Supplemental Norfolk Harbor Navigation Improvements Project – Thimble Shoal Channel, Chesapeake Bay Bridge Tunnel – Protective Rock Blanket Project

Virginia Beach, Virginia

Appendix A:
2018 GRR/EA for the Norfolk Harbor Navigation Improvements Project

January 2021

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Cooperating agencies: U.S. Environmental Protection Agency, National Oceanographic and Atmospheric Administration/National Marine Fisheries Service, U.S. Department of the Navy

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Foster sustainability as a way of life throughout the organization.

Proactively consider environmental consequences of all U.S. Army Corps of Engineers (USACE) activities and act accordingly.

Create mutually supporting economic and environmentally sustainable solutions.

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

Consider the environment in employing a risk management and systems approach throughout the life cycles of projects and programs.

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

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

COVER SHEET

Norfolk Harbor Navigation Improvements, Virginia Final General Reevaluation Report and Environmental Assessment

LEAD AGENCY: Department of the Army
U.S. Army Corps of Engineers, Norfolk District

COOPERATING AGENCIES: U.S. Department of the Navy
U.S. Environmental Protection Agency, Region 3
National Oceanographic and Atmospheric Administration/National Marine Fisheries Service

ABSTRACT:

The Norfolk Harbor Study Area includes the ocean entrance channel, the inner harbor channels, and dredged material disposal sites. Alternative plans combined multiple structural and nonstructural measures to improve the safety and efficiency of the existing navigation system. Navigation concerns include three main types of problems: limited channel depth that causes navigation inefficiencies, channel width that does not allow safe meeting of vessels, and existing anchorages which are insufficient to fully accommodate the existing vessel fleet.

The Preferred Alternative (also referred to as the Action Plan or Recommended Plan is the National Economic Development (NED) Plan which includes:

- Deepening the Atlantic Ocean Channel (AOC) to a required depth of -59 feet;
- Deepening the Thimble Shoal Channel (TSC) to a required depth of -56 feet;
- Deepening the Norfolk Harbor Channel to a required depth of -55 feet;
- Deepening the Norfolk Harbor Entrance Channel to a required depth of -55 feet;
- Deepening the Newport News Channel to a required depth of -55 feet;
- Widening the TSC east of the Chesapeake Bay Bridge Tunnel to 1,300 feet;
- Widening Anchorage F to 3,620 feet and associated modifications of the Approach Area;
- Deepening Anchorage F to a required depth of -51 feet;

The Preferred Alternative includes construction and maintenance of these features. Dredged material placement/disposal could occur at the Dam Neck Ocean Disposal Site, the Norfolk Ocean Disposal Site, the Craney Island Dredged Material Management Area (CIDMMA), and/or upland disposal sites for this project (if needed). Portions of the dredged areas may be suitable for beneficial use projects and beneficial use projects would be coordinated separately from this project. General operation and maintenance of the CIDMMA would continue with or without implementation of the Preferred Alternative. The project construction is anticipated to begin in approximately 2019 (or earlier depending on funding capability) and following construction, channel depths would be maintained over the 50 year lifecycle of the project.

EXECUTIVE SUMMARY

The results of engineering, economic, environmental, and real estate investigations performed for this Feasibility Study (FS) are being used to determine if improvements to the constructed Federal project are warranted and if necessary, seek additional authorization where not already granted for navigation system improvements at Norfolk Harbor, Virginia (Figure 1). The Virginia Port Authority (VPA) requested the re-evaluation of the project which was authorized under Section 201 of the Water Resources Development Act (WRDA) of 1986 (Public Law 99-662).

This law authorized the construction of the Norfolk Harbor and Channels, Virginia, Project, as described in House Document 99-85, dated 18 July 1985, entitled "Norfolk Harbor and Channels, Virginia." The original authorization included channel deepening from 45 to 55 feet within most of the project area and 57 feet within the Atlantic Ocean Channel (AOC). Since being authorized all areas were deepened to a depth of 50 feet with the exception of the AOC which was deepened to 52 feet. This study is being conducted under Section 216 of the Flood Control Act of 1970 (Public Law 91-611), which authorizes the review of completed projects in the interest of navigation and related purposes to determine the feasibility of further port deepening.

Figure 1: Norfolk Harbor and Channels

DESCRIPTION OF REPORT

This General Reevaluation Report (GRR) and Environmental Assessment (EA) documents the Feasibility Study (process and presents the results of investigations and analyses conducted to evaluate modifications to the existing Federal navigation system to improve its ability to efficiently serve the current and future vessel fleet and process the forecasted cargo volumes. It presents: (1) a survey of existing and future conditions; (2) an evaluation of related problems and opportunities; (3) development of potential alternatives; (4) a comparison of costs, benefits, adverse impacts, and feasibility of those alternatives; and (5) identification of a National Economic Development (NED) Plan and Recommended Plan (RP).

PURPOSE AND NEED

The cargo transportation industry continues its shift to increased use of standardized containers used for multimodal (marine, rail, and truck) freight transportation systems. Additionally, the marine vessel fleet is trending to larger, deeper-draft vessels, particularly for containerships. Norfolk Harbor also serves as the location of Naval Station Norfolk, which supports the operational readiness of the U.S. Atlantic fleet. The Federal channels serving Norfolk Harbor's major terminals are currently authorized to a depth of -55 feet Mean Lower Low Water (MLLW) but were constructed to only -50 feet and 1,000 feet wide and -52 feet in the AOC. The existing dimensions of those channels place constraints on deeper-draft containerships, which result in reduced efficiency and increased costs.

Specific problems warranting Federal consideration include navigation and safety considerations, engineering challenges, and concerns of those who live and work along or around the Federal navigation project. Navigation concerns include three main types of problems: limited channel depth causing navigation inefficiencies, channel width does not allow safe meeting of vessels, and existing anchorages are insufficient to fully accommodate existing vessel fleet. Larger ships currently experience transportation delays due to insufficient Federal channel depths. To reach port terminals, these larger ships might have to light load, experience delays while waiting for favorable tide conditions, and/or wait while Department of Defense (DoD) or commercial vessels transit the main channel. These approaches require the vessel operator to forego potential transportation cost savings available from the economies of scale associated with larger ships. Restrictive channel widths also limit ship passage to one-way traffic in many reaches.

ALTERNATIVES AND RECOMMENDED PLAN

Utilizing the Corps' Planning Process as specified in ER 1105-2-100, plan formulation was conducted with a focus on achieving the Federal objective of water and related land resources project planning, which is to contribute to the NED consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements. Plan formulation also considers all effects, beneficial or adverse, to each of the four evaluation accounts identified in the Principles and Guidelines (1983), which are NED, Environmental Quality, Regional Economic Development, and Other Social Effects.

Alternative plans combining multiple structural and nonstructural measures to improve the safety and efficiency of the navigation system were considered to determine whether the Federal government should participate in implementing navigation improvements. The expected returns to the NED benefits are calculated. NED benefits are generated by addressing inefficiencies in the existing transportation system to lower transportation costs. Net benefits are calculated by subtracting the total cost to construct and maintain the improvements over a 50-year study period from the total transportation cost savings that would be generated by the proposed improvements over that period. The NED Plan is the alternative that reasonably maximizes net NED benefits while remaining consistent with the Federal objective of protecting the nation's environment. Where two cost-effective plans produce similar net benefits, the less costly plan is identified as the NED plan, even though the level of outputs may be less. The NED Plan is the RP for implementation.

In this study, multiple alternatives were developed that generated significant annual net benefits. After careful consideration, the USACE identified the alternative that reasonably maximizes annual net benefits as the NED Plan. The RP is the NED plan. The plan recommends:

- Deepening the Atlantic Ocean Channel (AOC) to a required depth of -59 feet;
- Deepening the Thimble Shoal Channel (TSC) to a required depth of -56 feet;
- Deepening the Norfolk Harbor Channel to a required depth of -55 feet;
- Deepening the Norfolk Harbor Entrance Channel to a required depth of -55 feet;
- Deepening the Newport News Channel to a required depth of -55 feet;
- Widening the TSC east of the Chesapeake Bay Bridge Tunnel to 1,300 feet;
- Widening Anchorage F to 3,620 feet and associated modifications of the Approach Area;
- Deepening Anchorage F to a required depth of -51 feet;

The RP includes construction and maintenance of these features. Dredged material placement/disposal could occur at the Dam Neck Ocean Disposal Site, the Norfolk Ocean Disposal Site, and the Craney Island Dredged Material Management Area for this project. Portions of the dredged material may be suitable for beneficial use. Beneficial use projects are encouraged and would be coordinated separately from this project based on schedule and sponsor availability. They must also be individually authorized for such use.

COSTS AND BENEFITS

The USACE employed the traditional providers of traffic and fleet projections to study the Norfolk Harbor project. Based on existing and projected future vessel traffic, vessel fleet mix, trade route allocations, and liner services currently associated within Norfolk Harbor, two design vessels were selected. The vessel mix was allocated over time to provide benefit calculations using the HarborSym economic analysis model. The characteristics of the design vessels were used to develop channel dimension and alignment needs. Further refinement of the dimensions and alignment is expected through application of ship simulations prior to developing final designs. The dimensions of the two design vessels are described as follows:

- MSC Daniela:
    a. 1,201 foot length
    b. 168 foot beam
    c. 51.2 foot draft

- Large Capesize Bulker:
    a. 985 foot length
    b. 164 foot beam
    c. 59.7 - 60.4-foot draft

The projected traffic allocated between the time-modified mix of containerships and bulkers has provided average annual net benefits of $96.5 million for the RP (the NED Plan). The RP maximized annual net benefits and maintained a robust BCR of 5.3. The estimated project first costs are $271.8 million and economic investment costs are $322.2 million. The entire project is economically justified. Table 1 provides a summary of the Federal and non-Federal costs and Table 2 provides the annualized benefits and costs for the RP. The benefits are attributable to transportation cost savings through the use of existing ships with a deeper draft, the use of larger vessels, and delay reductions.

Table 1: Federal and Non-Federal Costs

	Total Cost	Federal	Non-Federal
Dredging Cost (Including Mob / Demob)	$207,366,000	$103,683,000	$103,683,000
Environmental Mitigation	$-	$-	$-
Monitoring	$-	$-	$-
Construction Management	$10,963,000	$5,482,000	$5,482,000
PED	$16,910,000	$8,455,000	$8,455,000
Contingency (11.7%)	$27,523,000	$13,761,000	$13,761,000
Total Construction of GNF	$262,762,000	$131,381,000	$131,381,000
Lands & Damages	$9,060,000	$-	$9,060,000
Total Project First Costs	**$271,822,000**	**$131,381,000**	**$140,441,000**
Non-Federal Berthing Area Dredging Costs	$20,003,000	$-	$20,003,000
Relocating Aids to Navigation	$-	$-	$-
10% GNF Non-Federal	$-	$(17,216,000)	$17,216,000
Total Cost	$291,825,000	$114,165,000	$177,660,000

Table 2: Costs and Benefits

Equivalent Annual Benefits and Costs FY2018 Price Levels 50-Year Period of Analysis / 2.75 % Discount Rate	
Project Costs	$291,825,000
Interest During Construction	$30,410,000
Total Economic Investment	**$322,235,000**
AAEQ Costs	
Economic Investment	$11,940,000
Increased O&M Costs	$6,140,000
Total AAEQ Costs	**$18,080,000**
AAEQ Benefits	
Transportation Cost Savings	$96,500,000
Total AAEQ benefits	**$96,500,000**
Net AAEQ Benefits	**$78,420,000**
Benefit-Cost Ratio (at 2.75%)	**5.3**

In addition to these improvements, economic and environmental analyses were conducted for a 1400-foot wide meeting area at TSC west of the Chesapeake Bay Bridge and Tunnel, which is the meeting area strongly preferred by the Pilots and the Virginia Port Authority. Although the west side meeting area generated positive benefits, benefits were not sufficient for inclusion in the NED Plan. Future changes in the fleet calling at Norfolk Harbor may improve the benefits generated by this project alternative.

ENVIRONMENTAL IMPACTS AND MITIGATION

The possible consequences of the RP were considered in terms of probable environmental impact, social well-being, and economic factors. Endangered Species Act, Section 7 consultation is ongoing and expected to be completed in July 2018. Upon completion of formal consultation, the final BO will be inserted into Appendix I. Marine Mammal Protection Act and Essential Fish Habitat consultation as required per the Magnuson-Stevens Fishery and Conservation Management Act with the National Marine Fisheries Service (NMFS) is also finalized. Impacts to these species and any designated Critical habitat are not anticipated to be "significant," as defined by the significance thresholds in Council on Environmental Quality's Regulations for Implementing The Procedural Provisions of the National Environmental Policy Act (40 Code of Federal Regulations 1500-1508), as amended. There is no anticipated required compensatory mitigation anticipated with implementation of the Preferred Alternative. All mitigation, in terms of avoidance and minimization measures, has been incorporated into the development of the proposed project. Best Management Practices have been incorporated in order to protect the environment and minimize impacts during construction, and operation and maintenance cycles. Best Management Practices and standard USACE protocols would be implemented for the protection of listed turtle and whale species, Atlantic Sturgeon, as well as other species protected by the Marine Mammal Protection Act to reduce any potential negative impacts of the project.

There would be no significant economic, recreation, aesthetic, or social well-being impacts, either adverse or unavoidable, as a result of the proposed action. This project would be expected to have a positive impact on the economy of Hampton Roads and the Commonwealth of Virginia. In addition, a Programmatic Agreement was coordinated and signed by USACE, Virginia Port Authority and the Virginia State Historic Preservation Office in June 2017 to address any potential cultural resource impacts anticipated during project implementation.

There would be no significant impacts anticipated to benthic resources, wetlands, and water quality. All impacts would be anticipated to be temporary and negligible to minor in nature. Total Suspended Solids and turbidity in the water column resulting from dredging and material placement/disposal would quickly return to ambient conditions after construction or maintenance operations.

The Norfolk Ocean Disposal Site (NODS) and Dam Neck Norfolk Ocean Disposal Site (DNODS) are authorized ocean disposal areas designated by the Environmental Protection Agency (USEPA) for AOC and the TSC dredged materials. U.S. Army Corps of Engineers has permitting authority under Section 103 of the Marine Protection, Research, and Sanctuaries Act (MPRSA) for the use of these sites. In the past, dredged material from these locations has met Ocean Dumping Criteria, as set forth under 40 CFR 227.

Dredged material which meets sediment and elutriate testing requirements for placement at the CIDMMA may be placed in the Craney Island Re-handling Basin (CIRB) or directly in one of the containment cells at CIDMMA.

Dredged material placement actions at CIDDMA will comply with Clean Water Act and CIDMMA acceptance criteria. Commanders Policy WRD-01 is a Norfolk District internal guidance document which also governs the operation of CIDMMA. Prior to commencement of construction, dredged material will undergo evaluation procedures. During construction effluent discharged from the CIDMMA will be managed in accordance with Commander’s Policy WRD-01 to maximize the retention of suspended solids minimizing migration of contaminants through the effluent pathway beyond the boundaries of the disposal site.

Table of Contents

APPENDICES

A. Engineering
B. Economics
C. Real Estate

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS AND ABBREVIATIONS

ACHP – Advisory Council on Historic Preservation
ADCIRC – Advanced Circulation Model
AOC – Atlantic Ocean Channel
APA – Administrative Process Act
APE – Area of Potential Effect
APP- Accident Prevention Plan
ASA – Assistant Secretary of the Army
BCR – Benefit-to-cost ratio
BFE – Base Flood Elevation
CAA – Clean Air Act
CBBT – Chesapeake Bay Bridge Tunnel
CEDEP – Cost Engineering Dredge Estimating Program
CERCLA – Comprehensive Environmental Response, Compensation and Liability Information System
CFR – Code of Federal Regulations
CIDMMA - Craney Island Dredged Material Management Area
CIEE - Craney Island Eastward Expansion
CIMT – Craney Island Marine Terminal
CIRB – Craney Island Rehandling Basin
CIRRC - Craney Island Road & Rail Connector
CMP – Congestion Management Process
CRA - Cost Risk Analysis
CSRM – Coastal Storm Risk Management
CWA - Clean Water Act
CWRY - Commonwealth Railway
CY – Cubic Yards
CZMA - Coastal Zone Management Act
DoD – Department of Defense
DNODs – Dam Neck Norfolk Ocean Disposal Site
DMMP – Dredged Material Management Plan
DPS – Distinct Population Segment
EA - Environmental Assessment
EFH - Essential Fish Habitat
EIS - Environmental Impact Statement
EJ – Environmental Justice
EO – Executive Order
EPCRA – Emergency Planning and Community Right-to-Know Act
ESA - Endangered Species Act
ESI - Environmental Sensitivity Index
ERSB - Elizabeth River Southern Branch
EQ-Environmental Quality
FEIS – Final Environmental Impact Statement
FA – Focus Area
FONSI - Finding of No Significant Impact
FCSA – Federal Cost Share Agreement
FWOP – Future Without Project
GDM – General Design Memorandum
GIS – Geographic Information System
GRR – General Reevaluation Report

GSP - Gross State Product
H & H – Hydrology and Hydraulics
HRBT – Hampton Roads Bridge – Tunnel
HRPDC – The Hampton Roads Planning District Commission
HRPTO - The Hampton Roads Transportation Planning Organization
IPCC - Intergovernmental Panel on Climate Change
IBI- Index of Biological Integrity
IDC Interest During Construction
LERRs - Lands, Easements, Rights-of-Way, and Relocations
LFA - Load Factor Analysis
LPC – Limiting Permissible Concentration
MEC/UXO – Munitions of Explosive Concern/Unexploded Ordinance
MBTA – Migratory Bird Treaty Act
MCY – Million Cubic Yards
MEC – Munitions and Explosives of Concern
MLLW – Mean Lower Low Water
MMBT – Monitor – Merrimac Memorial Bridge
MMPA – Marine Mammal Protection Act
MPA – Metropolitan Planning Area
MPO – Metropolitan Planning Organization
MPRSA - Marine Protection, Research and Sanctuaries Act
MSA - Metropolitan Statistical Area
MSFCMA - Magnuson-Stevens Fishery Conservation and Management Act
MSL – Mean Sea Level
MSI – Maritime Strategies International Ltd.
MS4s – Municipal Separate Storm Sewer Systems
MXSLLD - Maximum Summer Load Line Drafts
NAAQS - National Ambient Air Quality Standards
NACCS – North Atlantic Coast Comprehensive Study
NAD – North Atlantic Division
NAVD - North American Vertical Datum
NED – Net Economic Plan
NEPA - National Environmental Policy Act
NHPA - National Historic Preservation Act
NIT – Norfolk International Terminals
NMFS - National Marine Fisheries Service
NNBF – Natural and Nature Based Features
NN-DRY BULK - Newport News Dry Bulk Terminals
NNMT – Newport News Marine Terminal
NOAA – National Oceanographic and Atmospheric Administration
NODs - Norfolk Ocean Disposal Site
NPL – National Priorities List
NRHP - National Register of Historic Places
NS-PIER-VI - Lamberts Point Coal Terminal
NWI - National Wetlands Inventory Project
ODMDS – Ocean Dredged Material Disposal Site
OESS – Ordnance and Explosives Safety Specialist
OSE – Other Social Effects
OSH – Occupational Health and Safety
O&M – Operations and Maintenance
P&G – Principles and Guidelines

PAHs – Polycyclic aromatic hydrocarbons
PCB - Polychlorinated Biphenyls
PDT – Project Delivery Team
PED - Pre-construction, Engineering and Design
PMT - Portsmouth Marine Terminal
PPE – Personal Protective Equipment
PPT – Parts per thousand
PPX3 - Post Panamax Generation 3 vessels
RECONS – USACE online Regional Economic System
RED – Regional Economic Development
ROI – Region of Influence
RSLR – Relative Sea Level Rise
SAV - Submerged Aquatic Vegetation
SHPO - State Historic Preservation Officers
SLC – Sea Level Change
TBPS - Terabytes per second
TEU – Twenty-foot Equivalent Units
TMDL – Total Maximum Daily Load
TRI – Toxics Release Inventory
TSC – Thimble Shoal Channel
USACE – United States Army Corps of Engineers
USEPA – United States Environmental Protection Agency
USFWS – United States Fish and Wildlife service
USGS - United States Geological Survey
USN – United States Navy
VCRIS - Virginia Cultural Resource Information System
VDEQ - Virginia Department of Environmental Quality
VDCR – Virginia Department of Conservation and Recreation
VDGIF - Virginia Department of Game and Inland Fisheries
VDH - Virginia Department of Health
VDHR - Virginia Department of Historic Resources
VIG – Virginia International Gateway
VIMS - Virginia Institute of Marine Science
VMRC – Virginia Marine Resources Commission
VPA – Virginia Port Authority
VSMP – Virginia Stormwater Management Program
VTS - Vessel Traffic System
VWP – Virginia Water Protection Permit
WCSC - Waterborne Commerce Statistics Center
WRDA - Water Resources Development Act

1 STUDY INFORMATION

1.1 Introduction

This integrated Norfolk Harbor General Reevaluation Report (GRR) and Environmental Assessment (EA) documents the USACE feasibility study planning process for channel improvements at a subset of the existing Norfolk Harbor and Channels project and documents implementation of the National Environmental Policy Act (NEPA) in the planning process.

The existing Norfolk Harbor and Channels project consists of a network of Federally-improved channels extending from the Atlantic Ocean, through the Chesapeake Bay, and into the Port of Hampton Roads. The project is authorized Section 201 of the Water Resources Development Act (WRDA) of 1986 (Public Law 99-662) to a depth of -55 feet; however, since 2007 the project has been constructed and maintained to a controlling depth of -50 feet. Norfolk Harbor is the nation's largest coal export port and is the third largest container port on the U.S. east coast. The largest containerships and coal carriers calling on the U.S. east coast call at Norfolk Harbor. The fleet of coal ships and containerships regularly calling on Norfolk Harbor and channels includes vessels that are depth constrained at the existing channel depth.

The originally authorized project is currently undergoing two GRR/EA studies. These two studies break the Norfolk Harbor and Channels project into two subproject areas that are referred to as 1) the Norfolk Harbor Navigation Improvements project and 2) the Elizabeth River Southern Branch (ERSB) Navigation Improvements project. This GRR/EA and study will be referred to as the Norfolk Harbor GRR/EA. The study area will be referred to as the Norfolk Harbor project.

The Norfolk Harbor project consists of a network of Federally-improved channels extending from the Atlantic Ocean Channel (AOC) to Lamberts Point and branches off to include the Newport News channel (Figure 1-1). The project includes a system of channels with depths ranging from -55 to -57 feet. Since its authorization in 1986, the project has been constructed in separable elements based on the needs of the port community and the financial capability of the non-Federal sponsor. The project has not been constructed, nor is it maintained, to its full authorized depth.

The following introductory sections provide background information for the Norfolk Harbor GRR/EA.

1.2 Study Authority

The following describes the authorization for the original Norfolk Harbor and Channels project.

"The project for navigation, Norfolk Harbor and Channels, Virginia: Report of the Chief of Engineers, dated November 20, 1981, at a total cost of $551,000,000, with an estimated first Federal cost of $256,000,000 and an estimated first non-Federal cost of $295,000,000, including such modifications as the Secretary determines to be necessary and appropriate for mitigation of any damage to fish and wildlife resources resulting from construction, operation, and maintenance of each segment of the proposed project. The Secretary, in conjunction with appropriate Federal, State, and local agencies, shall study the effects that construction,

operation, and maintenance of each segment of the proposed project will have on fish and wildlife resources and the need for mitigation of any damage to such resources resulting from such construction, operation, and maintenance."

This study is authorized under Section 216 of the Flood Control Act of 1970 (Public Law 91-611), which authorizes the review of completed projects in the interest of navigation and related purposes to determine the feasibility of further port deepening.

The major components of the Norfolk Harbor project that are being studied as part of this GRR/EA include (Note: depths are listed in the negative for dredging throughout this report):

- Deepening the Atlantic Ocean Channel (AOC) to a required depth of -59 feet;
- Deepening the Thimble Shoal Channel (SC) to a required depth of -56 feet;
- Deepening the Norfolk Harbor Channel to a required depth of -55 feet;
- Deepening the Norfolk Harbor Entrance Channel to a required depth of -55 feet;
- Deepening the Newport News Channel to a required depth of -55 feet;
- Widening the TSC east of the Chesapeake Bay Bridge Tunnel to 1,300 feet;
- Widening Anchorage F to 3,620 feet and associated modifications of the Approach Area;
- Deepening Anchorage F to a required depth of -51 feet;
- The existing 10 feet sand cover of the Chesapeake Bay Bridge Tunnel in the TSC be reduced to five feet. The materials covering the tunnel would be sand or potentially sand and rock; and
- Associated operation and maintenance activities.

1.3 Federal Policy and Procedures

The lead Federal agency is USACE. The non-Federal sponsor for this study is the Commonwealth of Virginia, acting through its agent, the Virginia Port Authority (VPA). The VPA, as the non-Federal sponsor, entered into a feasibility cost sharing agreement with USACE on June 15, 2015. The National Oceanographic and Atmospheric Administration, National Marine Fisheries Service and the U.S. Environmental Protection Agency are cooperating agencies for this project.

Identification of project-specific planning criteria used in USACE project planning is guided by the Principles and Guidelines (P&G) of 1983, the Planning Guidance Notebook, ER 1105-2-100 (22 Apr 2000), and NEPA of 1969, the Council on Environmental Quality Regulations for Implementing the Procedural Provisions of NEPA (40 CFR 1500-1508), and Procedures for Implementing NEPA, ER 200-2-2 (4 Mar 1988).

Corps of Engineers project planning follows the six-step process first described in the P&G and further elaborated in the Planning Guidance Notebook, ER 1105-2-100 (April 2000). Although presented in series, these steps are applied in an iterative process, which focuses emphasis on succeeding steps. Steps in the plan formulation process include:

1. The specific problems and opportunities to be addressed in the study are identified, and the causes of the problems are discussed and documented. Planning goals are set, objectives are established, and constraints are identified.

2. Existing and future without project conditions are identified, analyzed and forecast. The existing condition resources, problems, and opportunities critical to plan formulation, impact assessment, and evaluation are characterized and documented.

3. The study team formulates alternative plans that address the planning objectives. A range of alternative plans are identified at the beginning of the planning process and screened and refined in subsequent iterations throughout the planning process.

4. Alternative project plans are evaluated for effectiveness, efficiency, completeness, and acceptability. The impacts of alternative plans will be evaluated using the system of accounts framework (National Economic Development (NED), Environmental Quality (EQ), Regional Economic Development (RED), Other Social Effects (OSE) specified in the Principles and Guidelines and ER 1105-2-100.

5. Alternative plans will be compared. Contributions to National Economic Development (NED) will be used to prioritize and rank alternatives. The public involvement program will be used to obtain public input to the alternative identification and evaluation process.

6. A plan will be selected for recommendation, and a justification for plan selection will be prepared.

1.4 Purpose and Need for USACE Action

The purpose of this investigation is to identify whether the authorized project is still in the Federal interest and if additional deepening and/or widening is warranted. The investigation includes evaluating measures which would improve the operational efficiency of commercial vessels currently using the Norfolk Harbor Federal navigation channels and commercial vessels projected to use the channels in the future.

The Norfolk Harbor project is a multipurpose deep draft navigation project located in Hampton Roads, a 25 square mile natural harbor serving the port facilities in the cities of Norfolk, Newport News, Portsmouth, Chesapeake, and Hampton in southeastern Virginia. Since its authorization in 1986, the project has been constructed in separable elements based on the needs of the port community and the financial capability of the non-Federal sponsor. The -50 Foot Outbound Element was completed in 1989; the -50 Foot Anchorage in 1999; and -50 Foot Inbound Element in 2007. The project is authorized for a system of two-way, full-width channels to a depth of -55 feet in the Norfolk Harbor and TSC and -57 feet in the AOC.

The need for this investigation arises from inefficiencies currently experienced by commercial and Department of Defense (DoD) vessels in the Norfolk Harbor. These inefficiencies are projected to continue in the future as vessel sizes are expected to increase.

1.5 Objectives

The goal of this study is to reasonably maximize the contribution that the Norfolk Harbor project provides to national economic development (NED), consistent with protecting the Nation's environment, by addressing the physical constraints and inefficiencies in the existing navigation system's ability to safely and efficiently serve the forecasted vessel fleet and process the forecasted cargo volumes. Specific objectives for this study are:

- Reduce cargo transportation costs for the existing and future fleet over the period of analysis at Norfolk Harbor
- Reduce navigation operational constraints caused by one-way traffic in certain reaches for the existing and future commercial and DoD fleet over the period of analysis at Norfolk Harbor.

1.6 Location and Description of the Study Area

Norfolk Harbor is located in the southeastern part of the Commonwealth of Virginia at the southern end of Chesapeake Bay, midway on the Atlantic Seaboard, approximately 170 miles south of Baltimore, Maryland, and 220 miles north of Wilmington, North Carolina. The harbor is formed by the confluence of the James, Nansemond, and Elizabeth Rivers. The project consists of a network of Federally improved channels extending from the Atlantic Ocean, through the Chesapeake Bay, and into the Port of Hampton Roads. Figure 1-1 below shows the Norfolk Harbor project in blue. The ERSB project, part of a separate GRR/EA study is shown in green, for reference.

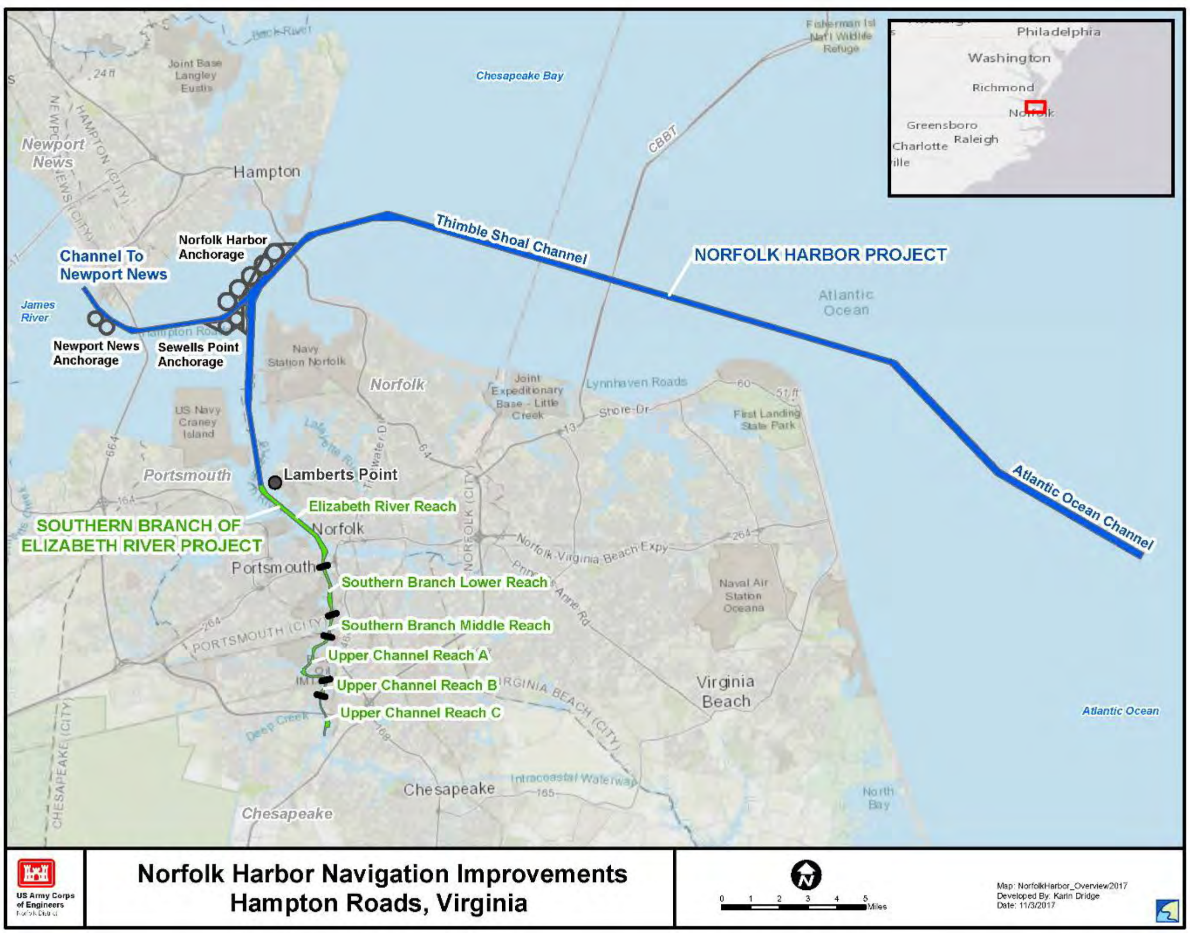

Figure 1-1. Map of the Norfolk Harbor Project

1.7 Existing Project

The Norfolk Harbor project consists of a network of Federally improved and maintained channels extending from the Atlantic Ocean, through the Chesapeake Bay, and into the Port of Hampton Roads. Table 1-1 presents the authorized and constructed dimensions of the Norfolk Harbor component of the Norfolk Harbor and Channels project. It is important to note that within the same footprint as the Norfolk Harbor and Channels project, the U.S. Navy (USN) has deepened portions of the channel to -50 feet from the Craney Island Reach of the Norfolk Harbor project through Lambert's Point and -47 feet from Lambert's Point to the Norfolk Naval Shipyard at the southern end of the Lower Reach of the Elizabeth River to meet USN operational needs. These conditions are contained within the existing conditions for the study.

Table 1-1: Existing Authorized and Constructed Channel & Anchorage Dimensions

Planning Segment	Channel Reach	Channel Depth Authorized/ Constructed (feet)	Channel Width Authorized/ Constructed (feet)	Length (miles)
Segment 1 (AOC to Lamberts Point)	Atlantic Ocean Channel	-57/-52	1,300/1,300	10.0
	Thimble Shoal Channel	-55/-50	1,000/1,000	13.0
	Norfolk Harbor Entrance Reach	-55/-50	1,500/1,000-1,440	2.0
	Norfolk Harbor Reach	-55/-50	850-1,200/850-1,200	4.0
	Craney Island Reach	-55/-50	800/800	3.0
Segment 2 (Entrance Reach to Newport News)	Newport News Channel	-55/-50	800/800	5.4
Anchorage F		-55/-50	3000	NA
Note: All depths are Mean Lower Low Water (MLLW)				

The Newport News Channel provides access to:

- Newport News Marine Terminal: Break-bulk and roll on – roll off cargo
- Newport News Shipbuilding: Naval shipbuilding
- Dominion Coal Terminal: Coal exports
- Kinder Morgan: Coal terminal

Port Facilities/Terminal Operators adjacent to the Norfolk Harbor Reach are:

- Naval Station Norfolk: USN homeport
- Norfolk International Terminals: Containers
- Craney Island Eastward Expansion Project (CIEE): Dredged material placement site and future container terminal

Port Facilities/Terminal Operators adjacent to the Craney Island Reach are:

- Norfolk Southern Coal Terminal: Coal exports
- Virginia International Gateway Terminal: Containers

The Norfolk Harbor project is grouped into two planning segments (Table 1-1). Segment 1 includes the AOC, TSC, Norfolk Harbor Entrance Reach, Norfolk Harbor Reach, and the Craney Island Reach (Figure 1-2). Segment one, identified as "AOC to Lamberts Point", provides access to the Norfolk International Terminals, the Virginia International Gateway terminal, and the Norfolk Southern coal terminal at Lamberts Point. In addition, the project covers a meeting area within the Thimble Shoals channel and a deepening and expansion of anchorage F.

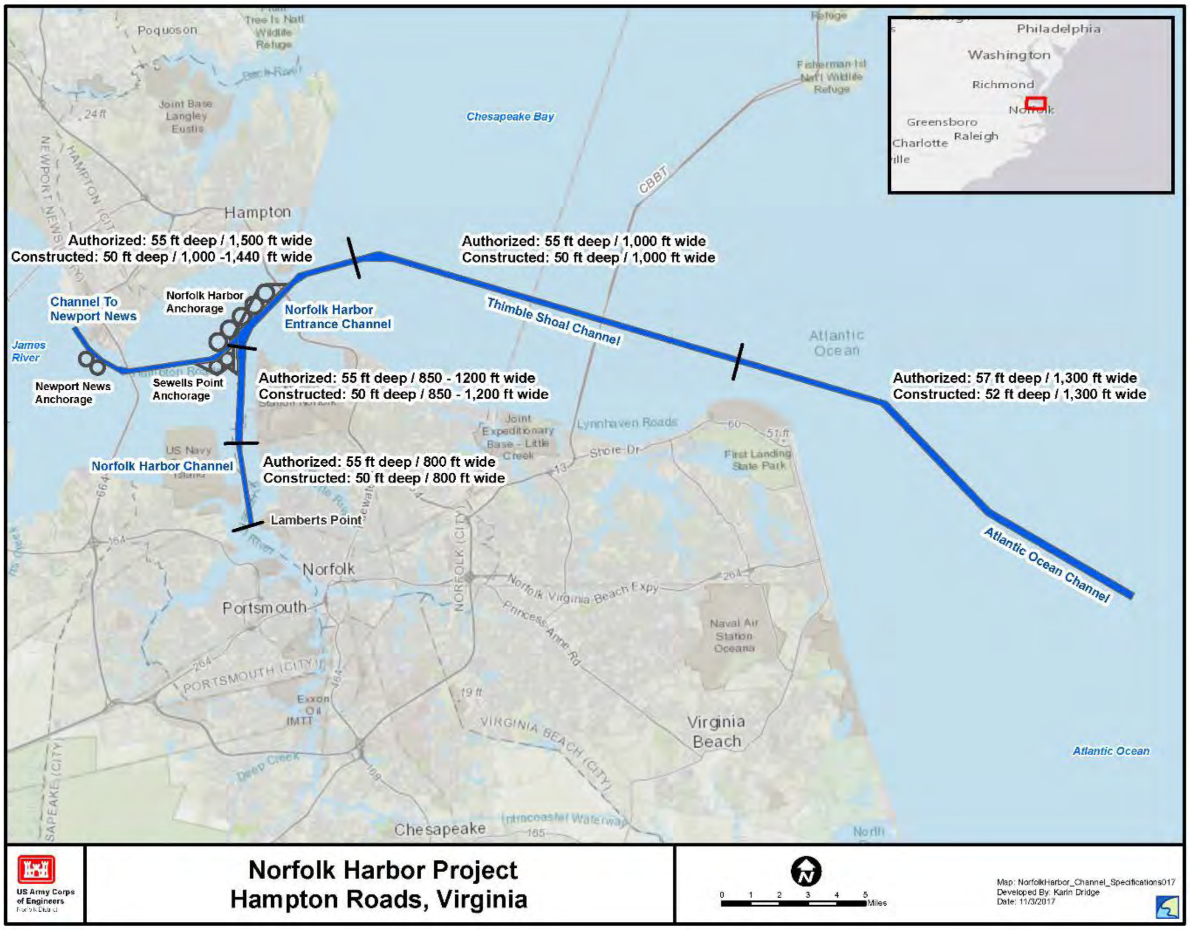

Figure 1-2. Segment 1, Atlantic Ocean Channel to Lamberts Point

Segment 2 is the channel from the Norfolk Harbor Entrance Reach to Newport News, which is identified as the "Norfolk Harbor Entrance to Newport News" (Figure 1-3). The Newport News Channel provides access to the Dominion Coal Terminal, the Kinder Morgan Coal Terminal (a.k.a. Pier 9), and other facilities in Newport News.

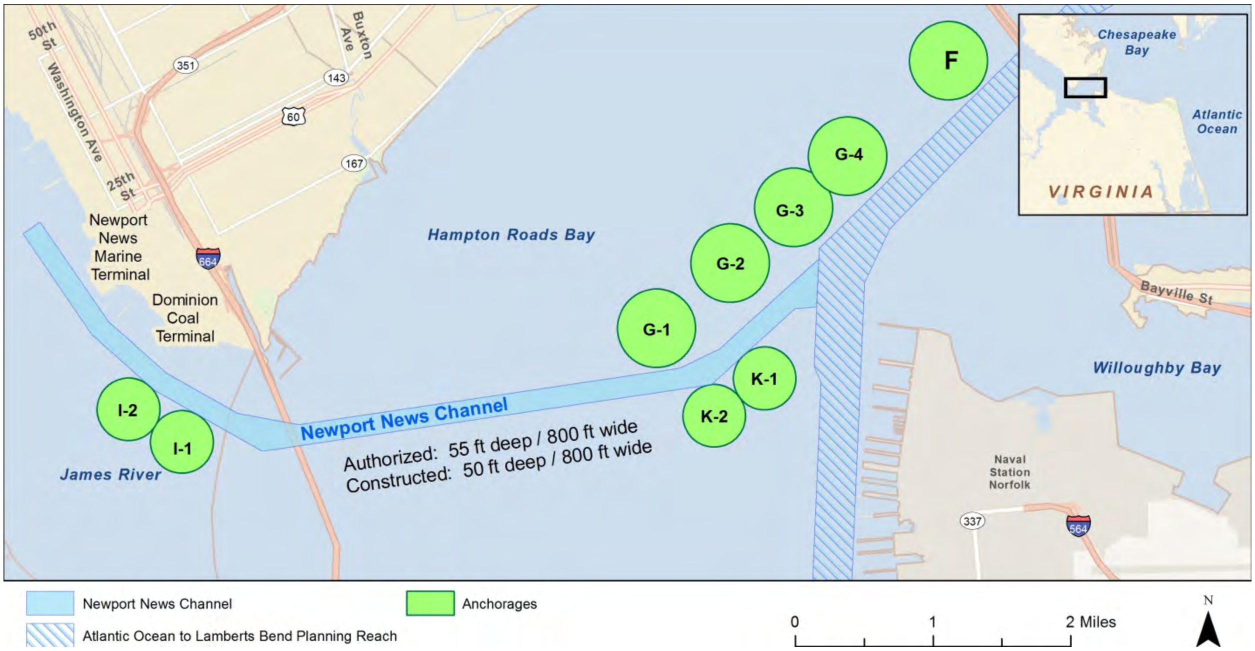

Figure 1-3: Segment 2, Newport News Channel & Anchorage F

Container ships and coal ships are the vessels that operate with the deepest drafts in Norfolk Harbor. Outbound coal ships operate at drafts up to -50 feet and use the tide to maintain appropriate clearances. Outbound container ships also use the tide but are limited to drafts up to -49'3" by the Pilots due to the vessel's speed and squat. At low tide, all vessels may sail with a draft of -47 feet (Table 1-2).

Table 1-2: Norfolk Harbor Number of Vessel Transits by Drafts Ranging from 40 to 50 feet (2009-2014).

Draft	2014		2013		2012		2011		2010		2009	
	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
50	0	59	0	96	0	73	0	52	0	33	0	8
49	0	47	0	56	0	50	0	25	0	12	0	13
48	1	110	0	88	1	90	0	85	0	81	0	57
47	4	86	3	95	6	115	0	119	1	116	0	100
46	14	49	5	56	10	68	0	64	0	51	0	55
45	24	29	13	26	23	32	2	40	1	32	0	30
44	23	44	18	24	20	34	10	47	4	32	0	20
43	20	54	35	41	19	63	21	46	16	33	3	22
42	43	74	27	81	28	76	29	46	26	47	9	30
41	86	132	78	135	87	112	76	79	56	62	28	45
40	97	143	99	119	86	108	83	112	56	78	20	40
Source: Virginia Port Authority												

The Port of Virginia is the third largest container port on the U.S. east coast handling 2.4 million Twenty Foot Equivalent Units (TEU) (Table 1-3). There are two Port of Virginia container terminals in the Norfolk Harbor study area: Virginia International Gateway Terminal (VIG) and Norfolk International Terminals (NIT). A third Port of Virginia container terminal, the Portsmouth

Marine Terminal (PMT), is located in the Elizabeth River. In 2014, there were 1,786 containership calls, of which 946 were to the VIG and 823 were to NIT. Seventeen containership calls were to PMT.

Table 1-3: Annual TEU Throughput at Port of Virginia Terminals

Year	Import Loaded	Export Loaded	Empties	Total TEUs
2016	1,174,893	1,006,119	474,694	2,655,705
2015	1,082,520	997,828	468,922	2,549,270
2014	1,017,879	1,034,526	340,633	2,393,038
2013	934,119	998,843	290,571	2,223,532
2012	870,318	936,809	298,759	2,105,887
2011	768,874	855,334	293,821	1,918,029
2010	766,680	824,331	304,007	1,895,018
2009	689,931	791,831	263,466	1,745,228
2008	858,259	942,075	282,944	2,083,278
Source: Virginia Port Authority				

Norfolk Harbor is the largest coal export harbor in the U.S. (Table 1-4). In 2014, 36.7 million tons of coal were exported to countries in Europe, Asia, and Central and South America. There are three coal terminals in Norfolk Harbor. Two coal terminals (Dominion Coal and Kinder Morgan) are located in Newport News at the north side of Norfolk Harbor. The Norfolk Southern coal terminal is located at Lamberts Point at the southern end of Norfolk harbor. Coal ships with the potential to operate at drafts up to 60 feet call at each of the three coal terminals light loaded.

Table 1-4: Coal Exports from Norfolk Harbor 2009 – 2014 (Metric Tons)

Year	Annual Tonnage	Number of Shipments
2016	19,938,764	416
2015	24,191,593	451
2014	36,638,709	670
2013	45,207,706	797
2012	43,496,895	796
2011	38,212,396	791
2010	29,918,408	696
2009	25,183,003	600
Source: Virginia Maritime Association		

In the last three years Norfolk Harbor has seen a major increase in the size of vessels calling on the port. In 2015, vessel capacity ranging over 9,000 TEUs were calling at the port. Since then the size capacity has ranged up to over 14,000 TEUs with a recent visit by the CMA CGM Theodore Roosevelt (August, 2017), the largest ship to ever visit the east coast of the United States. The Roosevelt measured at 14,400 TEUs.

1.7.1 Construction History

The project was initially authorized in 1986 but was not completely constructed. Below is a timeline of the construction history for the project:

- In 1986, -55/45-foot project authorized by WRDA 1986

- In 1989 project deepened to -50 feet within the outbound channels in Norfolk Harbor, full width in Newport News Channel
- In 2007, remaining inbound components deepened to 50 feet, Atlantic Ocean Channel to -52 feet full width
- In 2007, the -50-foot inbound component from the Atlantic Ocean to Lamberts Bend constructed
- In 2015, Congress appropriated funds for two GRRs and two FCSAs signed by the Virginia Port Authority (VPA)

1.8 Prior Reports and Studies

Numerous studies and reports have been conducted on the Norfolk Harbor project and in the vicinity of the Port of Hampton Roads. A detailed listing of these reports, as well as a historical summary of the numerous Federally authorized channels and anchorages in the Port of Hampton Roads, can be found in the Navigation Management Plan for the Port of Hampton Roads, Virginia, dated February 2000. Additional studies, reports, and authorizations, including those since February 2000 are listed below:

- Final Environmental Impact Statement (FEIS) for the Proposed Dredging of Norfolk Harbor Channel, Norfolk and Portsmouth, Virginia, July 2009.
- Craney Island Eastward Expansion, Norfolk Harbor and Channels, Hampton Roads, Virginia, Final Feasibility Report and Environmental Impact Statement, January 2006.
- Norfolk Harbor and Channels, Virginia, -50-foot Channel Project, -50-foot Inbound Element, Final Limited Reevaluation Report, October 2002.
- Navigation Management Plan for the Port of Hampton Roads, Virginia, February 2000.
- Limited Reevaluation Report, Norfolk Harbor and Channels, Virginia, -50-Foot Anchorage Project, May 1996, Revised July 1996.
- FEIS for the Designation of an Ocean Dredged Material Disposal Site Located Offshore Norfolk, Virginia, Environmental Protection Agency, November 1992.
- Norfolk Harbor and Channels, Virginia, Long-Term Dredged Material Management (Inner Harbor), Final Supplemental Report, May 1992.
- Norfolk Harbor and Channels, Virginia, Long Term Disposal (Inner Harbor), Draft Information Report, June 1990.
- Norfolk Harbor and Channels, Virginia, -50-Foot Outbound Element, Supplemental Engineering Report to General Design Memorandum 1, Revised September 1989.
- Norfolk Harbor and Channels, Virginia, -50-Foot Outbound Element, Supplemental Engineering Report to General Design Memorandum 1, June 1986.
- Norfolk Harbor and Channels, General Design Memorandum (GDM) 1, June 1986.
- Norfolk Harbor and Channels, Virginia, Deepening and Disposal, Final Supplement 1 to the FEIS, and Appendix: Dam Neck Ocean Disposal Site Evaluation Study, May 1985.
- Norfolk Harbor and Channels, Virginia, Feasibility Report and Final Environmental Impact Statement, July 1980, and FEIS Addendum, December 1980 (all in House Document 99-85 dated 18 July 1985, 3 volumes).

1.9 Overview of General Reevaluation Report/Environmental Assessment

This document integrates the General Reevaluation Report (GRR) and the Environmental Assessment (EA). The purposes of the General Reevaluation Report are to:

- Identify the plan that reasonably maximizes national economic development benefits while being technically feasible and environmentally sustainable; and
- Recommend a plan for future action.

The purposes of the EA are to:

- Identify and analyze the environmental impacts of the alternatives;
- Incorporate environmental concerns into the decision making process;
- Evaluate a reasonable range of project alternatives have been considered and evaluated; and
- Determine whether projected environmental impacts warrant the preparation of an Environmental Impact Statement (EIS).

1.10 NEPA Scoping and Public, Resource Agency, and Tribal Coordination

- Extensive coordination with both the public and Federal and state agencies as well as local non-profit environmental nongovernmental organizations has been completed and is ongoing. In 2015, initial coordination with the National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS) was conducted at the USACE/USFWS quarterly coordination meetings to orient them to the project and also discuss consultation questions. Resource agency coordination was formerly initiated with a NEPA scoping session that was conducted as part of the Norfolk Harbor and Channels and Elizabeth River and Southern Branch of the Elizabeth River Problems, Opportunities, and Constraints Workshop on July 21, 2015. Coordination with pertinent Federal and state agencies, including but not limited to the Virginia Department of Conservation and Recreation (DCR), USFWS, NMFS, Virginia Department of Game and Inland Fisheries (VDGIF), Virginia Marine Resources Commission (VMRC), Virginia Department of Environmental Quality (VDEQ), as well as local non-profits such as the Chesapeake Bay Foundation and the Elizabeth River Project occurred during the workshop.
- On July 15, 2015 a coordination meeting was held with VDEQ to discuss water quality impacts associated with the project and discuss the scope of work and goals of the proposed hydrologic and water quality modeling.
- On September 22, 2015, a Notice of Intent to publish an EA was published, along with information on a NEPA public scoping meeting on September 25, 2015 open to the public. A Federal Register Notice was also published to announce the initiation of the feasibility study and also the public NEPA scoping meeting.
- An open house NEPA scoping meeting was held on September 25, 2015; no public comments were submitted at the meeting.
- A coordination meeting with the Virginia State Historic Preservation Officer (SHPO) was held on May 9, 2016 to discuss the proposed Section 106 consultation and the feasibility of preparing a Programmatic Agreement.

- On August 8, 2016 the USACE invited the Catawba Nation, the Delaware Nation, the Delaware Tribe, Narragansett Indian Tribe, the Pamunkey Tribe, and the Shinnecock Indian Nation to consult on cultural resources and the development of a Programmatic Agreement as concurring parties. The Catawba Nation and Delaware tribe responded that they were not interested in consulting on this project, and the other tribes did not respond.
- The cities of Chesapeake, Norfolk, and Portsmouth were invited to consult on Section 106 compliance and in the development of a Programmatic Agreement and either declined or did not respond.
- On August 16, 2016 a coordination meeting was conducted with the VMRC. The USACE provided an overview of the harbor deepening project, anticipated impacts to benthic resources, and the permitting pathway with the VDEQ. The USACE noted during the meeting that environmental mitigation for impacts to benthic resources is not anticipated.
- On August 22, 2016 an Endangered Species Act, Section 7 coordination meeting was conducted with the USFWS and NMFS. The USACE provided an overview of the harbor deepening project, anticipated impacts to Federally listed species and the USFWS and NMFS concurred with the species lists, draft affect determinations, and proposed consultation pathway (formal consultation will be conducted).
- Cooperating agency invitations were sent on May 22, 2017 to the U.S. Environmental Protection Agency (USEPA), the USN, USFWS, the U.S. Coast Guard, and NOAA. The USEPA and the NOAA accepted to be cooperating agencies.
- A Programmatic Agreement between the USACE and SHPO was signed in 2017. The Virginia Port Authority (VPA) also signed the Programmatic Agreement as an Invited Signatory and the Naval History and Heritage Command also signed the Programmatic Agreement as a Concurring Party.
- The USACE has requested the USFWS to prepare a Fish and Wildlife Coordination Act in 2017. Preparation of the report is underway by the USFWS.
- In accordance with Section 7 of the Endangered Species Act, the USACE has prepared a Biological Assessment. Coordination with the USFWS is complete and the NMFS consultation is ongoing for Section 7 and expected to be completed in July 2018. Upon completion of formal consultation, the final BO will be inserted into Appendix I.
- In accordance with the Magnuson-Stevens Fishery Conservation and Management Act, the USACE has prepared an Essential Fish Habitat Assessment and consultation with NMFS is complete.
- A draft of the report was made available for public comment. The draft report was available for from November to December 2017 for a 30-day comment period.

1.11 Report Organization

This report serves as the USACE decision support document for the recommended navigation improvements and as the EA to meet NEPA requirements for the proposed action. It is also formatted to facilitate review and processing by the Assistant Secretary of the Army (ASA) (CW) to provide a report with recommendations to Congress. The remainder of the report is organized as follows.

Section 2: Existing Economic, Environmental, and Navigation Feature Conditions
Section 3: Future without Project Economic and Navigation Feature Conditions
Section 4: Plan Formulation
Section 5: Recommended Plan/Proposed Action
Section 6: Environmental Consequences
Section 7: Summary of Proposed Management Actions
Section 8: Environmental Compliance
Section 9: List of Agencies and Persons Consulted
Section 10: Recommendations
Section 11: Finding of No Significant Impact
Section 12: References
Appendices

2 EXISTING ECONOMIC, ENVIRONMENTAL, AND NAVIGATION CONDITIONS

2.1 Navigation Features

2.1.1 Channels, Anchorages and Turning Basins

The authorized project includes a system of channels with a depth of -55 feet in the Norfolk Harbor and TSC and -57 feet in the AOC (Figure 2-1). Since its authorization in 1986, the project has been constructed in separable elements based on the needs of the port community and the financial capability of the non-Federal sponsor. The -50 Foot Outbound Element was completed in 1989; the -50 Foot Anchorage was completed in 1999; and -50 Foot Inbound Element was completed in 2007. The project has not been constructed, nor is it maintained, to its full authorized depth.

Norfolk Harbor is located in the southeastern part of the Commonwealth of Virginia at the southern end of Chesapeake Bay, midway on the Atlantic Seaboard, approximately 170 miles south of Baltimore, Maryland, and 220 miles north of Wilmington, North Carolina. The harbor is formed by the confluence of the James, Nansemond, and Elizabeth Rivers. Norfolk Harbor's container terminals service a vast hinterland that extends from the Mid-Atlantic States out to the Mid-West and Southeastern portions of the U.S. One-third of the containers are moved over land by rail. The harbor's coal terminals service all of the major coal producing regions of the U.S.

Figure 2-1: Norfolk Harbor and Channels - Channel Reaches

Atlantic Ocean Channel

The AOC, just off the coast of Virginia, was authorized by the WRDA of 1986. The WRDA authorized the U.S. Army Corps of Engineers (USACE) to construct the AOC which consists of a channel 11.1 miles long, 1,300 feet wide, and -57 feet deep. Please note that depths described in this document are provided in Mean Lower Low Water (MLLW). As part of the -50 foot inbound construction effort in 2006, the channel was deepened to provide for a required depth and width of -52 feet and 1,300 feet, respectively. The AOC project is part of the Port of Virginia and Baltimore system of channels and is the segment providing access for all ships calling on port facilities, naval bases, and shipyards in the Hampton Roads, York River and Baltimore areas. All commercial tonnage entering and leaving the Ports of Virginia and Baltimore pass through this channel. The channel is currently maintained to a full width and a required depth of -52 feet to enable loaded colliers, container ships, and military vessels to transit the channel with ship drafts as great as -50 feet.

Material is typically dredged via hopper dredge from this channel. Dredged material is placed at DNODS. Dredged material also has been used for beneficial uses for the Virginia Beach Hurricane Protection project and the Craney Island Eastern Expansion (CIEE) Project. The sediment composition in this channel segment is largely fine sand (85%) with some silt (15%). The channel has been utilized as a sand borrow source for hurricane protection projects and port development projects, and, therefore, maintenance has not been required.

The existing USEPA concurrence (May 15, 2015) for this channel is located in Appendix I and expires on May 15, 2018. The USACE Norfolk District will continue to maintain compliance with MPRSA Section 103, as required, through sampling and testing at the Ocean Dredged Material Disposal Sites (ODMDS), NODS and DNODS. Coordination and compliance with USEPA Region III requirements to achieve this will continue into the future at required intervals.

Thimble Shoal Channel

The TSC is located in the southern part of the Chesapeake Bay, just off the shoreline of Norfolk and Virginia Beach, east of the CIDMMA. This project was originally authorized by the River and Harbor Act of 1917. The authorized channel dimensions are 13.4 miles long and 1,000 feet wide between the -55 foot contours, to a depth of -55 feet. Although the channel is authorized to be dredged to -55 feet, the channel is currently maintained to a required depth of -50 feet. Thimble Shoal Channel extends from the deep water to the east of Hampton Roads to the deep water at the mouth of the Chesapeake Bay.

Material dredging is via hopper dredging. Dredged material is placed at the DNODS. The sediments of TSC to the west of the Chesapeake Bay Bridge Tunnel are predominantly clays and silts (50 - 75%). In contrast, sediments in the eastern portion of channel are largely fine to medium grained sand (75 - 90%).

The existing USEPA concurrence (May 15, 2015) for this channel is located in Appendix I and expires on May 15, 2018. The USACE Norfolk District will continue to maintain compliance with MPRSA Section 103, as required, through sampling and testing at the ODMDS sites, NODS and DNODS. Coordination and compliance with USEPA Region III requirements to achieve this will continue into the future at required intervals.

Channel to Newport News and Anchorages

The Channel to Newport News and associated Newport News anchorages segment of the Norfolk Harbor Federal navigation project is authorized to -55 feet deep by 800 feet wide from Norfolk Harbor Channel in Hampton Roads to Newport News and the Newport News Anchorages. However, the channel is currently maintained to a required depth of 50 feet by removing approximately 800,000 CY every four years. Material dredging is via hydraulic and/or mechanical dredging methods. Material dredged from this area is then placed at the CIDMMA.

