.4). The proposed realignment would move the channel 100 ft closer at one point in the outside turn before tapering to the current alignment 1,600 ft to the north (Figure 7.4). Modification of the current western channel slope would not be required due to the river depths within and adjacent to the current channel. No effects to the Southport waterfront are anticipated based on the distance of the current channel from the Southport waterfront, the slight movement of the channel to the northwest, and the speed of vessels within the Battery Island turn.

No direct effects from channel realignment are expected based on the above distances from the estimated top of slope and sites 31BW004, 31BW017, 31BW144, 0038CFR, 0052 CFR, 0081CFR, and 0085CFR. No indirect effects associated with ship induced waves anticipated due to the negligible increase in vessel wave height discussed in Section 7.1.

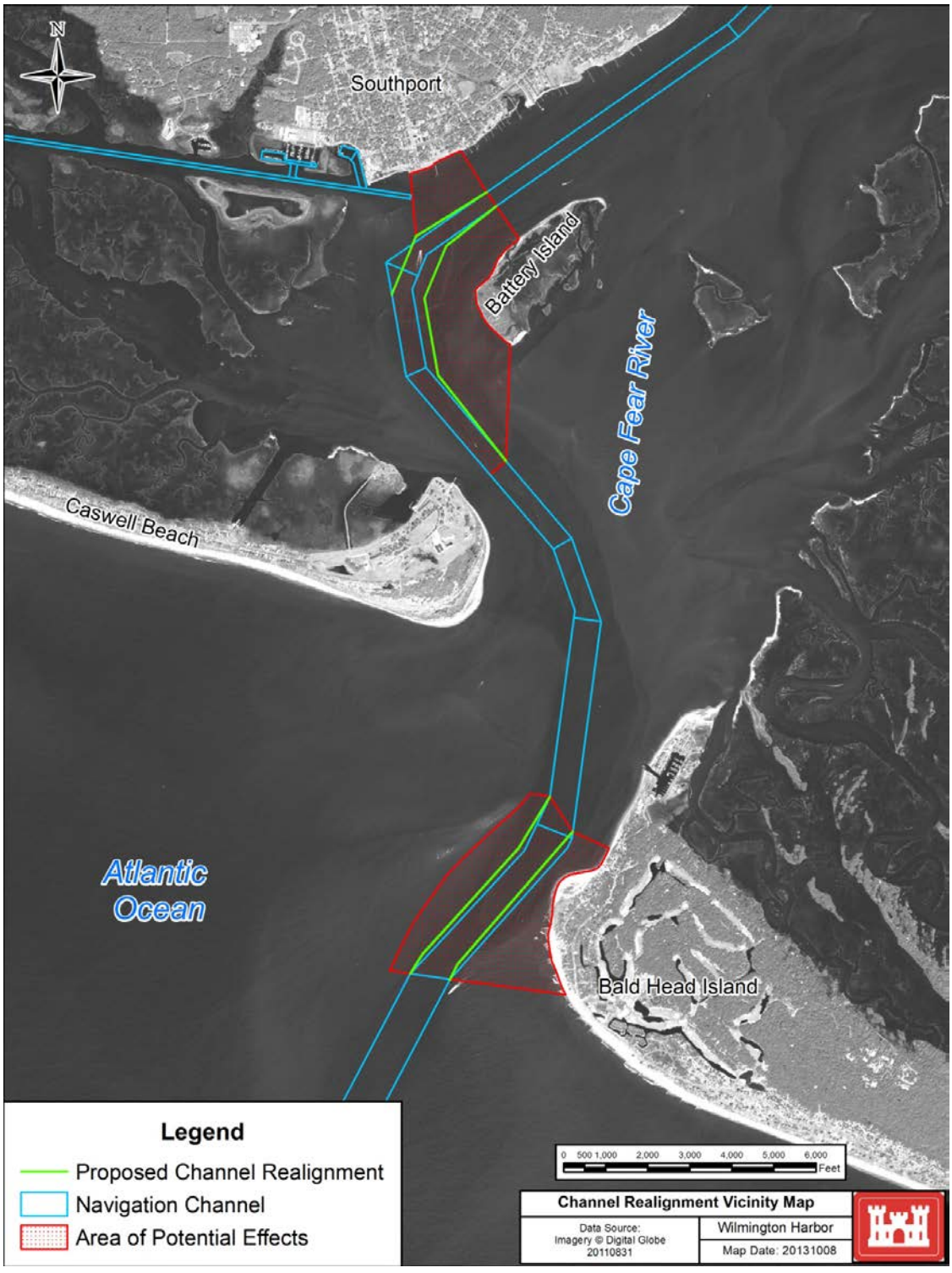

Figure 7.2. Area of Potential Effects

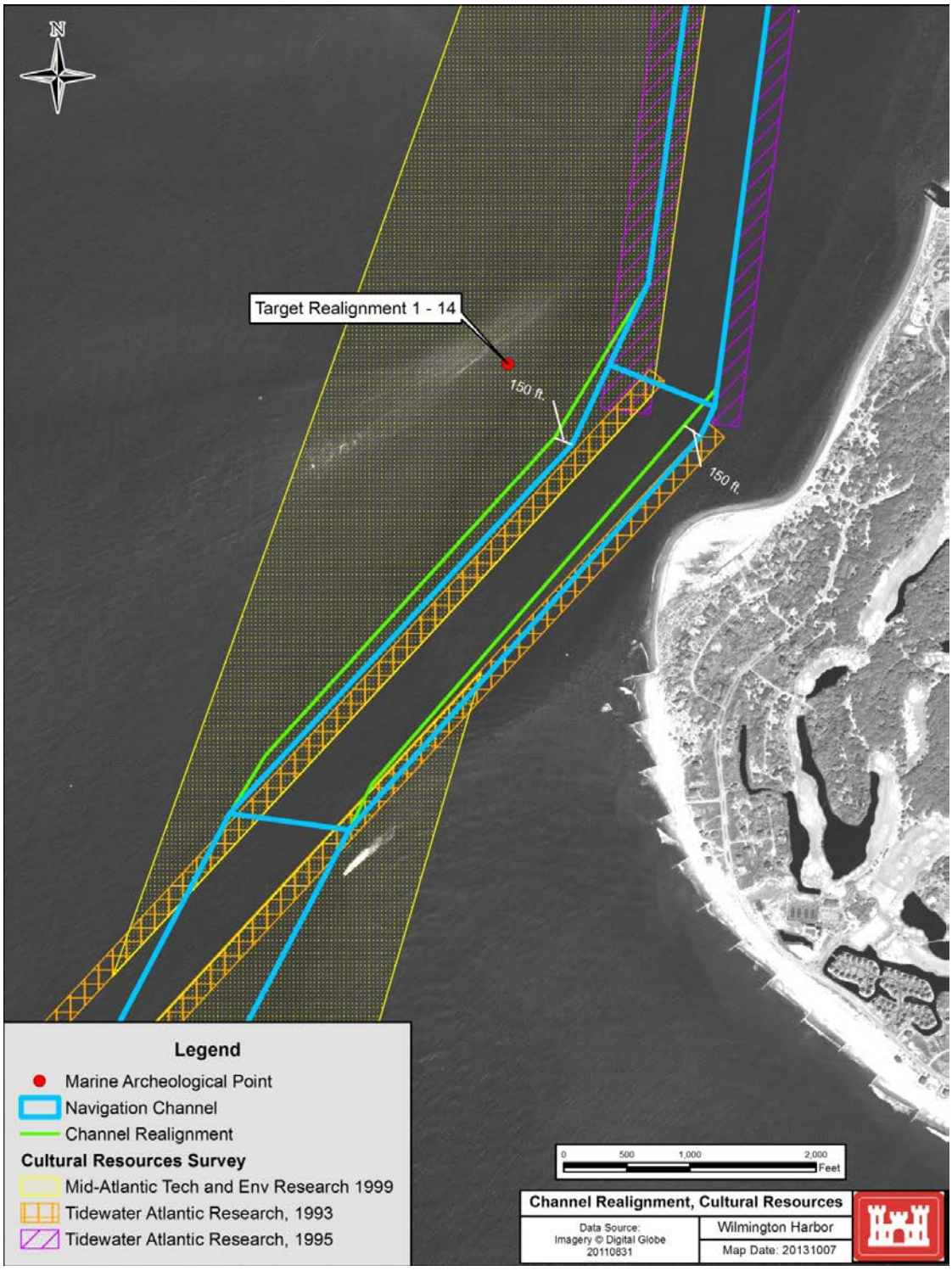

Figure 7.3. Bald Head Island Entrance Channel, Reach 1

Figure 7.4. Battery Island Turn

7.10 Aesthetic and Recreational Resources

Aesthetic resources will not be impacted because dredging and beach disposal until the proposed action will occur basically with the same frequency and duration as under existing conditions. No recreational activities will be impacted compared to existing conditions. Dredges are often present in the river and do not block traffic and sand is periodically pumped on Oak Island/Caswell and Bald Head Island Beaches.