The existing Virginia Water Protection Permit (VWP#:14-0749) for this channel segment was obtained on December 3, 2014 and is included in Appendix I. The permit expires December 2, 2024. The USACE will continue to coordinate and maintain compliance with VDEQ into the future at required intervals.

Norfolk Harbor Channel - Sewells Point to Lamberts Bend and Norfolk Harbor Anchorages

The Sewells Point to Lamberts Bend reach of the Norfolk Harbor Federal navigation project is located in Norfolk between Sewells Point and Lamberts Point. This segment of the project is approximately eight miles long and varies in width between 800 feet and 1,200 feet. This reach also consists of: Anchorage F, Sewells Point East Anchorage (includes the Naval Maneuvering Area and Approach Areas), Sewells Point West Anchorage and Approach Area, Anchorage G, and all approach areas.

The authorized project dimensions for this reach include a channel -55 feet deep and 1,200 feet wide from that depth in Hampton Roads to a point approximately 6.0 miles upstream from the Hampton Roads Bridge-Tunnel; thence -55 feet deep and 800 feet wide to Lambert Point. The Sewells Point to Lamberts Bend Channel is currently maintained to a required depth of -50 feet MLLW from the -55 foot contour in Hampton Roads (near the Hampton Roads Bridge Tunnel) to Lamberts Point.

Material is dredged from this area via hydraulic cutterhead pipeline dredge and/or a clamshell dredge. Material dredged from this area is then placed at the CIDMMA. The consistency of the dredged material in the Sewells Point to Lamberts Bend Channel is primarily silt and clay (85%) with some sand (15%). The consistency of the Elizabeth River sediment is predominantly clay in the Town Point area of Norfolk; however, as you travel south along the Elizabeth River (towards Chesapeake), the sediments become increasingly more coarse and sandy. In the southern most areas of the Southern Branch of the Elizabeth River, sediments are predominantly fine-grained and composed of at least 61% silt and clay.

The existing Virginia Water Protection Permit (VWP#:13-0856) for this channel segment was obtained from VDEQ on September 18, 2013 and is included in Appendix I. The permit expires September 18, 2028. The USACE will continue to coordinate and maintain compliance with VDEQ into the future at required intervals.

2.1.2 Dredging and Placement History

There are three dredged material placement/management areas that have historically served and continue to serve the Norfolk Harbor project:

- CIDMMA;
- DNODS; and

- NODS

Three USACE Erosion Control and Hurricane Protection projects, the USACE CIEE, and one Chesapeake Bay Bridge and Tunnel Authority project have completed NEPA documents and could accept dredged material for beneficial use[1].

In addition to the three established placement areas, the Craney Island Eastward Expansion (CIEE), which was authorized by Congress in 2007, will be available to supplement the confined placement available at CIDMMA (See Appendix A, Section 6.1.5 for additional information on potential placement sites).

To determine dredged material suitability for placement/disposal, dredged material is tested for contaminants in accordance with the Evaluation of Dredged Material Proposed for Discharge in Waters of the U.S.- Testing Manual, Inland Testing Manual (USEPA 1998), USACE Manual, Evaluation of Dredged Material Proposed for Disposal at Island, Nearshore, or Upland Confined Disposal Facilities – Testing Manual (2003); and the USACE (2013) Commander's Policy Memorandum WRD-01 Deposition of Dredged Material and Use of the Craney Island Dredged Material Management Area, Norfolk Harbor, Virginia.

Four beneficial use sites, three historical and one new, are also available for suitable material from the AOC and the TSC. Based on projected dredged material volumes and available capacity at existing placement areas, no additional placement areas are required.

Craney Island Dredged Material Management Area

The CIDMMA is approximately two miles square with existing ground elevations within the cells varying from approximately +32 to +40 feet MLLW. CIDMMA receives dredged material which is pumped hydraulically into the cells. Dredged material is typically pumped in over the east dike. This is evidenced by the large sand mounds observed at the influent points where these heavier sand particles quickly settle out of the dredge slurry. Existing external dikes range in elevation from +35 to +45 feet MLLW.

CIDMMA is currently operated using the guidance from the existing Dredged Material Management Plan (DMMP) prepared in 1981. The 1981 DMMP estimated that, over its operating life, CIDMMA would be able to accept over 250 MCY of dredged material (since it began operation in 1957), a significant increase over the original capacity estimate of 96 MCY.

The existing DMMP is based on the current configuration of CIDMMA, which is divided into three cells: South Cell (734 acres for storage), Center Cell (766 acres for storage) and North Cell (689 acres for storage). Currently Norfolk District rotates each of the three cells annually to allow two years of drying before dredged material is again pumped into the cell. The District also typically caps the volume of dredged material that can be pumped into an individual cell at no more than 5 MCY annually. Monthly inflows are typically limited to 650,000 CY.

The Norfolk District currently has an annual earthwork/grading contract to maintain and raise the perimeter and division dikes. Under this contract, approximately 750,000 CY of granular material is excavated and placed on the dikes annually. The material is borrowed from the eastern side of CIDMMA using conventional excavation equipment and hauled using off-road trucks to the required location. Existing dikes are continually maintained to compensate for consolidation settlement of the marine clay foundation beneath the dikes, and the need to maintain adequate freeboard on the dikes.

[1] Norfolk Harbor and Channel Deepening Study Beneficial Reuse Sites Overview, Technical Letter #013. 08 Jun 2016.

On the west side of the CIDMMA, each containment area has two primary spillways, each with four, 36-inch diameter outlet pipes. The pipes discharge effluent from the CIDMMA into the Elizabeth River. The east side is higher in elevation, where material flows downslope to the west, depositing the heaviest particles first. The spillways allow the release of water after the sediments from the dredged material have settled out. In general, under typical pumping operations, it can take up to five days to reach a working pool level with three feet of freeboard. Spillway stop-logs (boards) are used to control water levels during pumping operations. Prior to its release into the Elizabeth River, effluent from the CIDMMA is monitored to ensure compliance with the Clean Water Act, Section 404 requirements, 40 Code of Federal Regulation (CFR) 230, and state water quality standards. The effluent is visually inspected a minimum of six times per day at each operating spillway, approximately once every four hours. If at any time it is visually apparent that effluent other than clarified water is being released from CIDMMA, the effluent, Total Suspended Solids, is sampled and then immediate action is taken at the spillway to reduce the amount of suspended solids in the effluent by increasing the water retention time. The Total Suspended Solids samples are taken in accordance with the Norfolk District Commander's Policy WRD-01 at least twice daily at the weir crest of each operating spillway, once approximately every 12 hours. Permitted users are required to maintain a daily average Total Suspended Solids concentration of less than 500 mg/l.

As determined in the Craney Island Eastward Expansion Feasibility Report (USACE, 2006), capacity of CIDMMA is defined as when the dikes can no longer be raised. The CIEE Feasibility Report determined the maximum height of +50 feet MLLW without additional modifications to the subsurface or geometry.

The lifecycle of CIDMMA will be determined by the Corps' ability to continue to raise containment dikes based on dike foundation strengths while maintaining the required factor of safety for dike stability. Containment dikes are maintained to create additional dredged material storage capacity through the beneficial use of dredged material placed at the CIDMMA. Unimproved perimeter roads are maintained with suitable dredged material to ensure access to the facility for operation and maintenance. Maintenance of the containment dikes and access roads includes the excavation or borrow of dredged material and redeposit of the material to maintain and build the additional containment capacity. Currently, dikes range in height from +35 to +45 MLLW. Spillway lifecycles including maintenance and replacement occur as required as containment dikes are raised to accommodate new capacity. Spillway maintenance may require replacement of discharge pipes, outfall structures and associated rip-rap aprons. Containment cells are actively de-watered of dredged material effluent and runoff to maximize the dredged material drying and consolidation to maximize the life of the facility. The excavation and redeposit of dredged material for containment dike maintenance, dewatering containment cells of dredged material effluent and runoff, and maintenance of spillway structures are considered ongoing maintenance activities which include dredged material discharges at CIDMMA consistent with 40CFR232.2(1).

The CIEE Feasibility Report estimated that CIDMMA would achieve its full capacity in 2025, which includes acceptance of 118 MCY from 2000 to 2025. Actual inflow from 2000 – 2015 are 69 MCY, indicating that remaining capacity is 49 MCY. This remaining capacity estimate is currently being revised with updated fill level and dike elevations. To maximize capacity and the useful life of the CIDMMA the Norfolk District will manage dredged material placement between CIDMMA and ocean placement alternatives to provide for the long term maintenance of the Norfolk Harbor Federal navigation channels.

Norfolk Ocean Dredged Material Disposal Site

The NODS is a 42,600-acre area, with an estimated total capacity of 1,300 MCY. The site is delineated by a circle with a radius of 4 nautical miles centered at 36 degrees, 59 minutes north latitude, and 75 degrees, 39 minutes west longitude. Water depth at the site ranges from -43 to -85 feet. The NODS designation in the Federal Register, VOL 58, No. 126 dated Friday, July 2, 1993 indicated the intent for NODS:

The NODS was intended to be the primary disposal site for suitable dredged material in the lower Chesapeake Bay designated for disposal of suitable new work and maintenance material dredged from the lower Chesapeake Bay and Norfolk Harbor. The Craney Island Containment Area will receive material not suitable for ocean disposal, and the DNODS will receive material for which it has been designated. Per the NODS Site Management Plan of February 2009, *"If in the future the Craney Island Dredged Material Management Area (Norfolk, Virginia) is no longer available, suitable material currently placed in the Craney Island DMMA could be placed in the ODMDS." (NODS SMMP 2009)*

The NODS is permitted to receive both coarse and fine grained materials that meet the USEPA requirements for ocean disposal. The site has been used since 1979. The current Site Management and Monitoring Plan (SMMP) is dated February 2009 and will be in effect until 2019. After that time, USACE will renew its SMMP with USEPA. Placement will performed and monitored in accordance with the Norfolk District's SMMP.

Dam Neck Ocean Dredged Material Disposal Site

The Dam Neck ODMDS has an area of about 9-square nautical miles with a water depth averaging about 40 feet. The Dam Neck ODMDS is currently designed and managed to hold approximately 50 Million Cubic Yards (MCY) of dredged material. The Dam Neck SMMP states that future evaluation and management could increase this quantity.

No specific disposal method is required for this site. Disposal may be by hopper dredge, dump scow, or by pipeline discharge. There are no seasonal restrictions to the placement of dredged material within the Dam Neck ODMDS. Approximately 1.2 MCY of material from the three Federal navigation channels will be placed in the site every 2 years.

Material dredged for placement at Dam Neck will most likely be dredging via hopper dredge, although mechanical dredging with material transported to the site using bottom dump scows may be used. Placement will performed and monitored in accordance with the Norfolk District's Site Management and Monitoring Plan.

Craney Island Eastward Expansion

The CIEE Southeast Cell is currently under construction, with its completion dependent on Federal funding. If available at the time of the proposed deepening, the cells could be considered as a placement area. The CIEE project expands existing CIDMMA to the east by constructing a new placement area of approximately 522 acres. The CIEE area will be a total of approximately 8,500 feet by 2,500 feet. The cell will be subdivided with a cross dike to form the Southeast Cell and the Northeast Cell. With the proposed filling to elevation +18 feet MLLW, the Southeast Cell and Northeast Cell have a neat volume capacity of 6.7 and 12.7 MCY respectively. This is the volume within the cell, and does not include bulking of the dredged material.

CIEE will effectively provide an additional cell to CIDMMA. After the cell is completed (confined) filling with material from both the proposed deepening and maintenance dredging can occur.

Hydraulic filling will be similar to existing CIDMMA operations, by a hydraulic pipeline cutterhead dredge.

Approximately 4.8 MCY of sand is required to complete the construction the three cross dikes, and portions of the main dike, as part of the CIEE project. About 1.5 MCY of sand will be required for each of the three cross dikes. The construction of the south and center cross dikes will be a component of the south east cell dike construction. In addition, some (i.e., the lower portion) or all of the north cross dike will be completed during the south east cell construction.

Sands mined from the AOC or TSC (or both) that is placed using hydraulic techniques is anticipated to be the primary method of construction of the cross dikes. Material from the ocean channels will be delivered to site by hopper dredges and placed hydraulically. In the lower elevations (deeper water), the material may be bottom dumped while in the higher placement elevations, the hopper will pump the sand slurry through a pipeline and discharge at the location and elevation desired, as is done for beach nourishment projects. A spill barge will be used to help control the placement of the material and minimize turbidity.

Sand from upland sources will likely be transported to the site via barges and placed through a tremie pipe (from a spill barge) to the required location.

As determined by the Craney Island Eastward Expansion Feasibility Report (USACE 2006), capacity of the CIDMMA is governed by when the dikes can no longer be raised. The CIEE Feasibility Report determine that the maximum height is +50 feet above MLLW. Dike heights currently range from 36 to 40 feet above MLLW but are capable of being raised.

Beneficial Use Sites

Three USACE Erosion Control and Hurricane Protection projects, the USACE CIEE project, project have completed NEPA documents and could accept dredged material for beneficial use as available and when applicable (Table 2-1). Portions of the dredged areas may be suitable for beneficial use projects and beneficial use projects would be coordinated separately from this project. Additional beneficial use areas maybe identified during the design stage of the project. At such time any such beneficial use sites would be subject to additional requirements and studies as need to allow the area to be utilized.

Beach nourishment materials should be similar in geological make-up to the existing sediments of the native beach materials. Nourishment materials should have a low percentage of fine-grained sediments. The goal for typical local beach nourishment (Cities of Norfolk and Virginia Beach) material is a D50 grain size of greater than 0.2mm. Suitable materials will have no more than 5% fines by weight.

While, no beneficial uses sites are included in this project as this time. If during construction it is determined that such sites area available then each site must meet current USACE requirements which includes being authorized for such use. Beneficial use sites are subject to Section 207 of WRDA 1996, as amended whereby reuse represent a least costs disposal method and are reasonable in relation to the environmental benefits achieved. Any beneficial use not identified in the future as part of the base plan would need to be cost shared under a separate authority.

Table 2-1. NHC Deepening Project Potential Beneficial Use Sites

Project:	Description	NEPA/Permit Reference	Estimated Volume Needs
Big Beach	USACE/City of Virginia Beach Federally authorized hurricane protection project	Beach Erosion Control and Hurricane Protection Main Report and Supplemental EIS 1984 USACE	2 MCYs Estimated every 7 years
Sandbridge	USACE/City of Virginia Beach Federally authorized hurricane protection project	Sandbridge Beach, VA Erosion Control and Hurricane Protection EA 2009 USACE; 2012 BOEM	1.75 MCYs Estimated every 5 years
Willoughby Norfolk	USACE/City of Norfolk Federally authorized hurricane protection project	Willoughby Spit and Vicinity Norfolk Virginia Beach Erosion and Hurricane Protection Project, EIS 1983 USACE	1.2 MCYs Estimated every 5 years
CIEE	USACE/VPA Federally authorized expansion to CIDMMA	Final Environmental Impact Statement and Finding of No Significant Impact, dated Jan 2006 – EA Supp FONSI dated 11/10/2009	4 MCY

2.2 Terminal Facilities

2.2.1 Container Terminal Facilities

Norfolk International Terminals (NIT)

Norfolk International Terminals is located on 567 acres along the Elizabeth and Lafayette Rivers. NIT has 14 Super Post-Panamax Class ship-to-shore cranes, eight with a reach of up to 26 containers and 6 with a reach of 22 containers (Figures 2-2 and 2-3). NIT has a total of 6,630 linear feet of berthing area. As currently configured with existing equipment, NIT has a throughput capacity of 1.4 million TEUs.

Trucks are processed through 42 gate lanes. NIT is located adjacent to Interstates 64 and 564 and Hampton Boulevard in Norfolk, with additional easy access to US Route 17 and US Route 58, which provides access to Interstate Highways 95 and 85.

NIT is divided into three major sections: the South Terminal, the North Terminal, and the 50-acre Central Rail Yard. It has direct rail access to Norfolk Southern's Heartland Corridor, providing second-day double-stack service to Midwest markets.

Figure 2-2: Norfolk International Terminals (Port of Virginia, 2015)

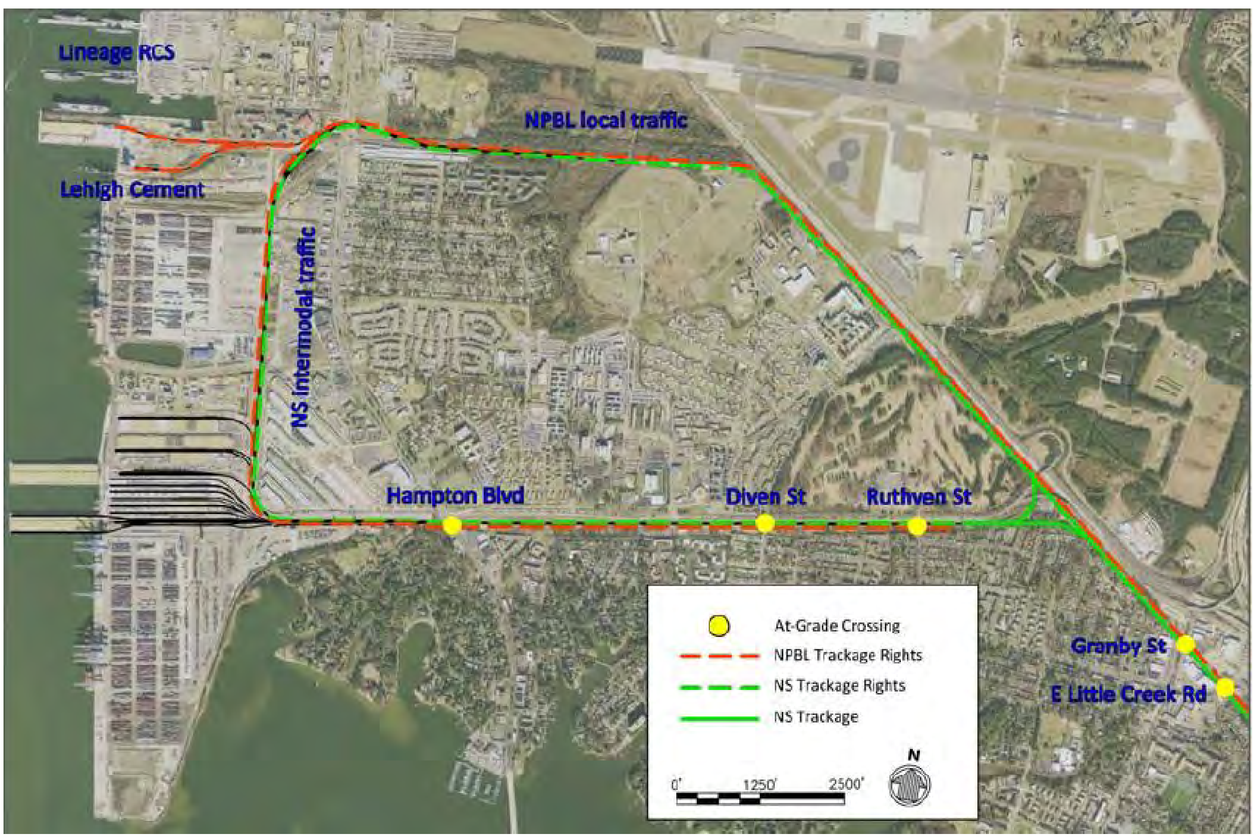

Figure 2-3: NIT Rail Operations (Port of Virginia, 2015)

Portsmouth Marine Terminal (PMT)

Portsmouth Marine Terminal occupies 287 acres of land and is located on the west bank of the Elizabeth River (Figure 2-4). PMT has six Super Post-Panamax Class ship-to-shore cranes with a reach up to 18 containers. PMT has 3,540 feet of wharf, three berths, and is able to handle containers, break-bulk, and roll-on/roll-off cargo. As currently configured with existing equipment, PMT has a throughput capacity of 438,000 TEUs. The terminal also includes a 44-acre Empty Container Yard.

PMT is accessed by road via Interstate Highways 164, 264, 664 and State Highway 164. There are 10 reversible gate lanes. Rail service is provided directly by CSX and by Norfolk Southern via the Norfolk Portsmouth Beltline Railway (Figure 2-5).

Figure 2-4: Portsmouth Marine Terminal

Figure 2-5: PMT Rail Operations

Virginia International Gateway (VIG)

Virginia International Gateway is one of the only functional semi-automated container terminals in the Western Hemisphere (Figure 2-6). The facility sits on a total footprint of 576 acres. The VIG has eight Super Post-Panamax Class ship-to-shore cranes, two with a reach of up to 26 containers and six with a reach of 22 containers. VIG has a total of 3,205 linear feet of berthing area. As currently configured (Phase I of VIG's development at 231 acres) with existing equipment, VIG has an annual throughput capacity of 1.1 million TEUs. Phase II will add approximately 60 acres in additional space and another one million-plus TEUs in capacity.

The VIG has 13 inbound and 13 outbound truck gates and has direct interchange to the interstate highway system (I-64 and I-664) via State Highway 164. Interstate Highways 95 and 85 are accessed via U.S. Highway 58.

The VIG provides Class I double-stack intermodal service. The terminal is equipped with a six-track on-dock intermodal yard and an intermodal transfer facility served by Norfolk Southern and CSX through an operating agreement with the Commonwealth Railway (Figure 2-7).

Figure 2-6: Virginia International Gateway Terminal

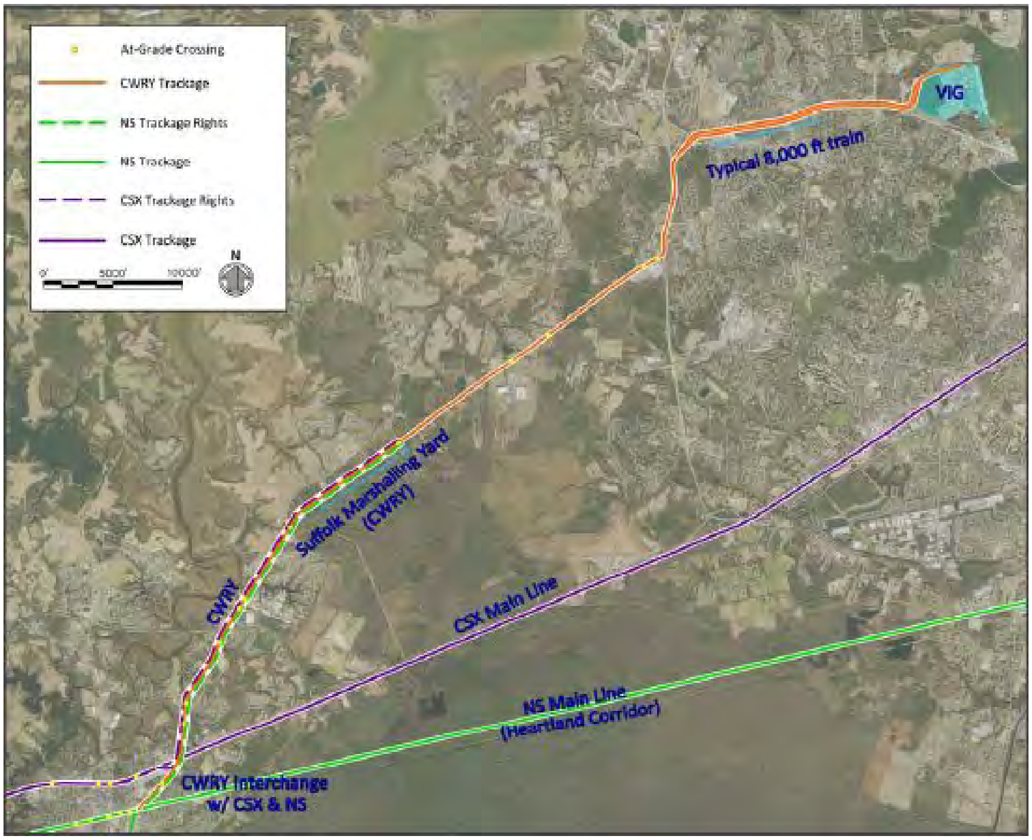

Figure 2-7: VIG Rail Operations

Craney Island Marine Terminal (CIMT)

The CIEE is a congressionally authorized project consisting of a 580 acre eastward expansion to an elevation of +18 feet MLLW to provide additional dredged material capacity and a suitable platform to construct a container handling terminal (Figure 2-8). The plan includes construction of an access channel to a depth of -55 feet MLLW to serve the VPA's container port. In preparation for future port development, the 580 acre area would be divided by a dike into two dredged material receiving areas consisting of 220 and 360 acres. The smaller area would be filled with dredged material first and would be the area where the VPA would begin port construction. The larger area would begin to receive dredged material after filling of the smaller area. Once the larger area is filled, it would also be turned over to the VPA for port construction.

Figure 2-8 Craney Island Marine Terminal

The CIMT is a planned semi-automated container terminal to be located on approximately 495 acres of the CIEE, adjacent to the CIDMMA. Current planning includes four phases of development that would provide a capacity of approximately 1.3 million TEU at the terminal's opening and approximately 5.0 million TEU at Build-Out. The planned CIMT will encompass 8500 linear feet of wharf, operate 28 Suez-class cranes, and have an on-terminal intermodal container transfer facility served by both Class I railroads (CSX and Norfolk Southern). The construction phasing of the CIMT is planned such that the operations of each new section of the facility is functional before the demand exceeds the capacity of the built portion.

Major elements include container handling mode and equipment, buildings, structures, utilities, and rail operating mode and equipment. The proposed CIMT concept is based on a goal of 50% of container traffic leaving or arriving via rail, which significantly will reduce the terminal's impact on highway traffic and the environment compared to concepts emphasizing truck hauling.

To provide access, the Craney Island Road & Rail Connector (CIRRC) is planned to include a 2.75 mile-long multi-modal road and rail corridor connecting the Route 164 Western Freeway to the CIMT. Rail is served by an extension of the Commonwealth Railway (CWRY). The CWRY is an existing Class III short line that provides connections to the Norfolk Southern railway.

2.2.2 Bulk Terminal Facilities

Newport News Dry Bulk Terminals (NN-DRY BULK)

Dominion Terminal is located on the east bank of the James River in Newport News, VA (Figure 2-9). The facility stockpiles and blends coal from the eastern United States and loads coal exports on coastal barges and colliers. Ground storage capacity for coal is 1.7 million tons. Rail service to the terminal is provided by CSX on 13 miles of track. Rail cars are offloaded by a rotary dumper at a rate of up to 5,200 tons per hour.

The terminal's single pier is 1,162 feet long and is capable of loading on either side. Depth at both berths is currently -50 feet MLLW to match the existing channel. Both berths are capable of being dredged to -55 feet MLLW. Vessels are loaded by a traveling ship loader capable of loading 6,500 tons per hour.

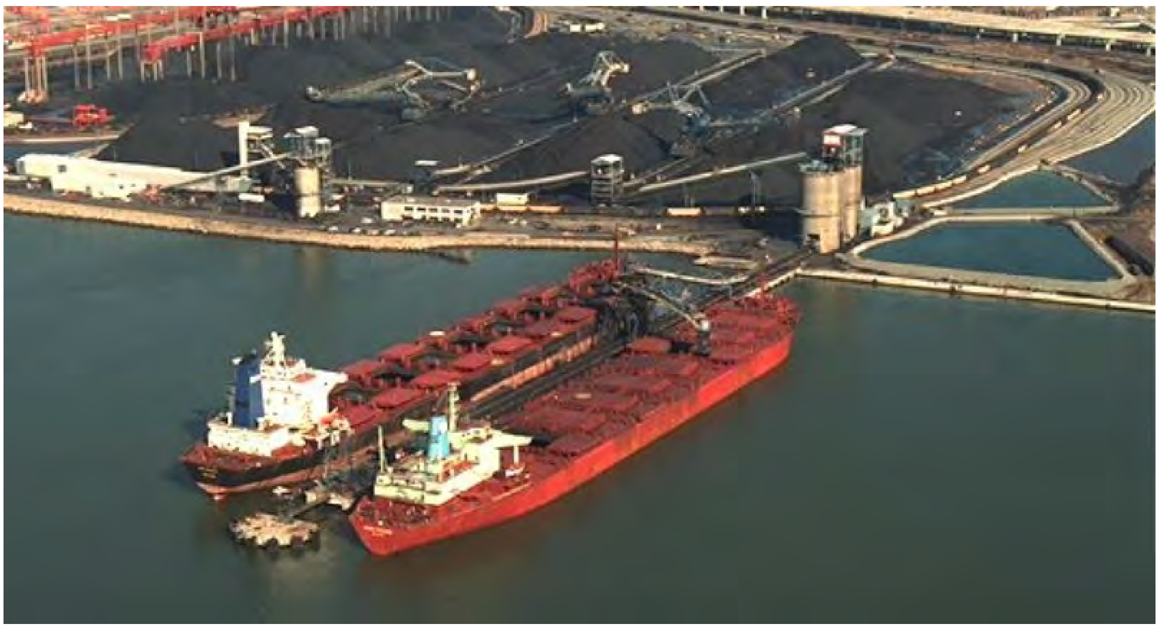

Figure 2-9: Dominion Terminal

Kinder Morgan Bulk Terminals – Pier IX

Kinder Morgan Bulk Terminals Pier IX is located on the east bank of the James River in Newport News, VA (Figure 2-10). The facility stockpiles and blends coal from the eastern United States and loads coal exports on coastal barges and colliers. Ground storage capacity for coal is 1.4 million tons with an export capacity of 16 million tons. The terminal is also capable of unloading cement from vessels with 30,000 tons of storage capacity in three silos. Rail service to the terminal is provided by CSX. Rail cars are offloaded by a rotary dumper at a rate of 3,000 tons per hour.

The terminal has two 1,200 foot long piers. Pier IX is capable of loading on either side and Pier X berths vessels on the south side only. Depth at both berths is currently -50 feet MLLW to match the existing channel. Both berths are capable of being dredged to -55 feet MLLW. Coal colliers are loaded by a traveling ship loader capable of loading 8,000 tons per hour.

Figure 2-10: Kinder Morgan Bulk Terminals Pier IX

Lamberts Point Coal Terminal (NS-PIER-VI)

Lamberts Point Coal Terminal is located on the east bank of the Elizabeth River in Norfolk, VA. The facility is served and operated by Norfolk Southern (Figure 2-11). The facility stockpiles and blends coal from the eastern United States and loads coal exports on coastal barges and colliers at its Pier 6 facility. Annual throughput capacity is 48 million tons. Rail cars are offloaded by twin tandem rotary dumpers at a rate of up to 8,000 tons per hour.

The terminal's single pier is 1,850 feet long and is capable of loading on either side. Depth at both berths is currently -50 feet MLLW to match the existing channel. Both berths are capable of being dredged to -55 feet MLLW. Vessels are loaded on the north side of the pier. Two vessel loaders are capable of loading vessels at a rate of 5,000 tons per hour each.

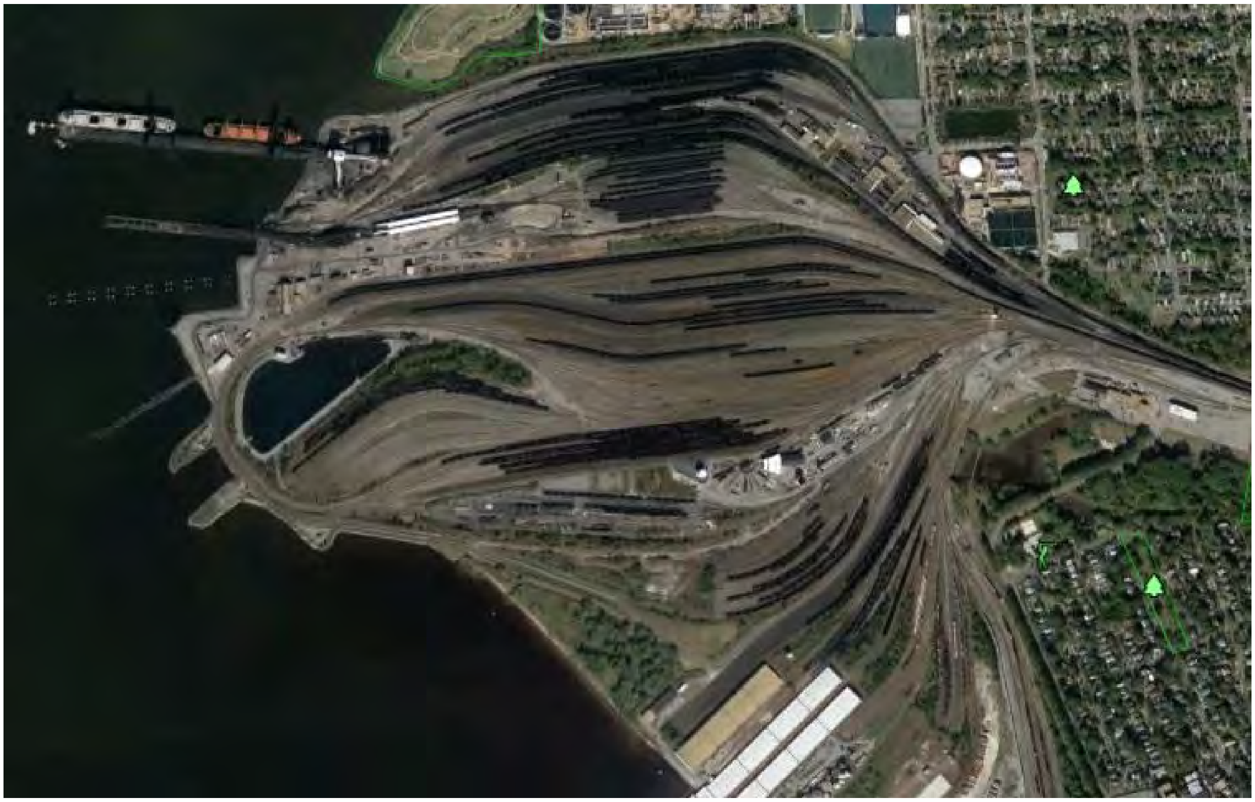

Figure 2-11: Lamberts Point Coal Terminal

2.3 Existing Economic Conditions

2.3.1 Socioeconomics

Socioeconomics include the basic attributes of demographics and economic characteristics within a particular area including population, race, employment, and income. As shown in (Figure 2-12) the region of influence (ROI) for the Norfolk Harbor socioeconomics is the U.S. Census Bureau's Virginia Beach-Norfolk-Newport News, VA-NC Metropolitan Statistical Area (MSA), which encompasses 15 jurisdictions: the cities of Chesapeake, Franklin, Hampton, Newport News, Norfolk, Poquoson, Portsmouth, Suffolk, Virginia Beach and Williamsburg; the Virginia Counties of Gloucester, Isle of Wight, James City, Southampton, and York; and the North Carolina Counties of Currituck and Gates (HRPDC 2013) (Table 2-2). At the time of the 2010 U.S. Census, Surry County was included in the MSA, while Gates County was not (HRPDC 2013a). The 2010 decennial census data are used to summarize the socioeconomic characteristics within the ROI unless otherwise noted (U.S. Census Bureau 2010).

Population

The U.S. Census Bureau's 2010 Census reported that the population of the MSA was 1,671,683 (U.S. Census Bureau 2010). Table 2-2 compares the population data from the 2000 and 2010 census and calculates the percent change for each of the municipal boundaries that were within the Hampton Roads MSA at the time the respective census was taken.

Table 2-2: Virginia Beach-Norfolk-Newport News, VA-NC MSA Population

MSA Component	2000 Census	2010 Census	Percent Change
Virginia Cities			
Chesapeake	199,184	222,209	11.6
Hampton	138,437	137,436	-0.7
Newport News	180,150	180,719	0.3
Norfolk	234,403	242,803	3.6
Poquoson	11,566	12,150	5.1
Portsmouth	100,565	95,535	-5.0
Suffolk	63,677	84,585	32.8
Virginia Beach	425,257	437,994	3
Williamsburg	11,998	14,068	17.3
Counties			
Currituck Co., NC	18,190	23,547	29.5
Gates Co., NC	10,516	12,197	16
Gloucester Co., VA	34,780	36,858	6
Isle of Wight Co., VA	29,728	35,270	18.6
James City Co., VA	48,102	67,009	39.3
Surry Co., VA	6,829	7,058	3.4
York Co., VA	56,297	65,464	16.3
Total MSA Population	**1,569,679**	**1,674,902**	**6.7**

Income

The Hampton Roads Planning District Commission (HRPDC) is a regional organization that represents local governments in Hampton Roads and does extensive research and reporting on the demographic and economic characteristics within the area. In 2014, HRPDC published a Benchmarking Study with a section focused on regional economy statistics (HRPDC 2014). The U.S. Census Bureau’s five-year American Community Survey for the MSA reported per capita income of $28,954, median household income of $59,293, and an unemployment rate of 7.9% (U.S. Census Bureau 2014).

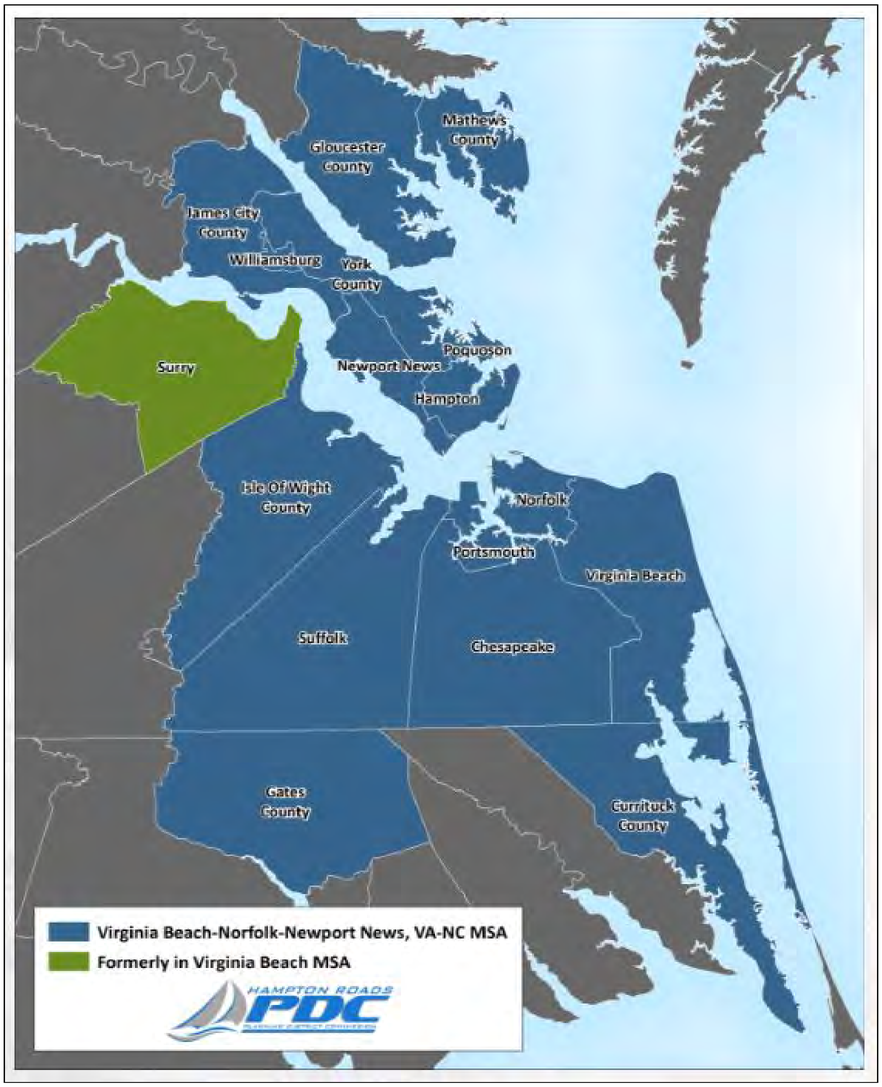

Figure 2-12: Virginia Beach-Norfolk-Newport News, VA-NC MSA.

Local Economy

The total economic impact in Virginia in FY 2013 directly and indirectly attributable to the Port of Virginia was $60.3 billion in spending (Pearson and Swan 2014). Some of this spending was for goods and services produced outside of Virginia, but the Virginia value-added to the Gross State Product (GSP) was $30.5 billion, equal to 6.8% of the estimated $448.8 billion total GSP in FY 2013 (Pearson and Swan 2014).

The Hampton Roads area has the largest concentration of military bases and facilities of any metropolitan area in the world and the employment in Hampton Roads consists mainly of military personnel and Federal civilians as well as other industries that are connected to the DoD. The healthcare sector has experienced significant growth in recent years, and was the only industry that added employment continuously throughout the 2008 recession.

Environmental Justice (EJ)

Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Population and Low-Income Populations, directs Federal agencies to identify and address, as appropriate, disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority populations and low-income populations[2] (Executive Order, 1994). When conducting NEPA evaluations, the USACE incorporates EJ considerations into both the technical analyses and the public involvement (CEQ 1997). Council on Environmental Quality (CEQ) guidance defines "minority" as individual(s) who are members of the following population groups: American Indian or Alaskan native; Asian or Pacific Islander; Black, not of Hispanic origin; and Hispanic (CEQ 1997). The Council defines these groups as minority populations when either the minority population of the affected area exceeds 50% of the total population, or the percentage of minority population in the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographical analysis.

Low-income populations, as defined for the purposes of EJ analyses, are identified using statistical poverty thresholds from the Bureau of the Census Current Population Reports, Series P-60 on Income and Poverty (U.S. Census Bureau 2010). In identifying low-income populations, a community may be considered either as a group of individuals living in geographic proximity to one another, or a set of individuals (such as migrant workers or Native Americans), where either type of group experiences common conditions of environmental exposure or effect. The threshold for low-income status for the 2010 census was an income of $10,956 for an individual and $21,954 for a family of four (U.S. Census Bureau 2010). This threshold is a weighted average based on family size and ages of the family members.

Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations," issued in 1994, directs Federal and state agencies to incorporate EJ as part of their mission by identifying and addressing the effects of all programs, policies and activities on minority and low-income populations. The fundamental principles of EJ are as follows:

(i) Ensure the full and fair participation by all potentially affected communities in the decision-making process;

(ii) Prevent the denial of, reduction in or significant delay in the receipt of benefits by minority and low-income populations; and

(iii) Avoid, minimize or mitigate disproportionately high and adverse human health and environmental effects, including social and economic effects, on minority populations and low-income populations.

Table 2-3 2-3 shows the 2010 U.S. census population and the ethnic mix (as a percentage) for each of the cities and counties located within the Virginia Beach-Norfolk-Newport News, VA-NC MSA. In 2013, the Hampton Roads Transportation Planning Organization (HRTPO) created an EJ Methodology Tool that can be used to identify potential EJ issues in an area (HRTPO 2015).

[2] Low-income is defined as a person whose household income is at or below the Department of Health and Human Services poverty guidelines.

Table 2-3: Percent Race and Poverty by County

City or County	2010 Population	White	Black	Native American	Hispanic	Percent Below Poverty
Chesapeake	222,209	62.6	29.8	0.4	4.4	8.3
Hampton	137,436	42.7	49.6	0.4	4.5	14.7
Newport News	180,719	49.0	40.7	0.5	7.5	14.5
Norfolk	242,803	47.1	43.1	0.5	6.6	18.2
Poquoson	12,150	95.1	0.6	0.3	1.8	4.1
Portsmouth	95,535	41.6	53.3	0.4	3.1	17.5
Suffolk	84,585	52.3	42.7	0.3	2.9	11.6
Virginia Beach	437,994	67.7	19.6	0.4	6.6	7.4
Williamsburg	14,068	74.0	14.0	0.3	6.7	18.4
Currituck Co., NC	23,547	90.3	5.8	0.5	3.0	8.9
Gates Co., NC	12,197	63.7	33.2	0.5	1.4	17.0
Gloucester Co., VA	36,858	87.2	8.7	0.4	2.5	9.1
Isle of Wight Co., VA	35,270	71.8	24.7	1.0	1.9	10.5
James City Co., VA	67,009	80.3	13.1	0.3	4.5	8.7
Surry Co., VA	6,829	51.3	46.1	0.3	1.2	10.8
York Co., VA	65,464	76.4	13.4	0.4	4.4	5.4

2.3.2 Port Hinterland

The Norfolk Harbor Project supports an international gateway for the Mid-Atlantic, Appalachian, and Mid-West regions of the United States. Port facilities at Norfolk, Portsmouth, and Newport News transport millions of tons annually between the U.S. and international trading partners (Figure 2-13). In 2015, more than 41 million tons of U. S. exports and imports moved through the Norfolk Harbor Project[3]. Of the cargo transited across the Norfolk Harbor Project, 70% had its domestic origin or destination in a state other than Virginia (Table 2-4).

Table 2-4: Top States by Total Tonnage Transiting Norfolk Harbor Channels 2015

State	Metric Tons	State	Metric Tons
Virginia	12,337,000	Illinois	1,953,000
West Virginia	10,647,000	Ohio	1,556,000
Pennsylvania	8,403,000	Kentucky	839,000

[3] This tonnage excludes cargo using the Norfolk Harbor Channel Project to access port facilities on the Elizabeth River.

North Carolina	2,246,000	Michigan	596,000

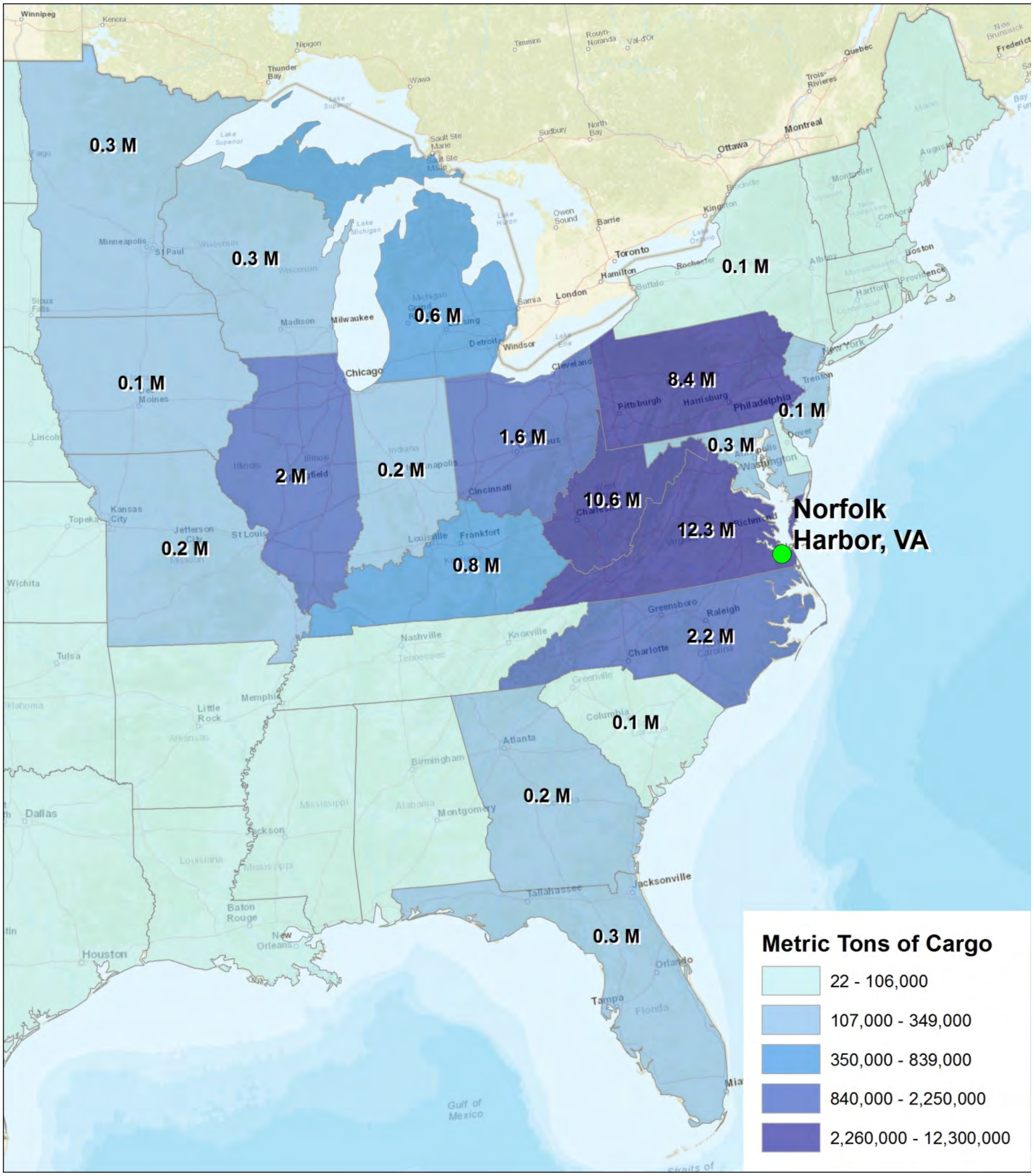

Figure 2-13. Norfolk Harbor Channels Hinterland All Transport Modes 2015

2.4 Port Operations

2.4.1 Norfolk Harbor Historical Cargo Volumes

Coal

Norfolk Harbor is the busiest coal exporting seaport in the United States. Coal exports are used primarily for power generation or metallurgical purposes. Coal is exported from two terminals in Newport News and one terminal in the Norfolk Harbor Main Channels.

Coal is exported from Norfolk Harbor to regions throughout the world (Table 2-5). In the period from 2009 through 2014, Northern Europe was consistently the destination for more coal exports leaving Norfolk than any other region, followed by the Mediterranean, making these the two most significant coal routes. Asia, South America, and North America have also consistently been destinations for Norfolk coal exports over this period; while Africa, Central American, and the Caribbean received small quantities of coal in a very limited number of years.

Table 2-5: Historical Coal Cargo Export Tonnage (Metric Tons) by Trade Region, 2009-2014

Region	2009	2010	2011	2012	2013	2014
AFRICA	117,293	-	-	-	-	-
NORTH AMERICA	846,337	785,063	502,168	312,889	558,893	995,027
SOUTH AMERICA	4,741,236	4,068,140	4,506,728	3,495,889	3,897,998	3,933,553
CENTRAL AMERICA	-	-	-	-	49,528	-
CARIBBEAN	112,986	-	-	29,372	-	-
FAR EAST	3,083,010	4,895,662	7,947,625	8,549,328	10,794,367	5,620,965
MEDITERRANEAN	5,598,416	7,518,696	9,798,775	13,503,293	13,163,284	11,873,080
NORTHERN EUROPE	10,683,725	12,650,847	15,457,100	17,606,124	16,743,636	14,216,084
Total	25,183,003	29,918,408	38,212,396	43,496,895	45,207,706	36,638,709

Containers

Norfolk Harbor is the 3rd busiest seaport on the US East Coast (behind New York, and Savannah) in terms of containerized cargoes. According to Port of Virginia statistics shown in Table 2-6, Norfolk Harbor generated approximately 2.5 million TEU of container cargo throughput per year between 2014 and 2016.

Table 2-6: Port of Virginia TEU Throughput

Container Cargo	2014	2015	2016	Average
Export Loads	1,034,526	997,828	1,006,119	1,012,824
Import Loads	1,017,879	1,082,520	1,174,893	1,091,764
Export Empties	263,863	394,384	422,843	360,363
Import Empties	76,771	74,538	51,851	67,720
Total TEUs	2,393,038	2,549,270	2,655,705	2,532,671

Tables 2-7 and 2-8 provide details on the distribution of container cargo imports and exports respectively at Norfolk Harbor based on IHS Global insight data for the year 2015.

Table 2-7: Container Cargo Import Composition

Commodity Group	Tonnes	TEUS	%	Tonnes/TEU
Manufactured Goods	2,086,752.58	312,482.25	25.05%	6.68
Food & Farm Products	1,429,756.93	130,462.71	17.16%	10.96
Dry Bulk Building Materials	781,641.04	75,146.58	9.38%	10.40
Consumer Goods	750,504.95	114,585.91	9.01%	6.55
Vehicles & Parts	645,598.55	116,242.47	7.75%	5.55
Metal Products	613,739.99	59,203.85	7.37%	10.37
Machinery	577,699.30	78,149.92	6.94%	7.39
Chemical Products	556,837.12	59,841.64	6.68%	9.31
Instruments & Appliances	334,995.53	63,844.16	4.02%	5.25
Crude Materials	285,460.74	25,437.70	3.43%	11.22
Textiles	196,366.52	28,916.39	2.36%	6.79
Miscellaneous	43,267.91	9,342.00	0.52%	4.63
Fertilizers	13,250.97	1,650.84	0.16%	8.03
Petroleum Products	12,317.64	1,089.78	0.15%	11.30
Coal	1,120.81	103.55	0.01%	10.82
LPG/LNG	603.47	65	0.01%	9.28
Total	8,329,914.05	1,076,564.75	100.00%	7.74

Major imports include manufactured goods, food products, building materials, and consumer goods. The composition of major import commodities is as follows:

- Manufactured Goods – Furniture, plastics, construction materials, paper and paperboard, hardware
- Food Products – Alcoholic and Non-Alcoholic beverages, fruits and vegetables, coffee, and frozen seafood
- Construction Materials –Building Stone, ceramic products, glass
- Consumer Goods – Toys & games, linens, tobacco, wine, whiskey, rum, clothing
- Major export cargoes include manufactured goods, food, crude materials, chemicals, and machinery. Major export cargo composition is as follows:
- Manufactured Goods – Pulp, plastic and synthetic rubber, waste paper
- Food & Farm Products – Soybeans, hay, feeds, frozen chicken & turkey
- Crude Materials – Wood, scrap, sawdust
- Chemical Products – Organic chemicals &chemical products, paints, varnishes, and lacquers
- Machinery – Mining & construction equipment, industrial machinery, filtering machinery & air pumps, agricultural machinery, parts, boilers, etc.

Table 2-8: Container Cargo Export Composition

Commodity Group	**Tonnes**	**TEUS**	**%**	**Tonnes/TEU**
Manufactured Goods	2,532,825.38	302,027.49	35.92%	8.39
Food & Farm Products	2,077,184.38	193,918.01	29.46%	10.71
Crude Materials	684,884.40	54,823.71	9.71%	12.49
Chemical Products	586,433.47	63,149.00	8.32%	9.29
Machinery	270,570.36	36,777.45	3.84%	7.36
Dry Bulk Building Materials	182,813.99	15,218.20	2.59%	12.01
Consumer Goods	178,302.80	23,506.53	2.53%	7.59
Metal Products	170,009.21	15,626.53	2.41%	10.88
Vehicles & Parts	140,267.01	25,811.62	1.99%	5.43
Textiles	99,508.44	12,764.42	1.41%	7.80
Instruments & Appliances	56,029.32	11,042.25	0.79%	5.07
Petroleum Products	36,090.09	3,213.67	0.51%	11.23
Miscellaneous	16,508.97	3,564.46	0.23%	4.63
Coal	11,692.83	1,080.24	0.17%	10.82
Fertilizers	7,889.05	982.84	0.11%	8.03

LPG/LNG	80.01	8.62	0.00%	9.28
Total	**7,051,089.71**	**763,515.04**	**100.00%**	**9.24**

Based on the information within the aforementioned tables suggests that import cargoes tend to exceed export cargo volumes and export loads tend to be heavier and less valuable than import loads.

2.4.2 Existing Cargo Traffic Characterization (Vessel Calls)

The existing condition vessel fleet was characterized using datasets from the Waterborne Commerce Statistics Center (WCSC), the Harbor pilots, Virginia Port Authority (POV), PIERS, Lloyds Seaweb, and data on coal transits from the coal terminal operators gathered by DMA (David Miller & Associates). These data combined cover a timeframe between 2009 and April 2015. All of this information was condensed into an annualized call list which serves as a baseline for change over time. The annualized call list is all of the information contained in the multiyear datasets compressed into one representative year for analysis purposes. Table 2-9 displays the vessel classes, types, and associated annual number of calls representative of the existing condition.

The current analysis will focus on container ships and bulk vessels for the following reasons:

- The design drafts (Maximum Summer Load Line Drafts - MXSLLD) of container ships and bulk vessels currently calling or projected to call Norfolk Harbor over the 50-year period of analysis (2023 through 2072) indicate that these vessels have the physical capacity to utilize additional channel depth.
- The historical sailing drafts of container ships and bulk vessels already calling the harbor indicate at least a portion of these vessel are currently depth-constrained. This means that given the physical capacity and loading practices of such vessels, the vessels are entering and/or exiting Norfolk Harbor at the maximum depth possible under the current channel constraints.

Table 2-9: Existing Condition Vessel Fleet Composition

Vessel Class	Vessel Type	# Calls/Year	Relative Significance
SPX	Container Ship	239	High - Vessel type has potential to benefit from deepening
PX	Container Ship	992	
PPX1	Container Ship	312	
PPX2	Container Ship	182	
PPX3	Container Ship	71	
PPX3-Max	Container Ship	0	
10K DWT Bulker	10-30K DWT Bulker	4	

Vessel Class	Vessel Type	# Calls/Year	Relative Significance
20K DWT Bulker	10-30K DWT Bulker	9	High - Vessel type has potential to benefit from deepening
30K DWT Bulker	10-30K DWT Bulker	39	
40K DWT Bulker	40-70K DWT Bulker	42	
50K DWT Bulker	40-70K DWT Bulker	11	
60K DWT Bulker	40-70K DWT Bulker	18	
70K DWT Bulker	40-70K DWT Bulker	109	
80K DWT Bulker	Capesize Bulker	240	
90K DWT Bulker	Capesize Bulker	44	
100K DWT Bulker	Capesize Bulker	54	
200K DWT Bulker	Capesize Bulker	52	
10K DWT Tanker	Tanker	4	Low - Add to port traffic/congestion; don't stand to benefit from additional channel depth
30K DWT Tanker	Tanker	0	
40K DWT Tanker	Tanker	1	
50K DWT Tanker	Tanker	3	
70K DWT Tanker	Tanker	1	
80K DWT Tanker	Tanker	1	
100K DWT Tanker	Tanker	2	
10K DWT Tank Barge	Tanker Barge	128	
20K DWT Tank Barge	Tanker Barge	4	
10K DWT Dry Barge	Dry Cargo Barge	611	
10K DWT Gen Cargo	General Cargo Ship	50	
20K DWT Gen Cargo	General Cargo Ship	66	
30K DWT Gen Cargo	General Cargo Ship	17	
40K DWT Gen Cargo	General Cargo Ship	29	
50K DWT Gen Cargo	General Cargo Ship	57	
Aircraft Carrier	Navy	52	
Other Navy	Navy	716	

Vessel Class	Vessel Type	# Calls/Year	Relative Significance
Misc.	Other	238	

2.4.3 Existing Cargo Fleet

Coal

For the current analysis, the bulker fleet is divided into 11 vessel classes based on vessel capacity. These vessel classes are outlined in Table 2-10. The bulker class with the ability to load deeper and thus benefit from channel deepening is mainly the 200K DWT Bulker class, with a few of the 100K DWT vessels also potentially benefitting.

Table 2-10: Bulker Vessel Size Ranges

Percentile Bin	Class	DWT (metric tons)	LOA (feet)	Beam (feet)	Design Draft (feet)
34%	10K DWT Bulker	6,359	367	49	20.93
67%	10K DWT Bulker	7,120	384	52	21.46
100%	10K DWT Bulker	7,120	384	52	21.46
50%	20K DWT Bulker	21,057	518	76	28.22
100%	20K DWT Bulker	23,723	494	85	31.39
25%	30K DWT Bulker	28,251	557	89	31.29
50%	30K DWT Bulker	29,909	623	77	33.14
75%	30K DWT Bulker	32,400	582	93	31.17
100%	30K DWT Bulker	34,372	656	77	35.23
25%	40K DWT Bulker	37,200	623	94	34.12
50%	40K DWT Bulker	37,965	623	94	34.12
75%	40K DWT Bulker	42,004	591	100	36.84
100%	40K DWT Bulker	43,929	623	100	36.75
25%	50K DWT Bulker	47,980	615	102	38.55
50%	50K DWT Bulker	52,395	623	106	39.45
75%	50K DWT Bulker	53,489	623	106	40.37
100%	50K DWT Bulker	53,806	623	106	40.98
25%	60K DWT Bulker	55,783	616	106	42.32
50%	60K DWT Bulker	57,000	623	106	42.00
75%	60K DWT Bulker	58,700	623	106	42.00
100%	60K DWT Bulker	64,684	754	106	42.66

Percentile Bin	Class	DWT (metric tons)	LOA (feet)	Beam (feet)	Design Draft (feet)
25%	70K DWT Bulker	71,749	734	106	44.17
50%	70K DWT Bulker	73,470	750	106	46.26
75%	70K DWT Bulker	74,242	738	106	45.34
100%	70K DWT Bulker	74,997	738	106	46.66
25%	80K DWT Bulker	76,015	738	106	45.98
50%	80K DWT Bulker	78,000	738	106	47.08
75%	80K DWT Bulker	82,100	751	106	47.34
100%	80K DWT Bulker	83,611	751	106	47.64
25%	90K DWT Bulker	87,334	751	121	46.59
50%	90K DWT Bulker	92,500	755	125	48.89
75%	90K DWT Bulker	92,524	753	121	48.23
100%	90K DWT Bulker	93,367	752	125	48.89
25%	100K DWT Bulker	106,498	835	141	44.18
50%	100K DWT Bulker	114,751	838	141	47.57
75%	100K DWT Bulker	115,000	837	141	47.57
100%	100K DWT Bulker	149,396	886	141	56.84
25%	200K DWT Bulker	172,559	948	148	58.43
50%	200K DWT Bulker	178,062	959	148	59.45
75%	200K DWT Bulker	180,200	948	148	59.55
100%	200K DWT Bulker	229,069	1,049	177	59.47

*The future bulker fleet is expected to be similar to the existing bulker fleet.

Containers

For analysis purposes the container fleet is divided into six distinct vessel classes for which the distributions of dimensions and capacities are presented in Table 2-11. The largest container ships calling Norfolk Harbor today are Post Panamax Generation 3 vessels (PPX3). The PPX3-Max is the largest container ship class anticipated to call consistently over the 50-year period of analysis.

Table 2-11: Container Ship Size Ranges and Underkeel Clearance

Percentile Bin	Class	DWT (metric tons)	LOA (feet)	Beam (feet)	Design (feet)	TEU	UKC (feet)
25%	SPX	13,627	485	76	27.92	1,118	2.4
50%	SPX	22,340	551	88	35.47	1,600	
75%	SPX	33,795	683	98	37.40	2,524	
100%	SPX	39,426	729	98	39.43	2,824	
25%	PX	49,856	907	106	41.01	3,802	2.4
50%	PX	53,663	866	106	41.83	4,298	
75%	PX	63,254	965	106	44.35	4,728	
100%	PX	68,483	965	106	44.36	5,089	
25%	PPX1	66,940	920	131	46.00	5,888	2.4
50%	PPX1	68,834	912	132	45.93	5,618	
75%	PPX1	74,453	964	131	46.07	6,402	
100%	PPX1	85,927	984	131	47.57	6,732	
25%	PPX2	97,535	1,101	140	45.93	8,450	2.4
50%	PPX2	104,750	1,138	140	47.57	8,160	
75%	PPX2	107,915	1,089	142	47.57	8,401	
100%	PPX2	110,000	1,138	140	49.22	8,648	
25%	PPX3	104,652	1,098	150	46.59	8,508	2.4
50%	PPX3	111,300	984	158	47.57	9,400	
75%	PPX3	115,177	1,105	158	49.93	10,100	
100%	PPX3	124,460	1,093	158	47.83	9,669	
25%	PPX3-Max	132,000	1,083	158	52.49	11,800	4.25
50%	PPX3-Max	143,000	1,199	159	50.85	12,825	
75%	PPX3-Max	147,500	1,200	168	50.85	13,870	
100%	PPX3-Max	166,093	1,200	168	52.49	14,036	

2.5 Affected Environment

This chapter describes the existing environmental and socioeconomic conditions found within the Region of Influence (ROI), the area of potential impact of the project alternatives. This chapter has been prepared in accordance with the NEPA and the CEQ Regulations for Implementing the Procedural Provisions of NEPA (40 Code of Federal Regulations (CFR) 1500-1508), regulations. This section summarizes the existing (baseline) conditions, to provide a sound basis for plan formulation as described in Section 4 and the impact analysis that is provided in Section 6. The existing conditions are used as the baseline to forecast the changes that would be expected to without USACE action to address inefficiencies in the Federal navigation system. The topics in this section are structured to mirror the topics presented in Section 6: Environmental Consequences of the Alternatives, where the “future without project” and “future with project” alternatives are evaluated and compared. For both existing and future either with or without implementation of an action alternative, dredged material placement/disposal could occur at the CIDMMA, the DNODS, and the NODS. Although not anticipated, dredged material not meeting open ocean disposal or CIDMMA placement requirements would be required to be disposed of at an approved, upland disposal facility.

2.5.1 Geology, Physiography, and Topography

The ROI includes areas transited by dredging vessels/equipment and areas of navigation channel and Anchorage F dredged, and dredged material placement placement/disposal sites.

The ROI is located within the Virginia Coastal Plain Physiographic Province (Figure 2-14). The topography of the Coastal Plain is a terraced landscape that stair-steps down to the coast and to the major rivers. The Coastal Plain a low-relief region along the major rivers and surrounding the Chesapeake Bay, at topographic elevations between zero and 60 feet above mean sea level.

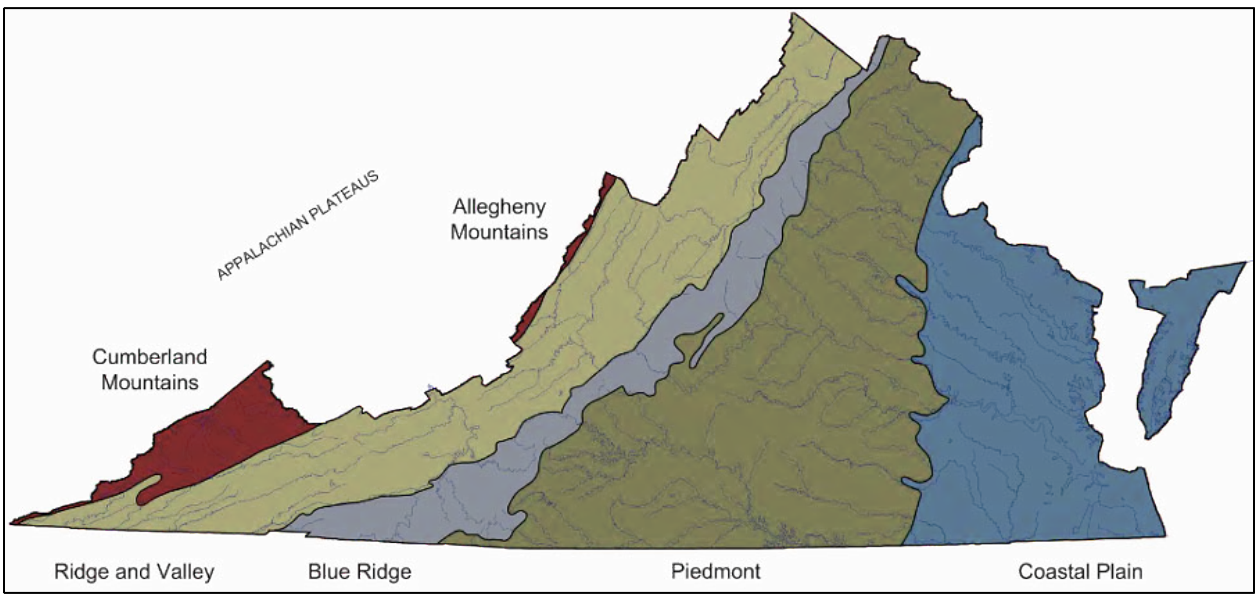

Figure 2-14: Physiographic Provinces of Virginia (Virginia Department of Conservation and Recreation 2016a)

The Virginia Coastal Plain Physiographic Province extends from the Fall Zone, which passes through Richmond, Virginia, approximately 100 miles eastward to the Atlantic Ocean. The “Fall Line” or “Fall Zone” is the transitional zone where the softer, less consolidated sedimentary rock of the Atlantic Coastal Plain to the east intersects the harder, more resilient metamorphic rock to the west, forming an area of ridges, waterfalls, and rapids (Frye 1986). Large rivers that originate west of the fall line cascade off the resistant igneous and metamorphic rocks of the Piedmont, eastward across the Coastal Plain, to sea level, emptying into the Chesapeake Bay and the Atlantic Ocean. The Chesapeake Bay, Hampton Roads and the Elizabeth River estuaries were created about 5,000-6,000 years ago when melting glaciers caused sea levels to rise approximately 400 feet and inundated the continental shelf. (College of William and Mary 2006).

The Coastal Plain is underlain by a thick wedge of sediments that increases in thickness from very thin near the Fall Zone, approximately 100 miles to the west, to more than 13,000 feet thick, under the continental shelf in the Atlantic Ocean. This wedge rests on an eroded surface of Precambrian to early Mesozoic rock.

The landforms surrounding the project area are comprised primarily of geologically recent (Pleistocene and Holocene) sediments, primarily fine sands, silts, with small amounts of small gravel (College of William and Mary 2006). The subaqueous terrain of the project area is of similar material, with sand, fine sand, shell, mud, with some pebbles or gravel that were deposited during interglacial periods under conditions similar to those that exist in the modern Chesapeake Bay and its tidal tributaries (College of William and Mary 2006).

Earthquakes of significant magnitude are unlikely occurrences for the Hampton Roads region (Hampton Roads Planning District Commission 2011). The Virginia Department of Emergency Management has identified no significant earthquakes within in the most recent 200 years in eastern Virginia (Commonwealth of Virginia 2013). The risk of seismic events affecting the navigation channels in the project area is sufficiently low; therefore.

Frequent dredged material placement and subsequent consolidation results in varying topography throughout the CIDMMA. Although not anticipated, any dredged material unsuitable for open water placement or placement at CIDMMA would likely be dewatered in accordance with Federal and state water quality requirements, and transported to a permitted, upland disposal facility. Dredged material placement and dynamic hydraulic processes at the DNODS and the NODS result in varying topography throughout the sites.

2.5.2 Bathymetry, Hydrology, and Tidal Processes

The lower Chesapeake Bay attained its current configuration after the end of the last Ice Age and it has been relatively stable for the last several thousand years (Bratton et al. 2002), although waters have continued to slowly rise over this time, due to glacial rebound and now the addition of human-induced climate change (Schulte et al. 2015) (Figure 2-15). The Norfolk Harbor has been in use since shipping into and out of Chesapeake Bay began, and has been deepened to accommodate larger ships over the decades. This channel was formed naturally as river valleys (in this case the James/Susquehanna). This dredging has not significantly altered the tidal prism of the lower Chesapeake Bay, due to the small size of the channel relative to the size of the Chesapeake Bay. It has been deepened by prior dredging efforts, with initial dredging to ensure at least -40 feet of depth occurring during 1917-1927 (VIMS 1993). Additional deepening to -45 feet occurred in 1967. In 1986, the channel was authorized to be deepened to -50 feet. The current authorized depth at this time is -55 feet, though most of the channel is at -50 feet at this time. Modifications to the channel and Anchorage F have the potential to affect the hydrodynamics of the lower Chesapeake Bay, including the mouth of the James River, and the Elizabeth River, including its bathymetry, hydrology and tidal processes.

The main shipping channel (Figure 2-15) follows the natural bathymetry of lower Chesapeake Bay. This natural channel, however, has been deepened where needed to accommodate larger vessels. Figure 1-2 shows the channel constructed and authorized depths, as well as the current channel location.

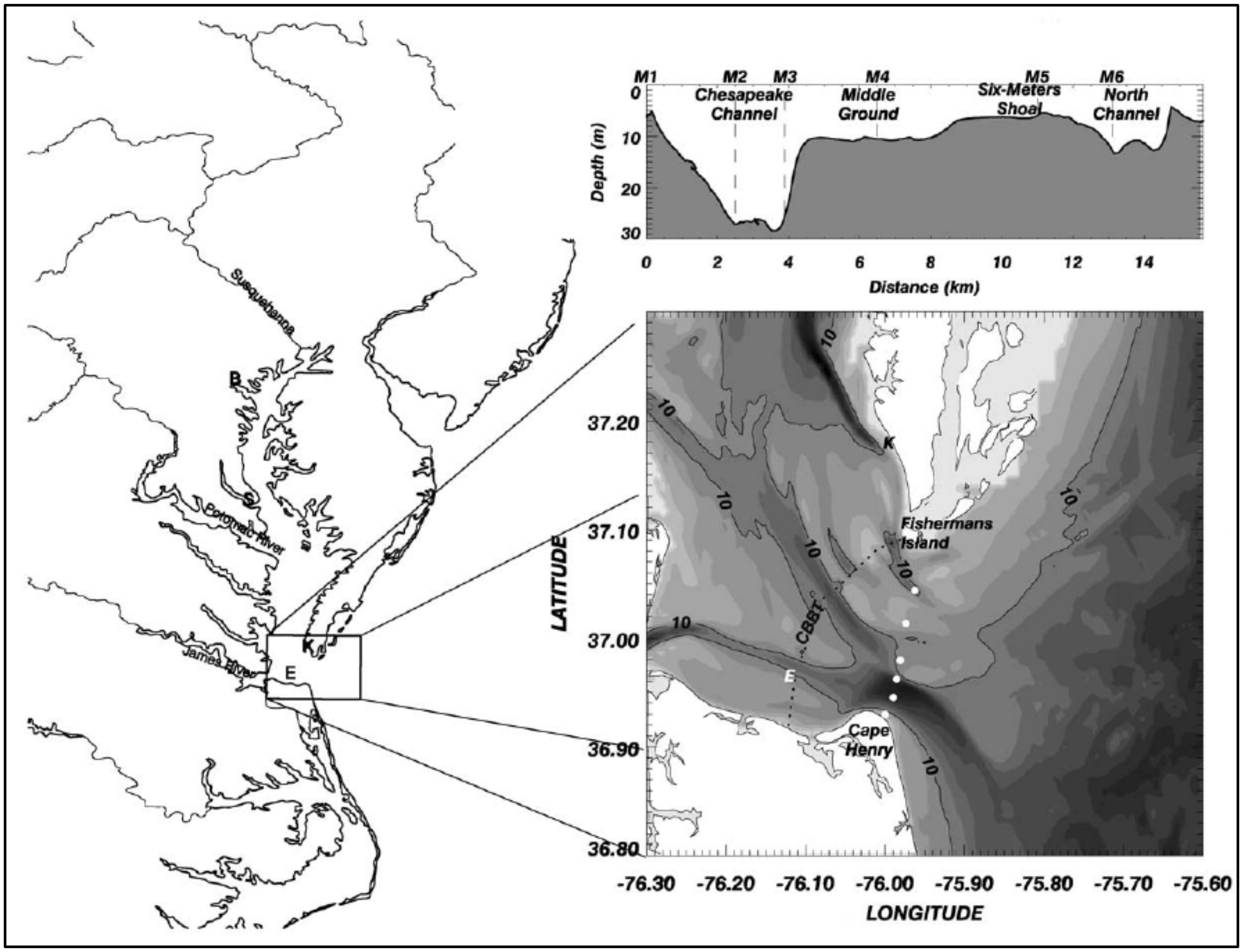

Figure 2-15: Bathymetry of the Region of Influence and Vicinity (from Valle-Levinson et al. 2002).

The typical tidal range in the ROI, including the Elizabeth River and nearby open waters of lower Chesapeake Bay, is approximately 2.85 feet, though this varies significantly with time of the month (spring and neap tides) as well as due to storm activity, which can create significant storm surges well beyond the normal tidal range. Tides are diurnal in the Chesapeake Bay, with two high and low tides per day. The mean discharge rate of Chesapeake Bay is approximately 2,500 m^3 /sec, over 80% of which is supplied by three rivers (the Susquehanna, Potomac, and James Rivers) (Goodrich 1988). Salinity typically ranges from 20-30 ppt (parts per thousand) in the ROI, which covers a broad area from the mouth of Chesapeake Bay into the lower James River. These areas are sufficiently mixed so that anoxic waters are not typical within the ROI. Such deep channels can go anoxic in the summer, particularly in the mid to upper Chesapeake Bay, causing a significant “dead zone” of hypoxic waters. The bathymetry of the ROI ranges from intertidal shallows to the deep channels, which generally lie within the immediate ROI where dredging is proposed and typically range in depth from approximately -20 feet in side and/or natural and unmaintained channels to -50 feet within the channel itself.

2.5.3 Hazardous, Toxic, and Radioactive Waste

Hazardous and/or toxic wastes, classified by the Resource Conservation and Recovery Act (RCRA), are materials that may pose a potential hazard to human health or the environment due to quantity, concentration, chemical characteristics, or physical characteristics. This applies to discarded or spent materials that are listed in 40 CFR 261.31-.34 and/or that exhibit one or more of the following characteristics: ignitable, corrosive, reactive, or toxic. Radioactive waste is the radioactive by-products from the operation of a nuclear reactor or from the reprocessing of depleted nuclear fuel; however, there is no history of radioactive waste deposited in the ROI. Therefore, radioactive waste is dismissed from further discussion.

The ROI includes the areas of navigation channel and Anchorage F dredged, dredged material placement sites, the effluent discharge area from the CIDMMA, and areas transited by dredging vessels/equipment. The ROI includes areas outside of the dredging footprint where potential contaminants could be spread by suspension and movements of sediments and also the water itself. The geographic extent of impacts is dependent upon factors such as the type of dredging equipment, the dredging depth, and environmental conditions such as wind and currents (USACE 1983).

Potential contaminant pathways are identified through testing and evaluation of dredged material. Ocean dredged material placement is regulated under Section 103 of the Marine Protection Resources and Sanctuaries Act of 1972, Public Law 92-532 (MPRSA). The law states that any proposed placement of dredged material into ocean waters must be evaluated through the use of criteria published by the USEPA in Title 40 of the Code of Federal Regulations, Parts 220-228 (40 CFR 220-228). The primary purpose of Section 103 of the MPRSA is to limit and regulate adverse environmental impacts of ocean placement of dredged material. Dredged material proposed for ocean placement must comply with 40 CFR 220-228 (Ocean Dumping Regulations) and 33 CFR 320-330 and 335-338 (USACE Regulations for discharge of dredged materials into waters of the U.S.) prior to being issued an ocean placement permit. The technical evaluation of potential contaminant-related impacts that may be associated with ocean placement of dredged material is conducted in accordance with 40 CFR 220-228. Dredged material proposed for discharge in Waters of the U.S. under Clean Water Act Section 404 are evaluated for contaminant-related impacts that may be associated with open-water placement is conducted in accordance with 40 CFR 230-232, Evaluation of Dredged Material Proposed For Discharge in Waters of the U.S. - Testing Manual, Inland Testing Manual, (USEPA, 1998). Dredged material proposed for placement in confined disposal facilities may be evaluated for appropriate contaminant-related pathways in accordance with "Evaluation of Dredged Material Proposed for Disposal at Island, Nearshore, or Upland Confined Disposal Facilities - Testing Manual, Upland Testing Manual (USACE, 2003).

The USACE evaluates, tests, and disposes of all dredged material using either the standards developed by the Ocean Testing Manual (for ocean disposal sites), Inland Testing Manual (for inland open-water disposal sites), and Upland Testing Manual (for Confined Disposal Facilities and nearshore sites). The Upland Testing Manual has a suite of procedures to evaluate contaminated material in a tiered approach, as well as guidelines for effluent, surface runoff, groundwater leachate, volatile emissions, and animal and plant bioaccumulation. The criteria in 40 CFR Part 227 are also used to determine compliance for dredged material. For the purposes of this document, current MPSRA reports and existing marine sediment sampling data will be characterized. Past testing history of MPRSA is located in Appendix I.

Existing Marine Sediment Data in the ROI

Marine Sediment Data from Marine Protection Resources and Sanctuary Act Section 103 - Dredged Material Characterization Reports

Atlantic Ocean Channel

The existing USEPA concurrence (May 15, 2015) for AOC is located in Appendix I and expires on May 15, 2018. The USACE Norfolk District will continue to maintain compliance with MPRSA Section 103, as required, through sampling and testing at the ODMDS sites, NODS and DNODS. Coordination and compliance with USEPA Region III requirements to achieve this will continue into the future at required intervals

To ensure the dredged material suitability from the AOC for placement at DNODS, sediment and site water samples were taken in 2009 and again in 2013 from discrete locations within the project's dredging footprint (Figure 2-16). Multiple samples at each location were combined to generate four composite samples for analysis of sediment and standard elutriate chemistry and ecotoxicological testing in accordance with Section 103 of the MPRSA. Reference sediments were also collected, evaluated, and used for comparison at an USEPA approved location in the Atlantic Ocean (Figure 2-16).

The tested material did not contain any prohibited materials from 40 CFR Section 227.5 which includes radioactive waste, chemical or biological warfare, persistent inert synthetic or natural materials that may float or remain in suspension, and nor did it interfere with legitimate uses of the ocean. In addition, the materials did not contain more than trace amounts of contaminants (as defined by 40 CFR 227.6). Sediments did not contain constituents expected to adversely affect aquatic organisms (EA Engineering, Science, and Technology, Inc. 2015a). Testing in 2009 confirmed Limiting Permissible Concentration (LPC) compliance for all phases of dredged material including liquid phase, liquid and suspended particulate phase, and solid phase. The 2013 samples also did not contain regulated toxic substances. All material was acceptable for use at DNODS. Dredged material testing in 2013 indicated that sediments were not significantly different with 2009 findings for physical characteristics and chemical concentrations. As a result USEPA did not request the 2013 data to be evaluated to determine LPC compliance. USEPA concurred that the dredged material was suitable for placement at DNODS for the concurrence period.

Figure 2-16: Atlantic Ocean Channel sampling locations (2009 and 2013), the Atlantic Ocean reference site, and the Dam Neck Ocean Disposal Site.

Thimble Shoal Channel

To ensure the dredged material suitability from the TSC for placement at DNODS, a recent marine sediment evaluation within the channel for at DNODS included twelve sampling locations (Figure 2-17). USEPA-approved reference sites are located in Willoughby Bank and in the Atlantic Ocean. Testing was completed in 2009 and again in 2014. Surficial sediment was collect at 10 locations west of the CBBT and three locations were sampled east of the CBBT (EA Engineering, Science, and Technology, Inc. 2015b).

Testing in 2009 confirmed LPC compliance for all phases of TSC dredged material including liquid phase, liquid and suspended particulate phase, and solid phase. Dredged material testing in 2013 indicated that sediments were not significantly different with 2009 findings for physical characteristics and chemical concentrations. As a result USEPA did not request the 2013 data to be evaluated to determine LPC compliance. USEPA concurred that the dredged material was suitable for placement at DNODS for the concurrence period.

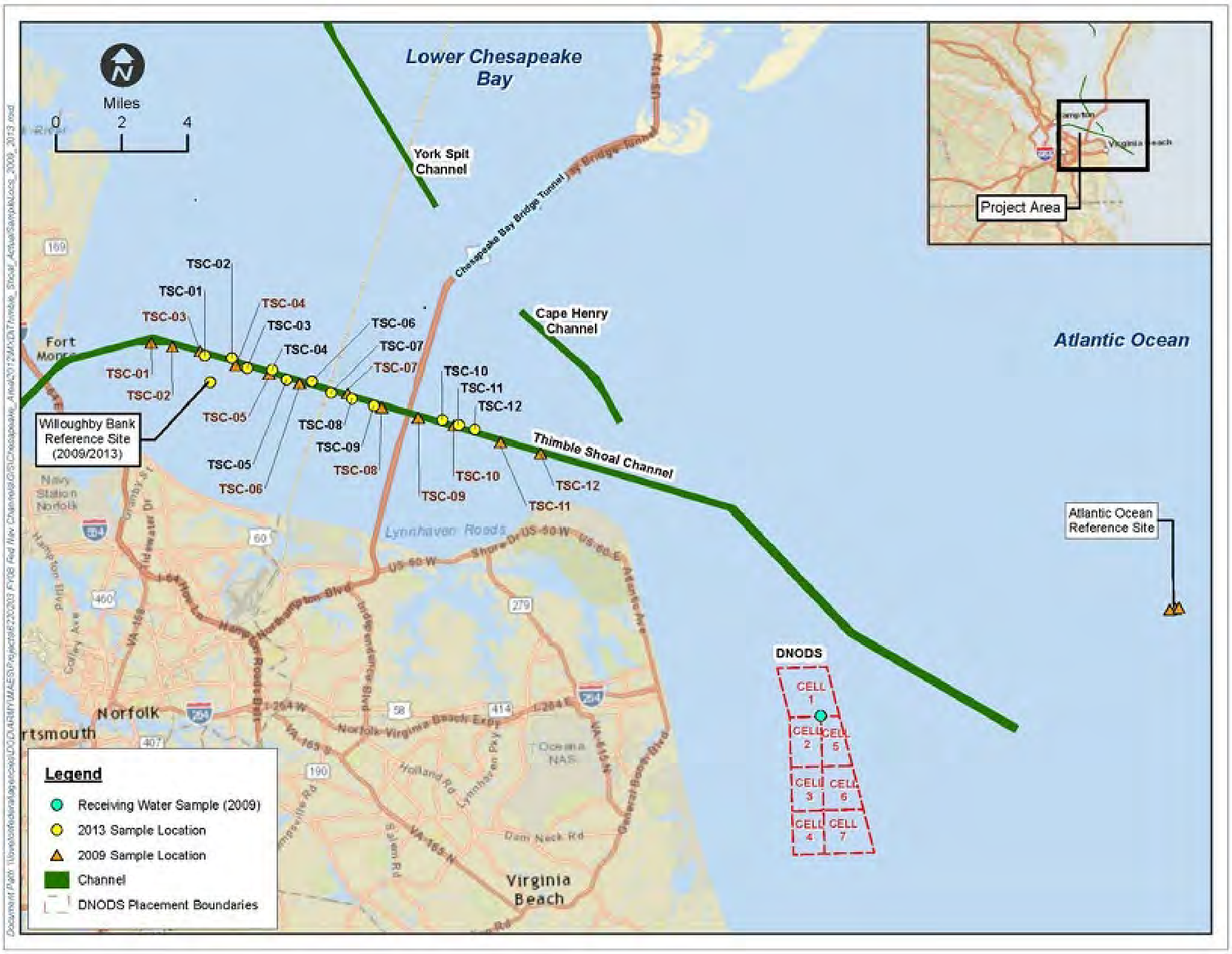

Figure 2-17 Sediment Testing in 2009 and 2013 in the Thimble Shoal Channel for Marine Protection Resources and Sanctuaries Reports.

__Norfolk Inner Harbor -50 foot Section__

This maintenance dredging project requested to place dredged material at NODS if CIDMMA became unavailable due to capacity issues. In order to utilize NODS as a disposal site, USEPA tiered testing was conducted consistent with *The Ocean Testing Manual* and the Mid-*Atlantic Regional Implementation Manual: Dredged Material Evaluation for Norfolk and Dam Neck Disposal Sites*. Samples were taken from locations in Norfolk Inner Harbor and in Craney Island Reach (Figure 2-18) to determine if the proposed dredged material meets the LPC for ocean placement at NODS. The samples collected so far have met the requirements for water column LPC, benthic toxicity LPC, and benthic accumulation LPCs for placement at NODS.

In 2012, the USACE Norfolk District received concurrence letter from USEPA Region III that material from Norfolk Inner Harbor meets Ocean Disposal Criteria (40 CFR 227). To provide a reasonable assurance that such material has not been contaminated by such pollution:

(1) Dredged material is composed predominantly of sand, gravel, rock, or any other naturally occurring bottom material with particle sizes larger than silt, and the

material is found in areas of high current or wave energy such as streams with large bed loads or coastal areas with shifting bars and channels; or

(2) Dredged material is for beach nourishment or restoration and is composed predominantly of sand, gravel, shell with particle sizes compatible with material on the receiving beaches; or

(3) When material proposed for dumping is substantially the same as the substrate at the proposed disposal site; and the site from which the material would be dredged is far removed from known existing and historical sources of pollution so as to provide reasonable assurance that such material has not been contaminated by such pollution.

Figure 2-18: Sample Locations (EA Engineering, Science, and Technology, Inc. 2010a).

The National Priorities List sites within the Vicinity of the ROI

The National Priorities List (NPL) established by Section 105(a)(8)(B) of the Comprehensive Environmental Response, Compensation, And Liability Act Of 1980 (CERCLA; Superfund), as amended, requires that the statutory criteria provided by the USEPA be used to prepare a Hazardous Ranking System. This system is composed of a list of national priority waste sites that are known to release or threaten to release hazardous substances, pollutants, or contaminants throughout the United States. USEPA regulations outline a formal process for assessing hazardous waste sites and placing them on the NPL. The NPL is intended primarily to guide USEPA in determining which sites warrant further investigation. Within the vicinity of the ROI, but not immediately within the ROI, Figure 2-19 identifies the location of these two NPL sites; Norfolk Naval Base Sewell's Point and Joint Expeditionary Force Base Little Creek-Fort Story (USEPA 2016).

Figure 2-19: National Priorities List sites in the Vicinity of the Region of Influence.

Norfolk Naval Base (Sewells Point Naval Complex)

The Norfolk Naval Base (Sewells Point Naval Complex) site is located directly northwest of Norfolk, Virginia. The 4,630 acre facility provides shore facilities and logistics support for Navy vessels and aircraft. Wastes generated at the facility include halogenated and non-halogenated solvents, corrosives, paint wastes, wastes from electroplating operations, petroleum products, and oils and lubricants. In addition, the facility manages used oils, construction debris, polychlorinated biphenyls (PCBs), contaminated soils, and trash. Historical operations and disposal practices contaminated soil, sediment, surface water and groundwater (USEPA 2016). Contaminants such as heavy metals, volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs), and dioxins were detected. Cleanup is considered complete at this site and monitoring continues at applicable remediation sites (USEPA 2016).

Joint Expeditionary Force Base Little Creek-Fort Story

Joint Expeditionary Force Base Little Creek-Fort Story is located near the mouth of the Chesapeake Bay between Willoughby Beaches and the Chesapeake Bay Beaches west of the CBBT. It was formerly named Naval Amphibious Base, Little Creek. Located within the city limits of Virginia Beach, the Little Creek component of the Base consists of 2,215 acres. It is surrounded by residential, commercial, industrial, and recreational developments. Historical use by the boat annex, electroplating shop, landfill, sand blast area, and the laundry caused documented impacts on groundwater and soil by contaminants such as heavy metals, VOCs, and base neutral acids. Polyaromatic hydrocarbons and lead were also found in sediments (USEPA 2016). As of May 14, 2015, USEPA announced that Superfund cleanup construction at the Joint Expeditionary Base Little Creek in Virginia Beach, Virginia was complete. This completion culminates 31 years of investigation (1999-2015) and remediation. The USEPA's Mid-Atlantic Regional office has determined that the installations at this facility have met the criteria for being added to USEPA's construction completion list (USEPA 2015). Monitoring will continue at applicable remediation sites by responsible agency.

Toxics Release Inventory (SARA TITLE III/EPCRA)

The Toxic Chemical Release Inventory System (TRIS) identifies facilities that release toxic chemicals to the air, water, and land in reportable quantities under the Superfund Amendments and Reauthorization Act (SARA) of 1986, Title III statute (SARA TITLE III), also known as the Emergency Planning and Community Right-to-Know Act (EPCRA) (Table 2-12). This regulation was created to synthesize a cooperative relationship among government, business, and the public involving all of them in the effort to prevent, plan, prepare for, and manage chemical emergencies. U.S. facilities report detailed information to USEPA on their management of toxic chemicals, including releases to the environment. The Toxic Release Inventory (TRI) National Analysis contains this information and trends in releases, waste management practices, and pollution prevention activities.

In the vicinity of the ROI, the following entities were documented by the VDEQ for their TRI between the years of 2012 and 2014 (VDEQ 2014).

Table 2-12: TRI Contributors in the Vicinity of the Region of Influence.

Organization	Location	Toxics Inventory
BAE Systems Norfolk Ship Repair	750 Berkeley Avenue Norfolk, VA	Copper Compounds N-Butyl Alcohol Xylene (mixed Isomers)
Colonna's Shipyard	400 East Indian River Road Norfolk, VA	Copper Compounds N-Butyl Alcohol Xylene (mixed Isomers)
U.S. Naval Station Norfolk	1510 Gilbert Street Norfolk, VA	Naphthalene

2.6 Water Quality

The ROI includes the areas of navigation channel and Anchorage F dredged, dredged material placement/disposal sites, the effluent discharge area at the CIRB, from the CIDMMA, areas transited by dredging vessels/equipment, and any potential sites where dredged material dewatering may occur. The ROI includes areas outside of the dredging footprint where water quality impacts such as increased levels of Total Suspended Solids, turbidity, and potentially nutrient fluctuations may occur. The geographic extent of water quality impacts is dependent upon factors such as the type of dredging equipment, the dredging depth, and environmental conditions such as wind and currents (USACE 1983).

Environmental Setting

More than 150 major rivers and streams flow into the Chesapeake Bay's 64,299 square mile drainage basin, which covers parts of six states from New York, Pennsylvania, Delaware, Maryland, Virginia and West Virginia as well as the District of Columbia. The ROI is located at the convergence of the brackish waters of the Lower Chesapeake Bay with the salt water of the Atlantic Ocean (see Figure 2-1).

The Chesapeake Bay is a slightly stratified estuary which forms where tidal activity is strong and river volume is moderate. A salt water wedge moves from the ocean west through the ROI causing salinity shifts and circulation patterns as freshwater from tributaries drain into the mainstream of the Chesapeake Bay (Figure 2-20.). In the Chesapeake Bay, the halocline is present, but less pronounced than in more stratified estuaries. Seawater moves landward along the bottom and is diluted progressively landward with freshwater moving out towards the Chesapeake Bay mouth as circulation is primarily driven by the movement of fresh water from the north and salt water from the south. Daily tidal currents in and out of the Chesapeake Bay enhance mixing of the two layers. As seawater moves landward and river water moves seaward they are influenced by the Coriolis Effect. Nutrients and other materials are mixed and resuspended in the area where fresh and salt water meet. This area is called the zone of maximum turbidity and it is located within the ROI.

The quality of the surface waters in the ROI is dependent upon the water quality of the Chesapeake Bay mainstem and the tributaries draining into the watershed. The following tributaries affect the water quality of the ROI: Elizabeth River, York River, James River, Lafayette River, Lynnhaven River, and Norfolk Harbor proper (CBP 2016a). Chesapeake Bay Foundation publishes a “State of the Chesapeake Bay Report” every two years. The report is based on the best available information about the Chesapeake Bay for indicators representing three major categories; pollution, habitat, and fisheries. Monitoring data serve as the primary foundation of the report, supplemented by field observations. In 2016, the overall health of the Chesapeake Bay was reported to be a C-, which is considered an increase from the 2014 Report. Federal, state and non-profit initiatives throughout the Chesapeake Bay are designed to help the Chesapeake Bay meet the goals and recommendations established in the report to continue improving the Chesapeake Bay’s health.

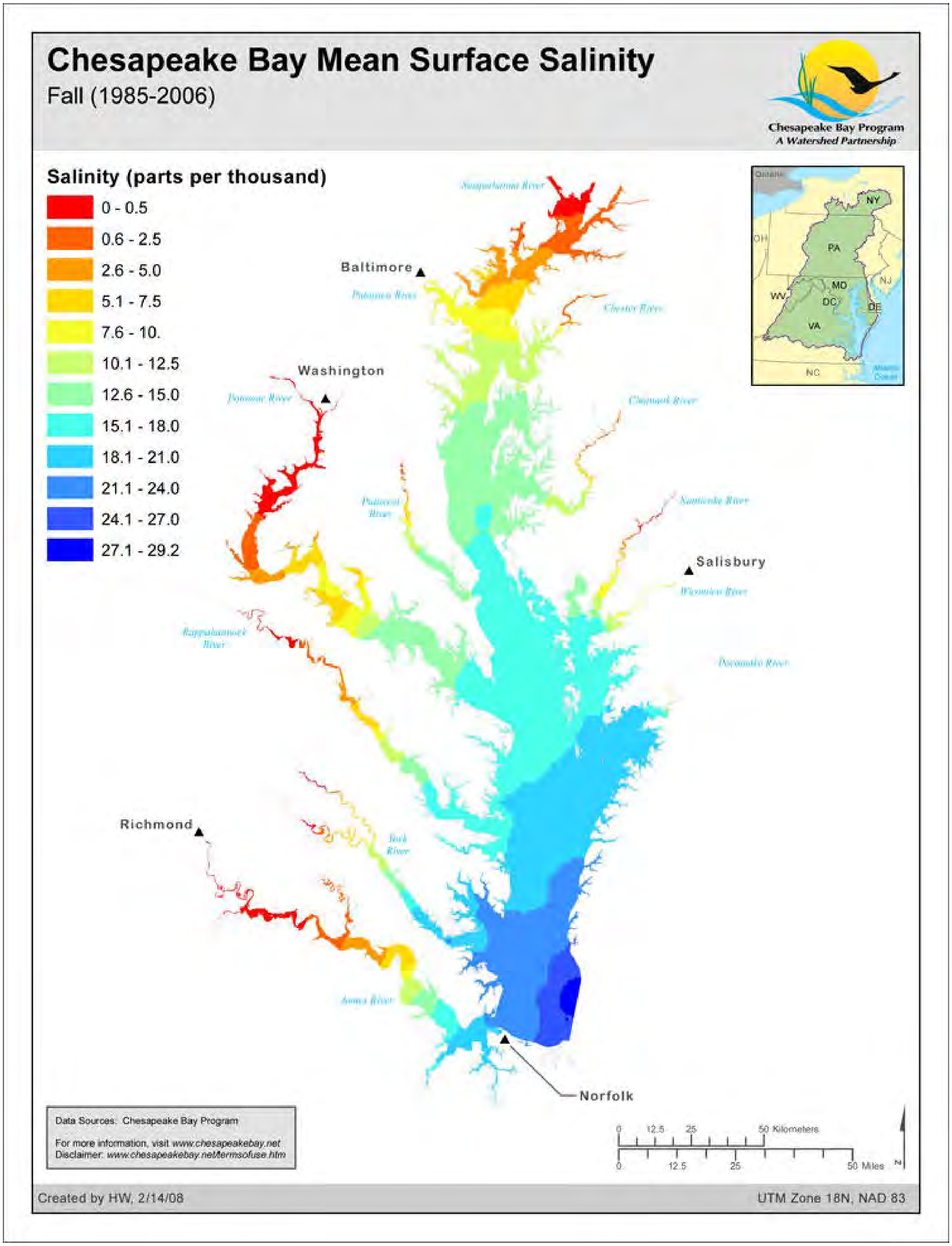

Figure 2-20: Salinities of the Chesapeake Bay

Impaired Waterways

The USEPA established a Total Maximum Daily Load (TMDL) for the Chesapeake Bay watershed on December 29, 2010. The TMDL identified the nitrogen, phosphorus, and sediment reductions that each Chesapeake Bay jurisdiction needs to achieve in order for the Chesapeake Bay to meet water quality standards. The TMDL included Phase I Water Implementation Plans developed by States within the Chesapeake Bay watershed. The Commonwealth of Virginia Phase I Water Implementation Plan outlined the actions expected of the wastewater sector, urban/stormwater sector, agriculture sector, and on-site sewage sector in order to meet statewide nutrient and sediment reduction goals.

There are many impaired waterways with contributing to the water quality of the ROI. An annual Virginia Water Quality Assessment 305(b)/303(d) Integrated Report summarizes findings and makes recommendations for a list of impaired waters by VDEQ. Every two years, a List of Impaired Waters is developed to describe segments of streams, lakes, and estuaries within the state that exhibit violations of water quality standards (VDEQ 2014). In order to maintain the water quality standard, VDEQ creates TMDLs on a tributary level that indicate the total pollutants that a water body can assimilate and still meet water quality standards.

The Chesapeake Bay and its tidal tributaries contain 291 designated uses. Each of these designated uses—also known as aquatic habitats—has its own set of criteria for Dissolved Oxygen, water clarity/underwater grasses and chlorophyll a designed to protect those uses. If the Chesapeake Bay and its tidal tributaries are to function as a healthy ecosystem, all water quality standards must be met. In the vicinity of the ROI, there are TMDLs established by VDEQ for the Lower James River Watershed and the Lafayette River for enterococci bacteria. The Lynnhaven River also has a TMDL established for fecal coliform.

The determination whether the Commonwealth's waters support their applicable designated uses as mandated by Section 305(b) of the Clean Water Act is made by VDEQ and reported annually to USEPA based on monitoring data. There are six designated uses that may be applied to surface waters: aquatic life, fish consumption, shellfishing, recreation, public water supply, and wildlife. Virginia's water quality standards define the water quality needed to support each of these uses by establishing the numeric criteria for comparison of physical and chemical data. If a waterbody contains more of a pollutant than is allowed by the water quality standards, it will not support one or more of its designated uses. Such waters are considered to have an "impaired" quality. An "impairment" refers to an individual parameter or characteristic that violates a water quality standard. A water fails to support a designated use when it has one or more impairments. Table 2-13 and Figure 2-21 indicate the locations and descriptions of these impairments.

Table 2-13. Designated Impairments in the ROI (Category 4 and 5)
Source: VDEQ 2014

Waterbody and Affected Boundary	Use	Impairment
Chesapeake Bay and Tidal Tributaries	Fish Consumption	PCB in Fish Tissue
Lynnhaven River System	Aquatic Life	Estuarine Bioassessments
Lynnhaven River System	Shellfishing	Fecal Coliform

Waterbody and Affected Boundary	Use	Impairment
Sara Constance Park, East End	Recreation	Bacteria (*Enterococcus*)
Chesapeake Bay segment CB8PH	Aquatic Life, Shallow-Water Submerged Aquatic Vegetation	Aquatic Plants (Macrophytes)
Owl Creek - Upper & Lower	Recreation	Bacteria (*Enterococcus*)
Owl Creek - Upper & Lower	Aquatic Life	Oxygen, Dissolved
Owl Creek - Upper & Lower	Shellfishing	Fecal Coliform
James River and Various Tributaries	Fish Consumption	PCB in Fish Tissue
Lynnhaven River and Broad Chesapeake Bay System	Aquatic Life, Shallow-Water Submerged Aquatic Vegetation	Aquatic Plants (Macrophytes)
Chesapeake Bay Segment ELIPH (Elizabeth River Mainstem)	Aquatic Life, Open Water Aquatic Life	Oxygen, Dissolved
James River - Lower	Aquatic Life, Open Water Aquatic Life	Chlorophyll-a
Elizabeth River Mainstem	Aquatic Life	Estuarine Bioassessments
James River - King/Lincoln Park Beach Area	Recreation	Bacteria (*Enterococcus*)
James River - Anderson Park Beach Area	Recreation	Bacteria (*Enterococcus*)
James River CBP segment JMSPH and Tidal Tributaries	Aquatic Life	Nutrient/Eutrophication Biological Indicators
Willoughby Chesapeake Bay - Beach Area	Recreation	Bacteria (*Enterococcus*)
Chesapeake Bay Segment LAFMH (Lafayette River)	Aquatic Life, Open Water Aquatic Life	Oxygen, Dissolved
Hampton River	Recreation	Bacteria (*Enterococcus*)
James River CBP segment JMSPH and Tidal Tributaries	Aquatic Life, Open Water Aquatic Life	Oxygen, Dissolved
Chesapeake Bay Segment CB7PH	Aquatic Life, Deep-Water Aquatic Life, Open-Water Aquatic Life	Oxygen, Dissolved
Chesapeake Bay Segment CB7PH	Aquatic Life, Shallow-Water Submerged Aquatic Vegetation	Aquatic Plants (Macrophytes)
Magoth Chesapeake Bay - Lower	Aquatic Life	Oxygen, Dissolved

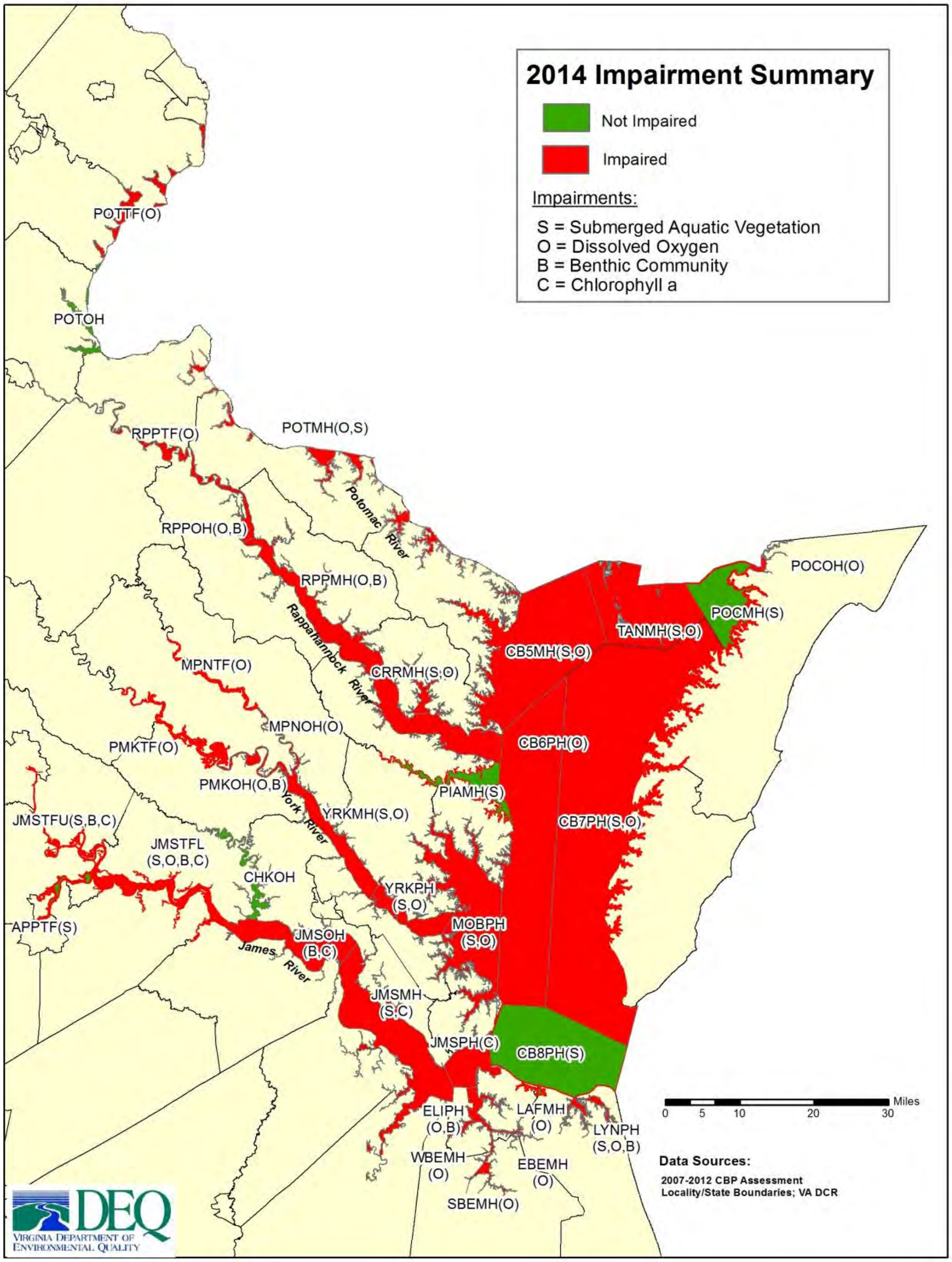

Figure 2-21: Impairment Status of the Chesapeake Bay Aquatic Use (VDEQ 2014).

Dredged Material Testing and Placement Areas

Currently suitable dredged material from navigation channels in the ROI are placed in USEPA designated and congressionally-authorized locations. Dredged materials from the AOC and the TSC are placed at the NODS and DNODS. Dredged material from AOC and TSC has been placed previously for beach nourishment projects in the vicinity of the ROI. In order to protect water quality, potential contaminant pathways are identified through testing and evaluation of dredged material. Ocean dredged material placement is regulated under Section 103 of the Marine Protection Resources and Sanctuaries Act of 1972, Public Law 92-532 (MPRSA). Any proposed placement of dredged material into ocean waters must be evaluated through the use of criteria published by the USEPA in Title 40 of the Code of Federal Regulations, Parts 220-228 (40 CFR 220-228). The primary purpose of Section 103 of the MPRSA is to limit and regulate adverse environmental impacts of ocean placement of dredged material. Dredged material proposed for ocean placement must comply with 40 CFR 220-228 (Ocean Dumping Regulations) and 33 CFR 320-330 and 335-338 (USACE Regulations for discharge of dredged materials into waters of the U.S.) prior to being issued an ocean placement permit. The technical evaluation of potential contaminant-related impacts that may be associated with ocean placement of dredged material is conducted in accordance with 40 CFR 220-228, the *Ocean Testing Manual*. These testing requirements are used to ensure dredged material meets acceptable criteria prior to disposal.

There have been SMMPs developed for NODS and DNODS by the USEPA in conjunction with the USACE to ensure use of the designated sites will not result in adverse environmental impacts, such as impacts to water quality.

The Craney Island Dredged Material Management Area (CIDMMA), Craney Island Rehandling Basin CIRB and Upland Disposal Sites

Dredged material from Norfolk Harbor Channels and Reaches, as well as the Newport News Channel are typically placed at CIDMMA. The USACE is required to make factual determinations in accordance with 40 CFR §§ 230.1 - 230.98 (Clean Water Act, Section 404(b)(1) Guidelines for Specification of Disposal Sites for Fill Material), as to the potential short-term or long-term effects of a dredged material discharge. Evaluation and testing are conducted in accordance with sections 230.60 and 230.61 and evaluations may apply the principle generally referred to as "reason to believe" as to whether the material is a carrier of contaminants. Testing may not be necessary if constraints are available to reduce contamination to acceptable levels within the disposal site and to prevent contaminants from being transported beyond the boundaries of the disposal site. Current and historical testing data and available records may be used in the determination to require testing of the material. Dredged material that is tested for compliance with the 404(b)(1) guidelines is conducted in a tiered approach in accordance with the Evaluation of Dredged Material Proposed for Discharge in Waters of the U.S. -Testing Manual, Inland Testing Manual (USEPA 1998) and the USACE Manual, Evaluation of Dredged Material Proposed for Disposal at Island, Nearshore, or Upland Confined Disposal Facilities – Testing Manual (2003).

Dredged material can either be deposited initially in the CIRB or directly into CIDMMA. Both meet the criteria above as well as any Clean Water Act requirements. Dredged material placed at CIDMMA is evaluated to determine compliance with CWA Section 404(b)(1) and CIDMMA facility requirements prior to commencement of dredging activities. Discharges are required to obtain VDEQ Section 401 Water Quality Certification prior to commencement of dredging operations. During dredged material placement operations the effluent (dredged material discharge to waters of the U.S.) is monitored to ensure only clarified effluent is released. The effluent is visually inspected a minimum of six times per day at each operating spillbox, approximately once every four hours. If at any time it is visually apparent that effluent other than clarified water is being released from CIDMMA, the effluent Total Suspended Solids is sampled and then immediate action is taken at the spillbox to reduce the amount of suspended solids in the effluent by increasing the water retention time. The Total Suspended Solids samples are taken in accordance with the Commonwealth of Virginia Water Quality Certification, but at least twice daily at the weir crest of each operating spillbox, once approximately every 12 hours. A daily average Total Suspended Solids concentration of less than 500 mg/l must be maintained.

Dredged materials from Norfolk Harbor Channel, Norfolk Harbor Reach, Anchorage F, and Newport News Channel are placed at CIRB and CIDMMA. In the past, all dredged material from these locations has been deemed acceptable according to the above referenced manuals and guidelines.

Virginia Pollutant Discharge Elimination System (VPDES) Permits

Section 402 of the Clean Water Act established the National Pollutant Discharge Elimination System (NPDES) program to limit pollutant discharges into streams, rivers, and Chesapeake Bays. In the Commonwealth of Virginia, VDEQ administers the VPDES Program. The VDEQ issues VPDES permits for all point source discharges to surface waters, to dischargers of stormwater from Municipal Separate Storm Sewer Systems (MS4s), and to dischargers of stormwater from Industrial Activities. Virginia Stormwater Management Program (VSMP) permits to dischargers of stormwater from Construction Activities. The USEPA maintains authority to review applications and permits for "major" dischargers, a distinction based on discharge quantity and content. Both VPDES General and Individual permits are issued by VDEQ.

Individual permits are issued by VDEQ to both municipal and industrial facilities (Table 1-14). Permit requirements, special conditions, effluent limitations and monitoring requirements are determined for each facility on a site specific basis in order to meet applicable water quality standards. In the immediate vicinity of the ROI, there are 35 Individual permits issued by VDEQ for discharges of pollutants as of April 2016 (Table 2-14). There are nine major dischargers of pollutants of which seven are attributed to the Hampton Roads Sanitation District and two attributed to Huntington Ingalls in Newport News. The other 26 permitted dischargers are considered “minor” by VDEQ standards (VDEQ 2015).

General permits are permits written for a general class of dischargers. In Virginia, general permits must be written as permits and adopted as regulations. Since they are regulations, they must be adopted using the Administrative Process Act (APA) requirements, which specify a standard adoption process and public participation/public input procedures. There are no general permits issued in the immediate vicinity of the ROI.

Table 2-14. Virginia Pollutant Discharge Elimination System Individual Permits in the Vicinity of the ROI

Permit No	Facility Name	Location Address 1	Location City	Major /Minor	Municipal/ Industrial	Design Flow	Total Flow
VA0004421	US Navy - Naval Station Norfolk	9900 Hampton Blvd	Norfolk	Minor	Industrial	2.7	2.7
VA0079928	US Navy - Joint Expeditionary Base - Little Creek	1450 Gator Blvd	Virginia Beach	Minor	Industrial	0.059	0.059
VA0005215	US Navy - Norfolk Naval Shipyard	2600 - 2700 Effingham St	Portsmouth	Major	Industrial	2.03	2.03
VA0005835	VDOT - I-564 Tunnel Facility	I-564 - Norfolk Air Station	Norfolk	Minor	Industrial	0.0504	0.0504
VA0080179	VDOT - Monitor Merrimac Memorial Bridge Tunnel	North Island MMBT I-664 Tunnel	Newport News	Minor	Industrial	1.63	1.63
VA0080179	VDOT - Monitor Merrimac Memorial Bridge Tunnel	North Island MMBT I-664 Tunnel	Newport News	Minor	Industrial	1.63	1.63
VA0005657	VDOT - Hampton Roads Bridge Tunnel I-64	204 National Avenue - I-64	Hampton	Minor	Industrial	0.06	0
VA0089605	US Defense Fuel Support Point Craney Island	4501 Cedar Ln	Portsmouth	Minor	Industrial	0.75	0.75
VA0089605	US Defense Fuel Support Point Craney Island	4501 Cedar Ln	Portsmouth	Minor	Industrial	0.75	0.75
VA0074781	Portsmouth Genco LLC	One Wild Duck Ln	Portsmouth	Minor	Industrial	0.659	0.659
VA0090778	Ocean Marine Yacht Center	1 Crawford Ct	Portsmouth	Minor	Industrial	0.01	0.01
VA0090778	Ocean Marine Yacht Center	1 Crawford Ct	Portsmouth	Minor	Industrial	0.01	0.01
VA0005860	Midtown Elizabeth River Tunnel	Route 58 Elizabeth River	Norfolk	Minor	Industrial	0.004	0.004
VA0005860	Midtown Elizabeth River Tunnel	Route 58 Elizabeth River	Norfolk	Minor	Industrial	0.004	0.004
VA0057142	Kinder Morgan Bulk Terminals - Pier IX	1900 Harbor Access Rd	Newport News	Minor	Industrial	1.6614	1.6614
VA0003263	J H Miles and Company Incorporated	902 Southampton Ave	Norfolk	Minor	Industrial	0.546	0.546
VA0003263	J H Miles and Company Incorporated	902 Southampton Ave	Norfolk	Minor	Industrial	0.546	0.546
VA0004804	Huntington Ingalls Incorporated - NN Shipbldg Div	4101 Washington Ave	Newport News	Major	Industrial	30	30
VA0004804	Huntington Ingalls Incorporated - NN Shipbldg Div	4101 Washington Ave	Newport News	Major	Industrial	30	30

VA0073091	General Dynamics NASSCO-Norfolk - Ligon Facility	200 Ligon St	Norfolk	Minor	Industrial	1.4	1.4
VA0089699	General Dynamics NASSCO-Norfolk - Harper Facility	2 Harper Ave	Portsmouth	Minor	Industrial	0.01	0.01
VA0005851	Downtown Elizabeth River Tunnel	Interstate 264-Elizabeth River	Norfolk	Minor	Industrial	0.22	0.22
VA0005851	Downtown Elizabeth River Tunnel	Interstate 264-Elizabeth River	Norfolk	Minor	Industrial	0.22	0.22
VA0057576	Dominion Terminal Associates LLP	600 Harbor Rd - Pier 11	Newport News	Minor	Industrial	1.01	1.01
VA0053813	Colonnas Shipyard Inc	400 E Indian River Rd and 111 S Main St	Norfolk	Minor	Industrial	0.12	0.12
VA0089222	C and M Industries Incorporated	739 E End Avenue	Norfolk	Minor	Industrial	0.004	0.004
VA0004383	BAE Systems Norfolk Ship Repair Inc	750 W Berkley Ave	Norfolk	Minor	Industrial	0.144	0.1
VA0004383	BAE Systems Norfolk Ship Repair Inc	750 W Berkley Ave	Norfolk	Minor	Industrial	0.144	0.1
VA0081230	HRSD - Army Base WWTP	401 Lagoon Rd	Norfolk	Major	Municipal	18	18.22
VA0081256	HRSD - Boat Harbor Sewage Treatment Plant	300 Terminal Ave	Newport News	Major	Municipal	25	25.02
VA0081264	HRSD - Chesapeake-Elizabeth Sewage Treatment Plant	5332 Shore Dr	Virginia Beach	Major	Municipal	24	24.01
VA0081272	HRSD - James River Sewage Treatment Plant	111 City Farm Rd	Newport News	Major	Municipal	20	20.003
VA0081272	HRSD - James River Sewage Treatment Plant	111 City Farm Rd	Newport News	Major	Municipal	20	20.003
VA0081299	HRSD - Nansemond Sewage Treatment Plant	6909 Armstead Rd	Suffolk	Major	Municipal	30	30.1
VA0081281	HRSD - Virginia Initiative WWTP	4201 Powhatan Ave	Norfolk	Major	Municipal	40	40.04

Clean Water Act, Section 401 Permits, Water Quality Certification

In order to comply with Section 401 of the Clean Water Act, USACE maintains a Virginia Water Protection Permit (VWP or Water Quality Certification) for Operations and Maintenance (O&M) dredging in Harbor channels of the ROI. The Commonwealth of Virginia, Department of Environmental Quality (VDEQ) grants these permits to protect wetlands and surface waters. These permits can be found in Appendix I.