7.11 Recreational and Commercial Fishing

No recreational or commercial fishing activities will be impacted compared to existing conditions. Dredges are often present in the river and do not work in prime fishing locations. Pumping sand on the beaches may temporarily disrupt surf fishing in the immediate area of disposal, but that is a temporary disruption and is no different than the existing periodic pumping of sand onto Oak Island/Caswell and Bald Head Island Beaches.

7.12 Coastal Barrier Resources System

The "John H. Chafee Coastal Barrier Resources System (CBRS)" will not be adversely affected by the proposed project. Portions of the existing Wilmington Harbor navigation channel border or lie within NC-07P as does a portion of the proposed channel realignment near Battery Island. However, the maintenance or construction of improvements of existing Federal navigation channels including the disposal of dredge materials related to such maintenance or construction is exempted from CBRS restrictions. http://www.fws.gov/CBRA/Consultations/Limitations-and-Exceptions.html.

7.13 Socio-Economic Resources

The Recommended Plan for the Wilmington Harbor Navigation Improvements Project is not anticipated to cause any negative socioeconomic impacts to the study area. This includes no long-term adverse impacts within local or regional employment, no adverse impacts to wages, and no detrimental impacts to local and regional tax bases.

As it is projected that the project will increase the efficiency of Port operations by reducing delay time by making it easier for larger vessels to navigate to staging areas, it is assumed that the potential for improved local and regional economies is increased by enhancements to the shipping channel. Any reduction in delays could translate to potentially more jobs and job stability as efficiency increases at the Port and at companies that are serviced by the Port. The addition of jobs in the region will theoretically improve local tax bases, leading to improved infrastructure and municipal services for the local and regional residents. Aside from direct employment impacts to the area's gross regional product, it is assumed that any expansion of direct economic inputs will result in a localized multiplier effect, potentially benefitting local businesses. This is quantified in the definition of RED in Table 5.5.

While there are no anticipated long term negative C-economic impacts from the Recommended Plan, it assumed that the impacted area will see a short-term increase in aesthetic pollution during the construction period of any project. Temporary effects on transportation including increased traffic on thoroughfares going to and from any

construction staging area are expected under any Recommended Plan, as material and equipment are hauled from the areas of the channel that are to be widened.

7.14 Hazardous and Toxic Wastes

There are no Hazardous and Toxic Waste sites in the Recommended Plan vicinity, the Battery Island Turn and the Entrance Channel, Reach 1.

7.15 Other Significant Resources (P.L. 91-611, Section 122)

7.15.1 Air, Noise, and Water Pollution

Temporary increases in exhaust emissions from construction equipment are expected during the construction of the project, however, the pollution produced would be similar to that produced by other large pieces of machinery during existing maintenance and should be readily dispersed.

Water quality impacts are discussed in Section 7.2 including the Section 404(b)(1) (P.L. 95-217) analysis in Appendix G. Noise in the outside environment associated with beach construction activities would be expected to minimally exceed normal ambient noise in the project area, however, construction noise would be attenuated by background sounds from wind and surf. In-water noise would be expected in association with the dredging activities for this project but no different than existing maintenance activities.

7.15.2 Man-made and Natural Resources, Aesthetic Values, Community Cohesion, and the Availability of Public Facilities and Services

Impacts to aesthetic values are discussed in Section 7.10. Impacts to natural resources are discussed previously throughout Section 7 including cultural resources discussed in Section 7.9. Beach disposal would benefit roads other infrastructure and residences especially in the eroded areas. Implementing the Recommended Plan would be expected to have beneficial effects on community cohesion and would reduce damage potential from storm events.

7.15.3 Adverse Employment Effects and Tax and Property Value Losses

Tax and property values will not be negatively affected by this project since private property will not be adversely impacted. Also employment will not be adversely impacted.

7.15.4 Injurious Displacement of People, Businesses, and Farms

Dredging and material placement activities will not negatively affect any people, farms, or businesses in the project area. In-water dredging activities may temporarily displace peoples utilizing the surf zone for fishing, recreation, or other purposes; however, this displacement will be short-term and will not have lasting effects.

7.15.5 Disruption of Desirable Community and Regional Growth

This project will not alter community cohesiveness or devalue communities in or near the project area. Similarly, regional growth will not be negatively affected by this project.

7.16 Summary of Cumulative Effects

The Entrance Channel, Reach 1 has been maintained in its approximate current alignment for over 100 years and is being shifted westward a maximum of 150 ft to follow naturally deep water to reduce dredging costs.

The Council on Environmental Quality (CEQ) defines cumulative impact as:

The impact on the environment which results from the incremental impact of the action when added to other past, present and reasonably foreseeable actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (40 CFR 1508.7). This detailed analysis is included in Appendix I and follows the 11-step process outlined by the CEQ in their 1997 publication *Considering Cumulative Effects Under the National Environmental Policy Act.*

Proposed Project. The assessment of cumulative effects focused on effects of the following: 1) widening of the Battery Island Turn; 2) continued placement of beach quality sediment on the Brunswick County beaches; 3) continued maintenance dredging within the existing federal navigation channels; and 4) Potential construction of a terminal groin by Bald Head Island.

1. Widening of Battery Island Turn. For the Battery Island turn widening, about 35.9 acres of the river bottom will be dredged, but the area to be dredged is essentially all over 25 ft deep and it is not designated a primary nursery area or other special designation. All but about 0.13 acres of this area is at or below the existing 25 ft contour at MLW. The 0.13 acre area is on the side slopes and the shallowest depth in this area is about 14 ft MLW. About 6.25 acres of the existing turn will be eliminated from future maintenance dredging.

No additional widening or deepening of the Wilmington Harbor Ship Channel is planned or anticipated in the foreseeable future by the USACE or other entity.

The State of North Carolina was investigating the potential of locating a new port facility north of Southport; however, the State is no longer pursuing that action.

2. Continued placement of beach quality sediment on the Brunswick County Beaches. The periodic pumping of sand on the Oak Island/Caswell and Baldhead Island Beaches has occurred for over 10 years and disposal of maintenance material on the beaches will continue under the Wilmington Harbor Sand Management Plan (Appendix F). During the deepening of Wilmington Harbor in the early 2000's, beach quality sand was placed on the Brunswick County beaches from Bald Head Island through Holden Beach. Also periodically since 2001, there has been a USACE project for placement of beach quality sand on Ocean Isle Beach.

There is one reasonably foreseeable new project on the Brunswick County Beaches and that is the Brunswick County Beaches Coastal Storm Damage Reduction (CSDR) Project. This project and any private beach nourishment projects would continue to place beach quality sediment on the same beaches that have been previously received dredged material placement. No new beach disposal areas on Brunswick County Beaches will be impacted by the proposed Wilmington Harbor Navigation Improvement Project.