Existing Section 401 Permits (Virginia Water Protection Permits)

a. **Newport News Channel (VWP Permit #:14-0749):** This 15-year Virginia Water Protection Permit (also referred to as a Water Quality Certification) was issued on December 3, 2014 and authorizes impacts to 643 acres of subaqueous bottom for mechanical or hydraulic maintenance dredging of the Newport News Federal Navigation Channel and the two associated anchorage basins. Dredged material disposal is via direct pump into the CIDMMA or via direct pump or bottom dump scow into the Craney Island Rehandling Basin. Dredging is authorized to a maximum allowable dredge depth of -55 feet MLLW in the channel and -48 feet MLLW in the two anchorage basins. Maximum allowable depths include all overdepth, advanced maintenance, and margin of error.

b. **Norfolk Harbor from Sewells Point to Lamberts Point (VWP Permit#13-0856):** This 15-year Virginia Water Protection Permit was issued on September 18, 2013 and authorizes impacts to maintain the existing 800 foot – 1,800 foot wide Norfolk Harbor Sewells Point to Lamberts Point Bend Channel to a maximum allowable depth of -55 feet MLLW. New and maintenance dredging of subaqueous bottom to maintain Anchorage F and it approach to -55 feet MLLW is also permitted. Maintenance dredging of subaqueous bottom to maintain the Sewells Point East Anchorage and its Approach and the Naval Maneuvering Area to the maximum allowable depth of -50 MLLW is also authorized. The final permit feature is the maintenance dredging of subaqueous bottom to maintain the Sewells Point West Anchorage and its Approach to -45 feet MLLW.

Procedure for Clean Water Act, Section 401, Water Quality Certification

In 2015, USACE developed an agreement with VDEQ (letter dated October 2, 2015) concerning the need for obtaining VWP permits and 401 certification utilizing the Coastal Zone Management Act Determination process. Pursuant to this letter, USACE requested State 401 certification through coordination of this NEPA and CZMA document for the construction and future maintenance dredged material discharges associated with the Norfolk Harbor Project to include placement at CIDMMA and other CIDMMA maintenance associated activities. VDEQ granted their concurrence in January 2018 and it is included in Appendix I.

MPRSA, Section 103, USEPA Concurrence

For Operations and Maintenance dredging in the AOC and the TSC, a VWP Permit is not required. These channels are outside jurisdictional state waters. In place of this permit, maintenance dredging is subject to the provisions of the Marine Protection Research and Sanctuaries Act (MPRSA). Dredged material placement for these channels must comply with MPRSA, Section 103 and receive concurrence with USEPA that dredged material meets the Ocean Disposal Criteria.

Existing USEPA Concurrence

a. **Thimble Shoal Channel (USEPA Concurrence letter with MPSRA, Section 103 on May 15, 2015):** USEPA concurred with the MPRSA Section 103 Evaluation and testing to authorize continued maintenance dredging of TSC (TSC). The TSC is congressionally authorized to a depth of -55 feet MLLW but is currently maintained at -50 feet MLLW width of 1,000 feet. Maintenance of Thimble Shoal requires the removal of approximately 600,000 cubic yards every two to three years. The material will be placed at DNODS in accordance with 40 CFR 228.15. This concurrence letter can be found in Appendix I.

b. **Atlantic Ocean Channel (USEPA Concurrence letter with MPSRA, Section 103 on May 15, 2015)** USEPA concurred with the MPRSA, Section 103 Evaluation and testing to authorize continued maintenance dredging of AOC (AOC). The AOC is congressionally authorized to a depth of -57 feet MLLW but is currently maintained at -52 feet MLLW width of 1,000 feet. Maintenance of AOC requires the removal of approximately 300,000 cubic yards every three years. The material will be placed at DNODS in accordance with 40 CFR 228.15.This concurrence letter can be found in Appendix I.

2.7 Vegetation, Wetlands, and Submerged Aquatic Vegetation

The ROI includes the areas transited by dredging vessels/equipment, areas of navigation channel and Anchorage F dredged, and dredged material placement/disposal sites. The ROI also includes the area of anticipated circulation pattern shifts and water quality impacts. The geographic extent of water quality impacts is dependent upon factors such as the type of dredging equipment, the dredging depth, and environmental conditions such as wind and currents (USACE 1983).

Upland Vegetation

Because the ROI is predominantly composed of subaqueous bottom, no upland vegetation occurs within the ROI, except in the dredged material disposal area, CIDMMA. Portions of CIDMMA are vegetated with approximately 10% cover from low lying shrubs or grasses due to overgrowth on dredged material in cells. This vegetation is in a state of flux, as the disposal area is managed according to usage. However, the USACE manages vegetation at CIDMMA for optimal erosion and sediment control.

Adjacent to the ROI, the land use is predominantly industrial, urban, and suburban in nature throughout in Newport News, Norfolk, Portsmouth and Virginia Beach. As a result, the majority of the waterfront property adjacent to the ROI is developed. Natural riparian vegetation along the waterways adjacent to the project area is minimal with the exception of public lands such as protected areas, parks, and military installations.

Wetlands

Wetlands are defined by the Clean Water Act regulations as, “those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas” (USEPA 2016). Estuary environments can be altered with the combined stress of inundation, desiccation, and changes in salinity. These conditions limit the types of vegetation that can survive within the ROI, and the plant communities within this dynamic ecosystem have evolved the capacity to thrive in the ever-changing environment (Perry et al. 2001).

Wetlands are resources that combine shallow water, high levels of nutrients, and primary productivity, which is ideal for the development of organisms that form the base of the food web and provide foraging sites for fish, amphibians, shellfish and insects. Dead plant leaves and stems break down in the water to form detritus, which feeds many small aquatic insects, shellfish and small fish that are food for larger predatory fish, reptiles, amphibians, birds and mammals. Many species of birds and mammals rely on wetlands for food, water, and shelter, especially during migration and breeding.

Over the course of many years of development and industry, shorelines have been built up, bulkheaded, or were filled to facilitate development; and large industrial and military deep water access piers and marine terminals have been constructed adjacent to the ROI. The entire navigation channel system within the ROI is subtidal, and classified as Estuarine and Marine Deepwater by U.S. Fish and Wildlife Service. The channel in the ROI ranges in depth from -35 to -55 feet MLLW and thus, is too deep to support wetland vegetation.

Tidal marsh exists only in portions of the shoreline fringing the CIDMMA. Within those areas, the entire habitat transition from open water, through salt marsh, to the adjacent uplands is generally less than 20 feet wide. The wetland fringes are typically comprised of dense, often mono-specific stands of smooth cordgrass (*Spartina alterniflora*), and occur at elevations between mean low water (MLW) and mean high water (MHW). The reed grass community, found further upslope of MHW in various areas, is dominated by the invasive reed grass (*Phragmites australis*). Both community types are considered estuarine wetlands. Upslope of these emergent wetlands and along the banks are saltbush communities dominated by marsh elder (*Iva frutescens*), groundsel tree (*Baccharis hamifolia*), and Chesapeake Bayberry (*Morella pensylvanica*). The USACE regularly treats reed grass via aerial application to help control its spread at the CIDMMA and adjacent areas.

Emergent wetland vegetation may form temporarily from time to time within the existing CIDMMA facility, as it is periodically altered by dredged material from various current dredging projects, and as that material settles and/or is managed. However, these are inadvertently created wetland vegetation sites and no jurisdictional wetlands are located within the confines of the CIDMMA itself.

Submerged Aquatic Vegetation

More than a dozen species of submerged aquatic vegetation (SAV) are native to the Chesapeake Bay and its tributaries. Salinity, light penetration, water depth, and bottom sediment are factors which determine where each species can grow. SAV survival depends on water clarity and the amount of sunlight available and provides food and shelter for diverse communities of waterfowl, fish, shellfish, and invertebrates; SAV also produces oxygen, which is a very important function in the Chesapeake Bay. Other ecological benefits of SAV include the ability to filter and trap sediment, and absorb nutrients like nitrogen and phosphorus (U.S. Fish and Wildlife Service, Chesapeake Bay Field Office 2016).

Since the 1960s, over half of the SAV has disappeared from Chesapeake Bay waters. Declining water quality, disturbance, and alteration of shallow water habitat all contributed to the decline of SAV.

In 2015, the Virginia Institute of Marine Science (VIMS) mapped the annual distribution of SAV in the Chesapeake Bay and its tributaries using multispectral digital imagery supplemented with black and white aerial photographs. Based on this latest survey and mapping effort, as well as data from the years 2010 through 2015, there is no SAV within the ROI. The closest SAV beds located outside of the ROI are approximately 0.5 – 1.0 miles away from the closest project element (Anchorage F).

2.8 Benthic Fauna

The benthic communities of the lower Chesapeake Bay are complex and include an array of fauna that play critical roles in the food web. The typical Chesapeake Bay ecosystem includes benthic communities of epifauna (organisms that live attached to surfaces on the Chesapeake Bay bottom) such as oysters, sponges, sea squirts, seas stars, and barnacles. Infauna are organisms that burrow into bottom sediments and infaunal communities are characterized by worms, clams, and other tunneling organisms.

Benthic communities have varied roles in the Chesapeake Bay ecosystem. Filter feeders such as clams, oysters, and sponges clarify and clean the waters of the Chesapeake Bay, through their biological processes, removing particulate matter and potentially toxic materials, providing for a healthy marine environment. As primary and secondary consumers, these organisms pass the energy of primary producers (phytoplankton) to higher levels of the food web. Many benthic species are food for economically important species of the Chesapeake Bay such as the blue crab (*Callinectes sapidus*), striped bass (*Morone saxatilis*), spot (*Leiostomus xanthurus)*, and croaker (*Micropogonias undulatus)* (CBP 2016c).

The ROI for benthic fauna includes the areas transited by dredging vessels/equipment, areas of navigation channel and Anchorage F dredged, and dredged material placement/disposal areas. The ROI also includes the area of anticipated circulation patterns shifts and water quality impacts that has the potential to impact benthic fauna (Figure 2-22). The geographic extent of water quality impacts is dependent upon factors such as the type of dredging equipment, the dredging depth, and environmental conditions, such as wind and currents (USACE 1983)

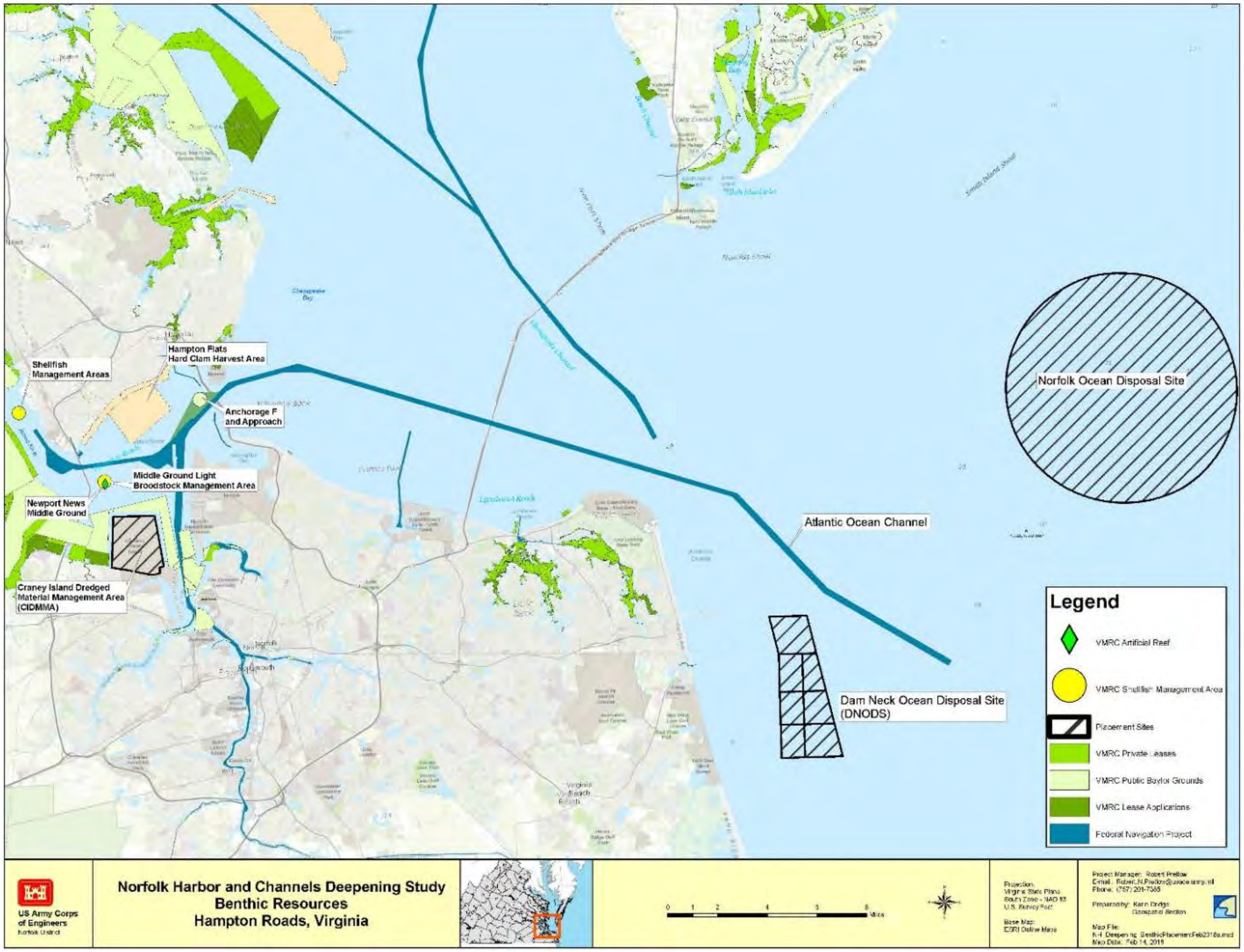

Figure 2-22: Benthic Resources in the ROI

Channel Characterization:

The navigation channels addressed in this study were characterized in Section 1.6 of this report. The bottom composition of these areas is summarized in Figure 2-23. This classification of substrates was created in 2015 from the NOAA geodatabase for the Natural Resources Technical Report for the Hampton Roads Crossing Study (VDOT 2016). The channel substrate was classified as the following:

- AOC - The main composition of the channel bottom is sand without shell and muddy sand without shell.
- TSC and Meeting Areas - The main composition of this channel bottom is sand without shell and muddy sand without shell.
- Norfolk Harbor Entrance Reach and Norfolk Harbor Reach - The main composition of this channel bottom sandy mud shell, sand without shell, and mud without shell.
- Newport News Channel - The main composition of this channel bottom is sand and muddy sand.

The VMRC manages submerged bottom (outside Federal navigation channels) in public trust in addition to managing both recreational and commercial saltwater fishing in the Commonwealth of Virginia. The agency is responsible for shellfish regulation and private leasing of submerged bottom as well as encroachment on these resources under Section 28.2 -1203 of the Virginia Code. Impacts to benthic resources are evaluated by VMRC when determining whether to issue a permit to encroach upon submerged bottom.

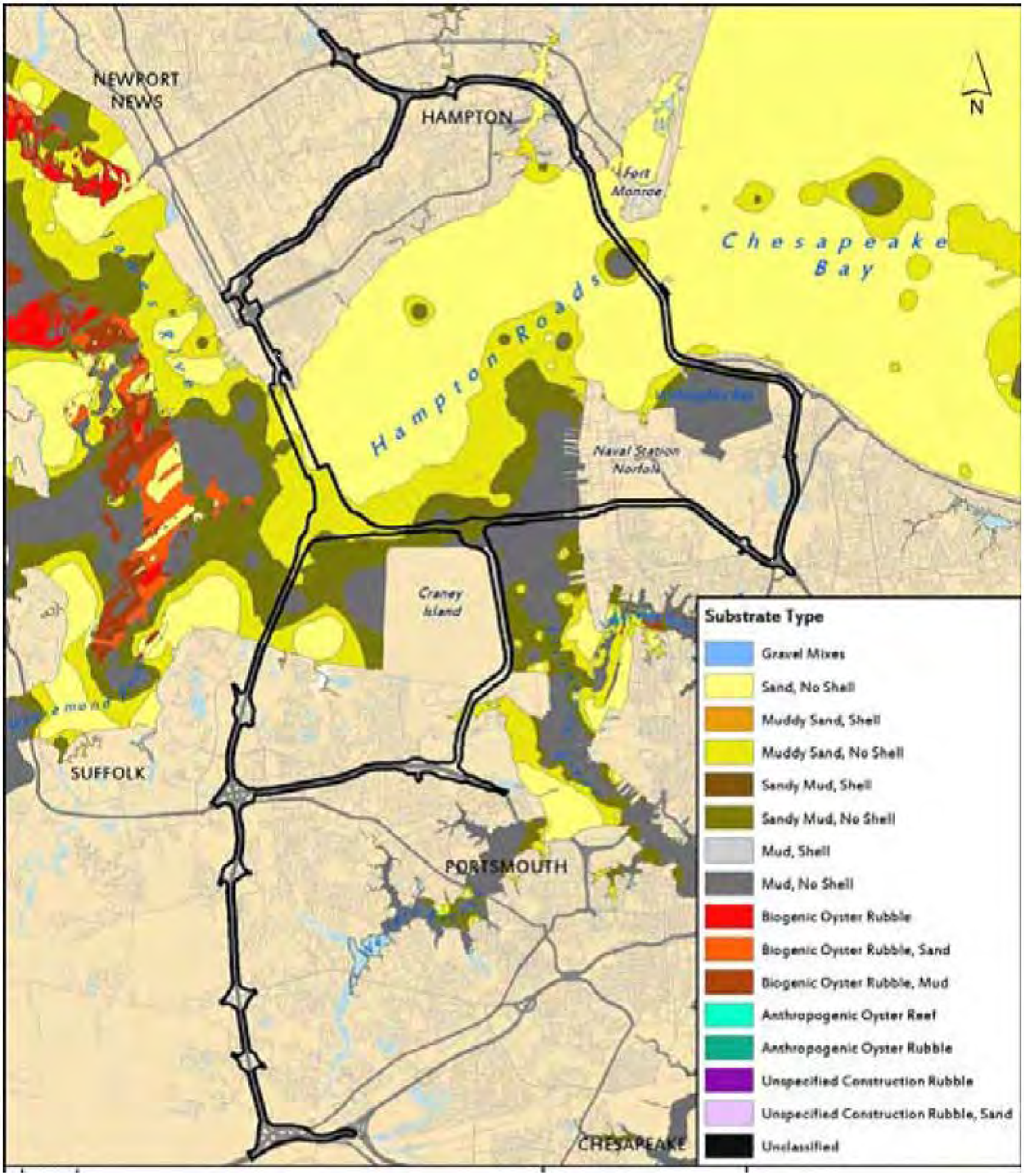

Figure 2-23: Bottom composition (VDOT 2016)

Resources in the ROI

Clam Resources

The hard clam (*Mercenaria mercenaria*), a bivalve mollusk, is common in Chesapeake Bay and lower James River. It can be found in waters with salinities greater than 25 ppt. (Whetstone et al. 2005) and at depths from the shoreline to -60 feet (CBP 2016a). This commercially harvested species occurs naturally along the Atlantic Coast from Canada to Florida and is increasingly harvested in Virginia's Chesapeake Bay waters. Hard clams are found, in decreasing order of abundance, in soft bottoms with shell, sand flats, sand/mud flats, and on muddy bottoms (Pratt 1953; Wells 1957). Density of young (0-2 years) hard clams in seagrass beds is >5 times that in sand flats (Peterson et al. 1984). They are typically harvested between 4 and 8 years of age when they reach commercial size classes. In addition to their economic value, hard clams play important roles ecologically as filter feeders, nutrient cyclers, and is an important prey species for gulls, tautogs, waterfowl, cownose rays, blue crabs and oyster drill. The hard clam is considered an important commercial species in Chesapeake Bay and can commonly be found in Norfolk Harbor (Figure 2-24), with high densities between Monitor–Merrimac Memorial Bridge–Tunnel (MMBT), Interstate 664 Bridge west of CIDMMA, and the Hampton Roads Bridge–Tunnel (HRBT) (Mann et al. 2005).

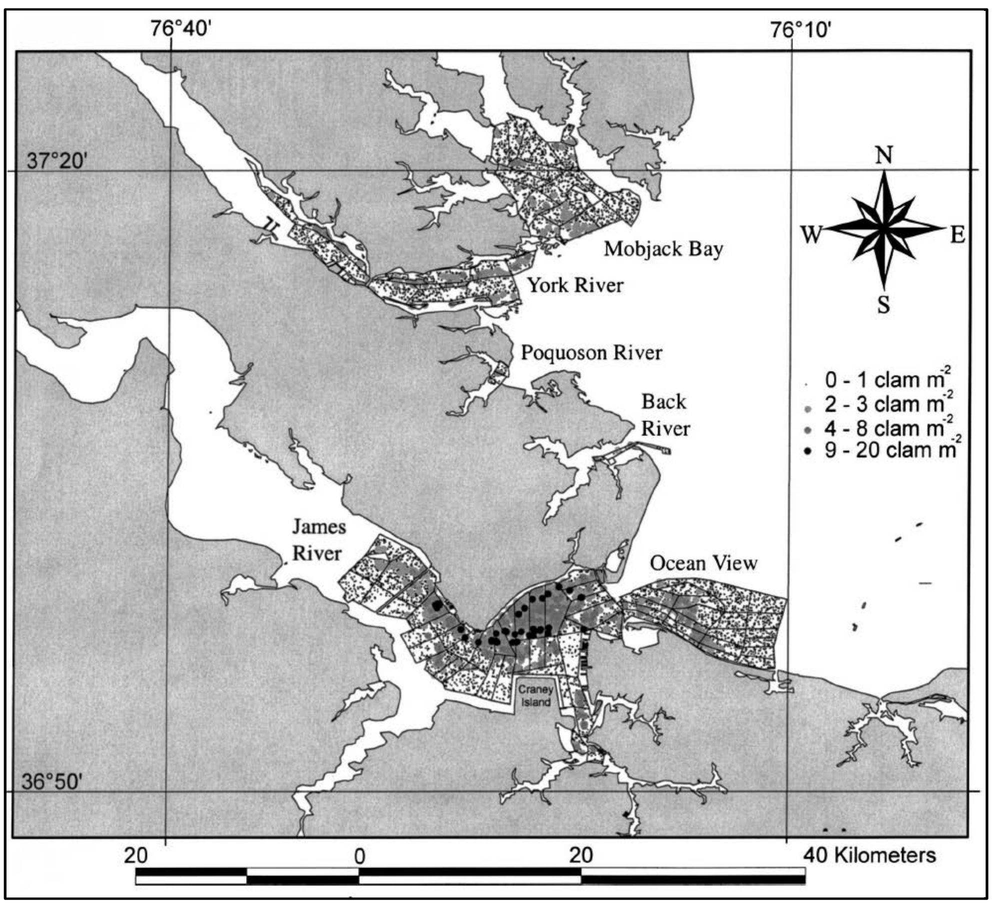

Figure 2-24: Northern Quahog (Hard Clam) Mercenaria mercenaria Abundance and Habitat Use in Chesapeake Bay (Mann, R. Harding, J., et al 2005).

From the VIMS Hard Clam Stock Assessment, 2002, "The hard clam resource in Virginia is managed under Regulation 4 VAC 20-560-10 and the following sequence, adopted on November 23, 1998 and made effective on December 1, 1998.The fishery is managed by Shellfish Management Areas, designated under 4 VAC 20-560-20, on a seasonal rotation basis, the designated areas being York River, Poquoson River, Back River and James River. Within the James there exists the Newport News Shellfish Management Area, from which direct harvest is allowed, and the Hampton Roads Shellfish Relay Area. The latter consists of condemned clam harvest grounds from which clams can be taken but must then be relayed in cages, under the supervision of VMRC personnel, for a period sufficient to allow depuration before eventual marketing. Finally, there are broodstock management areas at Middle Ground Light in the James River, York River, and Back River." There have been small scale surveys of clam resources in the Chesapeake Bay but no comprehensive efforts on Chesapeake Bay wide clam stock assessments.

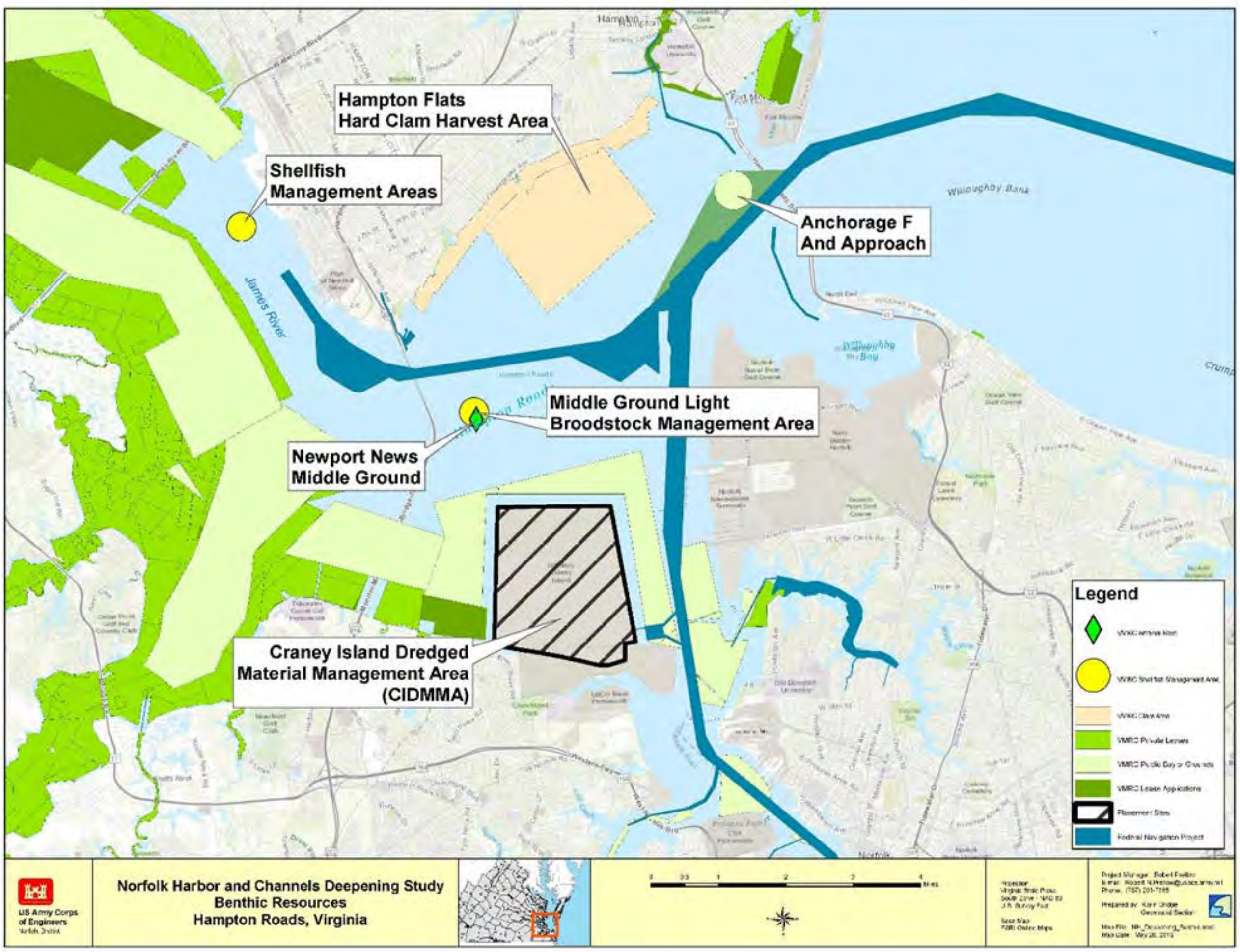

Figure 2-25: Norfolk Harbor Inset – Benthic Resources

Within the vicinity of the Newport News Channel, VMRC has a designated a Hard Clam Broodstock Program called the Middle Ground Light Broodstock Sanctuary (Figure 2-25) in March 1998 to facilitate disbursement of larvae throughout the Chesapeake Bay (Cool 1998). Initially, the site, located within a 1,000 foot radius of the Newport News Middle Ground Lighthouse, received a deployment of 30,000 bushels of dredged oyster shell to prepare 2.4-2.9 acres of bottom for the placement of 300,000 seed clams, along with 7,455 market-size clams from 2-2.875 inches (Cool 1998). This is the first reef site to be developed within the actual harbor of Hampton Roads and was developed as a combination artificial fishing reef and hard clam sanctuary. It is located 3,100 feet from the navigation channel.

The Newport News Shellfish Management Area is another clam resource in the near vicinity of the Newport News Channel between the James River Bridge and the Monitor Merrimac Tunnel (Figure 2-25). This resource is addressed by Virginia law (Regulation 4 VAC 20-560-10 et. Seq.). The purpose of this resource is to protect and promote the hard clam resources within the lower James River. The public is only allowed to harvest during the months of May through September between sunrise and two pm (VMRC 2016f).

Norfolk Harbor Channel:

Located in the near vicinity of Norfolk Harbor Entrance Channel (approximately 3,200 feet away) is the Hampton Flats Hard Clam Harvest Area (Figure 2-26) established in August 16, 2001 by Virginia law Regulation 4 VAC 20-561-10 et. Seq. This regulated area is guided by special provisions to manage the increased abundance of hard clams in the harvest area and increased harvest pressure on the hard clam resource by patent tongs (VMRC 2016c) Anchorage F is also located approximately 2500 feet from this resource.

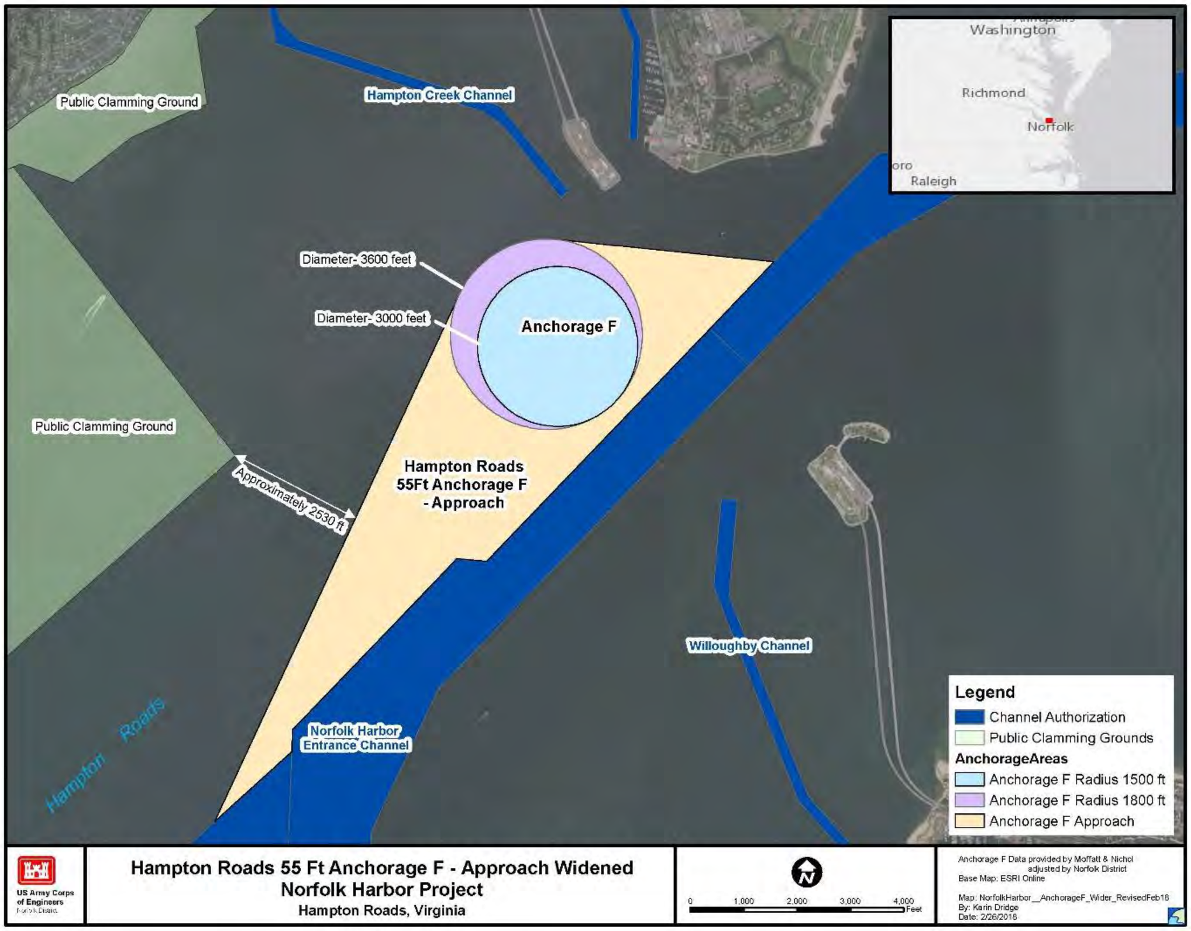

Figure 2-26: Anchorage F– Benthic Resources

Artificial Reef Resources

Virginia's Artificial Reef Program, managed by Virginia Marine Resources Commission (VMRC) has installed artificial reefs adjacent to the ROI that provide habitat for many benthic organisms. (VMRC 2016a). Found east of the Monitor Merrimac Bridge Tunnel (see Figure 2-24), adjacent to Newport News Channel, the Middle Ground Artificial Reef is located approximately 3,100 feet from the channel at the mouth of the James River. The reef encircles the Newport News Middle Ground Lighthouse with a ring of reef structures, concrete rubble, buoy sinkers, piling and pier sections extending radially 200 to 1,000 feet from the lighthouse. The reef sits at a depth of -22 feet with a profile of two to four feet (VMRC 2016b) and acts as a designated Broodstock Sanctuary providing seed clams for the lower James River (see Clam Resources above) (see Figure 2-25).

Shellfish Condemnation Zones

The Virginia Department of Health (VDH) Division of Shellfish Sanitation is responsible for protecting the health of the consumers of molluscan shellfish and crustacea by ensuring that shellfish growing waters are properly classified for harvesting, and that molluscan shellfish and crustacea processing facilities meet sanitation standards. The regulations protect shellfish consumers through water quality monitoring, growing area assessments, education and regulatory programs.

In the ROI, Shellfish Condemnation Zones are found in Norfolk Harbor, the Lafayette River and the waters surrounding the ocean placement area, DNODS. Shellfishing is condemned in these areas by the VDH. The term “shellfish” is used for defining both molluscs (oysters, clams, scallops, etc.) and crustaceans (crabs, lobsters and shrimp), but the Division's shellfish closures refer only to restrictions on the harvesting of molluscan shellfish. The latest shellfish closure (#056-007) for Hampton Roads and Norfolk Harbor was issued January 8, 2014 and its geographical limits are shown in Figure 2-27.

Figure 2-27: Shellfish Condemnation Zones in Norfolk Harbor

A shellfish closure was also issued on August 23, 2010 (#073-162) adjacent to and encompassing portions of the DNODS. The geographical limits of this closure are shown in Figure 2-28.

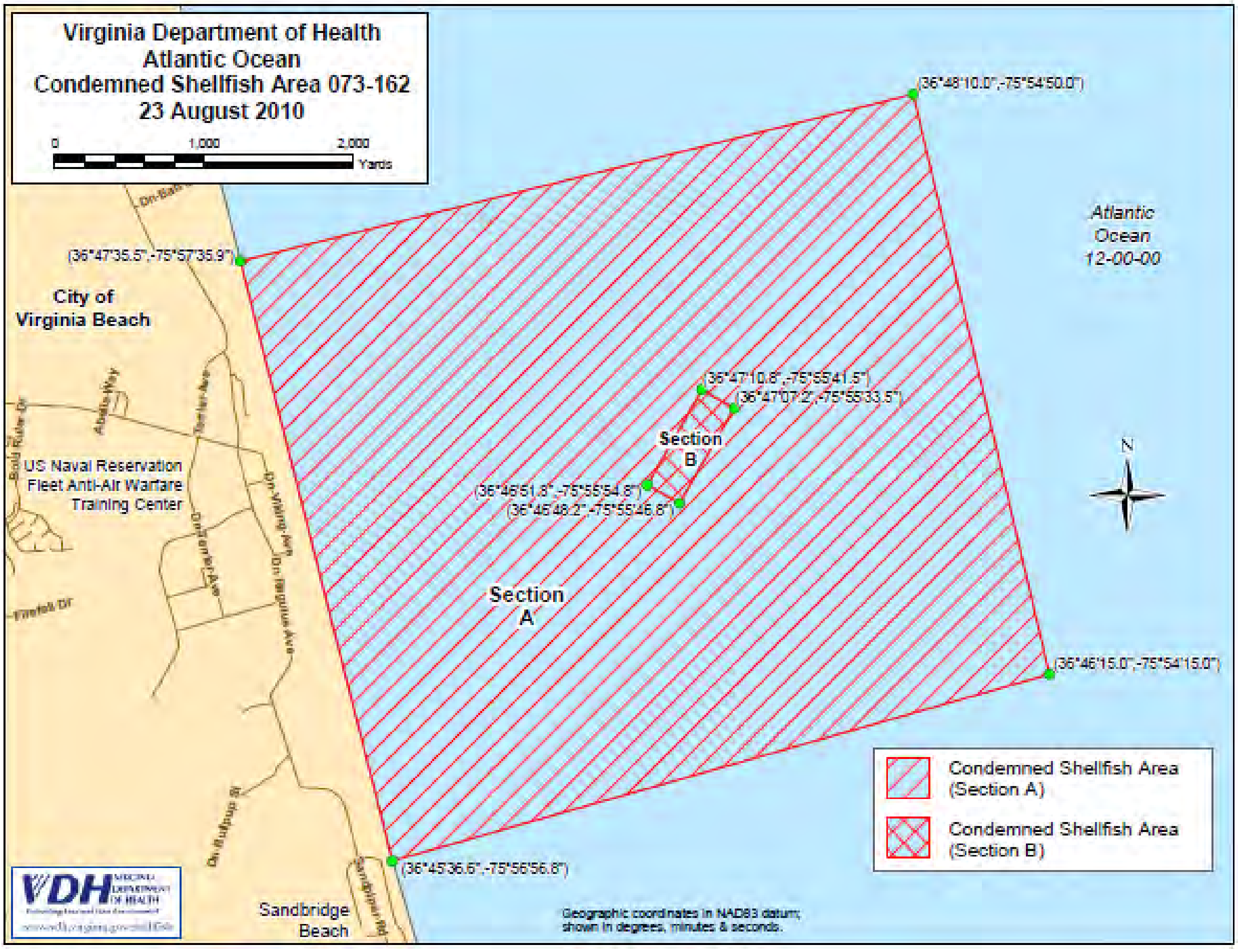

Figure 2-28: Condemned Shellfish Area at Dam Neck Ocean Disposal Site

The eastern oysters (*Crassostrea virginica*) is considered an important commercial fishery in the Chesapeake Bay and prefer a depth range of two to twenty-six feet in brackish or salt water. Although this fishery has declined over the years due to overharvesting, pollution and disease and loss of habitat, state, Federal, and local agencies as well as nongovernmental organizations have been successfully implementing programs to increase oyster populations. Most locations of natural (relict) or artificial oyster reefs within the vicinity of the ROI, such as at the mouth of the Lafayette River and in the Elizabeth River proper. These shallower areas are not within the proposed channel dredge sites and dredged material placement/disposal areas. There are no designated private oyster lease areas managed by VMRC within the ROI, but there are public oyster grounds (known as Chesapeake Baylor Grounds) surrounding CIDMMA and on either side of the Norfolk Harbor Channel to its end at Lamberts Point (see Figure 2-29*).*

Lafayette River Oyster Resources

The mouth of the Lafayette River borders Norfolk Harbor Channel and is located across from CIDMMA. Public oyster grounds or Chesapeake Baylor Grounds are located adjacent to the Channel and surrounding CIDMMA. Within the Lafayette River proper, there are few public oyster grounds and minimal private leases (Figure 2-29). The river has been closed to wild commercial oyster harvest since the 1930s due to poor water quality. All oysters in the Lafayette River are protected from harvest. The river was surveyed in 2015 and documented to contain 46 acres of relict oyster reef and 22 acres of oyster restoration reef projects (Lafayette Oyster Working Group 2016). These reefs are outside the ROI. Figure 2-30 identifies the relict reefs, restoration reefs, and any sites that could be suitable for future restoration.

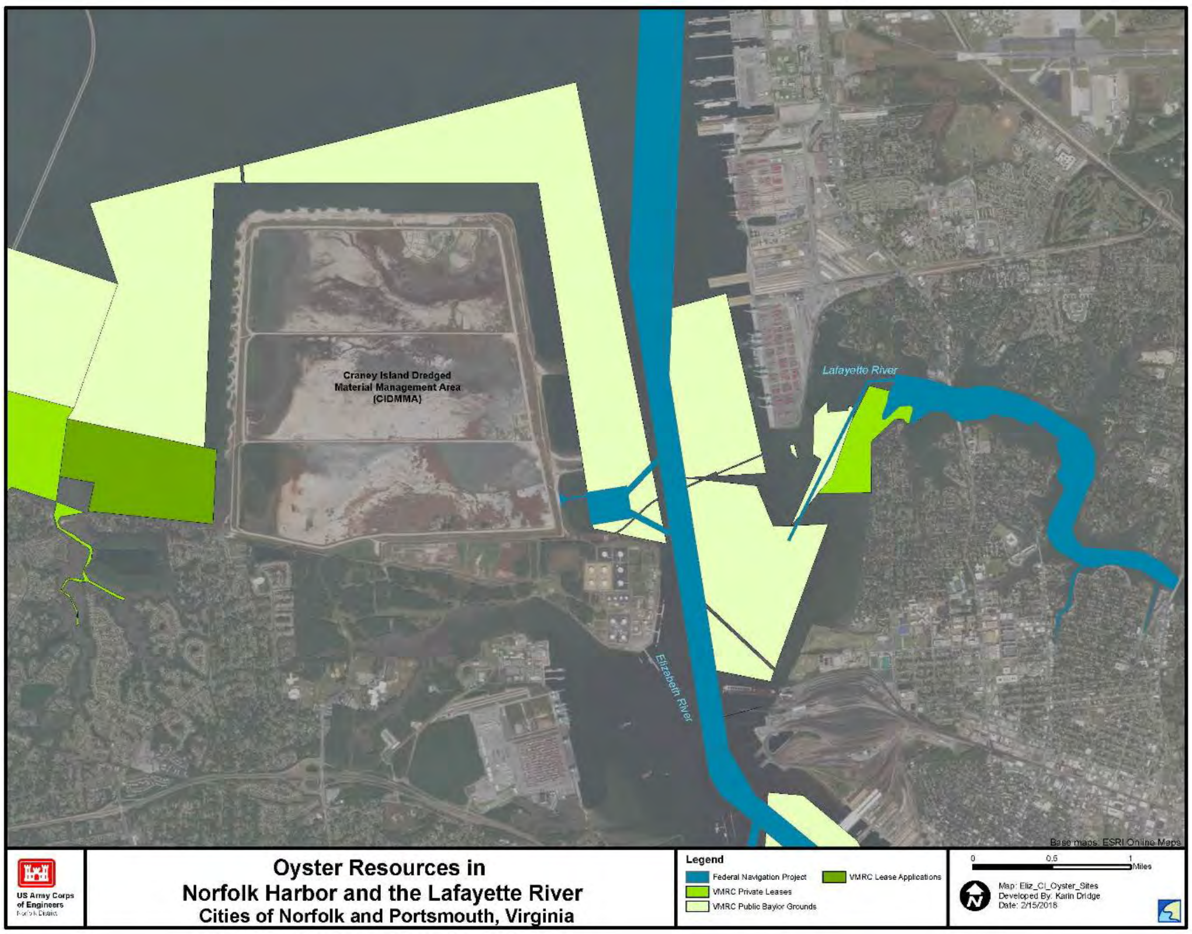

Figure 2-29: Oyster Resources in Norfolk Harbor and the Lafayette River

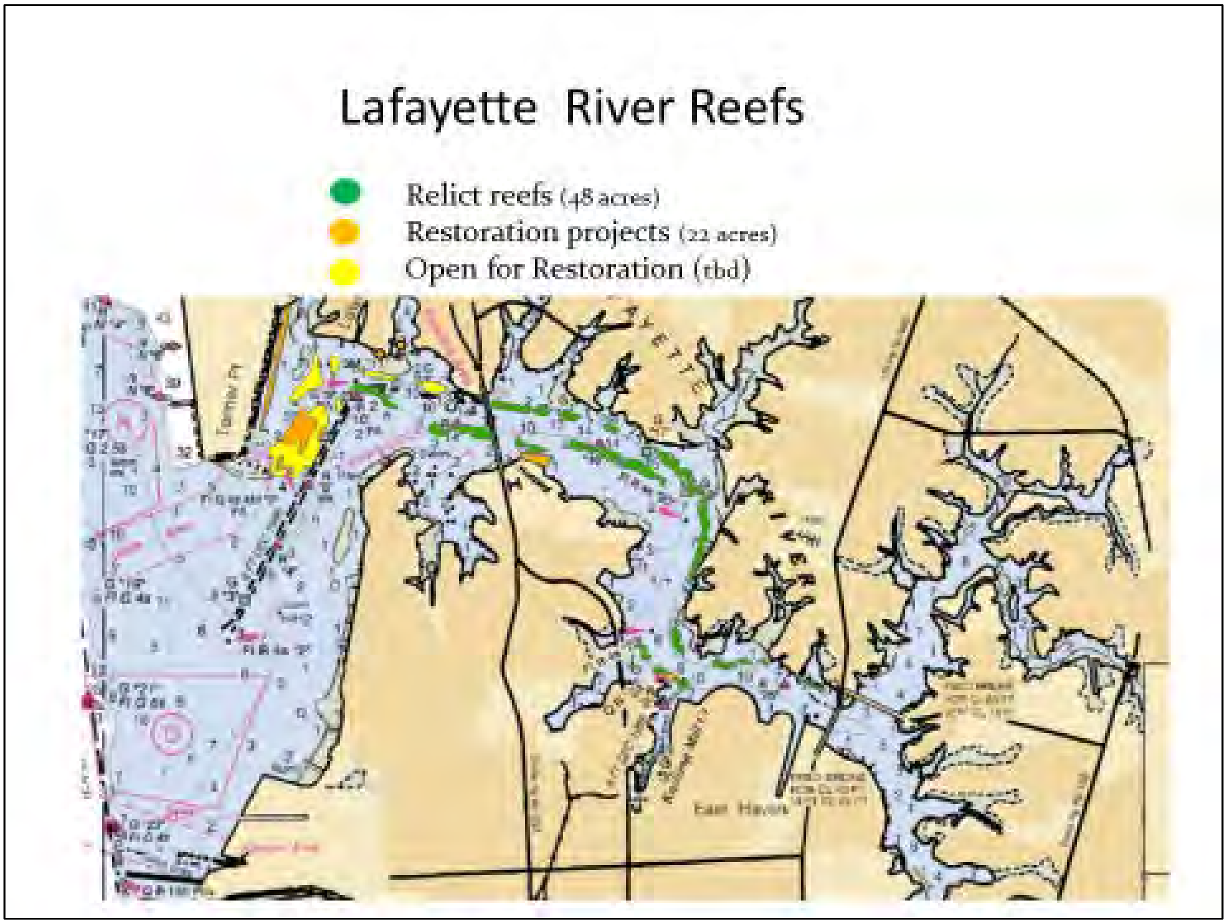

Figure 2-30: Existing Reefs in the Lafayette River

The eastern oyster does not prefer the depths or salinities in the other locations of the ROI. The AOC, NODS, and DNODS have salinities greater than 30 ppt and depths in excess of 40 feet and, therefore, these locations do not contain suitable oyster habitat.

Blue Crab Resources

The blue crab is an important benthic prey source for a variety of predators, including striped bass (Manooch 1973, Walter and Austin 2003, Walter et al. 2003), American eel (Wenner and Musick 1975), Atlantic croaker (Overstreet and Heard 1978a, Overstreet and Heard 1978b), and red drum (Jaworski 1972, Bass and Avault 1975, Scharf and Schlicht 2000, Guillory and Prejean 2001). They can tolerate a wide range of salinity in Chesapeake Bay from lower Chesapeake Bay waters (up to 32 ppt) to the upper reaches of its tributaries (Tan and Van Engel 1966, Ballard and Abbott 1969, Tagatz 1971, Guerin and Stickle 1992). Mating occurs from May through October in tributaries and middle and upper waters (Van Engel 1958), peaking in July and August (McConaugha et al. 1983, Epifanio et al. 1984, Jones et al. 1990, Epifanio 1995). Gravid females extrude fertilized eggs as a mass, called a sponge, from their aprons (Pyle and Cronin 1950). As the embryos in the sponge develop, female crabs migrate towards the mouth of Chesapeake Bay to spawn in these high-salinity waters, while males remain in less saline waters (Van Engel 1958, Millikin and Williams 1984, McConaugha 1988). Eggs hatch most successfully at salinities of 20 to 32 ppt (Sandoz and Rogers 1944, Costlow and Bookhout 1959, Davis 1965), and planktonic blue crab larvae, or zoeae, develop in coastal waters above the continental shelf (Epifanio et al. 1989, Epifanio 2007). After about six to eight weeks and several molts, zoeae metamorphose into benthic megalopae, which reinvade the Chesapeake Bay (Epifanio and Garvine 2001) and eventually undergo metamorphosis into the juvenile stage after reaching nursery grounds (Metcalf and Lipcius 1992, Etherington and Eggleston 2000). Megalopae and juveniles migrate up Chesapeake Bay and into all of its tributaries (DeVries et al. 1994, Forward et al. 1997, 2003). Adult crabs of both sexes overwinter in the muddy bottoms of deeper channels (Van Engel 1958, Schaffner and Diaz 1988), while juveniles more often overwinter in shallower areas (Van Engel 1958).

According to the 2014 Chesapeake Bay Blue Crab Advisory Report, the start of the 2014 crabbing season saw 68.5 million adult female crabs in the Chesapeake Bay. This number is based on the results of the winter dredge survey, and is tracked by the Chesapeake Bay Program as an indicator of Chesapeake Bay health. There is a designated VMRC Virginia Blue Crab Sanctuary located within portions of the ROI. Geographic locations (Figure 2-31) extend into the AOC and along the Atlantic Ocean beaches. The Blue Crab Sanctuary regulations restrict commercial and recreational harvest of blue crabs between the months of May through September. In the VIMS Trawl Survey Catch Summary for January 1955 through December 2017, approximately 234,862 male blue crabs were caught accounting for 1.06% of the catch and 194, 566 females were surveyed representing 0.88%of the catch.

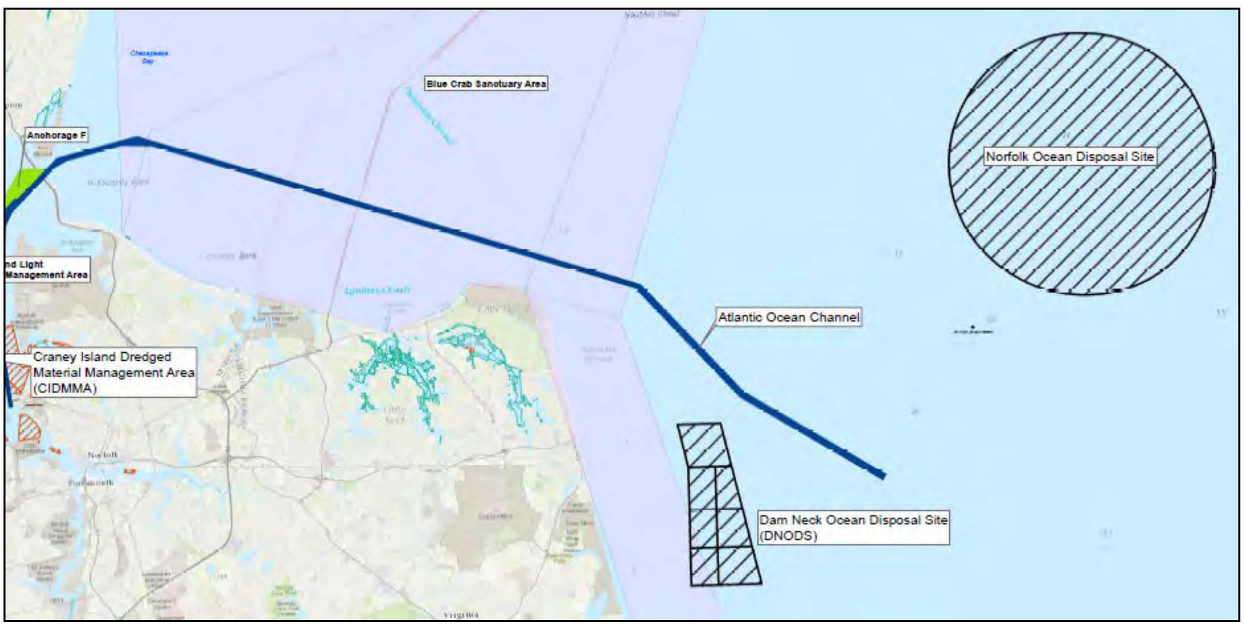

Figure 2-31: Blue Crab Sanctuaries in the ROI and Adjacent Areas

Horseshoe Crab Resources

Horseshoe crabs are bottom-dwelling organisms that belong to the largest group of all living animals, the phylum known as arthropods. The presence of chelicera (pincer-like appendages), 5 pairs of walking legs and book gills, and lack of jaws and antennae. Horseshoe crabs (*Limulus polyphemus*), are a benthic natural resource found in the Chesapeake Bay. Between 2010 and 2014, over 1.5 million pounds of horseshoe crabs were commercially landed in Virginia (NOAA 2016). Horseshoe crabs play an important ecological role in the food web. Horseshoe crab species support several important commercial fisheries, are used for biomedical purposes and are considered an important food source for migratory shorebirds and sea turtles. Adult horseshoe crabs prefer depths of less than 30 m (Button and Ropes 1987). Spawning habitats are typically protected sandy beaches adjacent to large intertidal sand flats (Thompson 1998). Nursery areas for juvenile (prosomal width <160 mm) horseshoe crabs are usually intertidal sand flats (Rudloe 1981; Thompson 1998). Adults have no known specific habitat requirements, but may migrate to the continental shelf in the fall to overwinter. Chesapeake Bay is used in the summer months as a summer nursery area and as an overwintering site in the winter months. Shorebirds primarily feed on horseshoe crab eggs exposed on the surface, but sufficient surface eggs are available only if horseshoe crabs are spawning at high densities. Sea turtles feed on adult horseshoe crabs, but their diet depends on relative abundance of the prey species as well. Horseshoe crab mortality includes natural mortality (beach strandings, predation, diseases, etc), mortality associated with biomedical applications, and fishing mortality (horseshoe crabs are used as bait), including by catch mortality.

Horseshoe crabs molt or shed their shell to grow. Molting occurs several times during the first two to three years and about once a year afterwards. Molting occurs approximately 16 to 17 times over a period of 9 to 11 years before sexual maturity is reached and once mature, it is believed they no longer molt. Females reach maturity one year later than males and consequently, go through an additional molt. Mature horseshoe crabs then repeat what has occurred for years, an annual spring migration to inshore spawning areas. If a horseshoe crab can survive the rigors of spawning, it may live to 18 years of age.

Horseshoe crabs are well known for their highly visible mating activities. Spawning in the Chesapeake usually begins in late May when large numbers of adults move onto beaches to mate and lay eggs. The peak in spawning activity usually coincides with the full moon and evening spring tides. Adults prefer beach areas within Chesapeake Bays and coves which are protected from rough water. Eggs are laid in clusters or nests along the beach, usually between high and low tide. Several nests are made during one beach trip and females will return on successive tides to lay more eggs. Females can produce approximately 88,000 per year. Egg development usually takes about a month and once hatched, larvae usually swim around in the shallow intertidal areas near the beaches where they were spawned until they settle to the bottom and molt. Juvenile horseshoe crabs spend their first and second summer on the intertidal flats and then begin moving offshore.

Adult horseshoe crabs feed mainly on marine worms and shellfish including razor clams and soft-shelled clams. Because they lack jaws, horseshoe crabs crush and grind their food items using the spiny bases of their legs and then push the small food particles into their mouths. Horseshoe crabs can tolerate a wide range of temperatures and can survive in low oxygen environments. As long as their book gills are kept moist, horseshoe crabs can survive out of the water for extended periods of time, especially to spawn.

This fishery is managed through the Atlantic States Marine Fisheries Commission which has created and amended the Horseshoe Crab Fishery Management Plan. In the VIMS Trawl Survey Catch Summary for January 1955 through December 2017, 584 Horseshoe Crabs identified (representing <0.01% of resources surveyed). The VMRC (through 4 VAC 20-900-10 et Seq.) has been regulating this fishery resource in accordance with this Commission by establishing licensing requirements and exemptions for the harvesting of horseshoe crabs by hand. The VMRC also established commercial fisheries management measures for horseshoe crabs, including an annual commercial quota for horseshoe crabs that comply with the provisions of the Interstate Fishery Management Plan for Horseshoe Crab (VMRC 2016e).

Benthic Index of Biological Integrity:

The existing overall health of the general benthic community in the ROI is evaluated yearly by the Chesapeake Bay Program. This program establishes an Index of Biological Integrity (IBI-Score) for Benthic Habitat in the Chesapeake Bay and its tributaries. In the ROI, there are multiple stations gathering data on this topic (CBP 2016a). In the most recently published data, the Benthic Habitat or IBI-score for the lower Chesapeake from the Atlantic Ocean to the James River was determined to be moderately good and meeting the goals of the Chesapeake Bay program with an IBI-score of greater than three. (UMCES 2013). The only degraded IBI-score within the ROI (shown in red in Figure 2-32) was identified at Willoughby Chesapeake Bay bordering Norfolk Harbor Channel. Benthic resources become less abundant due to poor water quality, pollution, and development pressure in downriver, higher salinity areas of the Elizabeth River.

Dauer (2008) conducted a long term trend analysis in the Elizabeth River and its mainstem. He recorded only the Lafayette sampling station had an increase in IBI-score station data. Dauer documented the Elizabeth River watershed as having a benthic community species diversity and biomass that "remains below reference condition levels, while abundance was often above reference condition levels and considered excessive" (Dauer 2008). He summarized that community composition was not balanced and demonstrated that levels of "pollution indicative species" were above reference conditions and levels of "pollution sensitive species" were found to be below the reference conditions (Dauer 2008).

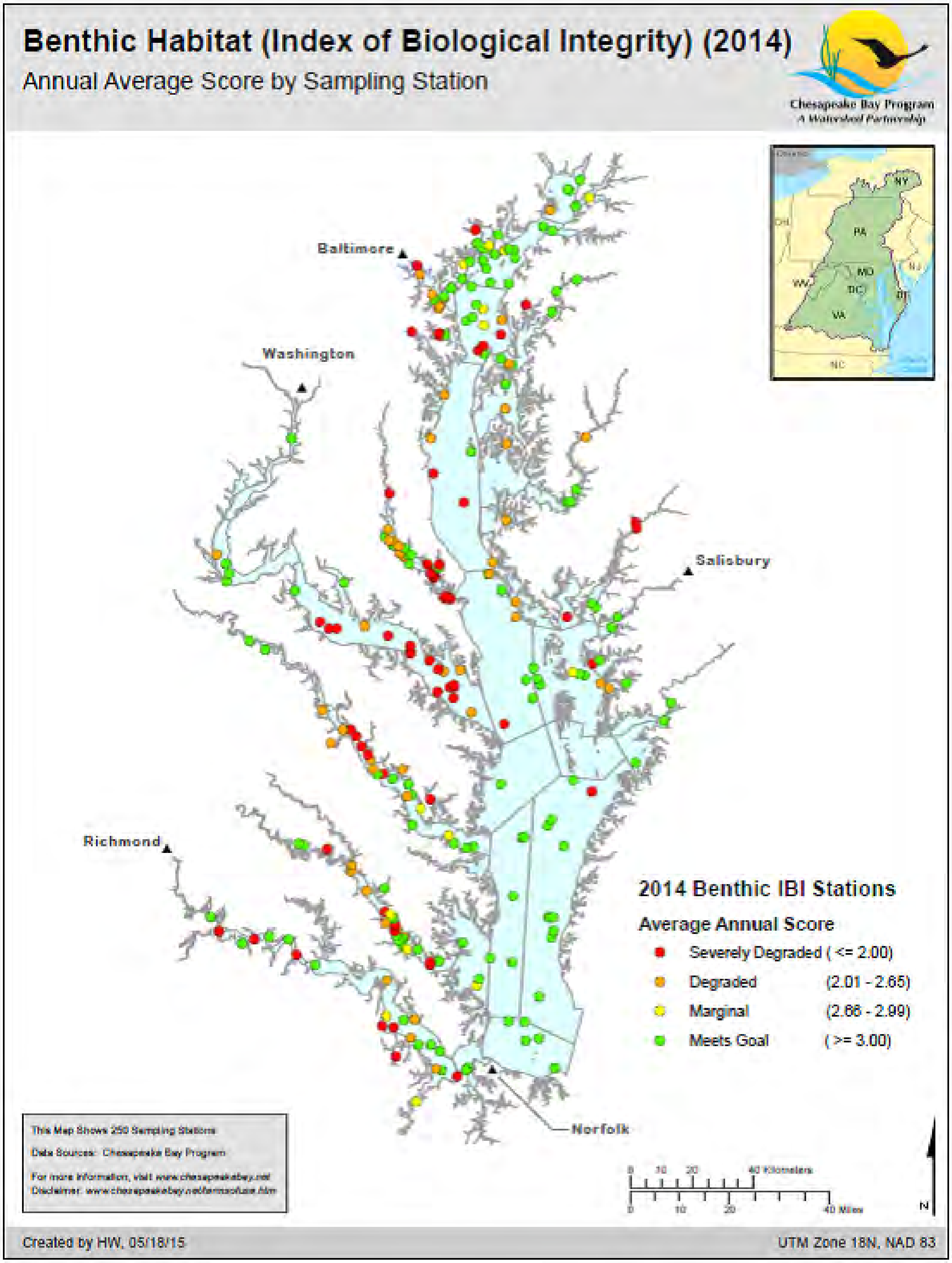

Figure 2-32: Benthic Index of Biological Integrity (IBI-score) in the Region of Influence and throughout the Chesapeake Bay Watershed

2.9 Plankton Community

The ROI for the plankton community includes the areas transited by dredging vessels/equipment, areas of navigation channel and Anchorage F dredged, and dredged material placement/disposal areas. The ROI also includes the area of anticipated circulation patterns shifts and water quality impacts that has the potential to impact the plankton community. The geographic extent of water quality impacts is dependent upon factors such as the type of dredging equipment, the dredging depth, and environmental conditions such as wind and currents (USACE 1983).

Plankton are free-floating organisms found in freshwater and marine ecosystems that are largely transported by wind and currents. Phytoplankton (microalgae) are tiny, single-celled organisms. Phytoplankton are primary producers because they generate food and oxygen in the Chesapeake Bay and its surrounding tributaries by a process called photosynthesis. To perform photosynthesis, phytoplankton need the energy of sunlight and they are typically found in the upper reaches of the water column. There are hundreds of species of phytoplankton in Chesapeake Bay but the most abundant phytoplankton in Chesapeake Bay and its surrounding tributaries are typically the diatoms and dinoflagellates (Chesapeake Bay Foundation 2015).

The abundance of phytoplankton in the Chesapeake Bay fluctuates seasonally with the highest abundance occurring during the spring when the highest concentration of nutrients flow into the Chesapeake Bay from melting snow and rain events. Nutrient pollution can cause algal blooms that can reduce oxygen levels in the Chesapeake Bay and its surrounding tributaries (Chesapeake Bay Foundation 2015). During a bloom, phytoplankton may accrue so densely in the water column that light availability for other photosynthetic organisms is diminished. After a bloom, phytoplankton sink to the benthos, which can produce anoxic conditions that can cause mortality of fish and other benthic organisms.

Zooplankton are mostly microscopic, free-floating animal life and are the most abundant animals found in the Chesapeake Bay and its surrounding tributaries (Chesapeake Bay Foundation 2015). Zooplankton form a crucial link in the food chain between primary producers and higher levels of the food chain. Zooplankton consist of primary consumers (those that eat phytoplankton) and secondary consumers (larger zooplankton that consume the secondary consumers). Zooplankton are then consumed by fishes which are subsequently prey for larger fishes and wildlife (Reshetiloff 1997).

Copepods are tiny crustaceans that are approximately one millimeter long and are the most abundant zooplankton in the Chesapeake Bay and its surrounding tributaries (Chesapeake Bay Foundation 2015). Larval fish and shellfish, which include commercial and recreational fisheries species and species of restoration and management concern, also comprise an important component of the zooplankton community. For example, oyster, blue crab, and finfish larvae such as red drum compose the zooplankton community seasonally.

Protozoa are single-celled zooplankton that consume bacteria and decaying plant and animal matter. Bacteria also play a crucial role in the Chesapeake Bay and surrounding tributaries because they break down decaying plant and animal matter and provide nutrients in the food chain for higher level organisms. Comb-jellies and jellyfish are larger zooplankton that are visible to the naked eye and have some swimming capability, however, their location is largely driven by tides and currents and therefore, they are still considered zooplankton.

All fish within the Chesapeake Bay and its surrounding tributaries depend, whether directly or indirectly, on zooplankton because of its critical role in the food chain. Some fish such as anchovies (*Anchoa mitchilli)*, blueback herring (*Alosa aestivalis*), and shad (*Alosa sapidissimia*) solely feed on zooplankton throughout their entire life cycle (Chesapeake Bay Foundation 2015). Other fish species depend on plankton for a portion of their lifecycle either directly or indirectly through the food chain.

2.10 Fishery Resources and Essential Fish Habitat

The ROI for fishery resources and Essential Fish Habitat includes the areas transited by dredging vessels/equipment, areas of navigation channel and Anchorage F dredged, and dredged material placement/disposal areas. The ROI also includes the area of anticipated circulation patterns shifts and water quality impacts that has the potential to impact fishery resources and Essential Fish Habitat. The geographic extent of water quality impacts is dependent upon factors such as the type of dredging equipment, the dredging depth, and environmental conditions such as wind and currents (USACE 1983).

This country's largest estuary, the Chesapeake Bay, is ranked third in the nation for fisheries; only the Atlantic and Pacific Ocean exceed Chesapeake Bay catch (U.S. Fish and Wildlife Service 2013). For centuries, the Chesapeake Bay and its tributaries have provided fishing grounds for both commercial and recreational users. Approximately 350 species of fish are known to inhabit the Chesapeake Bay Region. Of these fish species, only 32 species are year-round residents of the Chesapeake Bay (Chesapeake Bay Program 2016; National Wildlife Foundation 2016). The remaining species enter the Chesapeake Bay either from freshwater tributaries or the Atlantic Ocean to reproduce, feed, or find shelter.

The fish species in the Chesapeake Bay Region fall into two categories: resident and migratory. Resident fishes tend to be smaller than migratory species and are often found in shallow water, where they feed on a variety of invertebrates. Migratory fishes fall into two categories: catadromous or anadromous. Catadromous fishes live in freshwater and travel to high-salinity oceanic water to spawn, while anadromous fishes travel from oceanic, or high salinity areas, to spawn in freshwater streams and rivers. Common resident species include the Chesapeake Bay anchovy, Atlantic silverside (*Menidia menidia*) killifish (Cyprinodontidae), blennies (Bleniidae), skilletfish (*Gobiesox stumosus*), gobies (Gobiidae), pipefish (*Syngnathus spp.*), lined seahorse (*Hippocampus erectus*), oyster toadfish (*Opsanus tau*), blackcheek tonguefish (*Symphurus plagiusa*), hogchoker (*Trinectes maculatus*), windowpane (*Scophthalmus aquosus*), white perch (*Morone americana*), yellow perch (*Perca flavescens*), and silver perch (*Bidyanus bidyanus*).

Although these species are permanent Chesapeake Bay residents, some are considered semi-anadromous. These species often move around the Chesapeake Bay and its tributaries due to changes in temperature, water quality, and food availability as well as for spawning.

Common anadromous species found in the ROI include: alewife (*Alosa pseudoharengus*), blueback herring (*Alosa aestivalis*), American shad *(Alosa sapidissima)*, striped bass (*Morone saxatilis*), and white perch (*Morone americana*). The alewife, blueback herring, and shad species have spawning and nursery areas upstream in the James River and other coastal tributaries and use Hampton Roads for passage between upstream and coastal habitats (Klauda et al. 1991a, 1991b). Striped bass and white perch also move through Hampton Roads to spawning and nursery areas upstream in the James River and other coastal tributaries (Setzler-Hamilton 1991a, 1991b).

The Elizabeth River is an important nursery habitat for many commercial and recreational species, including spot (*Leiostomus xanthurus*), Atlantic croaker (*Micropogonias undulatus*), Atlantic menhaden (*Bevoortia tyrannus*), weakfish (*Cynoscion regalis*), striped bass, black sea bass (*Centropristis striata*), and summer flounder (*Paralichthys dentatus*). The most intensive use for spawning is by forage fish, including the Chesapeake Bay anchovy and Atlantic silverside. The river is also an important feeding ground for adult bluefish, weakfish, spot, and the Atlantic croaker (Priest 1981).

Hedgepeth et al. (in Priest 1981) concluded that temperature is the major factor determining the winter distribution of fishes, while food availability is the major factor controlling the summer distribution of fishes. They concluded fishes primarily use the Elizabeth and lower James Rivers for three reasons 1) nursery grounds for juvenile spot, Atlantic croaker, alewife, blueback herring, American shad, striped bass, and weakfish; 2) adult feeding grounds for spot, Atlantic croaker, weakfish, summer flounder, and 3) spawning grounds for important forage species such as Chesapeake Bay anchovy and Atlantic silverside. The observations of Hedgepeth et al. (in Priest 1981) determined that dredging operations in the project area will have a greater effect on juvenile and forage fishes than on the adult fishes found at summer feeding grounds.

Essential Fish Habitat.

The Magnuson-Stevens Fishery Conservation and Management Act, as amended October 11, 1996, defines the term "Essential Fish Habitat" as the “waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity”. The act applies to Federally managed species, and requires Federal agencies to identify and describe EFH for fisheries that may be impacted by a potential project. Using the NOAA (2016) Guide to Essential Fish Habitat Designations in the Northeastern United States, EFH for 40 species was identified to potentially occur within the ROI. For a detailed description of EFH and associated managed species anticipated to occur in the ROI as well as potential impacts to EFH from implementation of the Action Alternative, refer to the Essential Fish Habitat Assessment (Appendix H).

2.11 Wildlife

The Region of Influence (ROI) for wildlife includes areas transited by dredging vessels/equipment, areas of navigation channel and Anchorage F dredged, and dredged material placement/disposal sites. The ROI also includes the area of anticipated circulation patterns shifts and water quality impacts. The geographic extent of water quality impacts is dependent upon factors such as the type of dredging equipment, the dredging depth, and environmental conditions such as wind and currents (USACE 1983). For the purpose of the following discussion, wildlife consists of amphibians, birds, mammal species (excluding marine mammals) and terrestrial reptiles. Marine mammals, sea turtles, and migratory birds are described in Section 2.12, Special Status Species.

Avian species have the potential to occur throughout the ROI. For example, species may migrate through and/or forage within or adjacent to dredging and dredged material placement/disposal locations. The CIDMMA provides habitat for a diversity of bird species that utilize shallow water, beach, and open flats (USFWS 2002). A variety of bird species reside, breed, migrate through, and/or overwinter at the CIDMMA. The CIDMMA is also used as a stopover area for waterfowl and shorebirds during migration events (USFWS 2002).

The CIDMMA provides habitat for a variety of other wildlife as well. Mammals known to occur at CIDMMA include rabbits (*Sylvilagus spp.*), groundhogs (*Marmota monax*), river otters (*Lontra canadensis laxatina*), raccoons (*Procyon lotor*), opossums (*Didelphis virginiana*), red foxes

(*Vulpes vulpes*), coyotes (*Canis latrans*), and whitetail deer (*Odocoileus virginianus*) (USACE n.d.). The CIDMMA also contains potential habitat for terrestrial reptiles as well as amphibians.

2.12 Special Status Species

The ROI (or Action Area as it is referred to for threatened and endangered species per 50 CFR 402.02) is defined as “all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action.” (The terms ROI and Action Area are used interchangeably when referring to Federally listed species in the Environmental Assessment.) The ROI consists of the areas transited by dredging vessels/equipment, areas of navigation channel dredged as well as Anchorage F, and dredged material placement/disposal sites. The ROI includes the area of anticipated circulation patterns shifts and potential water quality impacts. The geographic extent of water quality impacts is dependent upon factors such as the type of dredging equipment, the dredging depth, and environmental conditions such as wind and currents (USACE 1983). The ROI includes the range of noise impacts as they pertain to special status species.

This section provides a summary of the special status species that are known or have the potential to occur in the Action Area. The following references were consulted for compilation of the special status species that have the potential to occur in the Action Area that is provided in Table 2-15:

- Marine mammal survey data collected in portions of the Action Area (Aschietto et al. 2017-2015);
- Virginia Aquarium Stranding Response Program’s Vessel Interaction datasets for sea turtles and marine mammals (Virginia Aquarium Foundation/Virginia Aquarium Stranding Response Program 2017a-2017b);
- Virginia Sea Turtle and Marine Mammal Stranding Network Reports (Swingle et al. 2017-2010; Barco and Swingle 2014);
- Information, Planning and Consultation System (IPaC) search conducted within the Action Area (U.S. Fish and Wildlife Service (USFWS) 2016a);
- Virginia Fish and Wildlife Information Service (VaFWIS) database search within a three mile radius of the Action Area (VDGIF 2016b);
- Virginia Natural Heritage Database Search (Department of Conservation and Recreation (DCR) 2016);
- National Oceanographic and Atmospheric Administration, National Marine Fisheries Service (NMFS) (2012) batched Biological Opinion that includes the Norfolk Harbor and Channels; and the
- Large Whale Strike Database (Jensen and Silber 2003).

Table 2-15: Federally listed species known or with the potential to occur in the Action Area (Aschietto et al. 2017-2015; Swingle et al. 2017; Virginia Aquarium Foundation/Virginia Aquarium Stranding Response Program 2017a and b; USFWS 2016a; VDGIF 2016b; DCR2016; Barco and Swingle 2014; NMFS 2012; Jensen and Silber 2003)

Taxonomic Category/Common Name	Scientific Name	Status	Critical Habitat
Birds			
Piping plover	*Charadrius melodus*	T, E	Y*
Red knot	*Calidris canatus rufa*	T	N
Roseate tern	*Sterna dougallii*	E	N
Fish			
Atlantic sturgeon (all DPSs)	*Acipenser oxyrinchus*	E	Y
Mammals			
Fin whale	*Balaenoptera physalus*	E	N
North Atlantic right whale	*Eubalaena glacialis*	E	Y*
Northern long-eared bat	*Myotis septentrionalis*	T	N
West Indian manatee	*Trichechus manatus*	T	Y*
Reptiles			
Green sea turtle (North Atlantic DPS)	*Chelonia mydas*	T	Y*
Kemp's ridley sea turtle	*Lepidochelys kempii*	E	N
Leatherback sea turtle	*Dermochelys coriacea*	E	Y*
Loggerhead sea turtle (Northwest Atlantic DPS)	*Caretta caretta*	T	Y*

DPS = Distinct Population Segment; E = Endangered; T = Threatened; Y = Yes; N = No; P = Proposed; ^Species status is reported as it pertains to the DPS/Action Area; *Critical Habitat not located in Action Area

Federally Threatened and Endangered Species and Designated Critical Habitat

Animals and plants listed as endangered or threatened are protected under the Endangered Species Act of 1973, as amended (ESA). According to the ESA, an "endangered species" is defined as any plant or animal species in danger of extinction throughout all or a substantial portion of its range. A "threatened species" is any species likely to become an endangered species in the foreseeable future throughout all or a substantial part of its range. "Proposed Species" are animal or plant species proposed in the Federal Register to be listed under Section 4 of the ESA. "Candidate species" are species for which the USFWS and NMFS have sufficient information on their biological status and threats to propose them as endangered or threatened under the ESA. Critical habitat is designated per 50 CFR parts 17 or 226 and defines those habitats that are essential for the conservation of a Federally threatened or endangered species and that may require special management and protection.

Relevant consultation correspondence and a copy of the reports generated from the Federal and state databases is provided in the Biological Assessment provided in Appendix E. The batched Biological Opinion submitted from the NMFS to the USACE in 2012 that includes the Norfolk Harbor Channels Project was used as a reference guide to identify Federally listed species known or with the potential to occur in the Action Area and to provide a frame of reference for potential impacts to listed species under the jurisdictional authority of the NMFS. There are no candidate species known or with the potential to occur in the Action Area. A limited segment of the Action Area located in the easternmost reaches of the Newport News Channel and immediate surrounding areas (in the James River) is located in the Atlantic Sturgeon Critical Habitat that was designated in 2017.

There is no documented occurrence of the shortnose sturgeon *(Acipenser brevirostrum)* in the Action Area*,* therefore, this species is not anticipated to occur in the Action Area and there would be "no affect" to this species and this species is dismissed from further analysis. Based on our review of the survey and Virginia stranding data, there is no documented occurrence of the blue whale (*Balaenoptera musculus)* in the Action Area or in coastal waters of Virginia. Also, blue whales have a predominantly offshore distribution. Therefore, we determined this species would not likely occur in the Action Area and therefore, there would be "no affect" to the blue whale and this species is dismissed from further analysis. There is only one limited occurrence of a stranded sperm whale (*Physeter macrocephalus)* in the Action Area and because of the preferred offshore distribution of this species we would not anticipate the sperm whale to typically occur in the Action Area; therefore, there would be "no affect" to the sperm whale and this species is dismissed from further analysis. There is no documented occurrence of the hawksbill sea turtle (*Eretmochelys imbricata)* in the Action Area and there is no preferred habitat for this species in the Action Area; therefore, there would be "no affect" to the hawksbill sea turtle and this species is dismissed from further analysis.

A detailed description of Federally listed species, their current status, and threats to these species and their habitat and is provided the Biological Assessment that is located in Appendix E. Please note that all of the species listed in Table 2-15 are also state listed in the Commonwealth of Virginia with the same status level as described for the Federal listing. Additional state listed species are described in Section 6 of this report.

Marine Mammals

The Marine Mammal Protection Act of 1972, as amended (MMPA) prohibits, with certain exceptions, the "take" of marine mammals in U.S. waters and by U.S. citizens on the high seas, and the importation of marine mammals and marine mammal products into the U.S. In reference to the MMPA, a marine mammal is a species found in the U.S. that is classified into one of the following four distinct groups: cetaceans (whales, dolphins, and porpoises), pinnipeds (seals, sea lions, and walruses), sirenians (manatees and dugongs), and marine fissipeds (polar bears and sea otters). Only cetaceans, pinnipeds, and sirenians have the potential to occur in the ROI. All marine mammals in the U.S. are protected under the MMPA.

The MMPA prohibits, with certain exceptions, the “take” of marine mammals in U.S. waters and by U.S. citizens on the high seas, and the importation of marine mammals and marine mammal products into the U.S. (NOAA, 2016m). The term “take” per the MMPA is defined as harass, hunt, capture, or kill, or attempt to harass, hunt, capture or kill any marine mammal. For most activities “harassment” refers to the act of pursuit, torment, or annoyance which:

- Can injure a marine mammal or a marine mammal stock in the wild which is referred to as Level A Harassment; or
- Has the potential to disturb a marine mammal or marine mammal stock in the wild by disrupting behavioral patterns that include but are not limited to the following: migration, breathing, nursing, breeding, feeding or sheltering which is referred to as Level B Harassment.

Table 2-16 provides a comprehensive listing of marine mammals documented to occur throughout the coastal waters of Virginia as documented in the marine mammal stranding record from 1988-2013 (Barco and Swingle 2014). Documented occurrences of marine mammals in the ROI per survey and/or marine stranding data are also indicated (Aschettino et al. 2017-2015; Swingle et al. 2017-2010; Virginia Aquarium Foundation/Virginia Aquarium Stranding Response Program 2017a-2017b). The humpback whale, West Indies Distinct Population Segment, the only humpback whale population segment that occurs in Virginia, is no longer Federally listed but is still protected under the MMPA.

Table 2-16 documents marine mammal species in stranding records from Virginia, 1988-2013. Threatened and endangered species and documented occurrences of marine mammals in the Region of Influence per survey and/or marine stranding data are also indicated (Aschettino et al. 2017-2015; Swingle et al. 2017-2010; Barco and Swingle 2014).

Table 2-16: Marine Mammal Strandings

Taxonomic Category/Common Name	Scientific Names	Strandings
Baleen Whales		
Bryde's whale	*Balaanoptera brydei*	historic
Fin whale^*	*Balanoptera physalus*	11
Humpback whale^	*Megaptera novaeangliae*	33
Minke whale^	*Balaenoptera acutorostrata*	9
Northern right whale*^	*Eubalena glacialis*	4
Sei whale*^	*Balaenoptera borealis*	2
Delphinids		
Atlantic spotted dolphin	*Stenella frontalis*	4
Atlantic white-sided dolphin	*Lagenorhynchus acutus*	14
Bottlenose dolphin^	*Tursiops truncatus*	1,593
Clymene dolphin	*Stenella clymene*	C. Potter, pers. Comm
Common dolphin^	*Delphinus delphis*	98
Long-finned pilot whale^	*Globicephala melas*	14
Melon headed whale	*Peponocephala electra*	2
Pantropical spotted dolphin	*Stenella attenuata*	historic
Pygmy killer whale^	*Feresa attenuata*	3
Risso's dolphin^	*Grampus griseus*	22
Rough toothed dolphin	*Steno bredanensis*	14
Short-finned pilot whale^	*Globicephala macrorhynchus*	7
Striped dolphin^	*Stenella coeruleoalba*	16
Other toothed whales		
Cuvier's beaked whale	*Ziphius cavirostris*	historic
Dwarf sperm whale	*Kogia sima*	10
Gervais' beaked whale	*Mesoplodon europaeus*	6
Harbor porpoise^	*Phocoena phocoena*	318
Pygmy sperm whale	*Kogia breviceps*	24
Sowerby's beaked whale	*Mesoplodon bidens*	2
Sperm whale*^	*Physeter macrocephalus*	1
True's beaked whale	*Mesoplodon mirus*	1

Taxonomic Category/Common Name	Scientific Names	Strandings
Pinnipeds		
Grey seal^	*Halichoerus grypus*	15
Harbor seal^	*Phoca vitulina*	82
Harp seal^	*Pagophilus groenlandica*	38
Hooded seal	*Cystophora cristata*	12
Sirenians		
West Indian manatee*	*Trichechus manatus*	annual sightings
*Species is Federally listed in Virginia under the protection of the Endangered Species Act. ^Documented to occur in the Region of Influence based on survey and/or stranding data. 'Historic' refers to published accounts for the species. For these species, no animals were documented in the Virginia stranding record from 1988-2013		

Bald Eagles Protected under the American Bald and Golden Eagle Act of 1972

Previously listed as Federally endangered, the bald eagle (*Haliaeetus leucocephalus*) has made a remarkable comeback and is no longer Federally listed. It is currently protected under the American Bald and Golden Eagle Act, and the Migratory Bird Treaty Act (MBTA). Bald eagles breed throughout much of Canada and Alaska, in addition to scattered sites across the lower 48 states, from California to the southeastern U.S. coast and Florida. Wintering habitat covers most of the contiguous U.S., with some year-round distribution in the northwest. Northern birds return to breeding grounds as soon as weather and food availability permit, generally between January and March (USFWS 2016d).

A large raptor, the bald eagle has a wingspread of about seven feet. Adults have a dark brown body and wings, white head and tail, and a yellow beak. Juveniles are mostly brown with white mottling on the body, tail, and undersides of wings. Bald eagles typically breed and winter in forested areas adjacent to large bodies of water. However, such areas must have an adequate food base, perching areas, and nesting sites. Throughout its range, it selects large, super-canopy roost trees that are open and accessible. Nests are constructed from an array of sticks placed in an interwoven pattern. Other materials added as fillers may include grasses, mosses, and even corn stalks. Nests are massive; often exceeding several thousand kilograms in weight (USFWS 2016d).

The USFWS National Bald Eagle Management Guidelines (2007) are used to assess potential effects to nesting bald eagles and provides management guidelines to avoid impacts to nesting bald eagles (USFWS 2007). To avoid disturbing bald eagles, a nest buffer is recommended between the human activity and the nest where applicable. Human impacts are considered detrimental to nesting success within the primary buffer and within the secondary buffer, human impacts are thought to impact the quality of the primary nest buffer. The primary buffer is a distance of 330 feet from the nest and the secondary buffer is a distance of 660 feet from the nest. Human activities that are considered detrimental to breeding activities (e.g. development, logging, use of toxic chemicals, etc.) are to be limited within the primary buffer and those that could impact the integrity of the primary buffer are restricted within a secondary buffer (e.g. developments, roadways, etc.). Per the management guidelines, a nest buffer of 2,640 feet is recommended from the nest for loud, disturbing noises such as those caused by blasting and other loud, intermittent noises.

No bald eagle nests currently exist within the ROI, or on or within three miles of the CIDMMA (The Center for Biology Conservation 2016). No primary or secondary bald eagle management zones (buffers) occur within the ROI (The Center for Conservation Biology 2016). The ROI is not located in a Bald Eagle Concentration Area.

Species Protected under the Migratory Bird Treaty Act of 1918 and Executive Order 13186 (EO)

The Migratory Bird Treaty Act (MBTA) and Executive Order 13186 (EO) requires agencies to protect and conserve migratory birds and their habitats. Any activity that results in the take of migratory birds or eagles is prohibited unless authorized by the USFWS.

Migratory birds nest throughout North America, some as far north as the Arctic. In late summer and fall, they migrate south for the winter. Some winter in the southern United States, Mexico, the Caribbean or Central America while others go as far as South America. Each spring they return north to their breeding grounds. Many migratory songbirds, shorebirds, and raptors rest and refuel in the Chesapeake Bay Watershed during their spring and fall migrations (Table 2-17). Others winter south and return to the Chesapeake Bay watershed each spring to breed. (USFWS 2016c).

Migratory birds are defined as those described by the USFWS in the 50 CFR 10.13 and consist of species that that belongs to a family or group of species in the United States as well as Canada, Japan, Mexico, or Russia. Most birds native (naturally occurring in the U.S.) to the U.S. belong to a protected family and are protected by the Migratory Bird Treaty Act. A species qualifies for protection under the Migratory Bird Treaty Act if it meets one or more of the following four criteria:

(1) It (a) belongs to a family or group of species named in the Canadian convention of 1916, as amended in 1996; (b) specimens, photographs, videotape recordings, or audiotape recordings provide convincing evidence of natural occurrence in the United States or its territories; and (c) the documentation of such records has been recognized by the American Ornithologists Union or other competent scientific authorities.

(2) It (a) belongs to a family of group of species named in the Mexican convention of 1936, as amended in 1972; (b) specimens, photographs, videotape recordings, or audiotape recordings provide convincing evidence of natural occurrence in the United States or its territories; and (c) the documentation of such records has been recognized by the AOU or other competent scientific authorities.

(3) It is a species listed in the annex to the Japanese convention of 1972.

(4) It is a species listed in the appendix to the Russian convention of 1976.

Table 2-17: Migratory Birds Known or with the Potential to Occur in the Region of Influence (USFWS 2016a).

Common Name	Scientific Name
American bittern	*Botaurus lentiginosus*
American kestral	*Falco sparverius paulus*
American oystercatcher	*Haematopus palliatus*
Arctic tern	*Sterna paradisaea*
Bald eagle	*Haliaeetus leucocephalus*
Black rail	*Laterallus jamaicensis*
Black scoter	*Melanitta nigra*
Black skimmer	*Rynchops niger*
Black-legged kittiwake	*Rissa tridactyla*
Black-throated green warbler	*Dendroica virens*
Bonaparte's gull	*Chroicocephalus philadelphia*
Brown pelican	*Pelecanus occidentalis*
Brown-headed nuthatch	*Sitta pusilla*
Common loon	*Gavia immer*
Common tern	*Sterna hirundo*
Cory's shearwater	*Calonectris diomedea*
Double-crested cormorant	*Phalacrocorax auritus*
Fox sparrow	*Passerella iliaca*
Great black-backed gull	*Larus marinus*
Great shearwater	*Puffinus gravis*
Gull-billed tern	*Gelochelidon nilotica*
Herring gull	*Larus argentatus*
Horned grebe	*Podiceps auritus*
Hudsonian godwit	*Limosa haemastica*
Laughing gull	*Larus atricilla*
Least bittern	*Ixobrychus exilis*
Least tern	*Sterna antillarum*
Lesser yellowlegs	*Tringa flavipes*
Loggerhead shrike	*Lanius ludovicianus*
Long-tailed duck	*Clangula hyemalis*

Common Name	Scientific Name
Manx shearwater	*Puffinus puffinus*
Marbled godwit	*Limosa fedoa*
Nelson's sparrow	*Ammodramus nelsoni*
Northern gannet	*Morus bassanus*
Peregrine falcon	*Falco peregrinus*
Pied-billed grebe	*Podilymbus podiceps*
Piping plover	*Charadrius melodus*
Prairie warbler	*Dendroica discolor*
Prothonotary warbler	*Protonotaria citrea*
Purple sandpiper	*Calidris maritima*
Razorbill	*Alca torda*
Red knot	*Calidris canatus rufa*
Red-headed woodpecker	*Melanerpes erythrocephalus*
Red-necked phalarope	*Phalaropus lobatus*
Red-throated loon	*Gavia stellata*
Ring-billed gull	*Larus delawarensis*
Roseate tern	*Sterna dougallii*
Royal tern	*Thalasseus maximus*
Rusty blackbird	*Euphagus carolinus*
Saltmarsh sparrow	*Ammodramus caudacutus*
Seaside sparrow	*Ammodramus maritimus*
Sedge wren	*Cistothorus platensis*
Short-billed dowitcher	*Limnodromus griseus*
Short-eared owl	*Asio flammeus*
Snowy egret	*Egretta thula*
Surf scoter	*Melanitta perspicillata*
Swainson's warbler	*Limnothlypis swainsonii*
Whimbrel	*Numenius phaeopus*
White-winged scoter	*Melanitta fusca*
Wilson's storm-petrel	*Oceanites oceanicus*
Wood thrush	*Hylocichla mustelina*
Worm eating warbler	*Helmitheros vermivorum*

Common Name	Scientific Name
Yellow rail	*Coturnicops noveboracensis*

Migratory Bird Habitat at the Craney Island Dredged Material Management Area

Since 1989, the USACE, Norfolk District has actively engaged in a program to protect migratory bird species that have opportunistically utilized the CIDMMA. The inflow of dredged material, which consists of sands, silts, and clays high in organic matter, supports aquatic invertebrate populations on which migrating and resident waterbirds forage and the shallow ponds provide roosting and sanctuary habitat. Sand deposits from dredged material placement operations replenish potential nesting habitat for ground-nesting species. Voluntary monitoring of bird nesting and active management of avian habitat at the CIDMMA has served to enhance avian habitat and reduce any potential impacts of dredged material management on migratory birds utilizing the CIDMMA. The USACE, Norfolk District continually balances CIDMMA's authorized mission to support navigation by providing dredged material placement capacity and managing nesting and foraging areas to promote the success of avian species utilizing the site to the maximum practicable extent.

The CIDMMA provides habitats to a diversity of migratory bird species that utilize shallow water, beach, and open flats (USFWS 2002). A variety of bird species reside, breed, migrate through, and/or overwinter there. More than 270 bird species have been reported to occur on the island including waterfowl, shorebirds, wading birds, birds of prey, and other passerine species. The CIDMMA is used as a stopover area for waterfowl and shorebirds during migration events (USFWS 2002). The site is also inhabited by other waterbirds including terns, gulls, wading birds, and osprey (USFWS 2002). Peregrine falcons are known to hunt on the site because of the availability of open habitat and bird prey species (Davis 1988 in USFWS 2002).

Migratory birds, including threatened or endangered species, species of concern, and other protected species use this area as foraging and breeding grounds. Nesting areas are posted with signs and are closed during the breeding season. Ground nesting birds reported to nest on CIDMMA include: least tern (*Sterna antillarum*), killdeer (*Charadrius vociferus*), willet (*Tringa semipalmata*), black-necked stilt (*Himantopus mexicanus*), avocet (*Recurvirostra americana*), horned lark (*Eremophila alpestris*), and night hawk (*Chordeiles minor*) (USFWS 2002). The USACE previously partnered with the College of William and Mary to protect nesting birds on the island and enhance nesting habitats. In the late 1980s, fine sand and shell were placed at the island to improve nesting habitats (USFWS 2002). Wood decoys were also deployed to attract nesting birds to the habitat. Another management measure that has been taken at the island is the removal of mammalian predators. Least tern nesting numbers have varied year to year. The Norfolk District has constructed a shoreline stabilization project that incorporates habitat for ground nesting species along with vegetated wetlands. The USACE implements regular mammalian predator control program to maintain a balance between predators and nesting species. Since 2010, Least tern numbers have varied from 101 to 563 confirmed adult least terns with confirmed nests ranging from 28 to 281 nests.

Piping plover is a Federally threatened species that previously nested at CIDMMA from 1989 – 1997, although only in very limited numbers (ranging from 1 to 5 pairs) (USFWS 2002). It is thought they responded positively to the management measures that were implemented for the least terns. Because the management measures were stopped and chick foraging areas on the outside of the perimeter dike and the interior became unavailable, piping plover have not nested on the site (USFWS 2002). Without implementation of additional management efforts, piping plover nesting is not anticipated to occur at CIDMMA (USFWS 2002).

State Listed Endangered and Threatened Species

Table 2-18 lists additional state listed species that have the potential to occur within a three-mile radius of the ROI (VDGIF 2016b). However, within the limits of the ROI, there is no potential habitat for the Mabee's salamander or the canebrake rattlesnake and we would not expect these species to occur in the ROI. Therefore, there would be no impacts to these species and they are dismissed from further consideration. State listed birds have the potential to forage within, migrate through, and stopover in the ROI.

Table 2-18: Additional State Listed Species with the Potential to Occur within a Three-mile Radius of the Region of Influence (VDGIF 2016b).

Common Name	Scientific Name	State Status
Amphibian		
Mabee's salamander	*Ambystoma mabeei*	T
Birds		
Black rail	*Laterallus jamaicensis*	E
Gull-billed tern	*Gelochelidon nilotica*	T
Loggerhead shrike	*Lanius ludovicianus*	T
Migrant loggerhead shrike	*Lanius ludovicianus migrans*	T
Peregrine falcon	*Falco peregrines*	T
Wilson's plover	*Charadrius wilsonia*	E
Mammals		
Ratinesque's eastern big eared	*Corynorhinus ratinesquii*	E
Tri-colored bat	*Perimyotis subflavus*	E
Reptile		
Canebrake rattlesnake	*Crotalus horridus*	E
E=Endangered; T=Threatened		

2.13 Air Quality

The ROI for air quality is defined by the USEPA's regulatory boundary of the Hampton Roads Area, which comprises the cities of Chesapeake, Hampton, Newport News, Norfolk, Poquoson, Portsmouth, Suffolk, Virginia Beach, and Williamsburg, and the counties of Gloucester, Isle of Wight, James City, and York, Virginia.

Pursuant to the Clean Air Act, as amended, the USEPA Office of Air Quality Planning and Standards has set National Ambient Air Quality Standards (NAAQS) for six air pollutants, called “criteria” pollutants: carbon monoxide, nitrogen dioxide, ozone, lead, particulate matter (less than 10 microns and less than 2.5 microns), and sulfur dioxide.

The USEPA has set NAAQS for each criteria pollutant, which represents the maximum allowable atmospheric concentrations allowed in order to ensure protection of public health and welfare. The VVDEQ, Division of Air Quality, has adopted the NAAQS in its USEPA-approved State Implementation Plan (SIP) and approved monitoring program (USEPA 2015).

Clean Air Act Section 176(c)(4) established the General Conformity Rule, which USEPA implemented through rulemaking in 1993 and most recently amended in 2010 (75 FR 17253). The General Conformity Rule implements the Clean Air Act’s requirement that Federal actions occurring in nonattainment and maintenance areas shall not hinder local efforts to control air pollution. Nonattainment areas are Air Quality Control Regions that are in violation of one or more of the NAAQS. Maintenance areas are Air Quality Control Regions that USEPA previously designated as nonattainment areas, but have been subsequently designated as attainment and are subject to a maintenance plan.

Federal agencies are required to demonstrate that their actions “*conform with*” (i.e., do not undermine) the approved SIP for their project’s geographic area. The purpose of conformity is to (1) ensure Federal activities do not interfere with the air quality budgets in the SIPs; (2) ensure actions do not cause or contribute to new violations; and (3) ensure attainment and maintenance of the NAAQS. The attainment and nonattainment designations for the Commonwealth of Virginia for all the NAAQS are codified at 40 CFR 81.347; the Hampton Roads Area is in attainment for all the NAAQS standards (USEPA 2015).

The Commonwealth of Virginia has maintained a network of air monitoring stations in Virginia since 1980 and the ROI falls within the Air Quality Control Region 6 (AQCR 6)[4] as defined in 9 VAC5-20-200 as the Hampton Roads Intrastate Air Quality Control region (VDEQ 2015). The long-term air quality trends since 2004 for all criteria pollutants demonstrate decreasing ambient concentrations (VDEQ 2015).

2.14 Climate Change

The ROI for the climate change and sea level rise analysis is limited to the waters of the Norfolk Harbor as well as the shorelines and adjacent upland areas proximate to the proposed navigation improvements and dredged material placement/disposal sites.

Climate change and global warming have been observed during the 20th and 21st centuries and have resulted in changes in localized sea levels. The 2014 Intergovernmental Panel on Climate Change (IPCC) report states that over the period of 1901 to 2010, the global mean sea level rose by 0.62 feet (IPCC 2014). Data from the Sewells Point tidal gauge indicate that Hampton Roads has experienced an increase of 1.15 feet of relative sea level rise between 1927 and 2006 (HRTPO 2013). Subsidence is responsible for more than half (53%) of the measured relative sea level rise in the Chesapeake Bay area (HRPDC 2011). Sea level rise due to climate change is now the dominant factor in relative sea level rise whereas as only 2.10 mm/yr of the present rate of sea level rise of 4.85 mm/ is due to subsidence (Schulte et al. 2015).

[4] The area consists of the cities of Chesapeake, Franklin, Hampton, Newport News, Norfolk, Poquoson, Portsmouth, Suffolk, Virginia Beach, and Williamsburg, and the counties of Isle of Wight, James City, Southampton, and York, Virginia.

The U.S. National Climate Assessment (2012) has established a range of global sea level rise predictions for the year 2100 that all predict sea level rise and range in the predicted value from 0.7 feet on the low end to 6.6 feet as a high prediction with intermediate values between the extremes (U.S. National Climate Assessment 2012).

The IPCC also predicts local sea level rise, addressing the localized factors of subsidence and oceanic currents at any particular location. Changes to relative sea level can result from a number of factors including isostatic rebound (a process by which the earth's crust, having been compressed beneath the weight of glaciers, bounces back), faulting and consolidation of sediments in fill structures, and sediment compression caused by groundwater withdrawals (Boon 2010). Oceanic currents influence local sea level rise on the Atlantic Coast due to temperature and salinity changes in the Atlantic Ocean, which cause pressure gradients between the Gulf Stream and coastal waters to decrease, which then cause coastal waters to rise (Sallenger et al. 2012). As a result of these factors, local, relative sea level rise (RSLR) on the mid-Atlantic Coast of the United States from North Carolina northward is occurring at approximately twice the global mean rate, and the rate of sea level rise is accelerating both globally and locally. The USACE engineering documents require that planning studies and engineering designs evaluate the entire range of possible future rates of sea-level change, represented by three scenarios of "low", "intermediate", and "high" sea-level change (USACE 2013; USACE 2014) (See Section 5.10). The use of sea level change scenarios as opposed to individual scenario probabilities underscores the uncertainty in how local relative sea levels will actually play out into the future. At any location, changes in local relative sea level reflect the integrated effects of global mean sea level change plus local or regional changes in geologic, oceanographic, or atmospheric origin. The local rate, determined by the USACE, using the Sewells Point tide gauge, which is within the project ROI and has been operating for 80 years, was determined using the USACE sea level rise predictor (USACE 2017), and the results can be seen in Figure 2-33.

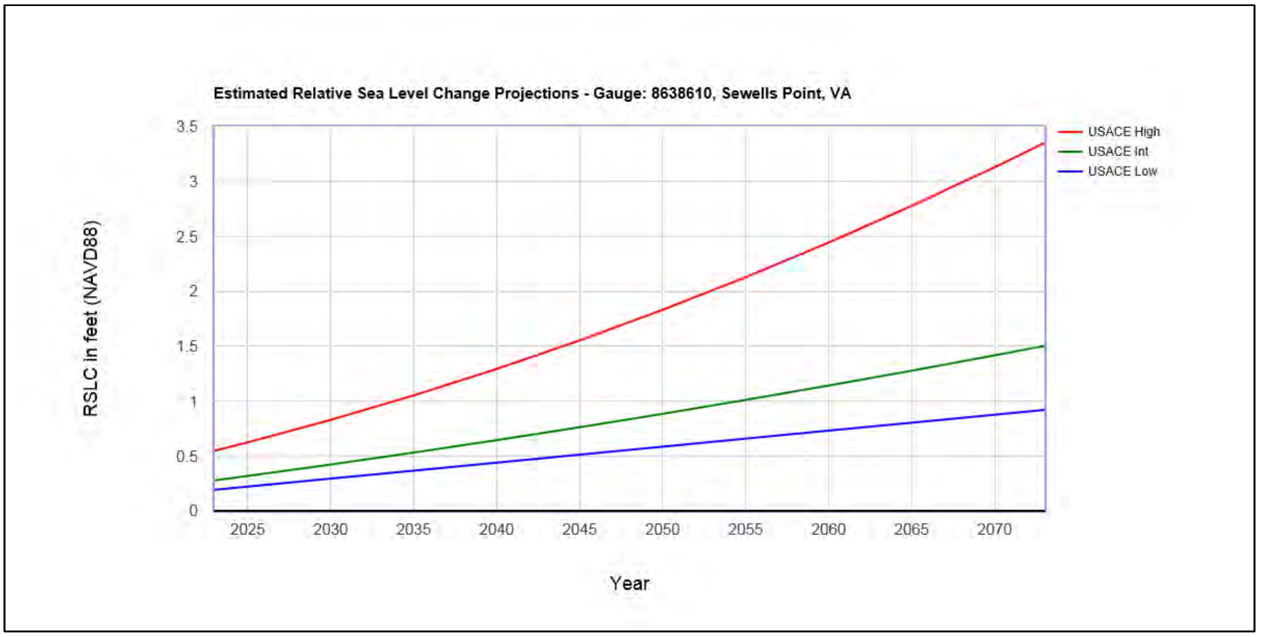

Figure 2-33: Relative Sea Level Rise in the project ROI, lower Chesapeake Bay.

An increase in storm surge events is another issue related to climate change because the IPCC predicts an increase in the intensity of hurricanes, which increases wind speed and precipitation, leading to flooding and property damage (IPCC, 2014). Hampton Roads is also prone to significant storm surges roughly every four to five years, which could increase in frequency due to the effects of climate change (HRTPO 2013).

In 2013, the USACE published Engineering Technical Letter 1100-2-1, “Procedures to Evaluate Sea Level Change: Impacts, Responses, and Adaptation” (USACE 2014) and Engineering Regulation ER-1100-2-8162, “Incorporating Sea Level Change into Civil Works Programs” (USACE 2013), which provide guidance to the USACE for how to incorporate sea level change for civil works projects.

2.15 Floodplains

Through Executive Order (EO) 11988, Federal agencies are required to evaluate all proposed actions within the 1% annual chance (100-year) floodplain. Actions include any Federal activity involving 1) acquiring, managing, and disposing of Federal land and facilities, 2) providing Federally undertaken, financed, or assisted construction and improvements, and 3) conducting Federal activities and programs affecting land use, including, but not limited to, water and related land resources planning, and licensing activities. In addition, the 0.2% annual chance (500-year) floodplain should be evaluated for critical actions or facilities, such as storage of hazardous materials or construction of a hospital. The EO provides an eight-step process to evaluate activities in the floodplain that generally includes 1) determine if the proposed action is in the floodplain, 2) provide public review, 3) identify and evaluate practicable alternatives to locating in the 1% annual chance floodplain, 4) identify the impacts of the proposed action, 5) minimize threats to life and property and to natural and beneficial floodplain values and restore and preserve natural and beneficial floodplain values, 6) reevaluate alternatives, 7) issue findings and a public explanation, and 8) implement the action. Proposed actions may have limited impacts such that the eight-step process may vary or be reduced in application, which is the case for this project.

Craney Island Dredged Material Management Area construction was initiated in August 1954 and completed in January 1957, to hold approximately 96 MCY of dredged material, with an expected useful life of 20 years. By 2010, Craney Island had received more than 253 MCY of dredged material. The 2,500 acre facility has a primary perimeter containment dike approximately eight miles in length and two division dikes that divide the site into three sub-containment areas. From east to west, the average distance within a containment area is approximately 1.8 miles, and approximately 0.5 miles from north to south. The drainage area within each containment area is approximately one square mile. The top of dike elevations currently range from approximately +30 to +45 feet, referenced to the North American Vertical Datum of 1988 (NAVD88). The USACE is also in the process of raising the dikes to approximately +40 to +50 feet, NAVD88. By using best management practices, such as spillways, annual rotation of sub-containment cells, more active dewatering by increased ditching, raising and stepping-in dikes, and the installation of vertical plastic drip drains, maximum future dike elevations under existing foundation strengths are expected to range from approximately +50 to +55 feet, NAVD88.

Typically, a single containment area is active for one year while the two inactive areas are extensively managed for water removal. On the west side of the facility, each containment area has two primary spillways, each with four, 36-inch diameter outlet pipes. The east side is higher in elevation, where material flows downslope to the west, depositing the heaviest particles first.

The spillways allow the release of water after the sediments have settled out. In general, under typical pumping operations, it can take up to five days to reach a working pool level with three feet of freeboard. Spillway stop-logs (boards) are used to control water levels during pumping operations. Current maximum depth within a containment area, from the top of the dike to the interior ground, is approximately seven feet on the west side and gradually decreases moving to the east dikes. Looking at a typical cross section of the dike, the distance from the centerline of the top of the dike to the exterior toe can range from over 200 feet for the west dike, 150 feet for the north, and 100 feet for the east and south dikes. The top width of the dike is generally around 40 feet.

Craney Island is bounded by water on the west and north sides by the Hampton Roads Harbor, on the east by the Elizabeth River, and on the south side by the U.S. Naval Supply Center and a residential neighborhood within the City of Portsmouth. On the west, north, and east sides, the distance from the top of dike to the edge of water generally ranges from 300 to 600 feet. On the south side, the closest residence is over 400 feet in distance and the U.S. Naval Supply Center tanks are approximately 2,000 feet.

2.16 Noise and Vibration

Noise and vibration is often defined as any sound that is undesirable because it interferes with communication, is intense enough to damage hearing, or diminishes the quality of the environment. Response to noise varies by the type and characteristics of the noise source; distance from the source; receptor sensitivity; and time of day. Noise can be intermittent or continuous, steady or impulsive, and it may be generated by either mobile or stationary sources, and changes in noise are typically measured and reported using a weighted sound intensity (or level), which represents sound heard by the human ear and is measured in units called decibels (dBA). The ROI includes the navigation channels dredged, dredged material placement/disposal areas, and the transit of dredging vessels through the project area. The geographic extent of noise impacts is dependent upon factors such as the type of dredging equipment, length of time spent dredging, and environmental conditions such as wind speed and direction.

Noise monitoring conducted during dredged material placement/disposal activities (i.e., from dredged material pumping) at the CIDMMA (USACE 2006) showed that during operational hours, noise levels within the material placement areas ranged from 43 dBA to 68 dBA. When dredging activities ceased for the day, noise levels dropped to a range of 35 dBA to 60 dBA (USACE 2006), indicating a relatively small contribution to ambient noise from dredged material pumping. Similar noise monitoring throughout the residential communities surrounding the CIDMMA site showed that noise levels were affected by routine road/street traffic with the highest daily levels corresponding to typical peak travel times in the morning, noon, and evening (USACE 2006).

The most likely dredges to be employed for the deepening and widening of channels for the Norfolk Harbor Navigation Improvements project could likely be hydraulic pipeline, hopper, or bucket dredges. Sound production is largely influenced by sediment properties – to excavate hard, cohesive and consolidated soils, the dredger must apply greater force to dislodge the material (Robinson et al. 2011) Sound from dredges can be variable, depending on the phase of operation, and the type of dredge used, but typically occur at low frequencies (<500) (Reine et al. 2014). The following sections describe sound from the types of dredges that have the potential to be used for this navigation project.

Hydraulic pipeline cutterhead dredges are commonly used throughout the U.S. for both new work and maintenance dredging operations. They are capable of removing most types of material and pumping the slurry through pipelines for several miles or longer with the use of booster pumps. The major processes contributing to hydraulic dredging sounds include:

1. Dredged material collection sounds originating from the rotating cutterhead in contact with the bed and intake of the sediment-water slurry,
2. Sounds generated by pumps and impellers driving the suction of material through the pipes,
3. Transport sounds involving the movement of sediment through the pipes, and
4. Ship and machinery sounds, including those associated with the lowering and lifting of spuds and moving of anchors by dredge tenders (Reine et al 2012)

In a study by Clarke (2002), cutterhead sounds peaked at 100-110 dB in the frequency range of 70-1,000 Hz and were inaudible at approximately 500 meters from the source.

Hopper dredges hydraulically remove sediment from the seafloor through dragheads. Sediment is sucked upward through a pipe by means of centrifugal pumps, and the slurry is transferred to the hopper bin. Much of the sound is associated with propeller and engine noise with additional sounds emanating from pumps and generators. Similar to the cutterhead suction dredge, hopper dredges produce noise ranging from 70 to 1,000 Hz with peaks at 120 to 140 dB (Clarke et al. 2002, unpublished). Robinson et al. (2011) carried out an extensive study of the noise generated by a number of trailing suction hopper dredges during marine aggregate extraction. Source levels of the vessels were estimated and an investigation undertaken into the origin of the noise. Source levels at frequencies below 500 Hz were generally in line with those expected for a cargo ship traveling at modest speed. In a study of hopper dredge noise on a sand shoal, Reine et al. (2014) found that source levels peaked at 178.7 db re 1uPa at one meter.

Bucket dredges produce a repetitive sequence of sounds generated by winches, bucket impact with the substrate, bucket closing, and bucket emptying. The noise generated from a mechanical dredge entails lowering the open bucket through the water column, closing the bucket after impact on the bottom, lifting the closed bucket up through the water column, and emptying the bucket into an adjacent barge. Once the barge is full, it would be towed by a tug to an approved disposal or placement site. The maximum noise spike with mechanical dredges occurs when the bucket hits the bottom. All other noises from this operation (i.e., winch motor, spuds, etc.) are minimal. Clark et al. (2002) found that the sound of a bucket impact with the substrate was at the limit of detection by a low-noise hydrophone and hydrophone audio amplifier at seven kilometers from the impact point.

2.16.1 Ambient Noise in Norfolk Harbor

Ambient noise is the all-encompassing sound associated with a given environment at a specified time. Humans hear sound from 0-140 dB, and sound above this threshold is associated with pain. There are several sources of ambient noise within the ROI for Norfolk Harbor, which can be attributed to both natural (wind waves, fish, tidal currents, mammals) and anthropogenic (commercial and recreational ships/vessels, dredging, pile driving, etc.) inputs. The ROI is a working waterway with adjacent land use characterized largely by industrial, commercial, and military uses. In fiscal year 2015, 38 ships (non-Navy) a week called at the Port of Virginia, importing and exporting containers to and from all corners of the world; 63%

was moved to and from the port by trucks and 33% was moved by train (POV 2015). The Norfolk Harbor hosts the world's largest naval station (NPS 2015) and three airports are within 15 miles (Norfolk International Airport, Chamber's Field, and Langley Air Force Base). Noise sources for vessels include cranes, whistles, and various motors for propulsion, while adjacent dockside noise sources include cranes, trucks, cars, and loading and unloading equipment. Ship traffic, including ships transiting the study area can generate sounds ranging from 10 to 1,000 Hz.

Within the Hampton Roads Crossing Study Final EIS (FHA 2001), the FHA characterized the existing noise conditions by collecting data at sample locations adjacent to the proposed highway work as shown in Figure 2-34. The highway and local street traffic represented the dominant sources of existing noise in the Hampton Roads study corridors. Within the study area, the loudest anthropogenic noise input can reach 120 dBA (Figure 2-34), which is caused by low flying jet aircraft; this is intermittent and depends largely on wind direction, time of day, and occurs in specific areas, where jet take offs and landings occur (FHA 2001).

In addition to noise and vibrational inputs attributed to Norfolk Harbor being a bustling commercial, industrial, and military center, the potential areas affected by noise and vibration include expanses of parks, open spaces, and greenways, as well as residential areas. These areas are considered to be sensitive noise receptors, or areas where human activity may be adversely affected by excess noise inputs (NYC DEP n.d.). These receptors include, but are not limited to schools, churches, cemeteries, homes, golf courses, and parks/playgrounds. Sensitive noise receptors are located in areas that generally have lower ambient noise levels, which can range anywhere from 40 dBA (quiet suburban area at night) to 70 dBA (in typical urban areas, i.e. downtown Norfolk) (NYC DEP n.d.) (Table 2-19).

While some anthropogenic underwater noise is produced intentionally (e.g., naval sonar, echosounders), most noise sources are an incidental by-product of human activity (e.g., shipping, construction) (Farcas et al. 2016). For underwater environments, ambient noise includes tides, currents, and waves, as well as noise produced by marine mammals, fish, invertebrates, and by humans. Low frequency noise levels such as these tend to carry long distances in the water but are attenuated the farther away one is from the source (Navy 2009). Appendix H (Essential Fish Habitat) has a further characterization of the underwater noise environment in the ROI.