Relatively small portions of North Carolina beaches (about 6%) are presently affected by the beach disposal or placement of sand from maintenance activities. With the proposed project, the impact area would not increase since disposal has occurred before on Oak Island/Caswell and Bald Head Island Beaches. On a statewide scale the existing and approved disposal sites are well distributed in northern central and southern parts of the state with undeveloped protected beaches (i.e., National/Federal and State Parks and Estuarine Reserves) in between. It is unlikely that cumulative impacts from space crowded perturbation are occurring or will occur due to the implementation of this project. The analysis suggests that the potential impact area from the proposed and existing actions is small relative to the area of available similar habitat on a vicinity and statewide basis. These areas are expected to recover food resources, which should continue to be available. It is expected that the risk is low that the direct and cumulative impacts of the proposed action and other existing similar activities, would reach a threshold with high potential for population level impacts on important commercial fish stocks and birds.

3. Effects of continued maintenance dredging. Benthic organisms within the defined federal navigation channels and widened Battery Island Turn would be lost. The benthic organisms found in the areas adjacent to the federal navigation channels would not be impacted and would provide benthic populations for recolonization. Deepening and maintenance dredging in Wilmington Harbor began in 1822 and periodic deepening occurred until the current project depth was achieved in the early 2000's. The proposed project will not involve any channel deepening and only widening in the Battery Island Turn. No additional deepening or widening is planned or anticipated for the foreseeable future. Maintenance dredging of the navigation channel and widened Battery Island Turn would be accomplished by pipeline, hopper and/or bucket and barge and would not cause any long term impacts in the project area.

4. Potential construction of a terminal groin by Bald Head Island.

The Village of Bald Head Island has applied for a Department of the Army permit and other clearances to construct a terminal structure (groin) at the western end of South Beach in close proximity to the Wilmington Harbor Navigation Project channel. The terminal groin would be intended to serve to reduce sediment loss from adjacent Bald Head Island beach fill construction projects which in turn could reduce dredge maintenance cost for the operation of the Wilmington Harbor navigation channel to an unknown degree. The terminal groin will also serve to stabilize the shoreline alignment along the western end of South Beach providing increased protection to property and infrastructure along this section of the beach. A decision on the permit application is expected late in 2014.

No Action Alternative

No adverse cumulative impacts are anticipated as a result of implementation of the No Action alternative. Maintenance dredging of the Entrance Channel, Reach 1 along its existing alignment will continue with periodic, funding dependent disposal of dredged material on the beaches of Oak Island/Caswell and Bald Head Island.

8.0 RISK & UNCERTAINTY CONSIDERATIONS

8.1 Economic Analysis Uncertainties

The Principles & Guidelines and subsequent ER1105-2-100 recognize the inherent variability to water resources planning. Navigation projects and container studies in particular are fraught with uncertainty about future conditions. A sensitivity analysis is a useful technique that addresses uncertainty by systematically adjusting parameters in a model to determine the effects of such changes.

Risk and uncertainty for the Wilmington Harbor Navigation Improvements Project are captured in various ways. The HarborSym model used in this study captures uncertainty in the vessel class attributes such as speeds and hourly cost for the vessels calling Wilmington Harbor. Turning times at the Anchorage Basin, vessel docking times, and commodity transfer rates are the categories that capture some uncertainty in the HarborSym model for the set up of the Port structure.

A sensitivity analysis was conducted for the commodity forecast for two scenarios: a no commodity growth scenario and half growth in commodities moving on the Far East trade route.

The first scenario assumed half growth for the commodities traded on the Far East. Commodity growth rates are subject to variability and are influenced by many hard to predict factors. For this reason, an adjustment was made to the Far East trade route that assumed half of the growth than the original analysis. The change was made for the Far East trade route only because the majority of the trade and benefits were derived from this region. The assumption for the fleet remained that by 2018 one of the Far East services would transition to a post-Panamax vessel. The remainder of the tonnage/TEUs would be carried on a Panamax containership. Once the commodity tonnage and TEUs were determined, the vessel fleet was determined for years 2018, 2024 and 2031 to model in HarborSym for the economic benefits. Total transportation cost savings benefits for the scenario are $18,546,300. When annualized and annual reduction in tug assist benefits included, the benefits are $791,000. The total investment cost is $14,469,700, when annualized and average annual O&M included, the annual cost are $618,900. The net benefits are $172,100 and the benefit to cost ratio is 1.28.

Another sensitivity analysis performed assumed no growth in the commodity forecast past 2018. It was assumed that growth for all trade regions occurred until the base year of 2018 and held constant afterwards. Hence, the number of calls per vessel type remained constant through the period of analysis, 2018 through 2067. Total transportation cost savings benefits are $21,192,000. When annualized and added to the annual reduction in tug assist cost, the average annual benefits are $903,000. The total investment cost remains at $14,800,000, when annualized and average annual O&M included the annual cost are $644,000. The net benefits are $259,000 and the benefit to cost ratio is 1.40.

8.2 Engineering

There is a risk associated with not performing a ship simulation analysis for the proposed improvements. A ship simulation would have provided a greater degree of confidence that ships would be able to navigate the modified entrance channel. But since the design vessel is currently navigating the channel, there is a low level of risk associated with this uncertainty. Additionally, the pilots do not envision any problems with the proposed Entrance Channel, Reach 1 realignment. There is also low risk associated with not performing a ship simulation analysis for the Battery Island Turn (channel) improvements: since the existing turn is made less severe and the pilots are in agreement with the proposed channel geometry changes.

Construction risk for the proposed study is considered low since subsurface information has been gathered, this type of construction has been performed before, and traditional dredging methods are expected to be used in performing the construction. Potential for risks associated with O&M are also low. A slight temporary increase in shoaling volume is expected until the widened channel banks stabilize and this increase is accounted for in the cost estimate. (also addressed in the Engineering Appendix (B)).

8.3 Cost Risk Analysis

A Cost Risk Analysis is a systematic and comprehensive method to evaluate uncertainty and risks that may affect the estimated project costs. Risks were characterized by the magnitude of possible uncertainties and the probability of occurrence for each item or event. In compliance with Engineer Regulation 1110-2-1302 Civil Works Cost Engineering, dated September 15, 2008, the USACE performed an abbreviated risk analysis to establish project contingencies by identifying and measuring the cost and schedule impact of project uncertainties with respect to the estimated project cost. The Cost Risk Analysis for this project was conducted by the USACE' Cost Engineering Center of Expertise at Walla Walla District. Details of the analysis can be found in the Cost Appendix (F).

8.4 Environmental Impact and Mitigation Uncertainties

Consideration was given to uncertainties that exist in the ability to predict the impacts from the proposed improvements to the Wilmington Harbor. Uncertainties occur when knowledge is incomplete. In the case of this project, there are uncertainties in such things as sediment quality, beach placement, and exposure of cultural resources. The major risks associated with the environmental analysis are (1) that the predicted level of impacts understates the actual impacts that will occur, and (2) that such understatement would alter a decision-maker's conclusions on whether the project should be constructed.

8.5 Risks and Uncertainty with Sea Level Change

USACE guidance (EC-1165-2-212) requires consideration of three possible future rates of sea-level change (SLC). SLC predictions for the USACE low, intermediate, and high rates are shown in Figure 8.1. The sea-level rise predictions over a 50 year period range from 0.4 ft to 2.0 ft. SLC is not expected to adversely affect the proposed changes to the existing navigation channel since changes due to SLC to the coastal processes affecting

the navigation channel would be the be the same with or without the projects under all scenarios.

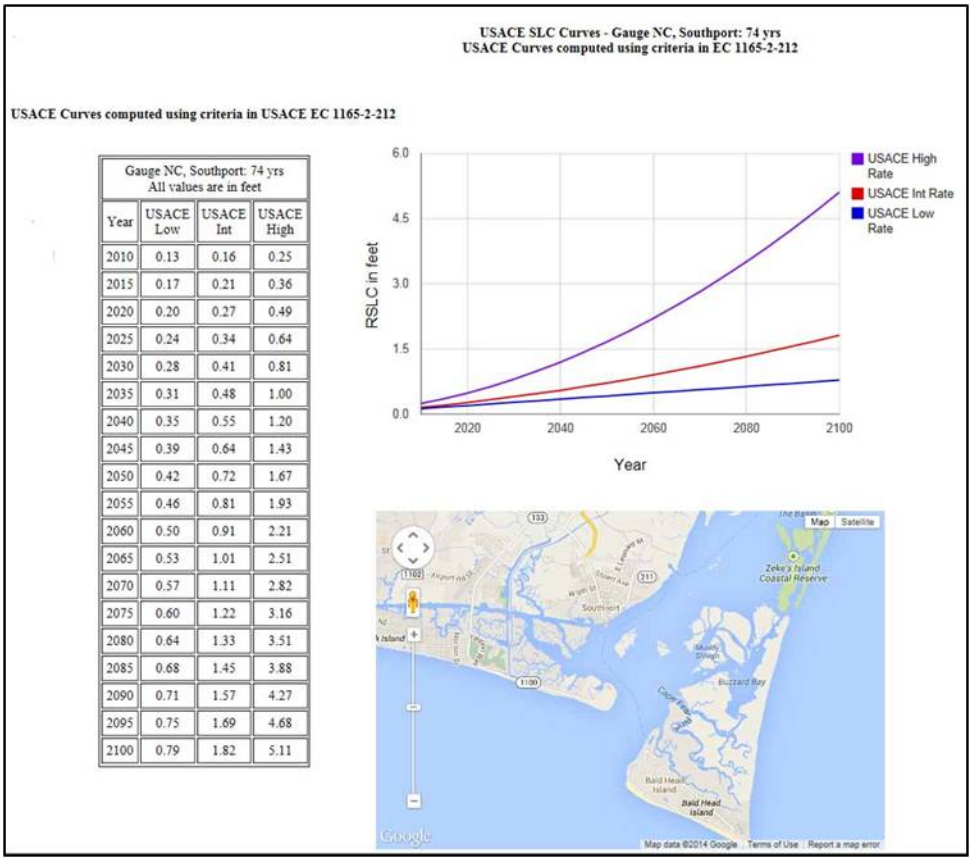

Figure 8.1. Sea-Level Change at the mouth of the Cape Fear River.

9.0 COMPLIANCE WITH ENVIRONMENTAL REQUIREMENTS*

The following paragraphs summarize the relationship of the proposed action to the most pertinent Federal, State, and local requirements. Table 9.1 at the end of this section lists the compliance status of all Federal laws and policies that were considered for the proposed Wilmington Harbor Improvements Project.

9.1 Water Quality

9.1.1 Section 401 of Clean Water Act of 1977

A Section 401 Water Quality Certificate under the Clean Water Act of 1977 (P.L. 95-217), as amended, is required for the proposed beach disposal and would be obtained from the NCDWQ before construction begins. This project will use the North Carolina Division of Water Quality's March 19, 2012, Water Quality Certification No. 3908: General Certification for Projects Eligible for U.S. Army Corps of Engineers Regional General Permit 198000048 Involving Disposal of Dredged Material on Ocean Beaches Within North Carolina. It is not anticipated that there will be any issues in obtaining the certification.

9.1.2 Section 404 of Clean Water Act of 1977

Pursuant to Section 404 of the Clean Water Act, the effects associated with the discharge of fill material into waters of the United States are discussed in the Section 404(b)(1) (P.L. 95-217) evaluation in Appendix G.

9.2 Marine Protection, Research, and Sanctuaries Act

The proposed Wilmington Harbor improvements at Battery Island would involve ocean disposal of dredged material. The presence of rock and/or cemented sands and high percentage of fines precludes its placement on the beaches. The dredged material would be evaluated pursuant to Section 103 of the MPRSA. Concurrence by EPA is required prior to transportation for the purpose of disposal. The Wilmington Harbor ODMDS Site Management and Monitoring Plan (SMMP) directs dredged material disposal in that EPA designated site.

9.3 Essential Fish Habitat

Potential project effects on EFH species and their habitats have been evaluated and are addressed in Section 7.5 of this document. It has been determined that the proposed action would not have a significant adverse effect on such resources. Informal EFH consultation has been ongoing since study commencement. Through coordination of the EA document with the NMFS, consultation will be officially initiated and concurrence with the USACE findings will be requested. Compliance obligations related to EFH provisions of the 1996 congressional amendments to the MSFCMA (P.L. 94-265) would be fulfilled before initiation of the proposed action.

9.4 Fish and Wildlife Resources

The Fish and Wildlife Coordination Act, as amended (16 U.S.C. 661, et seq), requires that the USACE coordinate and obtain comments from the USFWS, the NMFS, where applicable, and appropriate State fish and wildlife agencies, including the NCDMF and the North Carolina Wildlife Resources Commission. A Draft Fish and Wildlife Coordination Act Report (Appendix J) has been provided by the USFWS under the Fish and Wildlife Coordination Act.

9.5 Endangered and Threatened Species

A Biological Assessment evaluating the potential effects of the proposed action on Federally listed threatened and endangered (T&E) species has been prepared and will be coordinated with the USFWS (jurisdiction over the Florida manatee, nesting sea turtles, piping plovers, red knots, and seabeach amaranth) and NMFS (jurisdiction over other protected marine and aquatic species which can occur in the project vicinity) pursuant to Section 7 of the ESA of 1973 (P.L. 93-205), as amended. All compliance obligations under Section 7 will be satisfied. Environmental commitments to protect listed species, related to the construction and maintenance of the proposed project, are listed in Appendix K. The list of commitments should be considered preliminary at this stage and may be modified pending new information acquired through the public and agency review process.

9.6 Cultural Resources

A summary of the all the proposed Wilmington Harbor Improvements was submitted to the SHPO pursuant to Section 106 of the National Historic Preservation Act. The SHPO responded that all of the proposed improvements fall within areas previously surveyed for submerged cultural resources. The SHPO concurred with the finding that the work should have no impact on unknown submerged resources. As noted in the numerous survey reports, there are several known historic shipwrecks within the APE that must be considered. Extreme care will be taken during all dredging operations for channel realignment and all personnel will be made aware of restrictive buffer zones around these shipwreck sites.

9.7 Executive Order 11988 (Flood Plain Management)

Executive Order 11988 requires Federal agencies to avoid to the extent possible the long and short-term adverse impacts associated with the occupancy and modification of flood plains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. In accomplishing this objective, "each agency shall provide leadership and shall take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health, and welfare, and to restore and preserve the natural and beneficial values served by flood plains in carrying out its responsibilities.

The project is responsive to the EO 11988 objective of “avoidance, to the extent possible, of long- and short-term adverse impacts associated with the occupancy and modification of the base flood plain and the avoidance of direct and indirect support of development in the base flood plain wherever there is a practicable alternative” because it would not induce development in the floodplain, would reduce the hazard and risk associated with floods thereby minimizing the impacts of floods on human safety, health, and welfare, and would restore and preserve the natural and beneficial values of the base floodplain.

9.8 Executive Order 11990 (Protection of Wetlands)

Executive Order 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. The proposed action would not require filling any wetlands and would not be expected to produce significant changes in hydrology or salinity affecting wetlands. The proposed action is in compliance with Executive Order 11990.

9.9 Executive Order 13186 (Responsibilities of Federal Agencies to Protect Migratory Birds)

Executive Order 13186 directs departments and agencies to take certain actions to further implement the Migratory Bird Treaty Act. Specifically, the executive order directs Federal agencies, whose direct activities would likely result in the take of migratory birds, to develop and implement a Memorandum of Understanding (MOU) with the USFWS that must promote the conservation of bird populations. As discussed in Section 7.03.4, in consideration of the identified mitigation measures including dredging and placement windows, the proposed project would not be expected to adversely affect migratory birds and therefore, is in compliance with Executive Order 13186.