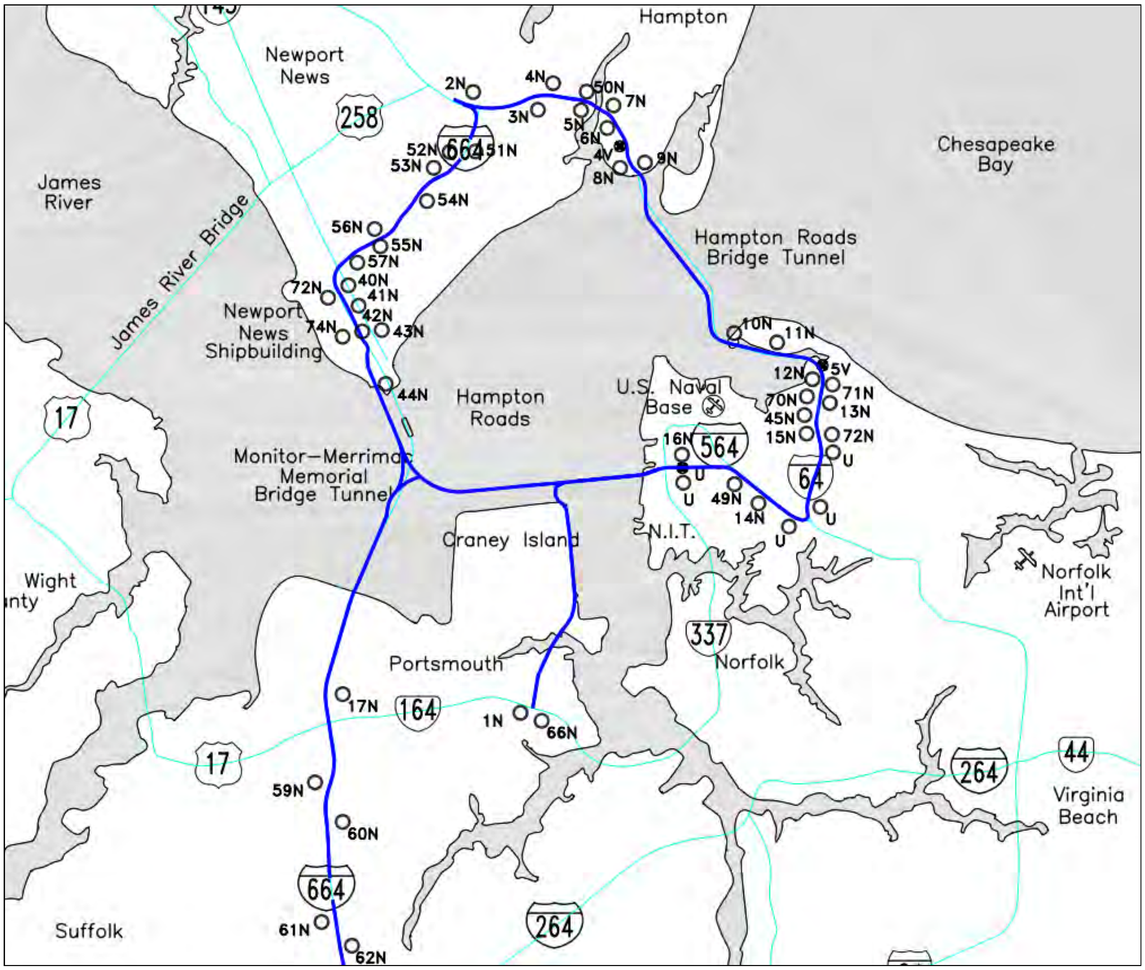

Figure 2-34: Hampton Roads Crossing Study Noise and Vibration Measurement Sites (FHA 2001).

Table 2-19: Displays a comparison of noise levels for various sound sources (USDOT n.d.)

Noise level (dBA)	Extremes	Home Appliances	Speech at 3 ft	Motor Vehicles at 50 ft	Railroad Operations at 100 ft	General Type of Community Environment
120	Jet Aircraft at 500ft.					
110–100				Sirens	Horns	
100–90				Diesel Truck (Not Muffled)	Locomotive	
90–80		Shop Tools	Shout	Diesel Truck (Muffled)	Rail Cars at 50 mph	
80–70		Blender	Loud Voice	Automobile at 70 mph	Loco Idling	Major Metropolis (Daytime)
70–60		Dishwasher	Normal Voice	Automobile at 40 mph		Urban (Daytime)
60–50		Air Conditioner	Normal Voice (Back to Listener)	Automobile at 20 mph		Suburban (Daytime)
50–40		Refrigerator				Rural (Daytime)
30						
20						
10						
0	Threshold of Hearing					

2.17 Occupational Health and Safety

The occupational health and safety (OSH) environment in the ROI of this project would be in the work of navigating to dredging sites and dredged material placement/disposal sites, dredging operations to deepen and widen channels, deepen Anchorage F, and placing the dredged materials at placement/disposal sites. Risk factors in this OSH environment include operation of heavy equipment, potential exposure to hazardous materials in the dredged material and water, and navigational hazards (American National Standards Institute 2011).

Norfolk District's Operations Branch recorded the number of man-hours of dredging contractor operations and the number of OSHA reportable accidents for six years spanning FY11-FY16 (it does not include dredging by other USACE Districts on Norfolk projects). They also recorded the number of days labor lost due to accidents, and days of restricted duty due to accidents. These are summarized in Table 2-20 below along with the rate of accidents per 10,000 operating hours.

Table 2-20: Rate of Accidents per 10,000 Operating Hours.

Year	Hours	Accidents	Days Lost	Restricted duty	Accidents/10,000 hrs.
FY11	297364.5	1	no data	no data	0.03
FY12	106012.5	1	0	19	0.09
FY13	198186	5	17	4	0.25
FY14	188801.5	0	0	0	0.00
FY15	108272.9	1	31	0	0.09
FY16	154432	1	0	3	0.06
Total	1053069	9	48	26	0.09

Phases of work each have their own set of potential hazards. Dredging projects involve the following phases of work:

- Mobilization
- Hydrographic surveying
- Hauling gear maintenance and cable replacement
- Hazards to navigation
- Pipeline installation
- Dredging
- Trip wire replacement
- Disposal site activities
- Severe weather precautions
- Demobilization

Contractors are required to prepare an Accident Prevention Plan (APP) for review by USACE safety staff prior to begin given notice to proceed with work (U.S. Army Corps of Engineers. EM-385-1-1). The APP specifies the safety and occupational health plan, responsible personnel and their OSHA certifications, safety training for all personnel, protective equipment, Clothing and Personal Protective Equipment (PPE) are typically required for workers. PPE includes:

- Appropriate clothing for weather conditions;
- Steel toed boots;
- Hard hat;
- Protective eyeware matched to work type (e.g., cutting or welding);
- Work vest/personal floatation device; and
- Hearing protection if exposed to various decibel levels for a scale of time periods.

Safety hazards in dredging operations are evident in a USACE safety checklist for dredges. Safety concerns include food safety, personal hygiene, vermin, first aid and emergency medical care, eye injuries, water safety, fire hazards, electrical hazards, slip and fall hazards, and equipment hazards. There are a total of 40 items on the checklist (USACE, 2009).

Bureau of Labor Statistics data on reported nonfatal occupational injuries tabulates the rate of cases reported for 100 workers over a year (200,000 hours). Separate statistics for dredging are not available, but the rate for heavy and civil engineering construction, where dredging would be placed, was 3.0. In comparison, the rate for all industries was 3.4, with securities brokerage at 0.02 the low and the highest was air transport with 7.5 (Bureau of Labor Statistics, 2015).

Specific to USACE and contracted dredging operations, in a 12 month period throughout the USACE, there were seven serious accidents on contractor and USACE marine operations; these included three fatalities and two disabling injuries (Anderson, 2016).

The fatalities were:

- A cook fell overboard while dumping garbage and drowned. The cook was not wearing a floatation vest, and was not required to as are deck hands.
- A crew member who had not reported for work, but whose vehicle was in the parking lot, was found dead under the gangway.
- A crew member was lost when a vessel overturned during anchor handling.

The disabling injuries were:

- A dredge worker lost a finger when repositioning pipe, which had been nudged by a tender.
- A dredge worker lost his left leg below knee when caught in line and pulled into a block when lowering a pipeline connection.

The following work injuries were reported during Norfolk District dredging operations from Fiscal Year 2009 through Fiscal Year 2015:

- 2009 - One lost work day injury case, March - Worker slipped and fell into water while trying to unhook a pipeline
- 2010 - One lost work day injury case, November - Worker was struck by section of pipeline that had shifted (James River/Richmond Dredging)

2011 – One accident, Norfolk Harbor

- 2012 - Three reportable lost or restricted work day injury cases (total two days lost and seven days restricted duty), May, June, and June, - one worker sprained wrist when fell in galley when vessel was struck by large swell, one worker cut fingers while attempting to attach a dragline pipe to a front end loader, one worker pinched fingers while trying to use a wrench to close a leaking valve (all on Wallops Island Dredging project). There was also one contractor accident on dredging the Tangier Island Channel resulting in 19 restricted duty days.

- 2013 - Three reportable lost or restricted work day injury cases (total six days lost and 25 days restricted duty), January, February, and April, one worker cut hand while opening hatchway, one worker twisted ankle when stepped in hole in wooden deck mat, one worker was dragged overboard by rope attached to pipeline (two injuries on Norfolk Harbor project and one injury on Sandbridge Dredging project). There were also two accidents on the Virginia Beach Nourishment project, but these did not result in any lost time.

2014 - No reported injuries

- 2015 - One lost work day injury case (20+ lost days), August, - Worker was struck by swing anchor on tender vessel deck and knocked overboard (James River Dredging project).

2.17.1 Munitions of Explosive Concern/Unexploded Ordnance Safety

Contract requirements are added to USACE dredging contracts where Munitions of Explosive Concern/Unexploded Ordnance (MEC/UXO) might be encountered during dredging activities. This involves safety support and avoidance of potential unexploded ordnance and exploded ordnance, inert ordnance, and ordnance fragments and similar explosives debris material (defined and identified in these specifications as "Munitions and Explosives of Concern"(MEC), within the dredging area during performance of dredging activities. Various sizes of munitions, both live and inert may be encountered in former coastal artillery ranges of Fort Story, Fort Monroe, and Fort Wool. Additionally, the Coast Artillery command of the US Army maintained remotely operated defensive minefields during World War II, and German U-Boats laid offensive magnetic mines around the channel near Cape Henry.

The contract for the Thimble Shoal and Cape Henry Maintenance Dredging project required the contractor to develop a MEC Safety and Work plan. Parts of the dredging areas for this project were within the Fort Story Inner Coastal Defense Range. Elements of the MEC Safety and Work plan included; a) a dredge intake screening device that would prevent passage of any material greater than 1.25 inches in diameter, although the openings could have another dimension up to 6 inches; b) screening devices would be made of rugged steel or composite material, one-piece or welded members, and constructed to cover the entire area where installed; c) screening devices would be removable for easy replacement if damaged; d) finally the contractor would maintain adequate replacement parts and/or additional screening to insure production for the work does not stop due to damaged screens. Additionally, a Government provided Ordnance and Explosives Safety Specialist (OESS) was to provide pre-dredging MEC safety training on the dredge prior to the commencement of dredging activities. In the event MEC was identified, the contractor’s personnel were to leave the vicinity, contact Navy Explosive Ordnance Disposal, and notify the Contracting Officer’s Representative.

The waters of the project area have been the scene of naval warfare in conflicts since the 17th century. Explosive shells, although first used in Western warfare as far back as the 15th century, did not become commonly used until the 19th century. The first year of the Civil War saw activity by warships and shore batteries around Hampton Roads and the Elizabeth River, but these amounted to shore batteries or gunboats firing a few, mostly short, rounds at each other until the Battle of Hampton Roads. This famous first duel of ironclad warships began with the CSS Virginia (Merrimack) and a few Confederate gunboats launching attacks on the blockading Union fleet, sinking two major warships and damaging a third. Returning the next day the USS Monitor was waiting for the Virginia, and a day long battle between the two slugging it out with hundreds of rounds ensued. Also in the fray were the guns of other Union and Confederate vessels and shore batteries of the Union.

Although no warfare in the Spanish American War took place, coast artillery installations at Fort Monroe and Fort Wool practiced their gunnery leaving many rounds on the bottom of the Chesapeake Bay, and a large area there is currently designated as part of the Military Munitions Response Program. World War I gave incentive to bolster these defenses. Sinking of merchant ships along the Eastern Seaboard happened during World War I, but there were no recorded sightings of U-Boats in or near the Chesapeake Bay. U-boats are known to have laid mines off New York where ships struck mines, and may have off the Chesapeake Bay, but no sinking or mines were reported in Virginia. This would be much different during World War II.

Although the United States stayed out of the conflict in Europe for more than two years, even Isolationists did not object to bolstering coastal defenses. Massive new guns, up to 16 inches in bore, were mounted at Cape Henry and Cape Charles (McGovern 2008). The firing arcs of these batteries may hold many unexploded shells on the seafloor. Although the batteries were never brought to bear on enemy ships, practice firings were carried out. Also falling under the U.S. Army Coastal Defense Command were defensive minefields. These were armed remotely, from bunkers with switchboards. Once armed the ‘horned mines’ were set off by contact with a ship’s hull, although they could also be directly detonated from the control bunkers. There were several mine fields at the entrance to Chesapeake Bay and the approaches to Hampton Roads. Altogether there were some 800 mines deployed. Distressingly, in the process of planting, maintaining, and removing the mines some 218 were lost (Albright 2013). These buoyant mines were anchored to the bottom, but if their cables were broken, or they lost buoyancy they could drift or sink anywhere.

Germany wasted no time in dispatching U-boats to the American coast after declaring war on the U.S. in December 1941. By the winter of 1942 scores of ships were being sunk by the German submarine fleet along American shores. In June of 1942 U-701 included the laying of magnetic mines in its patrol off the coast of Virginia and North Carolina (U-Boats.net 2012). The U-boat laid 15 of these mines in a winding line along the shipping lane, and centered just off Cape Henry. Five ships struck the mines, with two sunk, the others badly damaged. Three of the mines were detonated by minesweepers, and one may have been set off during a depth charge attack on a false contact by American destroyers (Blair 1996). The other four or five remain unaccounted for. Note C on NOAA Chart No. 12222 (NOAA 2009) warns mariners: “Danger Area, Area is open to unrestricted surface navigation but all vessels are cautioned neither to anchor, dredge, trawl, lay cables, bottom, nor conduct any other similar type of operation because of residual danger from mines on the bottom.” In the summer of 1943 U-566 laid 12 magnetic mines off Cape Charles (Shomette 2007). None of these are known to have been set off ships, or swept, and remain unaccounted for.

Failed attacks by U-boats may have left undetonated torpedoes, and counter attacks by anti-submarine vessels may have left depth charges off the mouth of Chesapeake Bay. On July 23, 1965 the trawler *Snoopy* was dredging for sea scallops 58 miles southeast of the entrance to the AOC. On retrieving the port trawl a torpedo was found to be lodged in the device. While attempting to dislodge the torpedo, the weapon exploded, completely destroying the *Snoopy* and killing eight of her crew (U.S. District Court, 1967). Even in peacetime, ordnance has been lost in an area busy with warships. Chart No. 12222 notes unexploded depth charges a mile off Chicks Beach, Virginia from April 1956, and explosives lost in Hampton Roads in 1962 near Anchorage F.

2.18 Utilities

The ROI for utilities is the navigation channels, Anchorage F, and dredged material placement/disposal sites during the construction and maintenance phases of the project lifecycle. Nautical charts and previous USACE dredging project plans were reviewed to identify utilities within the study area that could be impacted by the project.

City of Norfolk Utility Crossings

This is the shallowest of the utility crossings in the ROI (City of Norfolk Raw Water) and is located at -60 feet MLW, which is 5 feet below the study dredge of -55 feet MLLW (Plate 5 of Appendix A). There are also four sanitary sewer outfalls within the project area that are outside the limit of disturbance for the increased width of the channel at top of cut resulting from a deeper channel.

U.S. Navy DeGaussing Range at Sewell's Point (Magnetic Silencing Facility)

This Magnetic Silencing Facility or DeGaussing Range is located within the Norfolk Harbor Entrance Channel reach. The Norfolk District has documented the potential need for the United States Navy (Navy) to relocate the Degaussing Range at a deeper depth to accommodate the future channel deepening. During the 50 Foot Outbound Channel deepening during (1987-1989), the USN relocated the Degaussing Range to its present location (at -57 feet) in the Norfolk Harbor Entrance Reach to accommodate the 50 foot deepened channel. This relocation upgrade was completed in 2006 by the Navy for $3.2 million. The current permit conditions for NAO-2005-5012 stipulates the Navy would relocate the range as necessary to accommodate future channel deepenings.

MAREA and BRUSA Fiber Optic Utility Lines

MAREA (Figure 2-35), a 6,605 km transatlantic subsea fiber optic cable system, which traverses the Atlantic Ocean with a single segment between Virginia Beach, Virginia and Bilbao, Spain has been approved by the Federal Communications Commission. The cable will consist of eight optical fiber pairs, with a total design capacity of 20 Terabytes per second (Tbps) per fiber pair.

The cable is buried one meter under bottom depth east for 66 nautical miles, to the limit of the outer continental shelf. It lays along the sea floor east to Bilbao, Spain. In the ROI, it is installed south of the AOC near the Chesapeake Bay buoy. It crosses through the center of the dredged material placement site, DNODS, under containment cell two and five and remains buried 1.5 meters below existing grade.

The proposed BRUSA Fiber Optic Cable, an 11,000 km line will connect Rio de Janeiro, Brazil to Virginia Beach, Virginia. As it nears the Virginia coast, it follows the MAREA footprint (the lines are separated by a distance of approximately 15 feet). It has already also been approved by the Federal Communications Commission, but will not be fully operational until 2018. This cable will cross over the center of DNODS under containment cell two and five and will be buried 1.5 meters below existing grade.

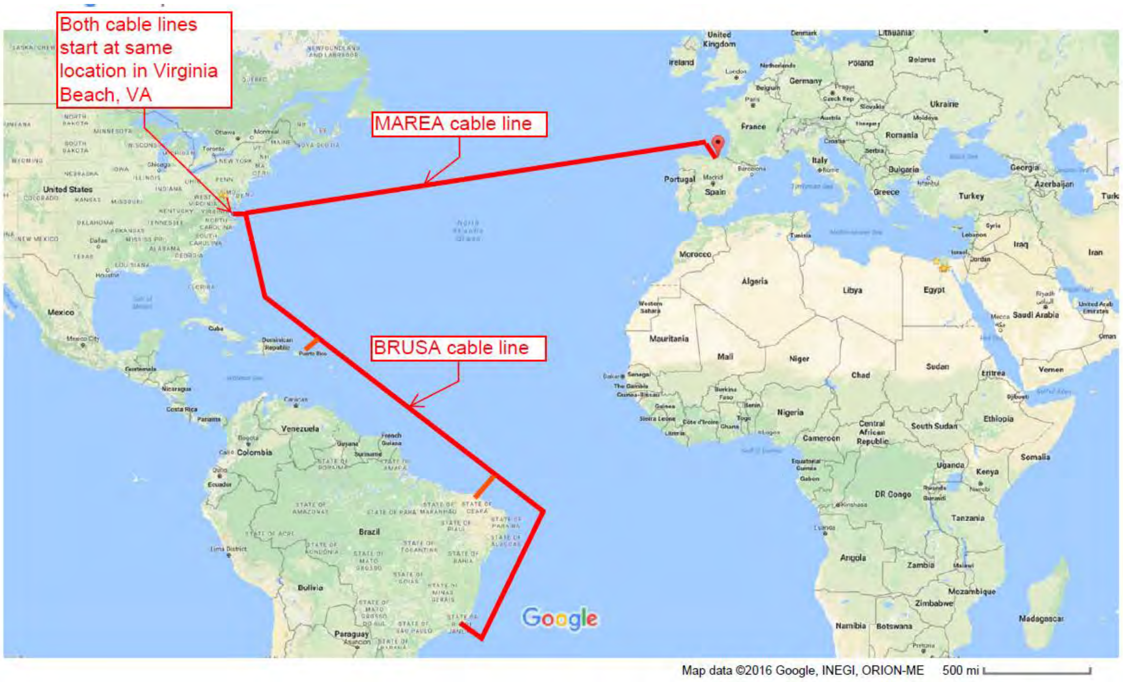

Figure 2-35: Location map of MAREA and BRUSA

2.19 Cultural Resources

Under NEPA, cultural resources include historic properties as defined under Section 106 of the National Historic Preservation Act (NHPA). Cultural resources considered in this section are those defined by the NHPA as historic properties listed in or eligible for listing in the National Register of Historic Places (NRHP). Historic properties eligible for listing in the NRHP include prehistoric and historic sites, structures, buildings, objects, districts, or any other physical evidence of human activity associated: a) with important historic events, b) with persons important in history, c) representing the work of a master or exemplary as a type, or d) have or may yield information important to history or prehistory. Section 106 of the NHPA and its implementing regulations, 36 CFR Part 800, requires the lead Federal agency, in this case the USACE, to assess the potential effects of an undertaking on historic properties that are within the proposed project's Area of Potential Effect (APE), which is defined as "the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist" (36 C.F.R. § 800.16[d]). The lead Federal agency consults with the State Historic Preservation Officer (SHPO) who acts on behalf of the Advisory Council on Historic Preservation (ACHP) to identify historic properties affected, determine whether the effects are adverse, and resolve the adverse effects. The ACHP may participate in the resolution of adverse effects, or if there is any disagreement between the lead agency and the SHPO.

Several other Federal laws may be applicable to cultural resources considered in the NEPA process, including the Archaeological and Historic Preservation Act of 1974, the American Indian Religious Freedom Act of 1978, the Archaeological Resources Protection Act of 1979, the Abandoned Shipwreck Act of 1987, the Native American Graves Protection and Repatriation Act of 1990, and the Sunken Military Craft Act of 2004. Shipwreck sites are protected under the Abandoned Shipwreck Act of 1987 (Public Law 100-298; 43 U.S.C. 2101-2106). This act transferred title of abandoned shipwrecks on state lands to the states. The act has provisions for protection of historic shipwrecks, and compliance with the Archaeological Resources Protection Act of 1979. Additionally, the Sunken Military Craft Act of 2004 protects sunken vessels and aircraft of the U.S. military worldwide, as well as foreign military craft within U.S. waters, regardless of NRHP status. Sunken military craft remain the property of the U.S. government rather than the states.

The APE or ROI for direct physical effects to cultural resources of this project has been defined as areas where dredging might take place and areas where dredged materials might be placed/disposed. The visual ROI (sometimes referred to as indirect APE) has been defined as areas within one mile of construction activities. Notably, the APE for this project is not the same as the Federal channel, as some parts of the Federal channels are naturally deeper than the project depth.

Known and anticipated archaeological resources of potential NRHP eligibility in the direct APE are likely to be limited to shipwreck sites. Although the existence of submerged terrestrial sites from the Pleistocene and early Holocene epochs is possible, methods are lacking for identifying and evaluating such sites. Existing information on shipwrecks has been gathered from the Virginia Department of Historic Resources (DHR) databases, NOAA data bases, and the database on military shipwreck of the Naval History and Heritage Command's Underwater Archaeology Branch. NRHP listed or eligible properties in DHR's database are shown in Figures 2-36 through 2-40, and listed in Table 2-21 In addition to these, the Captain John Smith Chesapeake National Historic Trail passes through the project area from around the CBBT.

There are 22 NRHP listed or eligible historic properties within about a mile of the project area, although none are east of Old Point Comfort. Included in these is Fort Monroe (at Old Point Comfort), long listed as a National Historic Landmark, it has recently been elevated to National Monument status, the highest Federal level for a cultural or natural site. The project construction area runs through two overlapping Civil War battlefields, marking the Battle of Sewells Point the Battle of Hampton Roads. Although not well known, the Battle of Sewells Point was one of the first engagements of the war by the Union Navy when gunboats fired on the Confederate batteries at Sewells Point on May 18, 1861. Much better known, the Battle of Hampton Roads was the first fight between armored warships, and the first battle fought by a ship with a revolving gun turret when the USS *Monitor* and CSS *Virginia* (*Merrimac*) faced off on March 9, 1862. The Monitor came a day late to save the USS *Cumberland*, sunk by the CSS *Virginia* the day before.

The wreck of the *Cumberland*, in the authorized Federal channel area, is listed in the NRHP as an archaeological site. Also in the Federally authorized channel and listed in the NRHP is the wreck of the Confederate cruiser CSS *Florida*. The *Florida* was captured by Union vessels while in Brazilian waters and brought back to Hampton Roads where she was anchored as Brazil litigated to claim the vessel, being a neutral country in the war. As Brazil proceeded with its claims, a Union transport ship collided with *Florida*, and sent her to the bottom. Both the Cumberland and the Florida are at depths below -50 feet, and thus in an area that has not been dredged. This area is up river of the Newport News coal piers, where deeper navigation is not needed. Other notable properties on the list include the Chamberlin Hotel, Newport News Middle Ground Lighthouse, Fort Wool, and the Naval Supply Depot Historic District. A third shipwreck, recently identified during Naval History and Heritage Command investigations of the *USS Cumberland*, 44NN0335, is an unidentified steel hulled vessel. Although it has not been evaluated for NRHP eligibility, it seems to have potential for eligibility as sonar imagery shows an intact hull. It is in the Federally authorized channel but at a depth of -65 feet or more, so the location has not been dredged. Locations of the three shipwreck archaeological sites are not shown on the mapping in this public document, in compliance with the Archaeological Resources Protection Act, Section 9.

In addition to these, the Captain John Smith Chesapeake National Historic Trail passes through the project area from around the Chesapeake Bay Bridge Tunnel to Hampton Roads, and into the Elizabeth River. The trails consists of land based information centers, water access points, and radio transmitter buoys. None of these assets are within the project area. Although the Keeper of the National Register of Historic Places has opined that some sections of the trail are NRHP eligible, it is unlikely that the cultural landscape, urban and developed, in the project area would support this. Effects would be limited to the presence of dredges during construction, with no lasting effects to the viewshed.

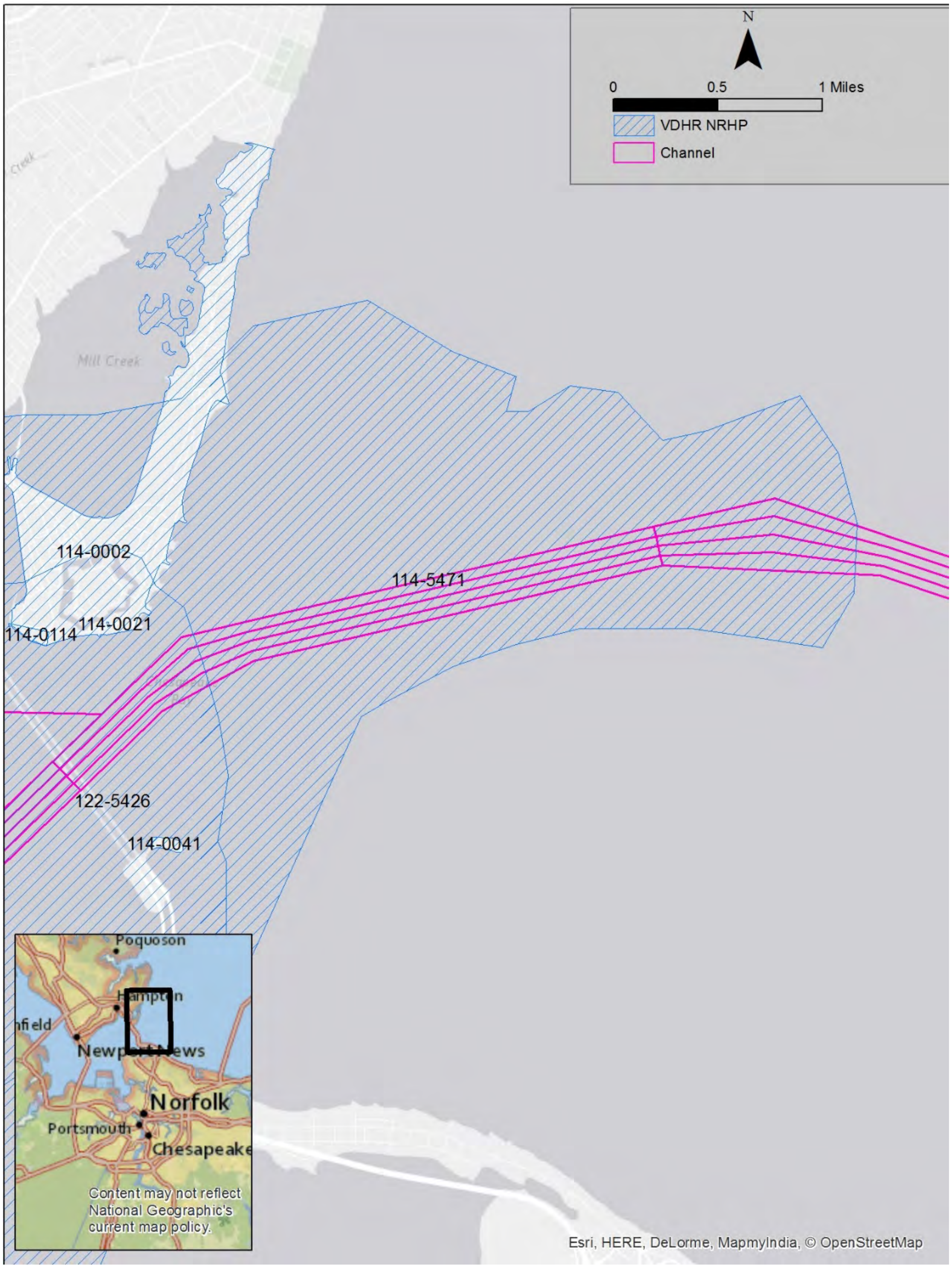

Figure 2-36: Historic Properties within about One Mile of the Project Area, East

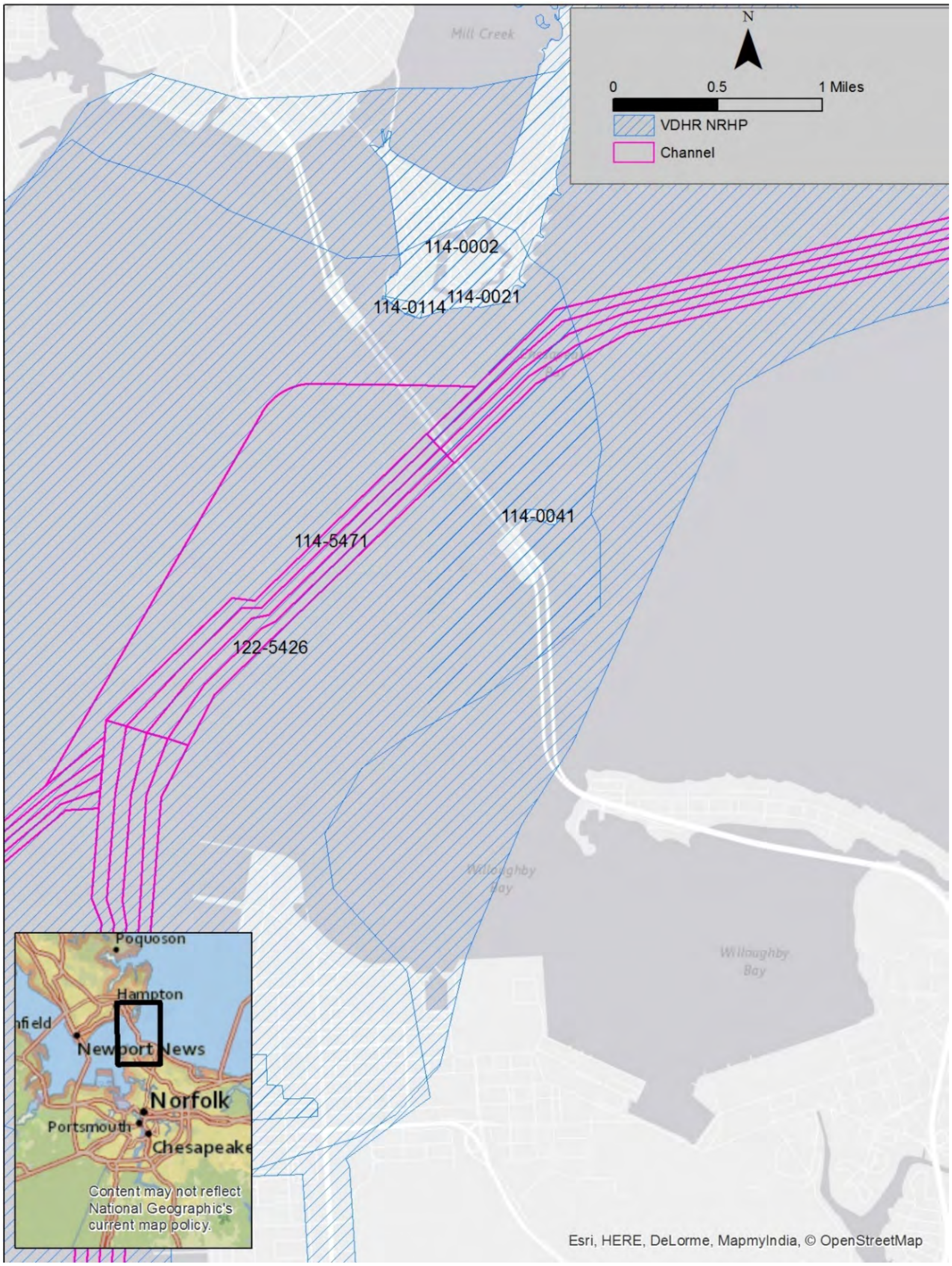

Figure 2-37: Historic Properties within about One Mile of the Project Area, Northeast

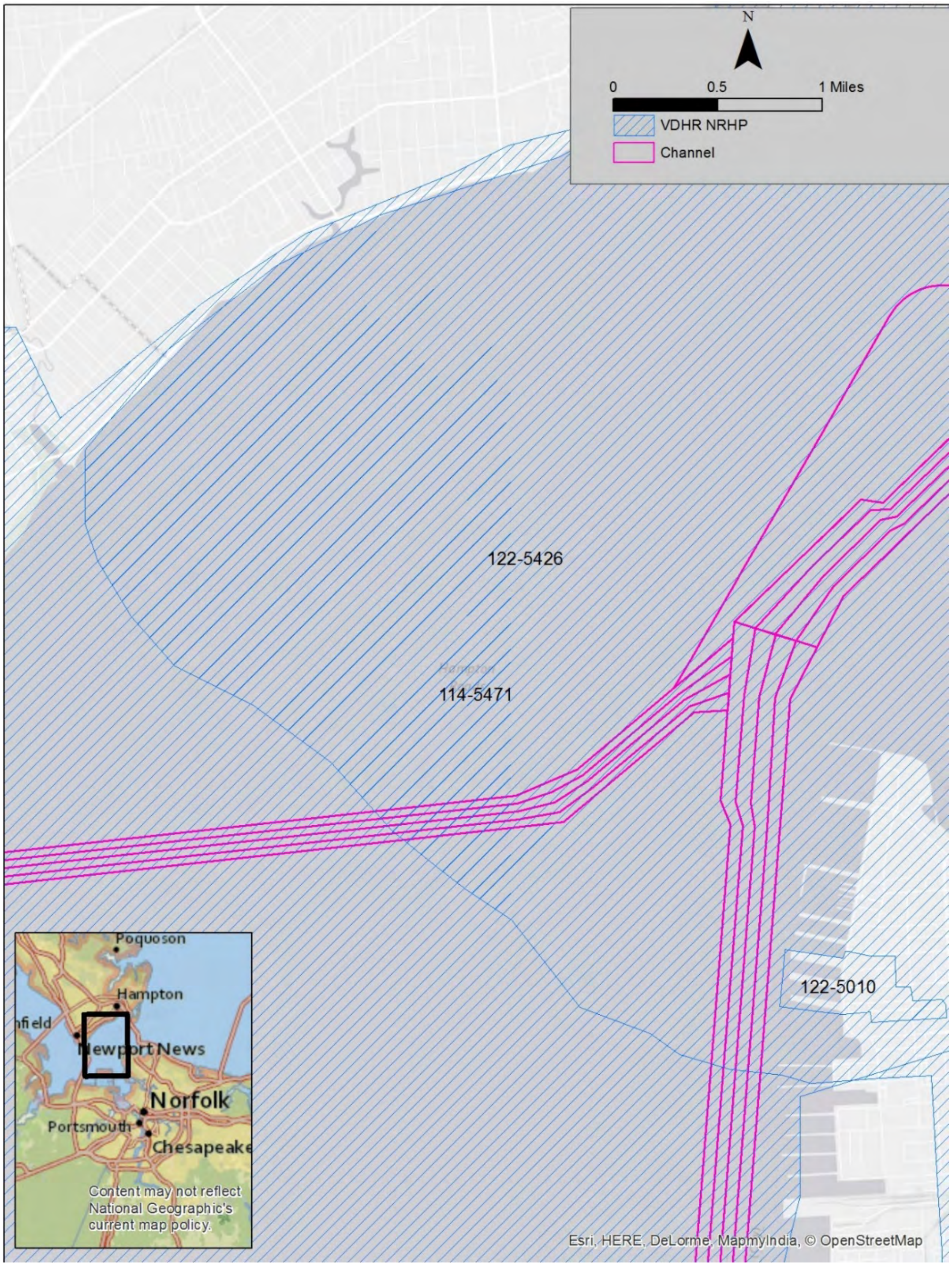

Figure 2-38: Historic Properties within about One Mile of the Project Area, Middle

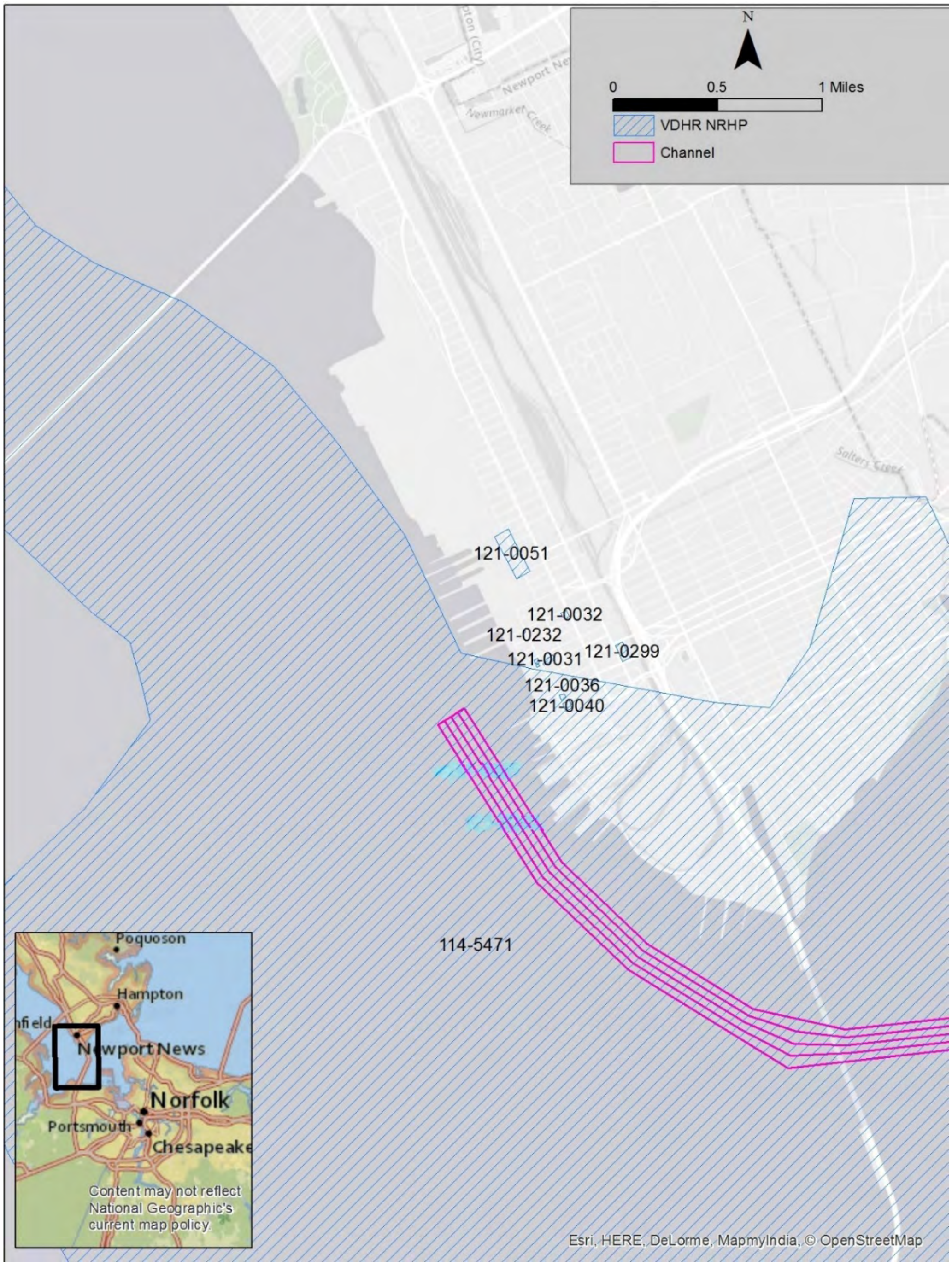

Figure 2-39: Historic Properties within about One Mile of the Project Area, West

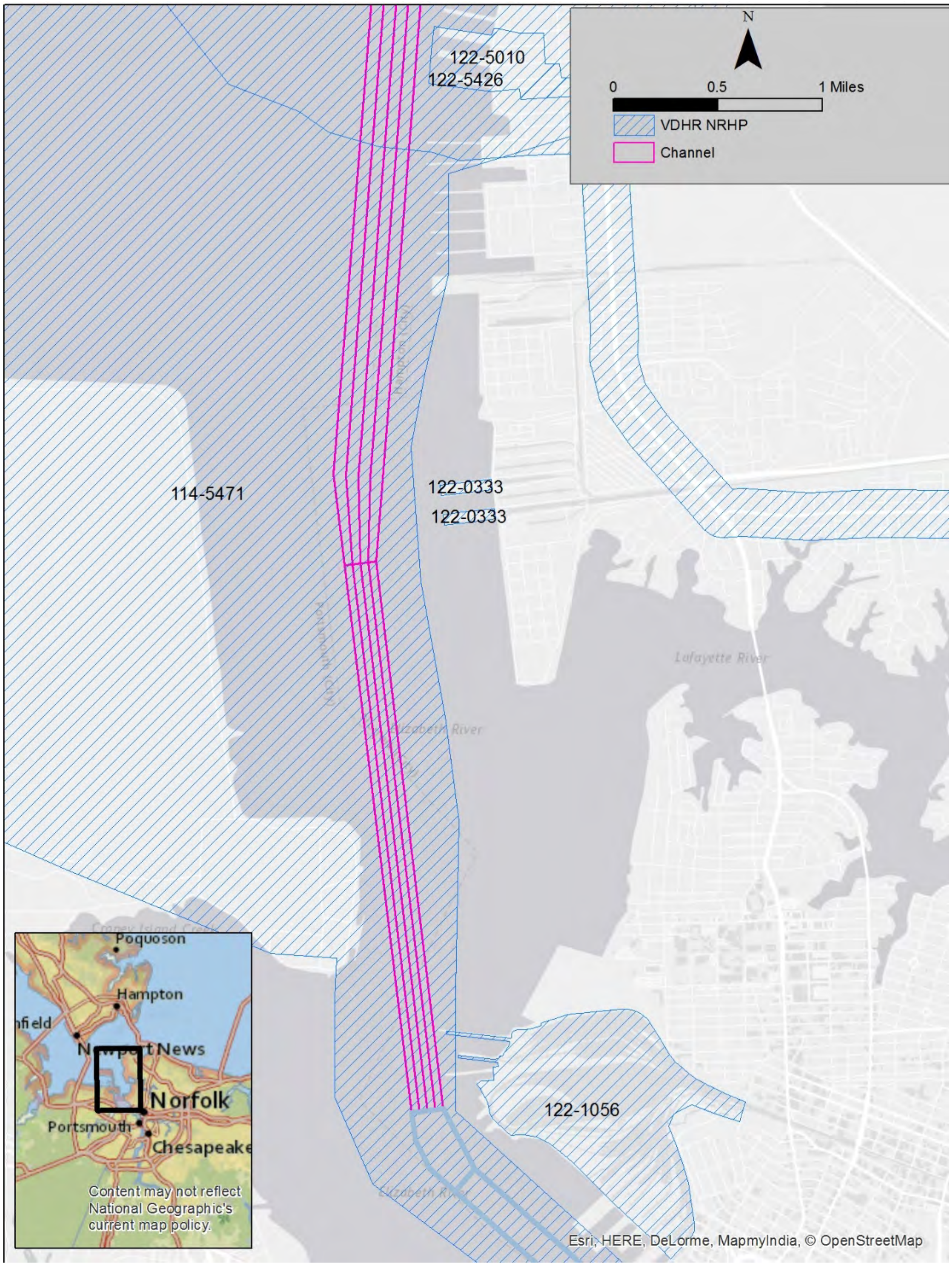

Figure 2-40: Historic Properties within about One Mile of the Project Area, South

Table 2-21: NRHP Listed and Eligible Historic Properties within One Mile of the Project

DHR ID	Name	NRHP Status
114-0002	Fort Monroe (NRHP Listing), Fort Monroe Historic District (NRHP Listing), Old Point Comfort	VLR/NRHP/NHL
114-0021	Lighthouse 001 Fenwick Road (Function/Location), Old Point Comfort Lighthouse (NRHP Listing)	VLR/NRHP
114-0041	Fort Calhoun (Historic), Fort Wool (Current)	VLR/NRHP
114-0114	Chamberlin Hotel (Historic/Current), Chamberlin-Vanderbilt Hotel (Historic)	VLR/NRHP
114-5471	Battle of Hampton Roads (Historic/Location), Battle of the Ironclads (Historic), Monitor vs. Virginia	NRHP Eligible
121-0020	Middle Ground Light Station (NRHP Listing), Newport News Middle Ground Light (Descriptive)	VLR/NRHP
121-0031	First Baptist Church (Historic)	VLR/NRHP
121-0032	St. Vincent de Paul Catholic Church (Historic/Current)	VLR/NRHP
121-0036	Newport News Post Office and Custom House (Historic), U.S. Post Office/District Court House (Current	NRHP Eligible
121-0040	The Hotel Warwick (Historic/Current)	VLR/NRHP
121-0042*	U.S.S. Cumberland (44NN0073) (NRHP Listing)	VLR/NRHP
121-0051	Newport News Shipbuilding & Dry Dock Company Shipyard (Historic/Current)	NRHP Eligible
121-0061*	CSS Florida Shipwreck Archaeological Site (Historic/Current)	NRHP
121-0080	Newport News Public Library (NRHP Listing), Newport News Public Library, West Avenue Branch (Current	VLR/NRHP
Table __ cont.		
DHR ID	Name	NRHP Status
121-0223	Medical Arts Building (Historic/Current)	VLR/NRHP
121-0232	The Wellington Apartments (Historic/Current)	NRHP Eligible

DHR ID	Name	NRHP Status
121-0299	Noland Company Building (Historic/Current)	VLR/NRHP
122-0333	Norfolk International Terminals (Historic/Current)	NRHP Eligible
122-1056	N & W Railyard Site-Norfolk Southern Railway Historic District (Descriptive), Norfolk & Western Rail	NRHP Eligible
122-5010	Naval Supply Depot Historic District (Current)	NRHP Eligible
122-5426	Battle of Sewells Point (Historic/Location)	NRHP Eligible
44NN0335*	Unidentified steel hulled vessel wreck	Potentially Eligible
* not mapped		
NHL = National Historic Landmark		
NRHP = National Register of Historic Places listed		
VLR = Virginia Landmarks Register		
114 = Hampton		
121 = Newport News		

A substantial portion of the APE has had previous archaeological survey, however large areas remain unsurveyed. Previous archaeological surveys have been reviewed and the survey areas mapped. These surveys are mapped, listed, and described in an attachment to the Programmatic Agreement, included in Appendix I of this document. Areas surveyed within the last 20 years will not be resurveyed. Unsurveyed areas subject to potential project impacts will be surveyed by a qualified marine archaeologist using side-scan sonar and marine magnetometer (or magnetic gradiometer), also known as a Phase I survey. Previous marine archaeology survey areas and areas where survey may be needed for this project are shown in Figure 2-41. Anomalies from this remote sensing survey that are identified as potentially significant sites will be investigated with further remote sensing survey for magnetic and sonar data, sub-bottom profiler data, and diver investigation to determine the NRHP eligibility of the site (also known as a Phase II survey). Through a Programmatic Agreement with the SHPO, additional surveys needed to complete the identification of historic properties in the APE will be deferred to the Preliminary Engineering and Design Phase of this project.

Along with the Virginia Department of Historic Resources and the Virginia Ports Authority, the USACE invited the Advisory Council on Historic Preservation, the Cities of Virginia Beach, Hampton, Newport News, Norfolk, and Portsmouth; the Catawba Nation, the Delaware Nation, the Delaware Tribe, Narragansett Indian Tribe, and the Shinnecock Indian Nation; and the Naval History and Heritage Command to consult on compliance with NHPA Section 106. Of the additional parties invited only the Naval History and Heritage Command responded with acceptance.

Figure 2-41: Areas Previously Surveyed, and Areas Needing Survey

2.20 Aesthetics

The ROI for aesthetics (visual resources) is the residential, recreational, and tourist sites with views of the Norfolk Harbor and the dredged material placement/disposal sites.

The visual experience in any locale is dependent upon the pattern of the land (i.e., the topography), the pattern of water bodies, vegetation, and manmade development. Within the ROI, the topography is relatively flat; because much of the ROI is low elevation with very slight relief, viewers can generally see long distances from locations that are only slightly higher than the surrounding area. Looking out at the AOC and TSC from the shore of Willoughby Spit, there are views of the Atlantic Ocean, Chesapeake Bay Bridge, large commercial cargo ships, and large U.S. Naval ships utilizing the channels.

The majority of the waterfront property in Hampton, Newport News, Norfolk, and Portsmouth consists of man-made development with views of an urbanized working harbor with Naval and deep draft navigation vessels and associated on-shore infrastructure. Suffolk and Chesapeake contain a mix of urban, suburban, and rural land (VDOT 2001), and Virginia Beach is a resort city with miles of beaches and hundreds of hotels, motels, and restaurants along its oceanfront.

The Norfolk Harbor Entrance Reach contains a few visually sensitive resources nearby. Set adjacent to the world's largest naval station and the commercial maritime transportation hub of Norfolk, Virginia, Fort Monroe National Monument provides visual access to sights and sounds of this maritime setting, major shipping channel, and recreational marina (NPS 2015). Designated as a national monument in 2011, Fort Monroe is at the southern tip of the Virginia peninsula (Figure 2-42), just to the north of the Hampton Roads Bridge Tunnel and approximately 2.8 miles east of the downtown area of the City of Hampton (NPS 2015). Views to, from, and within, Fort Monroe have been identified as significant historic views as these vistas reinforce the historic visual and natural character of the peninsula (FMA 2011; NPS 2015).

Fort Wool (Figure 2-42) is another visually sensitive resource located at the entrance of the Hampton Roads Harbor and within the Norfolk Harbor Entrance Reach. The Fort Wool passenger ferry, Miss Hampton II, allows tourists boarding in Hampton to visit the island during most of the year, but the fort can also be briefly glimpsed by passengers in westbound vehicles prior to entering the southern end of the tunnel portion of the Hampton Roads Bridge-Tunnel, which carries US-64 across the mouth of the harbor.

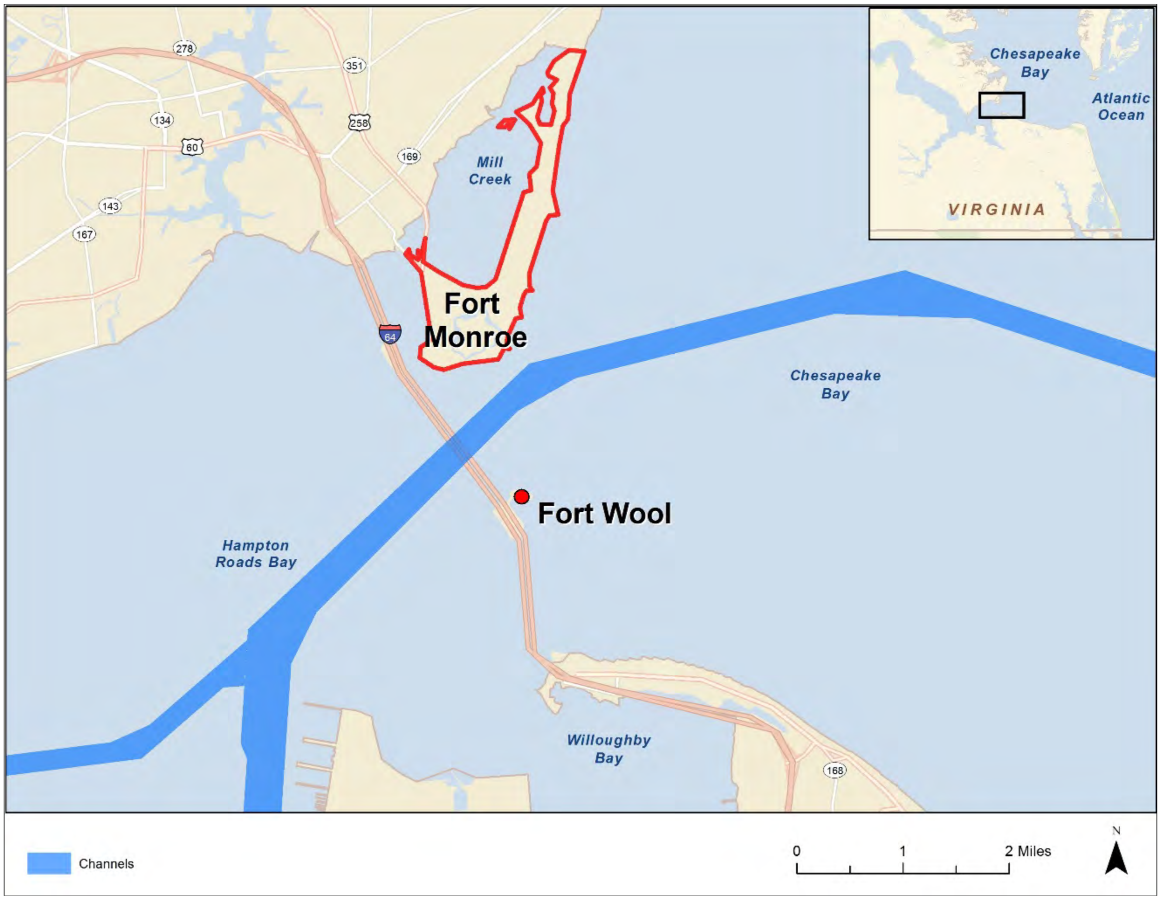

Figure 2-42: Fort Monroe and Fort Wool

On the southern side of the harbor entrance, the Willoughby Spit is a largely residential area where residents are likely to place value on their existing waterfront views and be sensitive to changes in the landscape (VDOT 2012). Residential communities with views of the ROI include the residential communities of Windmill Shores, Rivermill, Edgefield, Merrifields, and Edgewater in the City of Norfolk. The current viewshed for the Edgewater community includes NIT, Lamberts Point Coal Terminals, U.S. Navy Craney Island Fuel Depot, and CIDMMA.

Southwest of the Norfolk Harbor, is the CIDMMA. The CIDMMA is approximately two square miles of dredged material disposal area with existing ground elevations at more than +30 feet MLLW. As a result, the areas that contain the dredged material are visible from surrounding properties, including neighborhoods in nearby Portsmouth communities. The height of the dikes has been raised at the CIDDMA since the facility began operations in 1957.

2.21 Recreation

The ROI for the recreation includes the areas transited by dredging vessels/equipment, areas of navigation channel and Anchorage F dredged, and dredged material placement/disposal areas.

Although opportunities for recreation are present within the ROI, the major use of the Norfolk Harbor is for deep draft vessels and U.S. Navy navigation. The ROI is a busy working waterway where 38 ships a week called at the Port of Virginia in 2015 (POV 2015). The Norfolk Harbor is also home to the world's largest naval station (NPS 2015) and all the associated military vessel traffic.

Recreational boaters from the surrounding areas use many areas within the Hampton Roads Harbor evidenced by the numerous sailing communities with marinas and boat ramps on the waterfront of the project area. Recreational fishermen and pleasure boaters often cross or navigate the Norfolk Harbor to reach their destinations (USACE 2006).

Recreational fishing is permitted from the shoreline of the CIDMMA, but no commercial fishing is allowed within 1,000 feet (Navy 2009). One of the focal points of fishing in the Chesapeake Bay area is the Chesapeake Bay Bridge Tunnel, which spans more than 17 miles and is colloquially referred to as the world's largest artificial reef. More than 1.1 million tons of rock was used to build the four manmade islands that anchor the tunnels and more than 5,000 concrete pilings support the bridge sections; the placed rock and pilings provide attractive habitat for fish and thus attract recreational fishermen (VMRC 2006).

The following parks are located along the shore with views of the Norfolk Harbor, and are therefore located within the ROI: Monitor-Merrimac Overlook Park; Anderson Park; King-Lincoln Park (includes the King-Lincoln Fishing Pier); Victory Landing Park; Huntington Park; Sarah Constant Beach Park; Monkey Bottom Park; Ocean View Beach Park; Community Beach Park; First Landing State Park; and the Virginia Beach Boardwalk.

Designated as a National Monument in 2011, Fort Monroe is approximately 2.8 miles east of the City of Hampton (NPS 2015). Built near the strategic point where the James and York rivers meet the Chesapeake Bay, Fort Monroe contains many recreational opportunities including beaches stretching along the eastern and southern shore, a seawall to walk, run, bike, or sit and enjoy the maritime views, and recreational vehicle camping, sports fields, walking trails, and birding opportunities (NPS 2015).

Between 1607 and 1609 Englishman John Smith mapped and documented nearly 3,000 miles of the Chesapeake Bay and its tributary rivers. In 2006, the U.S. Congress designated the routes of Smith's explorations of the Chesapeake as a national historic trail, establishing the first national water trail (http://smithtrail.net/about-the-trail/). There are ample opportunities for boating, kayaking, canoeing, visiting historical parks, sailing, photography, and other recreational activities along the Captain John Smith Chesapeake National Historic Trail; portions of the trail are within the Norfolk Harbor as well as the Elizabeth River (NPS 2015).

2.22 Socioeconomics

The Affected Environment for Socioeconomics was previously described in Chapter 2, Section 2.3.1 Socioeconomics.

2.23 Land Use and Induced Development

Land use is a general term used to describe how land is or may be utilized or developed within a given area and typically includes industrial, commercial, residential, agricultural, and parks and open space. Because of the extent of property dedicated to military activities in the project area, military is also a defined land use category. The ROI for the land use analysis is limited to those shoreline and adjacent upland areas proximate to the proposed navigation improvements as well as land use near dredged material placement/disposal sites.

Existing land uses adjacent to the proposed Norfolk Harbor consist of industrial use from the Port of Virginia (e.g., Norfolk International Terminals, APM Terminal, Norfolk Southern

Railroad), military uses (e.g., Naval Station Norfolk, Navy Fuel Depot, and Coast Guard Support Center), historic sites (e.g., Fort Monroe), residential areas (e.g., Willoughby Spit), and recreational beaches (e.g., Virginia Beach). Waterfront land use along the ROI is predominantly industrial and military, supporting shipping, waterborne commerce, and other water dependent uses (USACE 1999).