9.10 North Carolina Coastal Management Program

The proposed action would be conducted in the designated coastal zone of North Carolina. Pursuant to the Federal Coastal Zone Management Act of 1972, as amended (P.L. 92-583), Federal activities are required to be consistent, to the maximum extent practicable, with the federally approved coastal management program of the State in which their activities will occur. The components of the proposed action have been evaluated and determined to be consistent with the North Carolina Coastal Management Program and local land use plans. Concurrence with this determination will be requested from the North Carolina Division of Coastal Management.

9.11 Coastal Barrier Resources Act

The Coastal Barrier Resources Act (CBRA) of 1982 (P.L. 97-348) prohibits expenditure of Federal funds for activities within the designated limits of the Coastal Barrier Resources System unless specifically exempted by Section 6 of the act. As stated in that section, Federal expenditures are allowable in association with maintenance of existing channel improvements, including disposal of dredged material related to such improvements.

The "John H. Chafee Coastal Barrier Resources System" will not be adversely affected by the proposed project. Portions of the existing Wilmington Harbor navigation channel border or lie within NC-07P as does a portion of the proposed channel realignment near Battery Island. However, the maintenance or construction of improvements of existing Federal navigation channels including the disposal of dredge materials related to such maintenance or construction is exempted from CBRS restrictions.

9.12 Estuary Protection Act

The Estuary (Estuarine) Protection Act provides a means to protect, conserve, and restore estuaries in a manner that maintains balance between the need for natural resource protection and conservation and the need to develop estuarine areas to promote national growth. The act authorizes the Secretary of the Interior to work with the states and other Federal agencies in undertaking studies and inventories of estuaries of the United States. The proposed project would be expected to have minimal effect on the estuarine environment, as discussed in Section 7 of this report; therefore the project would be in compliance with the Estuary Protection Act.

9.13 Sedimentation and Erosion Control

Pursuant to the Sedimentation Pollution Control Act of 1973, a State-approved soil erosion and sedimentation control plan would be implemented during construction to minimize soil loss and erosion.

9.14 Prime and Unique Agriculture Land

According to the Soil Surveys for Brunswick County, North Carolina, the soils on the beach that could be affected by the proposed project are not designated by the Natural Resource Conservation Service as prime or unique agriculture lands. No impacts to prime and unique agriculture lands would be expected to occur.

9.15 Environmental Justice

The proposed action would impact Bald Head Island and Oak Island beaches. The proposed action would not cause disproportionately high and adverse impacts on minority populations or low income populations. No impacts to either minority/low-income populations or low income communities are anticipated as a result of the Proposed Action therefore the action would comply with EO 12898.

Table 9.1. The relationship of the proposed action to Federal laws and policies.

Title of public law	U.S. Code	Compliance status
Abandoned Shipwreck Act of 1987	43 U.S.C. 2101	Full Compliance
Anadromous Fish Conservation Act of 1965, As Amended	16 U.S.C. 757 a et seq.	Full Compliance
Antiquities Act of 1906, As Amended	16 U.S.C. 431	Full Compliance
Archeological and Historic Preservation Act of 1974, As Amended	16 U.S.C. 469	Full Compliance
Archeological Resources Protection Act of 1979, As Amended	16 U.S.C. 470	Full Compliance
Clean Air Act of 1972, As Amended	42 U.S.C. 7401 et seq.	Full Compliance
Clean Water Act of 1972, As Amended	33 U.S.C. 1251 et seq.	Full Compliance
Coastal Barrier Resources Act of 1982	16 U.S.C. 3501-3510	Full Compliance
Coastal Zone Management Act of 1972, As Amended	16 U.S.C. 1451 et seq.	Full Compliance
Endangered Species Act of 1973	16 U.S.C. 1531	Full Compliance
Estuary Program Act of 1968	16 U.S.C. 1221 et seq.	Full Compliance
Federal Water Project Recreation Act of 1965, As Amended	16 U.S.C. 4601	Full Compliance
Fish and Wildlife Coordination Act of 1958, As Amended	16 U.S.C. 661	Full Compliance
Flood Control Act of 1944, As Amended, Section 4	16 U.S.C. 460b	Full Compliance
Historic and Archeological Data Preservation	16 U.S.C. 469	Full Compliance
Historic Sites Act of 1935	16 U.S.C. 461	Full Compliance
Magnuson Fishery Conservation and Management Act	16 U.S.C. 1801	Full Compliance
Marine Protection, Research and Sanctuaries Act of 1972	33 U.S.C. 1401	Full Compliance
Migratory Bird Conservation Act of 1928, As Amended	16 U.S.C. 715	Full Compliance
Migratory Bird Treaty Act of 1918, As Amended	16 U.S.C. 703	Full Compliance
National Environmental Policy Act of 1969, As Amended	42 U.S.C. 4321 et seq.	Full Compliance
National Historic Preservation Act of 1966, As Amended	16 U.S.C. 470	Full Compliance
National Historic Preservation Act Amendments of 1980	16 U.S.C. 469a	Full Compliance
Native American Graves Protection and Repatriation Act	25 U.S.C. 3001	Full Compliance
Noise Control Act of 1972, As Amended	42 U.S.C. 4901 et seq.	Full Compliance
River and Harbor Act of 1899, Sections 9, 10, 13	33 U.S.C. 401-413	Full Compliance
River and Harbor and Flood Control Act of 1970, Sections 122, 209 and 216	33 U.S.C. 426 et seq.	Full Compliance
Submerged Lands Act of 1953	43 U.S.C. 1301 et seq.	Full Compliance
Protection and Enhancement of Environmental Quality	11514/11991	Full Compliance
Protection and Enhancement of the Cultural Environment	11593	Full Compliance
Floodplain Management	11988	Full Compliance
Protection of Wetlands	11990	Full Compliance
Federal Compliance with Pollution Control Standards	12088	Full Compliance
Federal Compliance with Right-To-Know Laws and Pollution Prevention	12856	Full Compliance
Federal Actions to Address Environmental Justice and Minority and Low-Income Populations	12898	Full Compliance
Protection Of Children from Environmental Health Risks and Safety Risks	13045	Full Compliance
Invasive Species	13112	Full Compliance
Marine Protected Areas	13158	Full Compliance
Responsibilities of Federal Agencies to Protect Migratory Birds	13186	Full Compliance

Note: Items identified as being in Full *Compliance* will be in full compliance status after the NEPA process is complete.

10.0 SUMMARY OF AGENCY AND PUBLIC INVOLVEMENT

10.1 Scoping

A scoping letter describing the proposed Wilmington Harbor Navigation Improvement Project and requesting public and agency participation was circulated July 5, 2012 and a scoping meeting was held on August 7, 2012 in Wilmington, NC. Agency and public responses were received from: the US Department of Interior – US Fish and Wildlife Service, US National Oceanic and Atmospheric Administration-National Marine Fisheries Service, State of North Carolina (Natural Heritage Program, Division of Coastal Management and Department of Cultural Resources), Village of Bald Head Island, Kilpatrick Townsend & Stockton LLP representing Towns of Caswell Beach and Oak Island, and North Carolina Baptist Assembly.

10.2 Cooperating Agencies

Pursuant to Section 1501.6 of the CEQ NEPA Regulations, eligible Federal, State, and local agencies, along with stakeholders interested in or affected by the Federal agency decision on this project can participate as a cooperating agency. No agency indicated interest in become a cooperating agency.

10.3 Fish and Wildlife Coordination

A Draft Coordination Act Report (DCAR) was provided by the USFWS dated March 13, 2014, and is included in Appendix J. USACE has considered the recommendations of the USFWS. Responses can also be found in Appendix J.

10.4 Coordination of this Document

10.4.1 Public Review

The proposed action and the environmental impacts of the proposed action are addressed in the Wilmington Harbor Navigation Improvements Draft Integrated Feasibility Report and Environmental Assessment (EA), dated April 2014. The Draft Integrated Feasibility Report and EA has been made available to an extensive list of local, State and Federal regulatory agencies and the public on June 2014 for a 30-day review and comment period. The Feasibility Report and EA have also been placed on the Wilmington District Website.

10.4.2 Review Plan

The Review Plan (Appendix L) was originally developed in June of 2012 with the Deep Draft Navigation Planning Center of Expertise and the USACE Cost Engineering Center of Expertise in Walla Walla District and is currently being updated to reflect recent study activities and the IEPR waiver (March 2014). Reviews include District Quality Control reviews and Agency Technical Reviews of the Draft and Final Reports. A policy review and a legal review will be conducted on the Draft Report. Additional reviews include cost engineering review and certification, and legal review and certification.

10.4.3 IEPR

On the basis of the USACE Peer-review Guidance (EC1165-2-214), this study does not

meet the triggers for an independent external peer review (IEPR) because (1) an EIS is not included, (2) the Recommended Plan is not likely to have significant economic, environmental, or social affects to the nation, (3) the study is not likely to have significant interagency interest, (4) the study does not involve significant threat to human life, (5) the estimated total project cost is less than $45 million in total, (6) the study is not highly controversial, and (7) the study is not based on novel methods, does not present complex challenges for interpretation, does not contain precedent-setting methods or models, or present conclusions that are likely to change prevailing practices. Therefore, a request for exclusion from IEPR was submitted to USACE headquarters and the South Atlantic Division. The wavier was requested February 3, 2014.

11.0 PLAN IMPLEMENTATION

11.1 Preconstruction Engineering and Design (PED) Phase

During the PED phase all planning and engineering necessary for project construction will be performed. The planning and engineering studies are required to review earlier study data, obtain current data, evaluate any changed conditions, and establish the basic design of the project features in final detail. Presently, it is envisioned that additional vibracores (10) and washprobes (20) will be obtained to the east of Battery Island and Southport Channel during PED. The vibracore samples would require a grain size and compatibility analysis to determine proper disposal of the sediment. Wash probes will be used in determining the elevation of the refusal surface.

During the PED phase, plans and specifications will be prepared. These provide detailed drawings and instructions for constructing the project. A design documentation report (DDR), which describes the basis for design, will also be prepared during the PED phase.

11.2 Construction Phase

The USACE SAW Construction Branch will be responsible for construction management during the project construction phase of the project. Construction management includes contract administration and quality assurance. The primary function of quality assurance is to make sure the project is constructed in accordance with the contract requirements and the end product complies with the quality established by the contract.

The Entrance Channel, Reach 1 improvements will likely be accomplished by a large ocean certified cutterhead suction dredge and a hopper dredge. This improvement work would be combined with a routine maintenance dredging contract such as typically done for the Wilmington Harbor Outer Ocean Bar and the Wilmington Harbor Inner Ocean Bar. From historic dredging cycles, the dredged material within the existing entrance channel footprint is expected to be suitable for beach disposal and can either be pumped to the Bald Head Island beach or to the Oak Island/Caswell beach. Pumping onto the nearby beaches is the current method of disposal of dredged material from the existing entrance channel. The dredged material in the western portion of the realigned channel and outside of the existing channel footprint is not suitable for beach disposal and will be transported to and disposed of in the Wilmington Ocean Dredged Material Disposal Site (ODMDS). Dredging of the western portion of the realigned channel is most likely to be by hopper dredge but could also be performed with a cutterhead suction dredge.

The Battery Island Channel turn improvements could be accomplished by cutterhead suction dredge, clamshell dredge, or hopper dredge. If a cutterhead suction dredge or clamshell dredge is used, the dredged material would be placed in a dump scow and towed by tug to the disposal area. Dredged material from the Battery Island Channel turn improvements will be transported to and disposed of in the Wilmington Ocean Dredged Material Disposal Site (ODMDS).

11.3 Operations and Maintenance Phase

Entrance Channel, Reach 1

Maintenance dredging is expected to be accomplished by a large cutterhead suction

dredge, but could also be performed by hopper dredge. It is anticipated that shoaling within the realigned Entrance Channel in the period after initial construction will be suitable for the beach. The dredged material will be pumped to and disposed of on the nearby beaches of Bald Head Island or Oak Island/Caswell. The current SMP (Appendix H) for the entrance channel anticipates dredging of Baldhead Shoal Channel Reach 1 every other year; however, the actual dredging has been more intermittent due to Federal O&M funding shortfalls. For this report it will be assumed that maintenance dredging would occur every other year. Realignment of the entrance channel is not expected to reduce the rate at which the channel shoals. The average annual shoaling rate is anticipated to remain at approximately 250,000 cubic yards. Shoaling and channel conditions will be monitored by performing project condition surveys of the channel a minimum of twice a year.

Battery Island Channel Turn

Maintenance dredging is expected to be accomplished by hopper dredge or a clamshell dredge. Dredged material from the Battery Island Channel turn will be transported to and disposed of in the Wilmington Harbor Ocean Dredged Material Disposal Site (ODMDS). However during maintenance operations if the sediment to be dredged is determined to be beach quality, it may be pumped to the Bald Head Island beach or to the Oak Island/Caswell beach or placed in a zone within the ODMDS set aside for sandy material.

11.4 Project Schedule

If the project continues on a path that would require a Chief's Report and Congressional authorization, the remaining milestones of the feasibility phase include an Agency Decision Meeting in August of 2014, having a signed Chief's Report by March of 2015 and transmission to Congress in June of 2015. Assuming authorization from Congress, the PED phase would begin in April of 2017 and Plans and Specifications would be complete by December of 2018. The contract could be awarded by May 2019 and begin construction Aug 2019. It is anticipated the construction would require 30 days of mobilization, 60 days of dredging, and 15 days of de-mobilization.

Table 11.1. Project Implementation Schedule

Activity	Completion date
Project Engineering and Design start	Apr 2017
Plans and Specifications Complete	Dec 2018
Real Estate Acquisition Complete	No additional real estate is needed for this project
Construction Start	Aug 2019

If this project is approved to move forward as part of the existing authorization for Wilmington Harbor, the PED and construction schedules could potentially be earlier than indicated above.

11.5 Cost Sharing

The reconnaissance phase for the Wilmington Harbor Navigation Improvement Projects was 100% federally funded. The Feasibility phase was cost shared at 50% Federal and 50% non-Federal. The construction of the project will be cost shared at a ratio of 75% Federal and 25% non-Federal. This will be laid out in the Project Partnership Agreement that must be executed prior to awarding the contract.

11.6 Project Partnership Agreement

A Project Partnership Agreement must be executed between the State of NC and USACE prior to the award of the construction contract. This PPA will indicate the cost share of 75%/25% Federal/Non-Federal as well as identify any anticipated work-in-kind. However, if this project is approved to move forward as part of the existing authorization for Wilmington Harbor, then an amendment to the Wilmington Harbor 96 Act Project Partnership Agreement would be negotiated and executed.

12.0 RECOMMENDATIONS

It is the recommendation of the Wilmington District that the Entrance Channel, Reach 1 component of the Recommended Plan be implemented as part of regularly scheduled O&M cycle for the Wilmington Harbor 96 Act, NC Project authority. The proposed movement of the entrance channel to follow deep water in order to reduce maintenance costs, which will be realized in an immediate savings in the approximate amount of $2,364,790 is appropriate under the authority provided in ER 1165-2-119, Paragraph 9, which states in relevant part: "Where not otherwise precluded by project authorization, the location of a completed channel may be altered during the course of the periodic maintenance program if the maintenance can thereby be more economically accomplished and related aids to navigation are readily adjustable to suit the restored channel dimensions at the shifted location."

It is the recommendation of the Wilmington District that the Battery Island Turn component of the Recommended Plan be implemented under the existing Wilmington Harbor 96 Act, NC Project. The proposed modifications to the Battery Island Turn can be authorized under ER 1165-2-119, Paragraph 9, which states in relevant part: "The River and Harbor Act of 1915 provides (Section 5) an authority to increase channel dimensions, beyond those specified in project authorization documents, at entrances, bends, sidings and turning places as necessary to allow the free movement of vessels." Section 5 of the River and Harbor Act of 1915 (codified at 33 USC 562) was amended in 1992 to include the language "after the project becomes operational". The current ER 1165-2-119 precedes this amendment; therefore it indicates that the authority has no general application to completed projects. The ER has not been revised to take this amendment into account.