The Hampton Roads Transportation Planning Organization (HRTPO) has created a regional land use map by merging sixteen local comprehensive plans and existing land uses into a single data set that encompasses the project area (HRTPO 2011). Table 2-22 shows the categories and descriptions of the land use categories assigned in the HRTPO's Regional Land Use Classification System that are then depicted in Figure 2-43. The land use on shorelines adjacent to the Norfolk Harbor are dominated by military (blue), residential (yellow), and industrial (purple) land uses. Military facilities include the Naval Station Norfolk and Chambers Field, Expeditionary Warfare Training Group Atlantic Little Creek Amphibious Base, the Joint Expeditionary Base East at Fort Story, and Fort Monroe to the east of Hampton. Industrial uses in the ROI include the southwest side of the peninsula to the south of Newport News, which includes the Dominion Terminal and the Newport News Shipbuilding terminal. Residential land use is along the shorelines of Hampton, Virginia; Willoughby Spit, as well as Pinewell, Lynnhaven, and Virginia Beach, Virginia. Within the ROI, there is also industrial land use across the Elizabeth River from CIDMMA, which is the site of the Port of Virginia's Norfolk International Terminals. There is very little land designated for commercial use in the ROI (HRTPO 2011).

Table 2-22: HRTPO's Regional Land Use Classification System

Activity	Classification	CODE	Description
Residential	Rural Residential	RR	Encompasses residential uses with <1 dwelling units per acre (SFR >40,000 Sq. Ft lots
	Low Density Residential	RLD	Encompasses residential uses with 1-4 dwelling units per acre (12,000 - 40,000 Sq. Ft lots)
	Medium Density Residential	RMD	Encompasses residential uses with 4 - 12 dwelling units per acre (SFR <12,000 Sq. Ft lots)
	High Density Residential	RHD	Encompasses residential uses with >12 dwelling units per acre
Commercial	Neighborhood Commercial	CN	Encompasses limited scale shopping, business, or trade activity
	Community Commercial	CC	Encompasses inter-neighborhood shopping, business, or trade activity
	Regional Commercial	CR	Encompasses regional shopping, business, or trade activity
Industrial	Light Industrial	IL	Encompasses light industrial uses (Research & Development, warehousing, service, etc)
	Heavy Industrial	IH	Encompasses heavy industrial uses with possible adverse environmental impacts (manufacturing, etc)
	Port / Aviation Industrial	IPA	Encompasses Port, General and Commercial Aviation related industrial operations
Mixed Use	Mixed Use Commercial/Residential	MCR	Encompasses commercial/ residential mixed use activity
	Mixed Use Commercial/Industrial	MCI	Encompasses commercial/ industrial mixed use activity
Military	Military	MM	Encompasses military related facilities
Institutional	Utilities	IU	Encompasses utility facilities
	Public/Semi-Public	IP	Government/Educational/Religious/Social or healthcare facilities
	Transportation Network	IT	Encompasses transportation facilities
Agriculture	Agricultural	AA	Encompasses agricultural operations
Vacant	Vacant	V	Encompasses vacant developable lands
Parks, Open Space, & Greenways	Parks and Recreation	NP	Encompasses open space and recreational uses
	Resource Conservation	NC	Encompasses conservation lands
	Historic /Cultural	NH	Encompasses Historic Preservation / Cultural uses

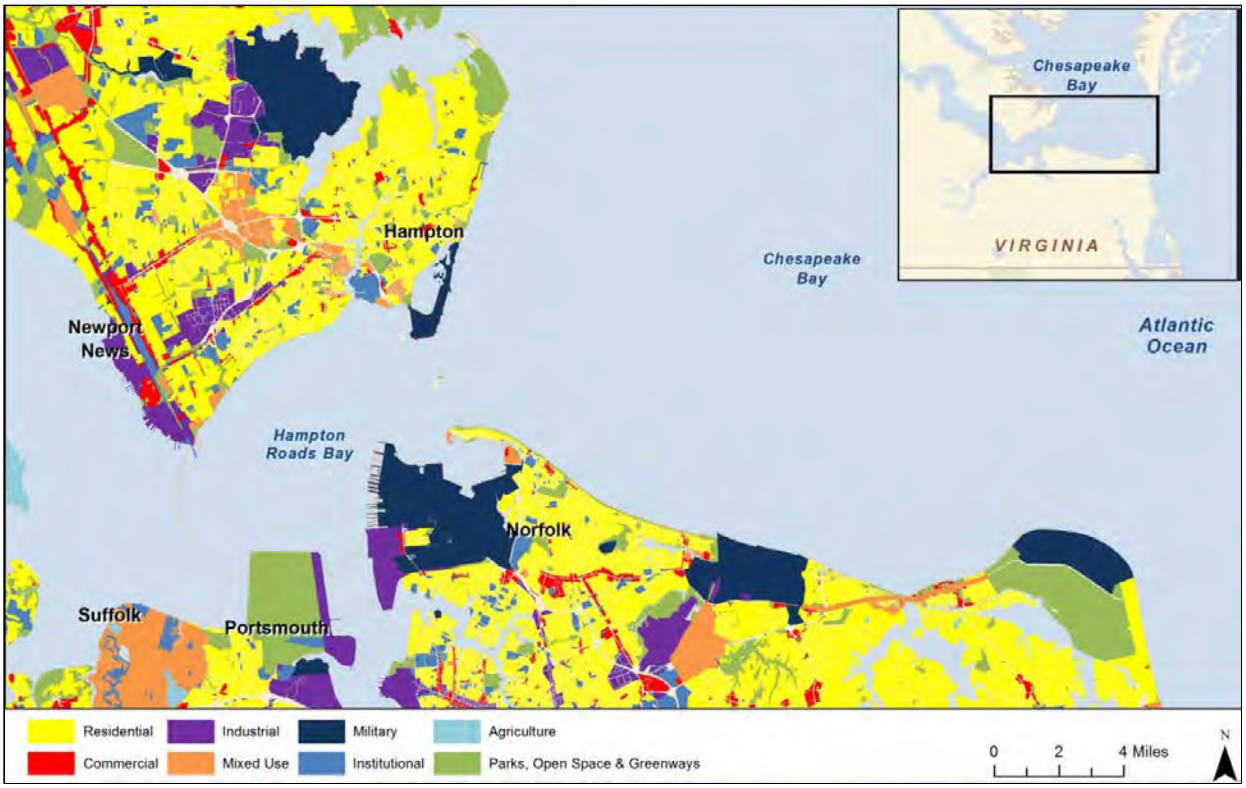

Figure 2-43: Land Use Adjacent to the Norfolk Harbor

The ROI for transportation is defined as those regionally significant roadway segments that presently accommodate the movement of freight into and out of the Hampton Roads region and would provide trucks and worker vehicles with access to the various Port of Virginia terminals. Because traffic congestion is a regional issue, data are presented for all of the Port of Virginia facilities, including Newport News Marine Terminal and the Dominion Coal Terminal on the James River.

The Hampton Roads Planning District Commission (HRPDC) represents 17 local governments "*to encourage and facilitate local government cooperation and state-local cooperation in addressing on a regional basis problems of greater than local significance*." (HRTPO 2014) The HRPDC serves as a resource of technical expertise to its member local governments and provides assistance on local and regional issues, including transportation. The HRPDC staff also serves the Hampton Roads Transportation Planning Organization (HRTPO), providing urban and regional transportation planning expertise. The HRTPO is the Metropolitan Planning Organization (MPO) for the Hampton Roads Metropolitan Planning Area (MPA).

Hampton Roads is a multimodal region that includes ports, airports, rail, private trucking, shipping and warehouse distribution facilities, as well as a network of road and rail corridors for the delivery of freight, goods, and services (HRTPO 2014). Trucks are the primary mover within this system and are responsible for delivering the majority of what local citizens consume and use on a daily basis. The Port of Virginia conducts international trade of containerized, bulk, break-bulk, and roll-on/roll-off cargo; railroads (e.g., Norfolk Southern and CSX) transport various commodities, such as coal, automobiles, and chemicals (HRTPO 2014).

The HRTPO is responsible for transportation planning and decision-making in the region and has annually prepared a report detailing average weekday traffic volumes for major roadways in Hampton Roads since 2006 (HRTPO 2015). Since 2012, this analysis has included roadway speed data sourced from millions of GPS-enabled fleet vehicles (e.g., taxis, delivery vans, trucks) and data from smartphone users allowing an analysis of peak period roadway congestion levels based on volumes and speeds. The current HRTPO annual report on volumes, speeds, and congestion on major roadways in Hampton Roads has a robust evaluation of congestion in the ROI (HRTPO 2015).

In 2014, 17,100 trucks entered or exited Hampton Roads through major gateways each weekday (HRTPO 2015a). The number of trucks passing through Hampton Roads gateways has increased each of the last two years for which data are available (2013-2014), but the number of trucks is still much lower than the levels seen before the economic downturn that started in 2008 (HRTPO 2015a). For example, more than 20,000 trucks passed through major gateways in 2007, just prior to the recession (HRTPO 2015a).

There was a total of 1.22 million miles of truck travel each day in Hampton Roads in 2013 according to VDOT estimates, which accounted for 3.1% of the 39 million vehicle-miles of travel experienced each day throughout the region (HRTPO 2015a). Even though regional truck travel increased 7% from 2012 to 2013, truck travel levels are still 15% lower than those seen in 2007 (HRTPO 2015a).

Although the amount of freight handled by the Port of Virginia now exceeds the levels prior to the economic downturn, the amount of truck travel both in Hampton Roads and at the gateways to the region is still well below pre-recession levels, as cited above. One reason is that Port of Virginia trucks only represent a small percentage of all regional truck travel; approximately 10% of all regional truck travel is originating from, or destined to, the Port of Virginia according to an HRTPO analysis of Port data (HRTPO 2015a). Additionally, an increasingly larger percentage of the Port's freight that was previously handled by trucks is now being transported by rail.

In 2005, 67% of all freight handled by the Port was transported by truck, while 25% was transported by rail (HRTPO 2015a). In 2014, freight transported by truck decreased to 63%, with rail's share increasing to 33%; the Port of Virginia anticipates that the share of freight transported by truck will continue to decrease in the future, and that 40 to 50% of cargo handled by the Port may eventually be transported by rail (HRTPO 2015a).

In an effort to plan effectively for moving freight and improving system performance, the HTRPO has also completed two studies evaluating the existing conditions involving freight movement in the area: the Hampton Roads Regional Freight Study (HTRPO 2012) and Existing and Future Truck Delay in Hampton Roads (HRTPO 2013). Figure 2-44 depicts the predicted change in 24-hour, weekday truck volumes (2010 existing to 20-year forecast) as estimated by the HRTPO

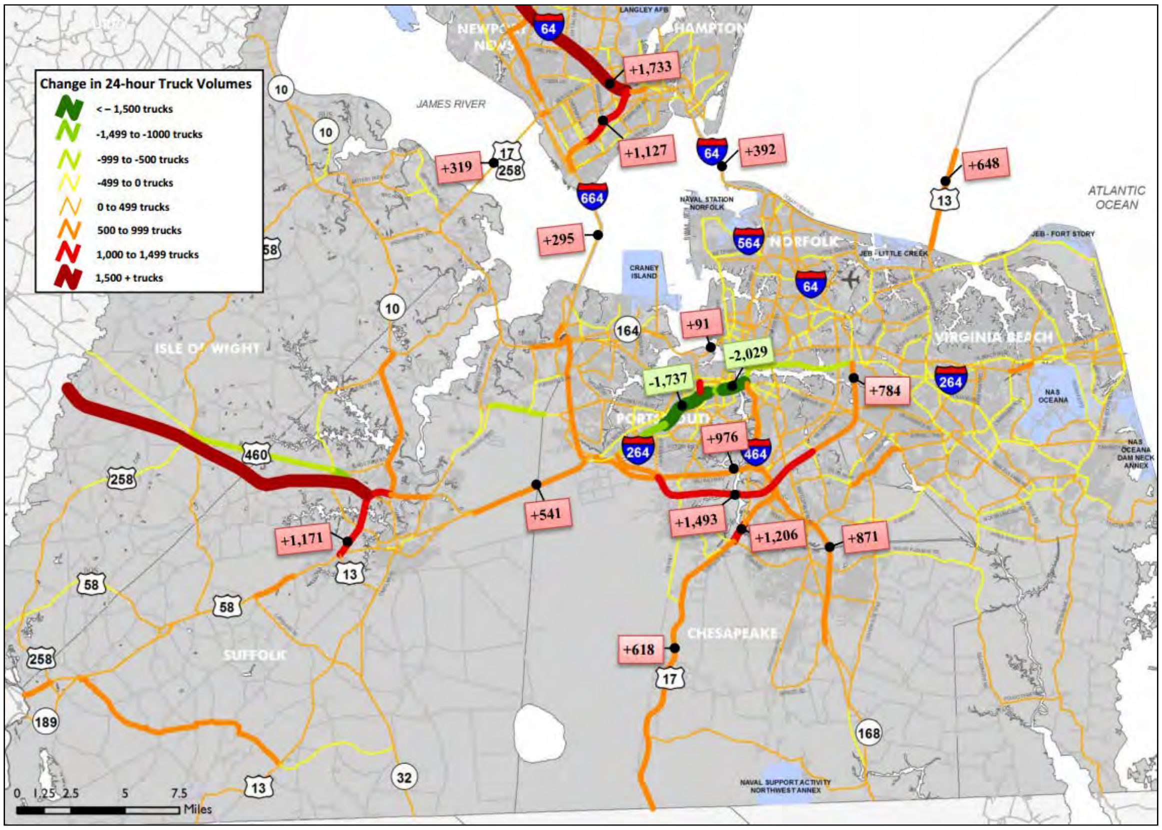

Figure 2-44: 20-Year Predicted Change in Weekday Truck Volumes

Roadway congestion is a primary concern facing the users of the Hampton Roads transportation system. In order to evaluate current roadway conditions, assess regional transportation needs, and outline strategies to manage current and future roadway congestion, the HRTPO staff maintains a Congestion Management Process (CMP). The CMP is an ongoing program in which congestion in the multi-modal, regional transportation system is evaluated and for which improvements are recommended. In addition, the CMP is used as a guide to develop recommendations for the HRTPO's Transportation Improvement Program (http://www.hrtpotip.org/) and the Long-Range Transportation Plan (http://www.hrtpo.org/page/long-range-transportation-planning-(lrtp)/)

In 2014, the Port of Virginia ranked third among East Coast ports in the volume of containerized cargo handled. Hampton Roads is the largest exporter of coal in the country and nearly 42 million tons of coal were shipped through the region in 2014 (HRTPO 2015). Understanding how the bulk or containerized commodities move from deep draft vessels onto surface transportation modes (truck or rail) or from truck and rail to deep draft vessels requires an understanding of how the Port of Virginia cargo and coal facilities operate.

Port of Virginia Facilities

Norfolk International Terminals (NIT)

The NIT is a marine container terminal located near the mouth of the Elizabeth River across from CIDMMA. The largest of the Port of Virginia's facilities, the NIT provides two 1,320 foot cargo piers, an 875 foot Ro/Ro berth, and approximately 6,630 feet of wharf. Situated on approximately 570 acres, the NIT is served by 14 ship-to-shore cranes that can reach across 22 to 26 containers and provide berth depth of up to 50 feet (POV 2015). The NIT has the capacity to process approximately 820,000 containers per year (approximately 1.4 million TEUs) and operated at approximately 88% capacity in FY 2014 (POV 2015).

All truck traffic accesses the terminal via the main gate, which is located at the southern terminal. Norfolk Southern and Norfolk Portsmouth Beltline railroad provide rail service to the NIT (POV 2015). Truck traffic accessing the NIT enters the facility at the intersection of Terminal Boulevard and Hampton Boulevard. Traffic originating from I-64 typically utilizes the Terminal Boulevard and the trucks arriving from the Mid-Town Tunnel characteristically use Hampton Boulevard. Although Hampton Boulevard is a four and six lane road, it has narrow lanes not conducive to trucks, is heavily used by residential, Navy base, and Old Dominion University traffic, and experiences congestion-related delays during peak hours. To address ongoing congestion issues, the Port of Virginia instituted truck restrictions to prohibit Port-based truck traffic on Hampton Boulevard during afternoon peak traffic hours (VPA 2008).

Newport News Marine Terminal (NNMT)

The NNMT, located on approximately 165 acres on the north bank of the James River in Newport News, is the Virginia Port Authority's main break-bulk and Ro/Ro facility. NNMT contains two piers with four vessel berths, approximately 968,000 square feet of covered storage, and on-dock rail served by CSX Rail. The NNMT also has Ro/Ro ramps for transfers to both vessels and rail (POV 2015). By surface road, the NNMT is 1.6 miles away from access to I-664 and the route can experience traffic congestions during peak hours. Cargo volumes at the NNMT are lower than the other VPA terminals and the NNMT does not usually experience significant delays between its terminal and I-664 (VPA 2008).

Virginia International Gateway (VIG)

The VIG is a marine container terminal located along the Elizabeth River and across from Lamberts Point in Portsmouth, Virginia. Constructed as a semi-automated operation that combines manual and automated container handling equipment, many of the VIG's operations are performed remotely from a centralized terminal operation center. The terminal operates at approximately 91% of its existing 650,000 container/year capacity (approximately 1.1 million TEUs) serving post-Panamax class vessels. The terminal consists of 231 developed acres, which are equipped with eight post-Panamax class ship-to-shore gantry cranes capable of handling container vessels with up to 22 rows of containers at the container wharf. The backlands of the VIG consist of a 65-acre semi-automated rail mounted gantry stacked storage container yard and 50 acres of storage space. There is an additional 60 acres of planned expansion area for additional container stacks, working tracks for intermodal operations, truck gate lanes, and an extended container wharf (POV 2015a).

The VIG is accessible by the interstate highway system and double-stack intermodal rail service. The VIG has a six-track, on-dock intermodal yard served by Commonwealth Railway and a short-line railroad that has rail access to CSX and Norfolk Southern railroads, which both have near-daily scheduled intermodal service to the terminal (POV 2015a).

Norfolk Southern Coal Terminal

Norfolk Southern Corporation's coal handling facility at Lamberts Point exports domestic coal originating from approximately 130 sources. Pier 6 has three berths with a berth depth of 50-feet. The concrete and steel pier has twin traveling loaders, each as high as a 17-story building and can serve two colliers or concentrate on a single ship. More than 150,000 tons of coal have been loaded onto a single collier, some of which are 1,000 feet in length and 175 feet in width (VMA 2015).

Storage yards at the Norfolk Southern Coal Terminal accommodate approximately 5,200 loaded coal cars. This terminal is operated by Norfolk Southern Railway Company and connects to the Norfolk Southern Railway (VMA 2015).

Dominion Coal Terminal

The Dominion Coal Terminal is a concrete and pile deck terminal located on the east bank of the James River in Newport News, Virginia; the terminal is 84 feet wide and 1,162 feet long, with a berth depth of 50 feet. The Dominion Coal Terminal receives coal from the coal fields of Virginia, West Virginia, and Kentucky and has an annual throughput capacity of approximately 22 million tons. Coal is stored in four areas, which are capable of storing up to 1.7 million tons. The single shiploader with a 145 foot boom can accommodate ships with 79 foot draft. The Dominion Coal Terminal is operated by Dominion Terminal Associates and connects to the CSX Rail system (VMA 2015).

Kinder Morgan Terminal

Kinder Morgan Bulk Terminals Pier IX is located on the east bank of the James River in Newport News, VA. The facility stockpiles and blends coal from the eastern United States and loads coal exports on coastal barges and colliers. Ground storage capacity for coal is 1.4 million tons with an export capacity of 16 million tons. The terminal is also capable of unloading cement from vessels with 30,000 tons of storage capacity in three silos. Rail service to the terminal is provided by CSX. Rail cars are offloaded by a rotary dumper at a rate of 3,000 tons per hour.

3 FUTURE WITHOUT PROJECT ECONOMIC AND NAVIGATION CONDITIONS

Under the future without-project condition, there would be no channel or anchorage modifications to the Norfolk Harbor project. The future without project (FWOP) condition is assessed through a determination of how relevant elements of the existing condition are likely to change over time in the absence of a Federal alternative. It is also the no action alternative considered for NEPA purposes throughout this report. Elements of the FWOP consist of commodities, vessels, trade routes and port facilities. The change in commodity volume over the period of analysis is informed by the Global Insight commodity forecast. The composition of the vessels bearing those commodities is informed by the Maritime Strategies International Ltd (MSI) fleet forecast. The number of vessel calls needed to move these commodities is based on analysis conducted of vessel loading patterns extracted from existing condition datasets and loading factor analysis. Port facilities/infrastructure are assumed to remain constant over time with the exception of the development of the Craney Island Marine Terminal (CIMT), which is anticipated to be online around 2040. The assumption was made that the introduction of this facility will not change the regional distribution of containerized cargo forecasted to move through the Port of Hampton Roads. The impact of introducing CIMT is to alter the distribution of cargo forecasted to move through NIT, Virginia International Gateway (VIG), and PMT (Southern Branch). With the exception of the movement of containerized cargo, the proportion of commodities as distributed across marine terminals is assumed to be similar to the existing condition. Existing condition trade routes are assumed to be constant over the period of analysis as there is no assumption of route distance changes since such change are not predictable.

The frequency of dredging actions in the future is projected for analysis, but the years in which the dredging would be expected to occur cannot be reliably predicted. Under the without-project condition, existing navigational uses within the project area (industry, commerce, military, and recreation) would continue into the foreseeable future with the predicted increase in vessel traffic assumed to occur over the period of analysis.

In addition, there is currently a separate, yet concurrent GRR being conducted on the ERSB project to evaluate channel deepening. The recommended plan in that GRR includes the following channel improvements for the ERSB:

- Deepening the channel from Lamberts Bend to Perdue Farms (Segment 1a) from a required depth of -40 feet to -45 feet deep in Segment 1a, and deepening the channel from Perdue Farms to the Norfolk Southern Lift Bridge (Segment 1b) from a required depth of -40 feet to -42 feet.

- Deepening the channel from the Norfolk Southern Lift Bridge to the Gilmerton Bridge (Segment 2), from a required depth of -35 feet to -39 feet deep; and

- Continuing to maintain the channel from the Gilmerton Bridge to the Chesapeake Extension to a required depth of -35 feet (Segment 3).

The ERSB project is included under the same Norfolk Harbor and Channels authorization and thus it was relevant to include it in the FWOP for this study as construction depths are already congressionally authorized. However, the economic analysis conducted for this study is completely separate from that completed for the ERSB project and benefits for each project are independent. The ERSB project is located below the Norfolk Harbor study area, however the depths under consideration there are less than the existing channel depths in Norfolk Harbor. It is also not expected that the implementation of the ERSB project would affect the environmental impacts of the Norfolk Harbor project. Finally, the full build out of the CIEE is also included in the FWOP for this study (USACE 2006).

3.1 Navigation Features – identify any changes from existing condition

3.1.1 Channels, Anchorages and Turning Basins

The Norfolk Harbor Channel project is dredged periodically to maintain channel dimensions. Under without-project conditions, maintenance dredging is projected to continue on a regular basis to maintain the existing condition dimensions presented in Table 3-1. An analysis of maintenance dredging records from 1980 to 2014 indicates that maintenance dredging occurs on a nearly annual basis (30 out of 34 years) with an average dredged material volume of 1.53 MCY per event. Although maintenance dredging of the project occurs on a nearly annual basis, individual channel reaches are typically dredged on a longer cycle of every other year or longer so that dredging occurs most every year with channel reaches alternating from year to year.

3.1.2 Dredging and Placement History

Dredged material placement follows a consistent pattern of CIDMMA receiving material from the inner channels and Dam Neck ODMDS receiving material from TSC and the AOC. Table 3-1 presents annualized historical maintenance dredging material volumes for the Norfolk Harbor Study since the deepening to -50 feet (2007).

Table 3-1: Norfolk Harbor Historical Maintenance Dredging Volume

Channel	Placement Site	Annualized Volume (CY)
Norfolk Harbor Craney Island Reach	CIDMMA	570,600
Norfolk Harbor Entrance Reach	CIDMMA	163,000
Newport News Channel	CIDMMA	109,600
Thimble Shoal Channel	DNODS	325,600
Atlantic Ocean Channel	DNODS	164,400
Annualized Total		1,333,200

*Willoughby Spit is a 2017 project that beneficially utilizes materials from a portion of Thimble Shoal.

Under without-project conditions, recent historical maintenance dredging practices are projected to continue. Maintenance dredging will continue on an assumed annual basis with individual channel reaches being dredged in alternate years as needed. The total projected maintenance dredged material volume over the 50-year study period is 64.3 MCY. Note that by approximately 2044 CIDMMA is projected to stop receiving dredged material and maintenance material from the inner channels will be placed at the Norfolk Ocean Disposal Site unless a new Dredge Material Management Placement Site (DMMP) is developed (see Section 2.1.2).

Willoughby

Willoughby Spit and Vicinity Coastal Storm Damage Reduction Project consists of 7.3 miles of shoreline and adjacent land area extending along the Chesapeake Bay from the eastern limit at the jetties at Little Creek Inlet to the western limit at the tip of Willoughby Spit. It includes the areas known as Willoughby Spit, West Ocean View, Central Ocean View, and East Ocean View. The project consists of a berm with an average width of 60 feet constructed at an elevation of 5 feet above mean low water [3.5 feet, North American Vertical Datum, 1988 (NAVD 88)], with a foreshore slope of one on 20 extending to the natural bottom along the entire 7.3-mile shoreline where an adequate berm does not presently exist. The city of Norfolk would continue to maintain the existing dune system at local expense throughout the life of the project. The project would require periodic nourishment on the average of once every eight years in order to maintain the integrity of the protective berm and the construction duration is expected to be 3 months. Annual monitoring would determine the actual nourishment requirements. The Thimble Shoal Auxiliary Channel (Thimble Shoals Meeting areas) is the designated borrow area. The most recent nourishment activity concluded in May 2017 with the placement of 1.2 MCY of sand on the publicly owned portion of Willoughby Beach from Little Creek to Willoughby Spit, totaling approximately 7 miles of beach, excluding the Cottage Line Area.

3.1.3 Anchorage F

Anchorage F is a one of a series of Anchorages located along the Norfolk Harbor channel. The depth of the anchorage was designed to be compatible with the present 50-foot navigation channels that provide access to Hampton Roads. This would allow vessels with a 48 foot draft to use the anchorage. The -50 Foot Anchorage construction was evaluated with respect to advance maintenance dredging and that 1-foot of advance maintenance dredging would be appropriate. This would result in a required dredging depth of -51 feet. This determination was based on the anticipated shoaling rate of approximately 2 to 3 inches per year on average. The anchorage is currently authorized to a depth of -55 feet with a 3000 foot width. The anchorage was constructed in 1999 where a total of 416,026 cubic yards of materials were removed. Since the initial dredging it has only been maintained once in 2014 where 54,936 cubic yards of materials were removed from the anchorage

3.2 Terminal Facilities

3.2.1 Container Terminal Facilities

Norfolk International Terminals

Planned expansion of NIT includes projects for the north and south portions of the terminal. On June 30th, 2017 the NIT North Gate Expansion Project entered service. The North Gate Expansion added 26 new truck gates, which tie into a new Interstate Highway 564 connector. The NIT South Optimization Project is a $350 million investment to increase operations at NIT South, which will increase TEU capacity to 1.56 million by 2020. Construction of the NIT South Optimization Project began in 2017 and is scheduled for completion in 2020. The combined planned improvements at NIT North and South will increase total NIT TEU capacity to 2.1 million TEUs per year. Berths at NIT are capable of being deepened to the authorized depth of 55 feet.

Virginia International Gateway

The VIG Phase II Expansion Project is a $320 million investment in:

- Wharf expansion to 4,000 linear feet;
- Gate expansion to total of 17 inbound gate lanes;
- Stack yard expansion to 28 stacks; and
- Rail expansion including new configuration, additional tracks, and new cantilevered rail mounted gantry cranes.

The VIG Phase II Expansion Project began in 2017 and is projected to be completed in 2019. The planned improvements to VIG will increase container capacity to 2.1 million TEUs per year. Berths at VIG are capable of being deepened to the authorized depth of 55 feet.

Craney Island Marine Terminal

The CIEE is a congressionally authorized project consisting of an 580-acre eastward expansion to an elevation of +18 feet MLLW to provide additional dredged material capacity and a suitable platform to construct a container handling terminal. The plan includes construction of an access channel to a depth of -55 feet MLLW to serve the VPA's container port. In preparation for future port development, the 580-acre area will be divided by a dike into two dredged material receiving areas consisting of 220 and 360 acres. The 220-acre area will be filled with dredged material first and will be the area where the VPA will begin port construction. The 360-acre area will begin to receive dredged material after filling of the 220-acre area. Once the 360-acre area is filled, it will also be turned over to the VPA for port construction. Engineering and design of the project commenced in 2007 with the Pre-construction Engineering and Design (PED) phase, and construction began in 2009.

The CIMT is a planned semi-automated container terminal to be located on approximately 495 acres of the CIEE, adjacent to the CIDMMA (Figure 3-1). Current planning (Figure 3-2) includes four phases of development that would provide a capacity of approximately 1.3 million TEU at the terminal's opening and approximately 5.0 million TEU at build-out. The planned CIMT will encompass 8,500 linear feet of wharf, operate 28 Suez-class cranes, and have an on-terminal intermodal container transfer facility served by both Class I railroads (CSX and Norfolk Southern). The construction phasing of the CIMT is planned such that the operations of each new section of the facility is functional before the demand exceeds the capacity of the built portion. For analysis purposes, the CIMT is assumed to come online around 2040.

Figure 3-1: Craney Island Marine Terminal (Source: Port of Virginia)

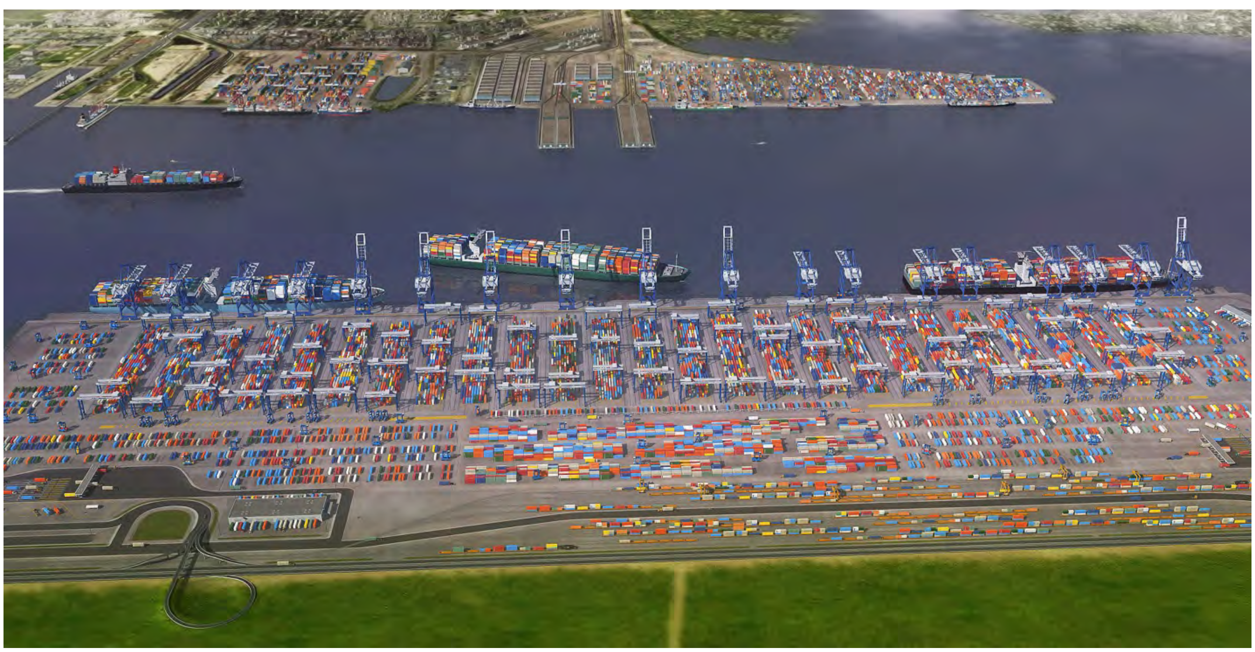

Figure 3-2: Planned Craney Island Marine Terminal

Major elements include container handling mode and equipment, buildings, structures, utilities, and rail operating mode and equipment. The proposed CIMT concept is based on a goal of 50% of container traffic leaving or arriving via rail, which significantly will reduce the terminal's impact on highway traffic and the environment compared to concepts emphasizing truck hauling.

To provide access, the Craney Island Road & Rail Connector (CIRRC) is planned to include a 2.75 mile-long multi-modal road and rail corridor connecting the Route 164 Western Freeway to the CIMT. Rail is served by an extension of the Commonwealth Railway (CWRY). The CWRY is an existing Class III short line that provides connections to the Norfolk Southern (NS) and CSX Railways in downtown Suffolk, Virginia.

Container Terminal Capacity over Time

The total Norfolk Harbor container terminals throughput capacity currently is 3 million TEUs. Planned terminal expansion projects at NIT, VIG, and CIMT will substantially increase container throughput capacity at Norfolk Harbor (Table 3-2). Total throughput capacity is project to reach 9.6 million TEUs by 2062 (Table 3-3).

Table 3-2: Future Container Terminal Throughput Capacity

Terminal	**TEUs**
NIT	2,100,000
VIG	2,100,000
PMT	438,000
CIMT Phase I	1,300,000
CIMT Phase II	1,200,000
CIMT Phase III	1,200,000
CIMT Phase IV	1,300,000
Total	**9,638,000**

Table 3-3: Norfolk Harbor Total Container Throughput Capacity by Year

Year	**TEUs**
2021	4,471,800
2026	5,167,800
2036	5,916,000
2040	7,215,780
2052	8,404,200
2062	9,638,000

3.2.2 Coal Terminal Facilities

The three Norfolk Harbor coal terminals – Dominion Terminal, Kinder Morgan Pier IX, and Norfolk Southern Pier 6 – do not currently plan for major expansion. The wharves at each of these terminals are capable of deepening to the authorized channel depth of -55 feet MLLW without the need for substantial modifications.

3.3 Economic Conditions -- Projected Growth

3.3.1 Socio-Economics

Long-term forecasts for the region indicate continued growth of both population and employment, but at slower rates than has been experienced in the past decades. The HRPDC's Hampton Roads 2040 Socioeconomic Forecast predicts that the population and employment within the Hampton Roads MSA will both increase by 2040 (HRPDC, 2013a). The HRPDC has estimated population growth for the constituent counties and cities as listed in Table 3-4; the total population is projected to increase from 1,666,310 in 2010 to 2,037,000 (approximately 22-percent) by 2040 (HRPDC 2013a).

Table 3-4: Hampton Roads Predicted Population Change (2010 and 2040)

City or County	2010 Population	2040 Population Forecast	Percent Change
Chesapeake	222,209	314,600	41.58
Hampton	137,436	137,200	-0.17
Newport News	180,719	189,100	4.64
Norfolk	242,803	253,200	4.28
Poquoson	12,150	12,400	2.06
Portsmouth	95,535	98,200	2.79
Suffolk	84,585	182,700	116.00
Virginia Beach	437,994	497,500	13.59
Williamsburg	14,068	17,200	22.26
Gloucester Co., VA	36,858	40,200	9.07
Isle of Wight Co., VA	35,270	62,800	78.06
James City Co., VA	67,009	104,200	55.50
York Co., VA	65,464	82,700	26.33

3.4 Port Operations

3.4.1 Commodity Forecast

Coal

The IHS provided a commodity forecast for the Atlantic Coast region with a focus on Norfolk Harbor in 2015. The USACE economists used this information as a resource in developing the commodity forecast applied to the Norfolk Harbor study. According to the Norfolk Harbor commodity forecast provided by IHS, coal exports are expected to decrease sharply in the short term (2015 to 2016) and then to remain relatively constant with the potential for modest growth over the remainder of the forecast period (Table 3-5). The majority of Norfolk coal exports are metallurgical coal exports to Europe, while a smaller percentage is thermal coal exported for use in power generation. According to IHS, the decrease in coal export tonnage from Norfolk can be attributed to several factors, including increasingly strict environmental regulations and decreasing gas prices. Also, metallurgical coal exported through Norfolk Harbor is high quality and therefore more expensive than other coal sources, making it difficult for this coal to compete on the world market.

Table 3-5: Forecasted Coal Cargo Export Tonnage (Metric Tons), 2015-2060

Calendar Year	CAGR*	NN-DRY BULK	NS-PIER-VI	Coal Exports
2015		20,206,931	15,863,827	36,070,758
2016	-25.66%	15,022,651	11,793,812	26,816,463
2020	0.60%	15,385,607	12,078,757	27,464,365
2023	0.50%	15,616,516	12,260,037	27,876,553
2025	0.49%	15,770,455	12,380,890	28,151,345
2030	0.44%	16,116,987	12,652,941	28,769,928
2035	0.41%	16,446,391	12,911,546	29,357,937
2040	0.37%	16,751,453	13,151,040	29,902,493
2045	0.33%	17,028,722	13,368,716	30,397,438
2050	0.29%	17,275,202	13,562,219	30,837,421
2055	0.25%	17,488,038	13,729,310	31,217,347
2060	0.20%	17,664,633	13,867,949	31,532,582

*CAGR = Compound annual growth rate

Containers

Table 3-6 and 3-7 display container growth rates by route group for imports and exports, respectively. Growth rates by route group are derived using IHS import and export tonnage forecast data by country over the period from 2005-2045 (included years 2005, 2014, 2020, 2035, 2045). The “2015-2023” growth rates displayed in the aforementioned tables were applied to the 2015 import and export tonnage estimates to yield the 2023 import and export tonnage estimates displayed in Table 3-8 and 3-9. The “2023-2030” growth rates were then applied to the resulting 2023 import and export tonnages to yield the 2030 import and export tonnage estimates. This process continued through 2045, the last year in which commodity growth was assumed.

The report provided by IHS cites increased demand for consumer products as the driving factor behind the growth in import container tonnage, including both finished consumer products and parts to be manufactured into finished consumer goods. Specifically, motor vehicles parts, furniture, and non-alcoholic beverages are examples provided by IHS of high-volume, high-growth containerized goods arriving at Norfolk Harbor.

Table 3-6: Import Container Cargo Compound Annual Growth Rates by Route Group

IMPORT CONTAINER GROWTH RATES					
	2015-2023	**2023-2030**	**2030-2035**	**2035-2040**	**2040-2045**
FE-SUEZ-ECUS	4.57%	4.23%	3.99%	3.82%	3.64%
FE-PAN-ECUS	4.54%	3.86%	3.34%	3.06%	2.79%
EU-MED-ECUS	3.00%	3.10%	3.05%	2.85%	2.63%
AF-SA-CAR-ECUS	4.36%	4.84%	4.97%	4.76%	4.51%

The IHS commodity forecast calls for growth in containerized exports as well. This includes increases in plastics and chemicals due to growing trade with Asian countries, South America, and Europe (Table 3-9).

Table 3-7: Export Container Cargo Compound Annual Growth Rates by Route Group

EXPORT CONTAINER GROWTH RATES					
Route Groups	**2015-2023**	**2023-2030**	**2030-2035**	**2035-2040**	**2040-2045**
FE-SUEZ-ECUS	4.75%	4.27%	3.40%	3.20%	3.04%
FE-PAN-ECUS	4.56%	4.20%	3.08%	2.82%	2.61%
EU-MED-ECUS	3.71%	2.91%	2.24%	2.04%	1.85%
AF-SA-CAR-ECUS	3.84%	4.14%	3.58%	3.32%	3.07%

Total container cargo throughput is forecasted to more than double between the project base year of 2023 and 2045 (Table 3-10). Such high growth in throughput is significant because as tonnage increases over time, more annual vessel calls can be expected in Norfolk Harbor than are seen in the existing condition. Greater vessel traffic creates additional opportunity for deeper loading, call reductions, and decreased congestion with the implementation of proposed harbor deepening and widening measures, respectively.

Table 3-8: Total Forecasted Tonnage by Route Group

Total Tonnes						
Route Groups	**2015**	**2023**	**2030**	**2035**	**2040**	**2045**
FE-SUEZ-ECUS	6,385,135	8,763,739	11,370,637	13,483,080	15,866,842	18,538,765
FE-PAN-ECUS	4,200,849	5,729,470	7,341,306	8,522,751	9,779,717	11,101,599
EU-MED-ECUS	2,308,543	2,926,324	3,542,803	4,012,340	4,505,693	5,015,463
AF-SA-CAR-ECUS	1,195,932	1,595,813	2,110,186	2,587,160	3,145,250	3,787,050
Total	**14,090,458**	**19,015,347**	**24,364,932**	**28,605,331**	**33,297,502**	**38,442,876**

Table 3-9: Total Forecasted Import Tonnage by Route Group

Total Import Tonnes						
Route Groups	**2015**	**2023**	**2030**	**2035**	**2040**	**2045**
FE-SUEZ-ECUS	2,753,814	3,761,000	4,875,340	5,849,125	6,966,519	8,235,277
FE-PAN-ECUS	1,873,694	2,554,339	3,243,824	3,786,251	4,366,393	4,975,713
EU-MED-ECUS	917,901	1,138,113	1,385,342	1,596,486	1,823,817	2,063,590
AF-SA-CAR-ECUS	713,129	962,026	1,288,084	1,608,453	1,991,449	2,440,305
Total	**6,258,539**	**8,415,478**	**10,792,590**	**12,840,315**	**15,148,178**	**17,714,885**

Table 3-10: Total Forecasted Export Tonnage by Route Group

Total Export Tonnes						
Route Groups	**2015**	**2023**	**2030**	**2035**	**2040**	**2045**
FE-SUEZ-ECUS	3,631,320	4,959,446	6,428,873	7,712,956	9,186,408	10,859,457
FE-PAN-ECUS	2,327,155	3,172,525	4,028,875	4,702,577	5,423,122	6,179,906
EU-MED-ECUS	1,390,641	1,724,267	2,098,824	2,418,711	2,763,123	3,126,385
AF-SA-CAR-ECUS	482,803	651,311	872,059	1,088,955	1,348,250	1,652,135
Total	**7,831,919**	**10,507,549**	**13,428,630**	**15,923,199**	**18,720,904**	**21,817,882**

3.4.2 Fleet Forecast

Coal

The future bulker fleet is expected to be similar to the existing bulker fleet. See “Existing Cargo Fleet – Coal” section above (See Section 3.4.1).

Containers

As part of the Norfolk Harbor study MSI completed a fleet forecast to reflect projected changes in fleet composition over. In order to apply the forecast to Norfolk Harbor, several steps were needed. First, historical port call data (2009-2014) was used to establish a representative call list used for economic model calibration. Growth rates from the commodity forecast were applied to the tonnage in the calibrated call list to grow the commodity over the period of analysis. Data from the existing condition was used to represent sailing draft distributions as well as annual and instantaneous vessel loading patterns. Finally, the rate of change between vessel class TEU capacities from the MSI fleet projections was used to represent changes in fleet composition over the period of analysis.

Table 3-11 shows the rate of fleet transition for the transatlantic container fleet over the period from 2016 through 2045. One trend of note is that the percentages of total capacity allocated to Sub-Panamax and Panamax container ships both decline in almost all forecasted years. However, neither drop to zero, suggesting that there are some services on the transatlantic routes for which use of smaller vessels is preferable even when larger vessel options exist. Post Panamax Generation 3 PPX3 vessels see growth throughout the forecasted period, with growth continuing but slowing to lower rates than previous years after 2030.

Table 3-11: Transatlantic Container Fleet Transition over Time

EU-MED-ECUS, AF-SA-CAR-ECUS Fleet Transition					
Year	**SPX**	**PX**	**PPX1**	**PPX2**	**PPX3**
2016	-22%	2%	-1%	11%	20%
2017	2%	2%	1%	6%	16%
2018	-66%	-2%	7%	8%	12%
2019	1%	-14%	2%	9%	16%
2020	-39%	-11%	3%	13%	20%
2021	-8%	-11%	2%	11%	18%
2022	-6%	-9%	4%	7%	13%
2023	-6%	-8%	5%	4%	10%
2024	-7%	-9%	2%	5%	12%
2025	-6%	-8%	5%	3%	7%
2026	-3%	-3%	4%	2%	7%
2027	-1%	-1%	2%	0%	8%
2028	-15%	-21%	0%	3%	11%
2029	-15%	-19%	0%	1%	12%
2030	-9%	-13%	0%	-2%	10%
2031	-10%	-13%	2%	-2%	7%
2032	-9%	-11%	0%	-3%	7%
2033	-11%	-15%	1%	-3%	5%
2034	-17%	-22%	-2%	-4%	7%
2035	-9%	-13%	0%	-4%	4%
2040	0%	0%	0%	0%	1%
2045	0%	0%	0%	0%	1%

Table 3-12 displays the Asian container fleet transition over time. Sub-Panamax vessels are projected to be completed removed from this route by 2020 as use of larger, more-efficient vessels takes over Asian routes. Deployment of PPX3 class vessels continues to grow through 2035 and is the vessel class that is projected to see the largest growth in capacity over the forecast period.

Table 3-12: Asian Container Fleet Transition over Time

ASIA Fleet Transition					
Year	**SPX**	**PX**	**PPX1**	**PPX2**	**PPX3**
2016	-22%	2%	-1%	11%	20%
2017	2%	2%	1%	6%	16%
2018	-66%	-2%	7%	8%	12%
2019	1%	-14%	2%	9%	16%
2020	-100%	-11%	3%	13%	20%
2021		-11%	2%	11%	18%
2022		-9%	4%	7%	13%
2023		-8%	5%	4%	10%
2024		-9%	2%	5%	12%
2025		-8%	5%	3%	7%
2026		-3%	4%	2%	7%
2027		-1%	2%	0%	8%
2028		-21%	0%	3%	11%
2029		-19%	0%	1%	12%
2030		-13%	0%	-2%	10%
2031		-13%	3%	-5%	10%
2032		-11%	1%	-9%	10%
2033		-15%	1%	-8%	7%
2034		-22%	-4%	-11%	11%
2035		-13%	1%	-12%	7%
2040		0%	0%	0%	0%
2045		0%	0%	0%	0%

As of 2015, the largest container vessels to call Norfolk Harbor were classified as a PPX3 and had capacities of 9600 TEUs. The analysis assumes that some of the PPX3 calls in the historical record will be replaced by PPX3-Max calls over time. As shown in Table 3-13, the percentage of the total TEU capacity allocated to PPX3 vessels decreases relative to the capacity allocated to PPX3-Max vessels over the forecast period, with the TEU capacity allocated to PPX3-Max vessels surpassing that allocated to PPX3 vessel by 2032. The transition from PPX3 to PPX3-Max vessels over the analysis period is important because the PPX3-Max vessels have deeper design drafts (up to 52.49 feet) than PPX3 class vessels (up to 49.93 feet), which means that there is opportunity for PPX3-Max vessels to benefit from channel depths of 53 feet and beyond.

Table 3-13: Fleet Transition from PPX3 to PPX3-Max over Time

Year	PPX3	PPX3-Max
2015	100%	0%
2016	97%	3%
2017	94%	6%
2018	91%	9%
2019	88%	12%
2020	85%	15%
2021	82%	18%
2022	78%	22%
2023	75%	25%
2024	72%	28%
2025	69%	31%
2026	66%	34%
2027	63%	37%
2028	60%	40%
2029	57%	43%
2030	54%	46%
2031	51%	49%
2032	48%	52%
2033	45%	55%
2034	41%	59%
2035	38%	62%
2040	38%	62%
2045	38%	62%

3.4.3 Projected Cargo Traffic Characterization (Vessel Calls)

Coal

Error! Reference source not found. provides detail on the projected number of bulker calls over the analytical period by model year and depth measure. Commodity growth over time means that during the period of analysis (base year 2023) the number of calls needed to move increasing quantities of commodities through Norfolk Harbor at any given channel depth will also increase. This can be seen by looking at the columns in **Error! Reference source not found.**. Channel deepening measures allow large bulker vessels to load deeper, which means that less calls are needed to move the same quantity of commodities. For example, the number of calls needed to move the 2023 bulker tonnage is assumed to be 564 at -50 feet of channel depth and only 542 at -55 feet of channel depth since vessels would be able to load more efficiently with a deeper channel. See Economics Appendix B for additional information on bulker load factor analysis (LFA) and number of calls by vessel class and dock.

Table 3-14: Projected Bulker Calls by Model Year & Depth Measure (feet)

Year	50	51	52	53	54	55
2023	564	559	554	550	546	542
2030	579	574	569	565	561	557
2035	592	587	583	578	573	570
2040	601	596	591	587	582	578
2045	614	609	604	599	594	591

Containers

Table 3-15 provides detail on the projected number of container ship calls over the analytical period by model year and depth measure. As discussed above, substantial growth in container throughput at Norfolk Harbor is anticipated over the period from 2015 to 2045. Thus, the number of calls needed at any given depth to carry the goods forecasted to pass through Norfolk Harbor increases over time. As the channel depth increases from -50 feet up to -55 feet in 1 foot increments, the number of calls needed to move a constant quantity of commodities decreases. In other words, vessels can now load deeper and carry more tonnage per voyage which means less total voyages (or calls) are needed to carry the same quantity of goods. See Economics Appendix B for additional information on container vessel load factor analysis (LFA) and number of calls by vessel class and dock.

Table 3-15: # Containership Vessel Calls by Model Year & Depth Measure (feet)

Year	50	51	52	53	54	55
2023	1831	1828	1828	1825	1825	1825
2030	2101	2097	2091	2086	2084	2083
2035	2357	2346	2337	2327	2321	2318
2040	2792	2780	2768	2756	2747	2745
2045	3284	3269	3254	3241	3235	3230

The future without project condition in this section is characterized using the number of vessel calls, system times, and transportation costs expressed in average annual equivalent dollars (Figure 3-16). The number of vessel calls include all traffic moving through Norfolk Harbor and Elizabeth River Southern Branch. Voyage cost figures include allocated voyage costs for trades that could be impacted by a change in channel depth. Port cost consist of the cost of all traffic moving from the entrance to Chesapeake Bay to and through Norfolk Harbor, Newport News, and the Southern Branch of the Elizabeth River. The number of calls also includes the naval traffic anticipated to move through the harbor.

Table 3-16. FWOP Condition Transportation Cost

FWOP Condition Transportation Cost					
Model Year	**# Calls**	**System Time (hours)**	**Voyage Cost**	**Port Cost**	**Transportation Cost**
2023	7,520	171,762	$2,069,800,000	$189,500,000	$2,259,300,000
2030	8,047	186,541	$2,532,100,000	$209,700,000	$2,741,800,000
2035	8,477	198,863	$2,891,000,000	$228,600,000	$3,119,600,000
2040	9,070	211,326	$3,358,500,000	$245,000,000	$3,603,500,000
2045	9,729	228,714	$3,881,900,000	$267,200,000	$4,149,100,000
AAEQ FWOP Transportation Cost			**$3,247,000,000**	**$240,000,000**	**$3,487,500,000**

3.5 Future Transportation Corridor Assumptions

Future projects that impact the Future Without Project Scenario, such as Craney Island Marine Terminal (CIEE expansion) and the Virginia Gateway (or NIT Expansion) are previously described in Section 1.2.1. In addition to those future projects, there are a number of other future transportation projects considered as assumptions for the Future Without Project scenario within the project area (Figure 3-3):

Figure 3-3 Future Transportation Projects in the Future Without Project Scenario

3.5.1 Chesapeake Bay Bridge Tunnel (Parallel Thimble Shoal Tunnel)

The Parallel Thimble Shoal Tunnel Project will construct a new two-lane tunnel under the TSC. When complete, the new tunnel will carry two lanes of traffic southbound and the existing tunnel will carry two lanes of traffic northbound. The new tunnel will have an outer diameter of 42 feet extending 5,238 feet running parallel to the CBBT's existing tunnel under the waters of the Chesapeake Bay. Construction began in October 2017 on the new tunnel with project completion expected October 2022.

3.5.2 Hampton Roads Crossing (Third Crossing) Study

I-64 Hampton Roads Bridge Tunnel Expansion

The I-64 Hampton Roads Bridge Tunnel in southeastern Virginia will expand its existing 3.5-mile facility (a two 2-lane immersed-tube tunnels on artificial islands, with trestle bridges to shore). These tunnels are 7,500 feet long and traffic on these four lanes exceeds 100,000 vehicles per day during peak summer traffic. The Hampton Roads Bridge-Tunnel Expansion project will ease this congestion by widening the four-lane segments of the I-64 corridor in the cities of Hampton and Norfolk.

Patriots Crossing

This project was designed to improve mobility across Hampton Roads and relieve congestion at the I-64 Hampton Roads Bridge Tunnel. Patriot's Crossing will focus on:

- Widening I-664 in Newport News to eight lanes.
- Constructing two new tubes parallel to the Monitor-Merrimac Memorial Bridge-Tunnel
- Constructing an additional an additional bridge-tunnel structure from the Monitor-Merrimac Memorial Bridge-Tunnel near Naval Station Norfolk
- Adding a new four-lane highway connector from the new bridge tunnel to the Western Freeway in Portsmouth. This will be known as the Craney Island Connector
- Widening I-664 to six lanes from the Monitor-Merrimac Memorial Bridge-Tunnel to the Bowers Hill interchange

3.5.3 I-64 Widening and High Rise Bridge Replacement

This project will increase capacity and mobility, and improve safety and operational deficiencies along this section of the I-64 corridor in Chesapeake over the Elizabeth River. The length of improvements will be 8.75 miles adjacent to the existing bridge. The following improvements are project elements:

- New High Rise Bridge with a fixed span, south of the existing bridge
- Widening existing bridges at Military Highway, Yadkin Road and Shell Road
- Replacement and realignment of the Great Bridge Boulevard Bridge
- Asphalt overlay on existing I-64 lanes
- The project is designed to accommodate a future Phase 2 project which will expand the corridor to a total of eight lanes

Construction began in October 2017 and expected to be complete in February 2021.

4 PLAN FORMULATION

Preliminary plans were formulated by combining management measures. Each plan was formulated in consideration of the following 4 criteria described in the P&G:

- Completeness: Extent to which the plan provides and accounts for all necessary investments or actions to ensure realization of the planning objectives;
- Effectiveness: Extent to which the plan contributes to achieving the planning objectives;
- Efficiency: Extent to which the plan is the most cost-effective means of addressing the specified problems and realizing the specified opportunities, consistent with protecting the nation's environment; and
- Acceptability: Workability and viability of the alternative plan with respect to acceptance by Federal and non-Federal entities and the public, and compatibility with existing laws, regulations, and public policies.

PLAN FORMULATION RATIONALE

The underlying rational of the Planning Process is described in ER 1105-2-100 as "Formulation of Alternative Plans."

- Alternative plans are formulated to identify ways of achieving planning objectives within the project constraints, in order to solve the problems and realize the opportunities listed in Step 1 of the Planning Process which is to "Specify Problems and Opportunities."
- Structural and nonstructural management measures are identified and combined management measures to form alternative plans.
- Planners will keep focus on complete plan(s) while doing individual tasks, to ensure their plans address the problems of the planning area.
- Section 904 of the WRDA (Water Resources Development Act) of 1986 requires USACE to address the following during the formulation and evaluation of alternative plans:
    - Enhancing national economic development (NED) - including benefits to particular regions that are not transfers from other regions
    - Protecting and restoring the quality of the total environment
    - The well-being of the people of the United States
    - Preservation of cultural as well as historical values
- Nonstructural measures must be considered in the plan formulation process as means to address problems and opportunities.
- Revised costs of mitigation will be included in the final cost/benefit analysis.

Plan formulation was conducted with a focus on achieving the Federal objective of water and related land resources project planning, which is to contribute to NED consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements. Alternative plan development considered study area problems, opportunities, and constraints.

Alternative plan evaluation includes all effects, beneficial or adverse, to each of the four evaluation accounts identified in the Principles and Guidelines (1983), which are National Economic Development, Environmental Quality, Regional Economic Development, and Other Social Effects.

4.1 Problems, Opportunities, and Constraints

4.1.1 Problems

There are three major problems occurring on the Federal navigation project:

- The existing Federal channel depth is insufficient for the largest vessels which causes inefficiencies in maritime commerce.
- The existing Federal channel width does not allow for some DoD and commercial navigation activities to occur simultaneously.
- Existing anchorages are insufficient to fully accommodate existing vessel fleet (depth, quantity, dimensions).

Multiple issues were identified as contributors to these three major problems. For the first problem, existing Federal channel depth and width cause inefficiencies in maritime commerce, specific issues include:

- Federal channel depth forces tide timing for large deep draft vessels. This restricts arrival and departure of vessels, contributes to congestion in the channel, and results in inefficient use of berths. The effects of this are increased operating costs, delays, and customer service issues.
- Some deep draft vessels must 'light load' to safely navigate the Federal channel, resulting underutilization of vessel capacity.
- There is insufficient underkeel clearance for large deep draft vessels and several ships have grounded in the Federal channel in the past few years. This causes vessel delays and associated costs and can require channel closure.
- Weather conditions increase the need for tug assist in the channel. In the future, as vessels increase in size, the need for tug assist will increase, which increases transportation costs in the channel.
- There is no place within the channel for large ships to meet, often resulting in one-way traffic in the Federal channel. This delays cargo schedules, causes port congestion, and berth inefficiency.

The specific issues contributing to the second problem, existing channel width does not allow for some DoD and commercial navigation activities to occur simultaneously, are:

- Commercial vessel navigation may be restricted in the channel at times when naval vessels are navigating the channel.
- Anchorage congestion may affect DoD training operations.
- The proximity of the Federal channel to Naval Station Norfolk's waterfront restricts vessel speed in the channel.

The specific issues contributing to the third problem, existing anchorages are insufficient to fully accommodate existing vessel fleet (depth, quantity, dimensions), are:

- Lack of deep anchorages within the harbor causes delays in transits.
- Anchorage Alpha is the only place where deeper ships can anchor and is also located within a primary DoD training/exercise area which makes access available only with prior Navy authorization.

- Deep draft ships at anchorage compete with Navy training assets for water space off the Lynnhaven Anchorages (listed on NOAA charts as Anchorages A-E) because these are currently the only locations capable of accommodating both.