Implementation of both components under the existing Wilmington Harbor 96 Act, NC Project authority will not exceed the 902 limit of the Project.

Date: _____

_____

Kevin P. Landers, Sr.

Colonel, U.S. Army
District Commander

13.0 LETTERS OF SUPPORT AND FINANCIAL CAPABILITY

(TO BE INSERTED LATER)

14.0 POINT OF CONTACT

Any comments or questions regarding this Feasibility Report and EA should be addressed to Wilmington Harbor Navigation Improvements Project Manager, U.S. Army Corps of Engineers, 69 Darlington Avenue, Wilmington, NC 28403, telephone (910)251-4483.

14.0 REFERENCES

Anderson, D.G., L.D. O'Steen, and K.E. Sassaman. 1996. Environmental and Chronological Considerations. In *The Paleoindian and Early Archaic Southeast,* edited by D.G. Anderson and K.E. Sassaman. The University of Alabama Press, Tuscaloosa, Alabama.

Angley, W. 1983. An historical overview of the Sunny Point Terminal on the Lower Cape Fear River. Ms. On file, Research Branch, N.C. Division of Archives and History.

Birkhead, W.A., B.J. Copeland, and R.G. Hodson. 1979. Ecological monitoring in the lower Cape Fear estuary, 1971-1976. Report 79-1, Carolina Power and Light Company, Raleigh, North Carolina. 292 pp.

Blanton, J.O., J. Amft, R.A. Luettich Jr., J.L. Hench and J.H. Churchill. 1999. Tidal and subtidal fluctuations in temperature, salinity, and pressure for the winter 1996 larval ingress experiment – Beaufort Inlet, NC. Fisheries Oceanography. (suppl. 2):134–152.

Churchill, J.H., J.O. Blanton, J.L. Hench, R.A. Luettich Jr., and F.E. Werner. 1999. Flood tide circulation near Beaufort Inlet, North Carolina: Implications for larval recruitment. Estuaries 22:1057–1070.

Cushing, D.H. 1988. The Study of Stock and Recruitment. In Fish Population Dynamics 2nd ed. ed. J.A. Gulland. John Wiley and Sons, Ltd.

Dew, C.B., and J.H. Hecht. 1994. Recruitment, growth, mortality, and biomass production of larval and early juvenile Atlantic tomcod in the Hudson River estuary. Transactions of the American Fisheries Society 1235):681–702.

Diaz, H. 1980. The mole crab *Emerita talpoida* (say): A case study of changing life history pattern. Ecological Monographs 50(4):437–456.

Hackney, C.T., M.H. Posey, S.W. Ross, and A.R. Norris. 1996. A Review and Synthesis of Data on Surf Zone Fishes and Invertebrates in the South Atlantic Bight and the Potential Impacts from Beach Nourishment. Prepared for the U.S. Army Corps of Engineers, Wilmington, NC.

Hettler, W.F. Jr. and A.J. Chester. 1990. Temporal distribution of ichthyoplankton near Beaufort Inlet, North Carolina. Marine Ecology Progress Series. 68:157-168.

Hettler, W.F. Jr., and D.L. Barker. 1993. Distribution and abundance of larval fishes at two North Carolina inlets. Estuarine, Coastal and Shelf Science 37:161–179.

Hettler, W.F. Jr., and J.A. Hare. 1998. Abundance and size of larval fishes outside the entrance to Beaufort Inlet, North Carolina. Estuaries 21(3):476–499.

Jackson, C.V. III. 1996. The Cape Fear – Northeast Cape Fear Rivers Comprehensive Study: A Maritime History and Survey of the Cape Fear and Northeast Cape Fear Rivers, Wilmington, North Carolina, Volume 1, Maritime History. Underwater Archaeology Unit, prepared for the North Carolina Department of Cultural Resources

and the University of North Carolina at Wilmington and U.S. Army Corps of Engineers, Wilmington District.

Kieslich, J. M. 1981. Tidal inlet response to jetty construction, GITI Report 19, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

Lawler, Matusky & Skelly Engineers. 1975. Aquatic ecology studies, Cape Fear River estuary, North Carolina, September 1972 to August 1973. Appendix A of Environmental Impact Assessment of Alternatives for the Maintenance of Wilmington Harbor North Carolina. Report for the U.S. Army Corps of Engineers, Wilmington District.

Levisen, M. V. and R. F. Van Dolah. 1996. Environmental evaluation of the Kiawah Island beach scraping project. Final Report to the Town of Kiawah Island, Kiawah Island, SC. South Carolina Department of Natural Resources, Charleston, SC.

Lindquist, N., and L. Manning. 2001. Impacts of Beach Nourishment and Beach Scraping on Critical Habitat and Productivity of Surf Fishes, Final Report to the NC Fisheries Resource Grant Program, Morehead City, NC.

Lewis, R.B. 2000. Sea-Level Rise and Subsidence Effects on Gulf Coastal Archaeological Site Distributions. *American Antiquity* 65:525-541.

Remote Sensing Archaeological Survey: Proposed Cape Fear River Entrance Channel Alternatives, Ocean Dredged Material Disposal Site, and Navigation Channels Near Southport, NC.

Mid-Atlantic Technology and Environmental Research (MATER) 1999b. Underwater Archaeological Identification Survey at the Cape Fear River Entrance Channel Alternatives, Ocean Dredged Material Disposal Site, and Navigation Channels Near Southport, NC. Submitted to U.S. Army Corps of Engineers Wilmington District Office, Wilmington, NC.

Millis, T.L. 2011. Woodland Period Site Distribution and Landscape Use in the Coastal Plain of Southeastern North Carolina. In *The Archaeology of North Carolina: Three Archaeological Symposia*. North Carolina Archaeological Council Publication Number 30.

Moser, M.L. and S.W. Ross. 1993. Distribution and movements of shortnose sturgeon (Acipenser brevirostrum) and other anadromous fishes of the Lower Cape Fear River, North Carolina. Final Report to the U.S. Corps of Engineers Wilmington District.

NCDWQ. 2009. NC Division of Water Quality, Cape Fear River Basin Ambient Monitoring System Report, January 1, 2004 through December 31, 2008. http://portal.ncdenr.org/c/document_library/get_file?uuid=e91dfcac-6cbb-4e02-9daa-dccf06a35d8a&groupId=38364

NCNHP. 2012. The North Carolina Natural Heritage Program by letter dated August 9, 2012 listed the state rare plant and animal species and natural communities near the project area.

North Carolina Underwater Archaeology Unit (NC UAU) 1980. Magnetometer Survey of Battery Island and the CSS North Carolina Wreck Site. Field notes on file North

Carolina Division of Archives and History, Underwater Archaeology Unit, Kure Beach, NC.

Nelson, W.G. 1985. Guidelines for Beach Restoration Projects. Part I. Biological Guidelines. Report 76, Florida Sea Grant, Gainesville, FL.

Newland, B. 2012. Personal Communication. Mr. Brad Newland P.E., Regional Supervisor, Wilmington Region 9, stated on May 22, 2012 that New Hanover is in "attainment" for all criteria pollutants.

Nichols, P.R. and E.D. Louder. 1970. Upstream passage of anadromous fish through navigation locks and use of the stream for spawning and nursery habitat, Cape Fear River, North Carolina, 1962-66., U.S. Fish and Wildlife Service, Circ. 352.

Overton, G., R. Lawrence and C.Jackson III. 1996. The Cape Fear – Northeast Cape Fear Rivers Comprehensive Study: A Maritime History and Survey of the Cape Fear and Northeast Cape Fear Rivers, Wilmington, North Carolina, Volume 2, Submerged Cultural Resource Survey. Underwater Archaeology Unit, prepared for the NC Dept of Cultural Resources and the University of NC at Wilmington and U.S. Army Corps of Engineers, Wilmington District.

Peterson, C.H., D.H.M. Hickerson, and G.G. Johnson. 2000. Short-term consequences of nourishment and bulldozing on the dominant large invertebrates of a sandy beach. Journal of Coastal Research 16(2):368–378.

Phelps, D.S. 1981. Archaeology of the North Carolina Coast and Coastal Plain: Problems and Hypotheses. In *The Prehistory of North Carolina: An Archaeology Symposium*, edited by Mark a. Mathis and Jeffery J. Crow. North Carolina Division of Archives and History, Raleigh, North Carolina.

Ray, G.L. 1996. Benthic characterization of the Wilmington Harbor and Cape Fear estuary; March 1996. U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, MS.

Reaves, W.M. 1988. Notes on the Brunswick River and its Environs. Unpublished manuscript on file, Underwater Archaeology Branch, Kure Beach, North Carolina.

Reilly, F.J. and V.J. Bellis. 1983. A Study of the Ecological Impact of Beach Nourishment with Dredged Materials on the Intertidal Zone at Bogue Banks, North Carolina. Misc. Rept. No. 83-3. U.S. Army Corps of Engineers, Coastal Engineering Research Center, Vicksburg, MS.

Reine, K.J., D.G. Clarke, C. Dickerson. 2002. Acoustic Characterization of Suspended Sediment Plumes Resulting from Spider Barge Overflow During Hydraulic Dredging Operations in the Cape Fear River, North Carolina. US Army Corps of Engineers, Engineering Research and Development Center, Vicksburg, MS, February 2002.

Ross, S.W. and J.E. Lancaster. 1996. Movements of Juvenile Fishes using Surf Zone Nursery Habitats and the Relationship of Movements to Beach Nourishment along a North Carolina Beach: Pilot Project. Prepared for National Oceanic and Atmospheric Administration, Office of Coastal Resource Management Silver Spring, MD and the U.S. Army Corps of Engineers, Wilmington, NC.

Ross, S.W. 1996. Surf zone fishes of the south Atlantic Bight. Section III, pp. 42-107. In A review and synthesis of data on surf zone fishes and invertebrates in the South Atlantic Bight and the potential impacts from beach nourishment, ed C.T. Hackney,, M.H. Posey, S.W. Ross, and A.R. Norris. Prepared for the U.S. Army Corps of Engineers, Wilmington, NC.

Ross, S.W. and J.E. Lancaster. 2002. Movements and site fidelity of two juvenile fish species using surf zone nursery habitats along the southeastern North Carolina coast. Environmental Biology of Fishes 63:161–172.

SAFMC (South Atlantic Fishery Management Council). 1998. Final habitat plan for the South Atlantic Region: Essential fish Habitat Requirements for Fishery Management Plans of the South Atlantic Fishery Management Council. South Atlantic Fishery Management Council, Charleston, SC.

Schneider, C.W. and R.B. Searles. 1991. Seaweeds of the southeastern United States: Cape Hatteras to Cape Canaveral. Durham: Duke University Press. 553 p.

Schwartz, F.J., W.T. Hogarth, and M.P. Weinstein. 1981. Marine and freshwater fishes of the Cape Fear River estuary, North Carolina, and their distribution in relation to environmental factors. Brimleyana No. 7:17-37. July 1981.

Tidewater Atlantic Research (TAR). 1993. A Submerged Cultural Resource Survey for Bald Head Shoal Channel Vicinity of Wilmington, North Carolina. Submitted to U. S. Army Corps of Engineers Wilmington District Office, Wilmington, NC.

Tidewater Atlantic Research (TAR). 1995. An Archaeological Remote Sensing Survey and Diver Investigation at Smith Island Channel, Cape Fear River, Wilmington Harbor, NC. Submitted to Environmental Resources Section, U. S. Army Corps of Engineers Wilmington District Office, Wilmington, NC.

Tidewater Atlantic Research (TAR) 1966. Underwater Archaeological Site Recording and Damage Assessment, *CSS North Carolina*, Brunswick County, North Carolina. Draft management summary prepared for the U.S. Army Corps of Engineers, Wilmington, North Carolina.

Tidewater Atlantic Research (TAR) 1999. Underwater Archaeological Documentation of the Remains of the Ironclad "CSS North Carolina, Brunswick County, North Carolina. Submitted to U. S. Army Corps of Engineers Wilmington District Office, Wilmington, NC.

USACE. 1990. Wilmington Harbor, Northeast Cape Fear River, General Design Memorandum, Wilmington, District, April 1990. USACE. 1990.

USACE. 1993. Wilmington Harbor Ocean Bar – General Design Memorandum, Supplement and Environmental Assessment, Wilmington District, September 1993.

USACE. 2000. Environmental Assessment, Preconstruction Modifications of Authorized Improvements, Wilmington Harbor, North Carolina, February 2000.

USACE. 2001a. Final Feasibility Report and Environmental Impact Statement on Improvement of Navigation, Cape Fear – Northeast Cape Fear Rivers Comprehensive Study, Wilmington, North Carolina, June 1996.

USACE. 2001b. Final Report for The Army Corps of Engineers New York District's Biological Monitoring Program for the Atlantic Coast of New Jersey, Sea Bight to Manasquan Inlet, Beach Erosion Project, US Army Corps of Engineers, Engineer Research and Development Center, Vicksburg, MS.

USACE. 2004. Year 2 Recovery from impacts of beach nourishment on surf zone and nearshore fish and benthic resources on Bald Head Island, Caswell Beach, Oak Island, and Holden Beach, North Carolina: Final study findings. Prepared for the U.S. Army Corps of Engineers, Wilmington District, Wilmington, NC, by Versar, Inc., Columbia, MD.

USACE. 2011a. Section 905(b) Analysis, Wilmington Harbor Navigation Improvements, New Hanover and Brunswick Counties, North Carolina.

USACE. 2011b. Monitoring Effects of a Potential Increased Tidal Range in the Cape Fear River Ecosystem Due to Deepening Wilmington Harbor, North Carolina Final Report: October 1, 2000 – May 31, 2010, Prepared for the U.S. Army Corps of Engineers, Wilmington District by Dial Cordy and Associates.

USEPA. 2001. Final Environmental Impact Statement for the New Wilmington Harbor Ocean Dredged Material Disposal Site Designation, US Environmental Protection Agency Region IV, Cooperating Agency: Wilmington District US Army Corps of Engineers.

Van Dolah, R.F., P.H. Wendt, R.M. Martore, M.V. Levisen, and W.A. Roumillat. 1992. A Physical and Biological Monitoring Study of the Hilton Head Beach Nourishment Project. Marine Resources Division, South Carolina Wildlife and Marine Resources Department, Charleston, South Carolina.

Van Dolah, R.F., R.M. Martore, A.E. Lynch, P.H. Wendt, M.V. Levisen, D.J. Whitaker, and W.D. Anderson. 1994. Environmental Evaluation of the Folly Beach Project. Final report, U.S. Army Corps of Engineers, Charleston District, Charleston, SC, and the South Carolina Department of Natural Resources, Marine Resources Division, Columbia, SC.

Versar. 2004. Year 2 Recovery from impacts of beach nourishment on surf zone and nearshore fish and benthic resources on Bald Head Island, Caswell Beach, Oak Island, and Holden Beach, North Carolina: Final study findings. Prepared for the U.S. Army Corps of Engineers, Wilmington District, Wilmington, NC, by Versar, Inc., Columbia, MD.

Walburg, C.H. and P.R. Nichols. 1967. Biology and management of the American shad and status of the fisheries, Atlantic coast of the United States, 1960. U.S. Fish and Wildlife Service, Spec. Sci. Rpt.-Fish. No. 550. pp. 35-38.

Ward, H.T. and S. Davis Jr. 1999. *Time Before History: The Archaeology of North Carolina*. The University of North Carolina Press, Chapel Hill, North Carolina.

Woodward-Clyde Consultants. 1980. Aquatic and Terrestrial Ecology. Prepared by Brunswick Energy Company.