4.1.2 Opportunities

Opportunities are the desirable future outcomes which address the water resource problems and improve conditions in the study area. Opportunities identified for this analysis include:

- Beneficial Use of Dredged Material. The dredged material from the channel improvements is a potential resource for environmental restoration, beach nourishment, flood control structures, and Craney Island Eastward Expansion fill.
- More Efficient Transport of Commodities. Deeper channels would allow vessels to load more cargo and increase transportation efficiency of commodities. Additionally, if fewer vessels are restricted by tides, congestion and 'bunching' of ships will be relieved, allowing for more efficient flow of vessels in and out of the channels. Wider channels might reduce restrictions on vessels meeting or overtaking, which would reduce delays and transportation costs in the channel. Less restricted navigation could allow for more steady flow of vessels into berths and allow more efficient use of landside infrastructure.
- Reduce Impacts to Commercial Traffic due to DoD Activities. Improved channel configuration could possibly allow for both commercial and DoD activities to occur simultaneously. Improved anchorages could allow Navy and commercial users of the channels and anchorages to operate more efficiently.
- Improved safety of navigation. With channels designed to accommodate the fleet, navigational safety would likely be improved.

4.1.3 Planning Constraints

Constraints are conditions to be avoided or things that cannot be changed, which limit the development and selection of alternative plans. Specific constraints for this analysis include:

- Avoid impact to existing infrastructure, including bridges and tunnels, located within the study area. The Chesapeake Bay Bridge Tunnel (CBBT) and Hampton Roads Bridge Tunnel (HRBT) are located within the study area. The elevation of the Chesapeake Bay Bridge Tunnel (-58 MLLW to top of protective cover) constrains project depth in this reach to be no more than -55 ft, MLLW, which allows for one foot of advanced maintenance in this reach and two feet of overdepth dredging (see Appendix A section 8.1.1 Chesapeake Bay Bridge Tunnel)
- Avoid or minimize impacts to DoD facilities and activities in the study area. This includes maintaining required anti-terrorism/force protection buffer space between the channel and Naval Station Norfolk infrastructure and minimizing the hydrodynamic effects of passing ships on assets along the shoreline and/or in the channel. Also avoid or minimize impacts to buried assets (cables, sensors, etc.) and training areas and ranges within the study area.
- Avoid or minimize impacts to natural and historic resources within the study area. There are two known shipwrecks, the CSS Florida and USS Cumberland, which are located within the study area near the Newport News Marine Terminal. Also, avoid or

minimize impacts to various environmental mitigation and restoration sites within the study area.

- Avoid or minimize impacts to recreational boaters and commercial fishermen that also utilize the channels.

4.1.4 Objectives

Federal Objective:

The Planning Guidance Notebook (ER 1105-2-100, dated 22 April 2000) states that "water and related land resources project plans shall be formulated to alleviate problems and take advantage of opportunities in ways that contribute to study planning objectives and, consequently, to the Federal objective" (page 2-1). Plan formulation has been conducted for this GRR/EA with a focus on achieving the Federal objective of water and related land resources project planning, which is to contribute to National Economic Development (NED) consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements (Principles and Guidelines, 1983).

Planning Objectives:

The goal of this study is to reasonably maximize Norfolk Harbor's contribution to national economic development (NED), consistent with protecting the Nation's environment, by addressing the physical constraints and inefficiencies in the existing navigation system's ability to safely and efficiently serve the forecasted vessel fleet and process the forecasted cargo volumes. Specific objectives for this study are:

- Reduce cargo transportation costs for the existing and future fleet over the period of analysis at Norfolk Harbor
- Reduce navigation operational constraints caused by one-way traffic in certain reaches for the existing and future fleet over the period of analysis at Norfolk Harbor.

4.1.5 Assumptions

Modeling and Planning took into consideration the following assumptions:

- Underkeel Clearance Assumption (inner harbor) – 4.3 feet
- Useable Tide – 2 feet
- Reduced vessel take place by allowing traffic to become more efficient
- Discount Rate (i) – 2.75%
- Duration (n) – 50 years
- Base Year – 2024
- FY 2018 Price Levels
- Model Years – (2023, 2030, 2035, 2040, 2045)
- Maximum channel depth at Chesapeake Bay Bridge Tunnel is -58 feet

4.2 Management Measures, Screening, and Alternatives

The management measures identified were developed with information gathered during discussions and interviews with Norfolk Harbor operations and management personnel, Norfolk Harbor Pilots Association, terminal operators, shipping agents, and tugboat operators that work in Norfolk Harbor. The PDT compiled a list of measures for this study during a meeting held on September 16th, 2015.

Two structural measures, channel deepening and widening, advanced through the screening process to be used in the development of alternatives. Management measure identification and screening is presented below.

4.2.1 Structural Measures

Structural measures identified as potential improvements to Norfolk Harbor include:

- Channel deepening;
- Stepped channel;
- Improve existing turning areas and/or create new turning areas;
- Improve existing anchorages and/or create new anchorages;
- Channel widening.

Channel deepening

Deepening the existing channel could potentially allow for deeper and more efficient loading of the existing fleet and allow for the efficient use of larger vessels. The evaluation of deepening needs to include the deepening of berthing areas and consider the use of tidal advantage. Tidal advantage is the use of high tide to provide additional underkeel clearance, which allows vessels with deep drafts to transit the channel. This is a common practice within the study area that is projected to continue into the future. The use of tidal advantage is included as a standard operating procedure in the evaluation of alternative plans. This measure was carried forward.

Stepped channel

In a stepped channel configuration, the outbound lane would be dredged more deeply than the inbound lane. The outbound lane would be designed to accommodate deeply laden outbound traffic. The inbound land would be shallower than the outbound lane under the presumption that inbound traffic would have less cargo and thus be operating at shallower drafts. This configuration was used at Norfolk Harbor prior to the 2007 deepening of the inbound channel. The stepped channel configuration would be insufficient for existing and projected future conditions at Norfolk Harbor because inbound container traffic currently is loaded nearly as deeply as outbound traffic and can be expected to be loaded even more deeply as deepening projects at other U.S. east coast container ports completed to address the recent deepening of the Panama Canal. Therefore, a stepped channel configuration was not carried forward.

Improve existing/create additional turning areas

With one minor exception, turning vessels in Norfolk Harbor is not a problem under existing conditions and is not projected to be a problem under future conditions. The minor exception is that infrequently (12 times in 2014) coal vessels transited from a coal pier at Newport News to a coal pier at Lamberts Point, which requires a sharp turn where the channel from Newport News meets the channel to Lamberts Point. The infrequency of occurrence and the potentially small amount of travel time that might be saved each year indicates that it is highly unlikely that providing additional turning area would be economically justified. Therefore, expanding turning areas were not carried forward.

Improve existing/create additional anchorages

Anchorage F, which is currently designated for commercial vessels, is not deep or wide enough for existing and future vessels. Based on interviews with Harbor Pilots operating in Norfolk Harbor, Anchorage F will be considered integral to the function of the channel increment from the Ocean to Lamberts Point and was initially considered to be included with the channel as part of the deepening measure evaluation for that reach. The cost of deepening Anchorage F was initially projected to be approximately 2% of the cost of deepening the channel increment from the Ocean to Lamberts Point. While there was a low incremental cost of anchorage improvements, it was determine that the anchorage would still need to be incrementally justified as a separable component of the project. Anchorage F was evaluated for both deepening and widening as the anchorage is currently not suitable for future fleet forecast which would not fit within the area. It is recommended that a separate study effort be initiated to evaluate anchorages in Norfolk Harbor as warranted with future needs as this project only consider one of the existing anchorages.

Channel widening

Channel widening to create a meeting area or meeting areas could potentially reduce the restrictions on vessels meeting in the channel. This measure was carried forward. Additionally, widening the TSC to create a meeting area may incorporate areas adjacent to the existing channel that are naturally deep and/or areas that have historically been a borrow source for beach fill material.

4.2.2 Nonstructural Measures

Non-structural measures identified as potential improvements to Norfolk Harbor include:

- Reduce vessel speed in the channel;
- Increase the use of tugboat assistance to improve vessel maneuverability;
- Improve vessel scheduling and timing of transits (Vessel Traffic System);
- Relocate aids to navigation to take advantage of naturally deep areas; and
- Use lightering.

Reduce vessel speed in the channel

Reducing vessel speed while transiting the channel will reduce the amount of squat affecting the vessel. Reducing vessel squat would allow the vessel to ride higher in the water, thereby reducing the vessel's draft while transiting the channel. Implementation of vessel speed reduction is constrained by the need to maintain sufficient speed for maneuverability and the need to reduce crab angle when transiting the channel under windy conditions. The amount of squat reduction potentially gained by slowing to a minimum safe speed would be inconsequential because vessels typically operate at or very near this speed under existing conditions. Therefore, reducing vessel speed in the channel does not meet the planning objectives, and is not carried forward.

Increase tugboat assistance

Tugboats are used to improve the maneuverability of vessels that have slowed during channel transits, to turn vessels, and to dock vessels. The standard operating practices for tug assistance are sufficient for vessels currently using the channel. Additional tug assistance would not improve the efficiency of vessels transiting the channel because additional use of tugs would not improve vessel loading, increase the size of vessels using the channel, or appreciably increase vessel speed. Additional use of tugs is not carried forward.

Improve vessel scheduling and timing of transits (Vessel Traffic System)

Implementation of a Vessel Traffic System (VTS) could potentially reduce the need for restrictions on vessels meeting in the channel. Vessel Traffic Systems are used at the nation's busiest waterways, such as New York Harbor and the Sabine Neches Waterway and are implemented under the direction of the US Coast Guard. The traffic management system currently employed by the Norfolk Harbor Pilots includes ship to ship and ship to dispatch communication via radio/telephone as ships traverse the harbor. The existing traffic management system moves vessel traffic through the Federal channels as efficiently as current conditions allow and delays are not due to insufficient communication and coordination. Implementation of a VTS in Norfolk Harbor would add more traffic management resources to harbor operations, but would not improve on the traffic management system already in place. Therefore, implementing a VTS at Norfolk Harbor does not meet the planning objectives, and is not carried forward.

Relocate aids to navigation to take advantage of naturally deep areas

Some areas adjacent to the Federal channels at Norfolk Harbor are naturally deeper than Federally maintained channel depths. However, there are not sufficient areas of existing deep water where simply moving the aids to navigation would meet the planning objectives. Therefore, this measure is not carried forward. However, existing deep water areas may be incorporated into channel widening in some areas.

Use lightering

During a lightering operation, a vessel is loaded or unloaded to an operable draft in order to transit the channel. Container ships are not capable of lightering. Most of the deeper draft channel transits are outbound coal transits. Lightering exports requires that the cargo on the vessel making the ocean transit be initially placed onto two light loaded vessels so that the cargo can exit the harbor. The cargo would be consolidated onto one vessel by a cargo transfer operation that would occur in deep water. Lightering for bulk exports is an inefficient operation which is not currently practiced at any of the coal terminals at Norfolk Harbor. Therefore, this measure is not carried forward.

4.2.3 Development of Planning Segments (Local Service Facility Improvements)

Increasing terminal efficiency through the use of more and/or larger cranes and other equipment enhancements could potentially reduce the vessel's time at the dock and/or allow for larger vessels to be loaded and unloaded efficiently. Enhancement options discussed with the users include:

Container Terminals

The use of more and/or larger ship-to-shore cranes could reduce the vessel's time at the dock and/or allow for larger vessels to be loaded and unloaded more efficiently. The impact of this measure is expected to be fairly limited, considering the conditions at Virginia Port Authority/Virginia International Terminals are not negatively affecting operational efficiency. The number of cranes assigned to a vessel is a balance of physical ability of a ship to accommodate the cranes and the availability of crane and container handling resources. A minimum number is typically stipulated in the contract established between the terminal operator and ship line. In general, terminal operations are designed to prioritize vessel service over landside operations to minimize time in berth. Container terminal improvements are not carried forward, however; planned improvements will be included in the without and with-project conditions. Such improvements will be required of VPA prior to implementation of the project per ER-1105-2-100.

Bulk Terminals

Bulk operations have a low-margin/high-volume model where operational efficiency is a critical focus during initial design and during ongoing process improvements. The existing bulk facilities are sufficient for the amount and types of cargo handled. Any marginal improvements to terminal facilities are not projected to have a substantial effect on reducing channel congestion. This measure is not carried forward.

Breakbulk/General Cargo Terminals

General cargo terminals typically have transfer operations that preclude substantial streamlining due to the variability of their cargo. Volume is also likely too low to justify any gains that could be made with substantial investment in automation or other capital investments. This measure is not carried forward.

4.2.4 Screening of Measures

The study constraints and planning objectives were used to screen the range of measures as discussed above. Table 4-1 shows all of the measures considered for this study and the results of initial measures screening.

Table 4-1. Norfolk Harbor Measures Summary

Measure	Notes	Considered in Alternatives
Adjust vessel speed	Vessels already operate at the slowest speed possible without affecting maneuverability	No
Increase tugboat assistance	Standard tug operations are sufficient and additional tugs would not improve transportation efficiency	No
Traffic Management (Vessel Traffic System)	USCG and Pilots collaborate for effective traffic management	No
Relocate Aids to Navigation	There is insufficient area adjacent to channels that is	No

Measure	Notes	Considered in Alternatives
	deep enough to provide transportation cost savings	
Use lightering	Lightering would not increase efficiency because most deep draft vessels are bulkers carrying exports	No
Terminal Improvements	Projected terminal improvements are included in the without-project condition, additional improvements would not substantially improve transportation efficiency	No
Channel Deepening	Includes deepening of berthing areas, projected to improve transportation efficiency; evaluation of deepening considers use of tidal advantage	Yes (Anchorage F is considered to be a separable element from the channel and will be incrementally justified reach for deepening evaluation)
Stepped Channel	Inbound and outbound lanes at different depths is impractical because vessels use full channel depth in both directions	No
Improve Existing/Create Additional Turning Basins	Turning vessels in the harbor is not a problem	No
Improve Existing/Create Additional Anchorages	Existing anchorage capacity is insufficient for current and projected fleet, however, it is recommended that anchorage improvements be considered in a separate study due to current study cost and time constraints	No
Channel Widening	Widening to create meeting area(s) may improve transportation efficiency, there is existing deep water adjacent to the channel (ex. Thimble Shoal Auxiliary Channels)	Yes

4.2.5 Measures Carried Forward

The measures carried forward for consideration in the development of alternatives are shown in Table 4-2. These measures were combined using the plan formulation strategy developed by the PDT to form a focused array of alternatives.

Table 4-2. Norfolk Harbor Alternative Plan Measures

Measure	Description
Deepening	Segment 1 Channel Deepening[1] (includes Anchorage F)
	Segment 2 Channel Deepening
Widening[2]	Meeting Area 1 (Harbor side of the CBBT in the Thimble Shoal Channel)
	Meeting Area 2 (Ocean side of the CBBT in the Thimble Shoal Channel)
	Meeting Area 3 (Norfolk Harbor Reach)
Notes: (1) Deepening includes deepening of channel, berths of terminals in reach, and Anchorage F; deepening will be evaluated in one foot increments from -50 feet MLLW to -55 feet MLLW with additional depth in the Atlantic Ocean Channel(2) All widening (meeting areas) are located in Segment 1	

The deepening measure includes channel deepening in Segments 1 and 2. Deepening was evaluated in one foot increments for depths ranging from -50 to -55 feet and possibly deeper than -55 feet if needed to maximize project benefits (Note the maximum depth constraint at the CBBT limits depth in Thimble Shoal to a maximum of -58 feet (-56 feet plus 1 foot paid and 1 foot unpaid dredging) which in turn limits the maximum inner harbor depth to -55 feet due to vessel performance). Depth at the AOC was thus adjusted to match usable depth within the inner harbor and Thimble Shoal as the maximum depths to be used in the analysis. Maximum nominal depths are -55 feet for the inner harbor, -56 feet at the Thimble Shoal and -59 feet at the AOC. Deepening Anchorage F is considered to be separable from Segment 1 channel deepening and will be evaluated incrementally. Deepening of the channel in Segment 2 is dependent on the deepening of Segment 1, therefore, the range of depths evaluated for Segment 2 may be smaller than the range evaluated for Segment 1 if the incremental justification of Segment is less than Segment 2.

Widening was considered in three different areas within Segment 1. Meeting Area 1 is located on the Thimble Shoal Channel on the harbor side (inside) of the Chesapeake Bay Bridge Tunnel (CBBT). Meeting Area 2 is located on the ocean side (outside) of the CBBT. The existing conditions is a 1,000 foot channel within each meeting area. Projected initial dimensions for each meeting area (including existing channel) are approximately 1200 feet wide by a minimum of 1.5 miles long (similar to meeting area dimensions used for Savannah Harbor). Figure 4-1 shows the location of Meeting Areas 1 and 2.

Figure 4-1. Meeting Areas 1 & 2

Meeting Area 3 is the widening of the Norfolk Harbor Reach to address the Harbor Pilots' request to relieve congestion that occurs in the channel between Sewells Point and NIT. This relatively short portion of the channel carries all the traffic from the Elizabeth River and Southern Branch of the Elizabeth River, VIG, Norfolk Southern Coal Terminal, and NIT. Figure 4-2 shows the location of Meeting Area 3.

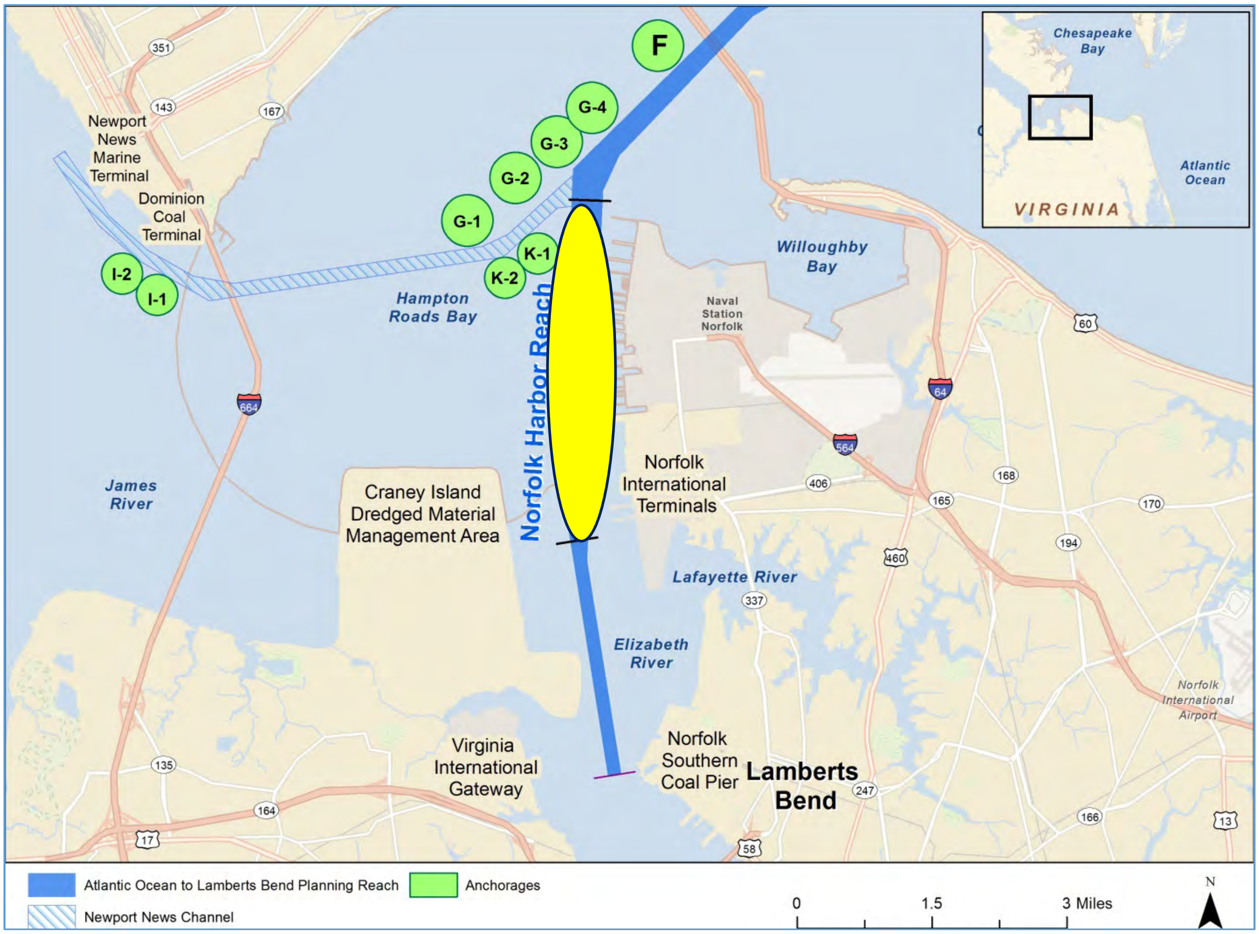

Figure 4-2. Meeting Area 3 Shown in Yellow

4.3 Focused Array of Alternatives (Formulation of Alternatives)

Once measures were established and initial screening completed (Table 4-3), a PDT meeting was held on November 4, 2015 to develop a plan formulation strategy. This strategy was used to combine the different measures under consideration (Table 4-4) into alternatives. Based on the configuration of the channels and vessel traffic in the study area, a phased approach was established as the best plan formulation strategy. The key considerations driving a phased approach are:

- Vessels must navigate through Segment 1 to reach Segment 2, so the deepening of Segment 2 is dependent on Segment 1.
- Channel deepening will change the vessel traffic conditions, so channel widening (meeting areas) should be evaluated after the channel depth(s) is established.

The plan formulation strategy for this study includes four phases or steps that, when executed sequentially, result in a focused array of alternatives. In the first phase, deepening of Segment 1 will be evaluated (Table 4-3 shows planning reaches). During this step, a range of depths (one foot increments from -50 to -55+ feet) were evaluated using HarborSym to select a depth for Segment 1. In the second phase, deepening of Segment 2 will be evaluated using HarborSym just as was done for Segment 1 in the first phase, but the range of depths will be capped at the depth selected for Segment 1. This means that Segment 2 can only be the same depth or shallower than Segment 1 because Segment 2 is dependent on navigation improvements in Segment 1. Therefore, the future without project condition for the Segment 2 analysis in HarborSym will include the Segment 1 plan. Once depths have been selected for Segments 1 and 2, meeting areas (channel widening) will be evaluated in the third phase. The widener within the Norfolk Harbor Entrance Channel was determined not be a primary requirement by the project and not supported by the Harbor Pilots as long as Anchorage F was being developed. Its location was south of segment two and thus would not be fully utilized by the project whereas the other two wideners we be fully utilized by the project. Thus it was removed from further consideration as only wideners within Thimble Shoal were carried forward. The fourth and final phase of plan formulation is the deepening of Anchorage F. Anchorage F is an independent variable and will be evaluated using HarborSym just as was done for Segment 1, but the range of depths will be capped at the depth selected for Segment 1. Table 4-3 shows the phased plan formulation strategy in more detail.

Table 4-3. Phased Formulation Strategy

STEP 1: Evaluate and select a depth for Segment 1		
Alternative	Planning Segment	Depth
Alt 1_{Step1}	Segment 1	-50
Alt 2_{Step1}	Segment 1	-51
Alt 3_{Step1}	Segment 1	-52
Alt 4_{Step1}	Segment 1	-53
Alt 5_{Step1}	Segment 1	-54
Alt 6_{Step1}	Segment 1	-55+
STEP 2: Evaluate and select a depth for Segment 2 Given depth selected for Segment 1		
Alternative	Planning Segment	Depth
Alt 1_{Step2}	Segment 1 Deepening Plan + Segment 2	-50
Alt 2_{Step2}	Segment 1 Deepening Plan + Segment 2	-51
Alt 3_{Step2}	Segment 1 Deepening Plan + Segment 2	-52
Alt 4_{Step2}	Segment 1 Deepening Plan + Segment 2	-53
Alt 5_{Step2}	Segment 1 Deepening Plan + Segment 2	-54
Alt 6_{Step2}	Segment 1 Deepening Plan + Segment 2	-55+
STEP 3: Evaluate widening given depth(s) selected for Segment 1+2 (Final Array)		
STEP 4: Evaluate incremental depths of Anchorage F		

Using the phased plan formulation strategy (Table 4-3), the measures under consideration can be organized into a focused array of alternative plans. The focused array of alternative plans is shown in Table 4-4.

Table 4-4. Norfolk Harbor Focused Array of Alternatives

Alternative Plan	Components
Alt 1	No Action
Alt 2	Segment 1+2 Deepening Plan + No widening
Alt 3	Segment 1+2 Deepening Plan + Meeting Area 1
Alt 4	Segment 1+2 Deepening Plan + Meeting Area 2
Alt 5	Segment 1+2 Deepening Plan + Meeting Area 1 and 2
Alt 6	Segment 1+2 Deepening Plan + Widening Plan + Anchorage F

Evaluation criteria were developed by the PDT based on the planning objectives and constraints.

Table 4-5. Draft Evaluation Criteria

Criteria	Metric	Inventory	Notes
Project Costs	Dollars	Dredged Quantities & Unit Costs	Data is available to develop cost estimates
Economic Benefits	Dollars	Commodity and Fleet Forecasts	HarborSym will be used to calculate transportation cost savings
Environmental Benefits	Yes/Neutral	Best Professional Judgment	Beneficial use of dredged material
Environmental Impacts	Significance/Intensity	Water Quality Modeling	Potential increase in tidal prism
Contribution to Federal Objective	Y/N	Qualitative Assessment	Systems of Accounts analysis
Meets Planning Objectives	Y/N	List objectives met	
Avoid Planning Constraints	Y/N	List constraints not avoided	

4.4 Comparison of the Final Array of Alternatives

Utilizing the evaluation criteria, a comparison of the six alternatives is needed to help in the evaluation of each of the selected alternatives carried forward from the final array. Project costs were developed for each of the alternatives utilizing projected volumes and associated history of construction costs. The Corps' nationally certified HarborSym model was run to determine economic benefits through optimization depths for Segment 1 (Step 1) and Segment 2 (Step 2) incrementally, along with the proposed widening of the Thimble Shoal Channel (Step 3) and Anchorage F (Step 4). The depth for Segment 1 was incrementally justified prior to calculating the benefits for Segment 2. The benefits of the proposed channel widening were calculated once the optimal depth for both Segments 1 and 2 were identified. Anchorage F benefits associated with the proposed deepening project were developed during project optimization such that they are consistent with National Economic Policy to create a Recommend Plan.

The environmental benefits account considers non-monetary effects on ecological, cultural, and aesthetic resources. Under this account, the preferred plan should avoid or minimize environmental impacts and maximize environmental quality in the project area. Beneficial use sites are described in Chapter 2 and to the extent practicable will be available for use.

Consideration of environmental impacts are incorporated as part of this integrated study as an Environmental Assessment was conducted and significance and intensity are described for the preferred alternative within chapter 6 of this document.

Finally, it was determined that each of the actionable alternatives would contribute to the Federal objectives while only alternative 6 meets all of the planning objectives for minimizing planning constraints. Each of the actionable alternatives would reduce cargo costs while the no action alternative would see continued fleet and cost inefficiencies continue. The use of widening plan with alternative 5 and 6 would assist with the reduction of one way traffic. But only alternative 6, with the increased depths and functionality associated with Anchorage F, provides assistance with deep anchorages and reduction of reduced conflicts with naval operations that exists with other anchorages within the harbor. Details on the acceptability of this alternative are discussed throughout various sections of this document. Additional information is also available in the attached appendices.

4.5 Alternative Plan Costs

4.5.1 Construction Assumptions

Construction assumptions are feasibility level assumptions regarding the proposed alternative channel modification actions. Estimates of materials and methods necessary to construct and maintain the different channel improvement alternatives were developed using the USACE's Cost Engineering Dredge Estimating Program (CEDEP), best professional judgment, and previous analyses for similar, completed projects. These construction assumptions are the basis for project cost estimates and environmental impact assessments.

Segment 1 - Construction Methods, Schedule, Dredging Equipment, and Material Placement

Construction of the Norfolk Harbor project will consist of dredging, dredged material placement at CIDMMA and Dam Neck ODMDS, and placement of rock cover over the CBBT in TSC (See Appendix A). Navigation buoys will be relocated to accommodate the new channel dimensions. No new ranges are required because the project is based on the existing channel centerline, which will not be relocated.

Construction Dredging of Focused Array

Prior to all dredging, sediment sampling will be performed to ensure that materials are suitable for their proposed placement locations and the appropriate permits will be obtained. All dredging will be performed within the voluntary environmental windows established by the USACE to protect sea turtles from hopper dredging during the fall migration period when there is a higher density of sea turtles in the Atlantic Ocean and Thimble Shoal channels. To the maximum extent practicable and dependent on mission requirements, a time-of-year restriction for hopper dredging in the lower Chesapeake Bay will be followed from September 1 through November 15 to avoid impacting sea turtles during the fall migration period when there is a high density of sea turtles in the lower bay preparing for migration south. There are no time-of-year restrictions for the remaining channels in the Norfolk Harbor project.

Overall, the dredging component of the Norfolk Harbor project improvement project could extend up to seven years depending if all of the final channel depth and width selections (the actual construction schedule on recommended plan is located in Appendix A) are selected as the recommended plan. Dredging will be performed by crews working 12-hour shifts 24 hours per day and seven days per week. Although dredging crews are projected to be on-site and working as described above, dredging production will likely be limited to 25 days per month due to necessary set up, break down, and maintenance operations.

Dredging will be performed by a 7,600 CY capacity hopper dredge in the Atlantic Ocean Channel, Thimble Shoal Channel (east and west of the CBBT), and in the meeting area. Excess water will be decanted on-site. The dredged material will be hauled to the placement area at the Dam Neck Offshore Disposal Site and dumped from the split-hull vessel. Average one-way haul distances include:

- Atlantic Ocean Channel: 9 miles;
- Thimble Shoal Channel East: 17 miles
- Thimble Shoal Channel West: 26 miles;
- Meeting Area 1 (west): 25 miles; and
- Meeting Area 2 (east): 17 miles.

The hopper dredge would be assumed to operate 24/7, with personnel shifts assumed to be eight hrs/day, seven days a week. A total of 27 personnel would be assumed to operate the cutterhead dredge including personnel for three shifts. The hopper dredge would be assumed to be actively dredging for 390 hrs/month with a dredging capacity of 379,000 CY per month.

Dredging will be performed in the interior channels (Norfolk Harbor Entrance reach, Channel to Newport News, Sewells Point to Lamberts bend, Craney Island reach, and Anchorage F) by a 30-inch cutter head. Dredged material will be pumped to CIDMMA. Average pumping distances are approximately 30,000 feet, with the exception of the channel to Newport News, which has an average pumping distance of 43,000 feet and has an additional booster pump requirement. The pipelines would discharge upland of the main dikes on the east side of CIDMMA where routine operation has excess water sampled and tested, and then decanted through the manually operated spill boxes on the west side of CIDMMA.

The cutterhead dredge would be assumed to operate 24/7, with personnel shifts assumed to be eight hrs/day, seven days a week. A total of 55 personnel would be assumed to operate the cutterhead dredge including personnel for three shifts, support staff, and all of the required shore crews. The cutterhead dredge would be assumed to be actively dredging for 340 hrs/month.

Dredging is projected to commence simultaneously at the Atlantic Ocean Channel (with a 7,600 CY capacity hopper dredge) and at the channel reach from Norfolk Harbor Entrance to Lamberts Point (hydraulically dredged with a 30-inch cutter head). After the Atlantic Ocean Channel has been dredged the large hopper dredge will move to Thimble Shoal channel. The meeting areas are projected to be dredged after the completion of Thimble Shoal Channel. The eastern meeting area will require less effort because much of the channel has been used as a borrow area for storm damage protection projects and is therefore at or below project depths. The western meeting area would require complete dredging of new material take approximately three years to complete.

Construction of CBBT Rock Cover

The design of the rock cover over the CBBT will be performed during PED. Several studies have been completed to determine concepts to allow for a deeper channel (USACE, 1986 and Transystems 2002). Both studies concluded the most economical method would be to provide a minimum 5 feet of protective cover, including a minimum of 3 feet of that protective cover be rock armor in place of the 10 feet of sand cover (Appendix A). The main elements of the work are projected to include:

- Dredging the existing sand fill cover over the tunnel to allow the rock blanket to be placed. Dredged sand is assumed to be placed beneficially on the CIEE dikes. Volume of dredged material is estimated to be 102,000 cubic yards (CYs).
- Placing the 3 feet thick rock blanket. The rock is assumed to be a nominal 10-inch diameter. Volume of rock is 20,300 CYs. Rock is assumed to come from existing and permitted upland quarries along the James River (near Richmond).
- Backfill excavated slopes on either side to the tunnel to elevation -59-feet with sand. This sand would be from upland sources, also from permitted borrow areas up the James River. Estimated volume of sand is 46,500 CYs.

Most of the dredging and fill placement will be within the limits of the existing 1,000-foot wide Thimble Shoal Channel. However, preliminary investigations indicate that the cover extending approximately 100-feet beyond the existing toe of channel. Therefore the bottom impacts include:

- Area disturbed within the channel limits = 237,162 square feet (5.4 Acres)
- Area disturbed beyond the existing toe of channel = 50,555 square feet (1.2 Acres)

Historical Maintenance Dredging

A desktop analysis has been conducted for a first-order estimate of the maintenance dredging rate to be expected in the navigation channels following deepening. Historic maintenance dredging records were provided by the USACE for the period 1980 to 2014, and reviewed to inform the desktop analysis (USACE 1994, USACE 2016). The available maintenance dredging records were used to develop an estimate of the annual sedimentation rate within the navigation channels in the study area. Historical (from 1980 onwards) and recent data were examined and used for developing the sedimentation rate (see Engineering Appendix A Section 5 Future Maintenance Quantities).

The Norfolk Harbor project has been dredged periodically to maintain channel dimensions. An analysis of maintenance dredging records from 1980 to 2014 indicates that maintenance dredging occurs on a nearly annual basis (30 out of 34 years) with an average dredged material volume of 1.53 MCY per event. Although maintenance dredging of the project occurs on a nearly annual basis, individual channel reaches are typically dredged on a longer cycle of every other year or longer so that dredging occurs most every year with channel reaches alternating from year to year. Dredged material placement follows a consistent pattern of CIDMMA receiving material from the inner channels and Dam Neck ODMDS receiving material from TSCI and the AOC. Table 4-6 presents annualized historical maintenance dredging material volumes for the Norfolk Harbor since the deepening to -50 feet (2007).

Table 4-6. Norfolk Harbor Channels Historical Maintenance Dredging Volume

Channel	Placement Site	Annualized Volume (CY)
Norfolk Harbor Craney Island Reach	CIDMMA	570,600
Norfolk Harbor Entrance Reach	CIDMMA	163,000
Newport News Channel	CIDMMA	109,600
Thimble Shoal Channel	Dam Neck ODMDS	325,600
Atlantic Ocean Channel	Dam Neck ODMDS	164,400
Annualized Total		1,333,200

4.5.2 Maintenance Dredging Assumptions

With-project Conditions Maintenance Dredging

Under with-project conditions, maintenance dredging volumes are projected to increase, with the largest increases in the AOC and TSCI (Table 4-7). The total projected maintenance dredged material volume over the 50-year study period, under with-project conditions, is 99.8 MCY. Note that under with-project conditions, CIDMMA is projected to stop receiving dredged material by approximately 2034 and maintenance material from the inner channels will be placed at the Norfolk Ocean Disposal Site (Further information can be found in Appendix A&D).

Table 4-7: Norfolk Harbor Channels With-Annualized Project Maintenance Dredging Volume

Channel	Annualized Volume (CY)	% Increase Over Without-Project Conditions
Norfolk Harbor Craney Island Reach	648,000	14%
Norfolk Harbor Entrance Reach	199,000	22%
Newport News Channel	133,500	22%
Thimble Shoal Channel	486,600	49%
Atlantic Ocean Channel	303,800	85%
Total	1,770,900	33%

4.5.3 Without Project Maintenance Dredging Assumptions

Without-project Conditions Maintenance Dredging

Under without-project conditions, recent historical maintenance dredging practices are projected to continue. Maintenance dredging will continue on an assumed annual basis with individual channel reaches being dredged in alternate years as needed. The total projected maintenance dredged material volume over the 50-year study period is 66.7 MCY. Note that by approximately

2044 CIDMMA is projected to stop receiving dredged material and maintenance material from the inner channels will be placed at the NODS.

4.5.4 With Project Initial Dredging Assumptions

Dredged Areas and Volumes Summary

Dredged areas and volumes are presented (Tables 4-8 and 4-9) for the range of alternatives assessed in the final array of alternatives. The smallest project alternative is a nominal 52 foot channel without the addition of meeting areas in Thimble Shoal Channel. The largest project alternative is a nominal 56 foot channel including two meeting areas at Thimble Shoal Channel.

Table 4-8. Cost Estimate Volume

	Cost Estimate Volume		**CIDMMA**		**Dam Neck**	
	-52	-56	-52	-56	-52	-56
Segment 1	6,479,000	26,932,000	1,654,000	8,089,000	4,824,000	18,843,000
AOC	2,110,405	8,419,809	-	-	2,110,405	8,419,809
TSC	2,713,989	10,423,074	-	-	2,713,989	10,423,074
NH Inner	1,654,144	8,088,731	1,654,144	8,088,731	-	-
Segment 2	185,000	2,394,000	185,000	2,394,000	-	-
NNC	184,891	2,394,039	184,891	2,394,039	-	-
Meeting Areas	3,102,000	5,455,000	-	-	3,102,000	5,455,000

Table 4-9. Range of Disturbances

	Channel Footprint			**Acres Dredged**			**Months Dredging**	
Segment	Current Depths	-52 Feet	-56 Feet	Current Depths	-52 Feet	-56 Feet	-52 Feet	-56 Feet
Segment 1	5,582	5,627	5,762	278	2,144	3,742	13.9	52.3
Segment 2	619	623	644	12	134	486	0.5	2.1
MA 1 & 2	0	304	321	0	303	321	10.3	18.0
Anchorage F	572	573	575	0	25	183	0.1	0.8
Total	6,773	7,127	7,302	290	2,607	4,731	25	73

4.5.5 Construction Assumptions Summary on Focused Array

The projected dredging will take up seven years depending if all of the final channel depth and width selections (the actual construction schedule on recommended plan is located in Appendix A) are selected as the recommended plan. The project is expected to increase maintenance costs for the channel with over 30 million additional cubic yards being removed from the widened and deepened channel. Over the course of the 50 year life of the project, materials will no longer be able to be sent to the CIDMMA and the NODS site will be the primary disposal location for maintenance materials.

4.5.6 Construction and Investment Costs

Construction and Investment Costs

Dredging quantities were developed based on the latest condition surveys provided by the USACE. Dates of the surveys are noted in the Engineering Appendix. Quantities include 1 Vertical to 3 Horizontal side slopes, to match existing channel width. With the exception of the two meeting areas in the TSC, no channel widening is considered in plan formulation. Volume calculations were completed for each channel reach at 1 foot increments to inform plan formulation. AutoCAD® Civil 3D® software was used to perform the volume calculations. Volumes are broken into “dredging zones”, to clarify the calculated volumes, as identified in the following Figure 4-3.

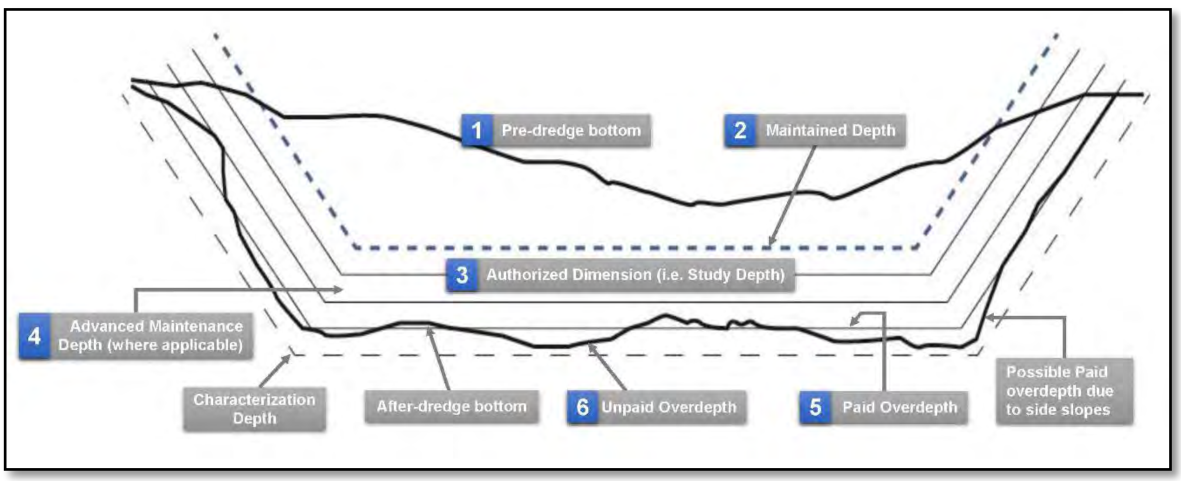

Figure 4-3. Typical Channel Cross Section with Dredging Zones and Channel Nomenclature

1. Pre-Dredge/ Existing Grade/Mudline – The mudline based on the latest condition survey of the channel.
2. Maintained Depth – Without-Project Condition - The maintenance quantity is the volume of dredging required to dredge from the existing condition (based on the latest condition survey of the channel) to the currently maintained channel dimensions. This volume to restore the channel to the District’s historically maintained depth is included for inclusion in the Dredged Material Management Plan, but is not a new work dredging cost.
3. Authorized Dimensions / Project Depth / Grade – This is the Nominal Depth used for Plan Formulation Increments and includes consideration for Underkeel Clearance (UKC). UKC is further discussed below.
4. Advanced Maintenance – For cost estimates the inner channels include 1’ of advanced maintenance.
5. Allowable (Paid) Overdepth – To be consistent with historic dredging in these project reaches, 1’ of paid overdepth is included.
6. Over-dig (Non-Pay/Unpaid) Overdepth – Non-pay volume is dredging beyond the new work quantity above due to inaccuracies in dredging, dredge type, dredge area, wind

and wave conditions, etc. For cost estimates, the volume of non-pay dredged is based on the dredging area. For hydraulic (cutterhead) dredges, this equates to about ½ foot of non-pay depth, while the hopper dredges average less non-pay volume with about 3 inches. These non-pay volumes are based on assumptions developed in the Cost Engineering Dredge Estimating Program (CEDEP) worksheet that accounts for the efficiency of the dredges for each reach based upon the areas, volume, amount of pay, amount not dug on average, and the amount dug in excess of the allowable pay amount, any many other factors associated with dredging operations. CEDEP is the basis for the unit cost for dredging. For NEPA documentation non-pay volume is considered a contingency allowance to be included in the total for new work improvements. Note the inclusion of non-pay is in accordance with a USACE memorandum (USACE, 2006) providing guidance on adequacy of describing the total volumes to be dredged (ex. Allowable overdepth and non-pay volumes).

Project Costs

Dredging costs (Table 4-10) are developed using the Corps of Engineers Dredge Estimating Program (CEDEP) worksheet that accounts for the efficiency of the dredges for each reach based upon the areas, volume, amount of pay amount not dug on average, and the amount dug in excess of the allowable pay amount, any many other factors associated with dredging operations. All costs associated for the contractor including overhead, profit, and bonds are included in the unit price calculated. The CEDEP spreadsheet also calculates costs for mobilization and demobilization, which are provided separately from the unit costs. It was assumed that the USACE would provide the post construction survey, so no cost was estimated with regards to surveys (note: the contractor is assumed to have a surveyor of their own, but no surveys were included for the owner). For the initial deepening scenarios, it is assumed that the initial mobilization is included in the maintenance dredging (where applicable). In addition, local service facility construction costs, which consist entirely of berth dredging, were estimated in a manner similar to channel dredging costs.

There are numerous submerged utilities that cross the project area, but none have been found to require relocation for the alternatives evaluated (see Engineering Appendix Section 8 Constraints). Rock cover over the CBBT will be placed as a necessary construction component of Segment 1. These costs are identified as mitigation for damages and are included in the Land, Easements, Rights of Way & Relocations (LERRs) category.

Pre-construction, engineering and design (PED) costs are estimated for input into the total project costs. The estimate for PED includes a breakdown of field work including Cultural Resources, sediment sampling and testing, engineering and surveys to assemble bid documents, as well construction management and support through construction.

An Abbreviated Risk Analysis (ARA) was performed to evaluate uncertainties associated with each major construction cost item or feature in coordination with input with other members of the project development team. The ARA was developed via Cost Planning Center of Expertise guidelines. The ARA updated into a complete Cost Risk Analysis (CRA). The CRA was developed via Cost Planning Center of Expertise guidelines.

Costs are presented for nominal project depths (-52 feet – -56 feet) (Table 4-10) and for nominal meeting area widths (1,200 feet and 1,400 feet). Note that without-project condition widths in the proposed meeting areas are 1,000, which means that channel widening in Meeting Areas 1 and 2 would include an additional 200, 300 or 400 feet.

Section 101 of the Water Resources Development Act of 1986 specifies project cost sharing between the Federal government and the non-Federal sponsor is based on material being dredged from waters deeper than 50 feet (cost-shared 50% Federal / 50% non-Federal). The non-Federal sponsor is also responsible for an additional payment of 10% of the cost of the general navigation features of the project in cash over a period not to exceed 30 years, at an interest rate determined. The non-Federal sponsor shall also pay 50% of the excess cost of operation and maintenance of the project over that cost which the Secretary determines would be incurred for operation and maintenance if the project had a depth of 50 feet (additional cost requirements are located in Section 10 of this report). A breakdown of cost apportionment is located in Table 4-11.

Table 4-10. GNF Construction Cost by Segment ($000's)

	-51 feet	**-52 feet**	**-53 feet**	**-54 feet**	**-55 feet**	**-56 feet**
Segment 1	$96,630	$133,296	$173,017	$216,172	$262,488	$96,630
Segment 2	$8,961	$12,205	$15,435	$18,949	$21,876	$8,961
MA #1 1,200 feet	$20,160	$23,797	$26,588	$29,455	$32,497	$20,160
MA #1 1,400 feet	$36,153	$42,675	$47,680	$52,878	$58,277	$36,153
MA #2 1,200 feet	$8,283	$9,766	$11,307	$12,763	$14,261	$8,283
MA #2 1,300 feet	$13,515	$15,934	$18,448	$20,846	$23,268	$13,515
Anchorage F	$7,012	$7,613	$8,200	$9,367	$11,225	$7,012
Seg1,Seg2, MA 2 1,300-foot width and Anch F at 51 feet	$125,901	$168,230	$213,695	**$262,762**	$314,427	$125,901
Note: GNF construction costs for the NED Plan are identified by **bold font**						

Table 4-11. NED Plan Cost Shares (55-foot nominal depth, MA2 1,300-foot width, Anch F 51 feet)

	Total Cost	Federal	Non-Federal
Dredging Cost (Including Mob / Demob)	$207,366,000	$103,683,000	$103,683,000
Environmental Mitigation	$-	$-	$-
Monitoring	$-	$-	$-
Construction Management	$10,963,000	$5,482,000	$5,482,000
PED	$16,910,000	$8,455,000	$8,455,000
Contingency (11.7%)	$27,523,000	$13,761,000	$13,761,000
Total Construction of GNF	$262,762,000	$131,381,000	$131,381,000
Lands & Damages	$9,060,000	$-	$9,060,000
Total Project First Costs	**$271,822,000**	**$131,381,000**	**$140,441,000**
Non-Federal Berthing Area Dredging Costs	$20,003,000	$-	$20,003,000
Relocating Aids to Navigation	$-	$-	$-
10% GNF Non-Federal	$-	$(17,216,000)	$17,216,000
Total Cost	$291,825,000	$114,165,000	$177,660,000

4.6 Economic Alternative Analysis

A phased approach to plan formulation and economic modeling was used to analyze study alternatives and "build" a Recommended Plan. Norfolk Harbor study measures were grouped into four economic modeling phases based on several factors, including location in the harbor and benefitting docks associated with those phases. Benefits resulting from with each phase are outlined in the sections that follow.

4.6.1 NED Benefits (National Economic Development)

Channel Deepening Benefits

Phase-I: Planning Segment-1

Phase-I of the economic analysis looks at deepening of the AOC, the Thimble Shoal Channel, the Norfolk Harbor Entrance Reach, the Norfolk Harbor Reach, and the Craney Island Reach up to a maximum inner-harbor reference depth of -55 feet. Due to vertical motion and other engineering considerations, outer channels (AOC and Thimble Shoal Channel) require depths greater than the reference depth set by the inner channels (the Norfolk Harbor Entrance Reach, the Norfolk Harbor Reach, and the Craney Island Reach).

Phase-I: Measures:

The following alternatives were analyzed to select the depths that maximize net benefits:

- P1-M2: Deepen AOC to -56 feet; deepen Thimble Shoal Channel to -53 feet; deepen Norfolk Harbor Entrance Reach, Norfolk Harbor Reach, and Craney Island Reach to 52 feet;

- P1-M3: Deepen AOC to -57 feet; deepen Thimble Shoal Channel to -54 feet; deepen Norfolk Harbor Entrance Reach, Norfolk Harbor Reach, and Craney Island Reach to 53 feet;
- P1-M4: Deepen AOC to -58 feet; deepen Thimble Shoal Channel to -55 feet; deepen Norfolk Harbor Entrance Reach, Norfolk Harbor Reach, and Craney Island Reach to 54 feet; and
- P1-M5: Deepen AOC to -59 feet; deepen Thimble Shoal Channel to -56 feet; deepen Norfolk Harbor Entrance Reach, Norfolk Harbor Reach, and Craney Island Reach to 55 feet.

Note that the deepening measures included in Phase-I were analyzed first because they include the AOC and Thimble Shoal Channels, which must be transited by any vessel entering the harbor. Thimble Shoal Channel is also limited to a maximum nominal depth of -56 feet due to the CBBT. Thus, the depth determined in Phase I of the analysis sets the maximum depth possible for other inner-harbor segments, including the depth of the Newport News Planning Reach discussed in Phase II below.

The HarborSym call list for Phase I included container ship and bulker traffic to docks at the Norfolk International Terminal, the Craney Island Marine Terminal, the Virginia International Gateway, the Portsmouth Terminal, and the Norfolk Southern Coal Terminal.

Phase-I: Results/Conclusions

Table 4-12 summarizes the average annual costs, benefits, and net benefits for each Planning Segment-1 deepening alternative. Net benefits are maximized at a depth of -55 feet in the Norfolk Harbor Entrance Reach, the Norfolk Harbor Reach, and the Craney Island Reach, which corresponds with depths of 56 feet in the Thimble Shoal Channel and -59 feet in the AOC. This combination of depths yields average annual net benefits of approximately $67.9 million and becomes the Phase-I Recommended Plan.

Table 4-12. Phase-1 – Norfolk Harbor Planning Reach Deepening Economic Summary (AAEQ)

Alternative	Description*	NED Benefits	NED Costs	Net NED Benefits	BCR
P1-M2	52	$46,949,000	$7,086,000	$39,863,000	6.63
P1-M3	53	$65,555,000	$9,845,000	$55,710,000	6.66
P1-M4	54	$77,324,000	$12,964,000	$64,360,000	5.96
P1-M5	55	**$84,300,000**	**$16,407,000**	**$67,893,000**	**5.14**
* The “Description” represents the inner-harbor depth or reference depth (in feet) associated with each alternative.					

Phase-I benefits are driven by deeper loading of container vessels calling docks at the Norfolk International Terminal, the Craney Island Marine Terminal, and the Virginia International Gateway and of bulkers calling docks at the Norfolk Southern Coal Terminal. The reduction in the number of calls by these vessels results in a decrease in transportation costs (both voyage costs and in-port costs) attributable to Norfolk Harbor.

<u>Phase-II: Planning Segment-2</u>

Phase-II of the economic analysis looks at deepening from the Norfolk Harbor Entrance Reach through the Newport News Channel up to a maximum inner-harbor reference depth of 55 feet. As mentioned previously, vessels accessing the Newport News Channel must pass through the AOC, Thimble Shoal Channel, and Norfolk Harbor Entrance Reach. Because the Phase I analysis resulted in a with-project reference depth of -55 feet, the Phase 2 selected depth must be equal to or less than -55 feet.

Phase-II: Measures

The following alternative depths from the Norfolk Harbor Entrance Reach through Newport News Channel were analyzed to determine the channel depth that maximizes net benefits (Note P-2-M1 is the no action alternative).

- P2-M2: Deepen Newport News Channel to 52 feet;
- P2-M3: Deepen Newport News Channel to 53 feet;
- P2-M4: Deepen Newport News Channel to 54 feet; and
- P2-M5: Deepen Newport News Channel to 55 feet.

Phase-II: Results/Conclusions

Table 4-13 summarizes the average annual costs, benefits, and net benefits for each Planning Segment-2 deepening alternative. A depth of -55 feet from the Norfolk Harbor Entrance Reach through the Newport News Channel maximizes net benefits, with average annual net benefits of approximately $6.1 million, and becomes the Phase-II component of the Recommended Plan.

Table 4-13. Phase-II – Newport News Planning Reach Deepening Economic Summary (AAEQ)

Alternatives	**Description***	**NED Benefits**	**NED Costs**	**Net NED Benefits**	**BCR**
P2-M2	-52	$2,814,000	$501,000	$2,313,000	5.62
P2-M3	-53	$4,827,000	$696,000	$4,131,000	6.94
P2-M4	-54	$6,296,000	$926,000	$5,370,000	6.80
P2-M5	-55	**$7,351,000**	**$1,196,000**	**$6,155,000**	**6.15**
* The “Description” represents the Newport News Channel depth associated with each alternative.					

Phase-II benefits are driven by deeper loading of bulkers exporting coal. The reduction in the number of calls by these vessels results in a decrease in transportation costs (both voyage costs and in-port costs) which translates to project benefits.

Channel Widening Benefits

Phase-III of the economic analysis looks at widening of the Thimble Shoal Channel in 200’ increments from its existing 1000’ channel width to a maximum width of 1400’. The widening phase includes two segments, the 7-mile Thimble Shoal Channel West (TSCW/Meeting Area 1) and the 4-mile Thimble Shoal Channel East (TSCE/Meeting Area 2). The Chesapeake Bay Bridge Tunnel, which runs underneath Thimble Shoal Channel, delineates the boundary between the western and eastern channel segments. The channel stretch separating TSCW and TSCE and passing directly over the tunnel will not be widened. During the optimization it was determined that the east meeting area had the same benefits for both 1400 feet and 1300 feet. Therefore it was determined that the greatest cost to benefits would be achieved by using the 1300 foot meeting area.

Phase-III: Measures

The TSCW and TSCE are separable elements, meaning that each segment can yield benefits without requiring the construction of the other segment. The following alternatives, representing different combinations of channel widths in the TSCW and TSCE segments, were analyzed to select the combination of widths that maximizes net benefits:

- P3-M1: Widen TSCE to 1,200 feet, maintain TSCW at current width of 1,000 feet;
- P3-M2: Maintain TSCE at current width of 1,000 feet, widen TSCW to 1,000 feet;
- P3-M3: Widen TSCE to 1,400 feet, maintain TSCW at current width of 1,000 feet;
- P3-M4: Maintain TSCE at current width of 1,000 feet, widen TSCW to 1,400 feet;
- P3-M5: Widen TSCE to 1,200 feet, widen TSCW to 1,200 feet;
- P3-M6: Widen TSCE to 1,300 feet, widen TSCW to 1,400 feet;
- P3-M7: Widen TSCE to 1,200 feet, widen TSCW to 1,400 feet; and
- P3-M8: Widen TSCE to 1,300 feet, widen TSCW to 1,200 feet.

The Phase-III HarborSym call list represents calls by all vessels visiting docks in the Norfolk Harbor Reach, the Craney Island Reach, the Newport News Reach, and the Elizabeth River Southern Branch (ERSB) channel segment. Widening is designed to allow for two-way traffic in situations where without a Federal widening project only one-way traffic is permitted. By doing this, widening has the potential to reduce waiting time and consequently total time in system and in-port transportation costs for any vessel that transits the channel where widening is being considered. Because all vessels visiting the reaches listed above must pass through the Thimble Shoal Channel to get to/from their destination docks, these vessels have the potential to benefit from TSCW and/or TSCE widening and thus are incorporated into the analysis.

Phase-III: Results/Conclusions

A width of 1300' in the TSCE maximize net benefits, with average annual net benefits of approximately $841 thousand, and becomes the Thimble Shoal Channel widening (economic modeling Phase-III) component of the Recommended Plan. Table 4-14 summarizes the average annual costs, benefits, and net benefits for each widening alternative.

Table 4-14. Phase-III – Widening Analysis Economic Summary (AAEQ)

Alternatives	Description*	NED Benefits	NED Costs	Net NED Benefits	BCR
P3-M1	TSCE1200+TSCW1000	$1,002,000	$605,000	$397,000	1.66
P3-M2	TSCE1000+TSCW1200	$1,694,000	$1,296,000	$398,000	1.31
P3-M3	**TSCE1300+TSCW1000**	**$1,766,000**	**$925,000**	**$841,000**	**1.91**
P3-M5	TSCE1200+TSCW1200	$2,463,000	$1,912,000	$551,000	1.29
P3-M4	TSCE1000+TSCW1400	$2,624,000	$2,862,000	-$238,000	0.92
P3-M8	TSCE1300+TSCW1200	$3,050,000	$2,237,000	$813,000	1.36
P3-M7	TSCE1200+TSCW1400	$3,307,000	$3,490,000	-$183,000	0.95
P3-M6	TSCE1300+TSCW1400	$3,806,000	$3,821,000	-$15,000	1.00

* The "Description" represents the Thimble Shoal Channel East and West widths (in feet) associated with each alternative. For example, "TSCE1200+TSCW1000" represents widening of the Thimble Shoal Channel East to 1200' and maintaining a width of 1000' in the Thimble Shoal Channel West.

Phase-IV: Results and Conclusions

The deepening of Anchorage F to -51 feet maximizes net benefits of approximately $1.3 million for the expansion of the Anchorage F. Associated with this analysis is the assumption that the anchorage will be widened to accommodate the next vessel class of Gen III ships. To accommodate this class the anchorage must be expanded to 3620 feet from its current 3000 feet. Table 4-15 summarizes the average annual costs, benefits, and net benefits for each alternative.

Table 4-15. Phase-IV – Deepening Analysis Economic Summary (AAEQ)

	Alternatives	Description	NED Benefits	NED Costs	Net NED Benefits	BCR
Phase-4 (P4): Anchorage F Improvement Analysis. Outcome: P4-M1 maximizes net NED Benefits for Phase 4.	**P4-M1**	**3620'+-51'**	**$1,547,000**	**$254,000**	**$1,293,000**	**6.09**
	P4-M2	3620'+-52'	$1,549,000	$273,000	$1,276,000	5.67
	P4-M3	3620'+-53'	$1,553,000	$327,000	$1,226,000	4.75
	P4-M4	3620'+-54'	$1,553,000	$407,000	$1,146,000	3.82
	P4-M5	3620'+-55'	$1,555,000	$540,000	$1,015,000	2.88

Net Benefits of Alternative Plans

The components considered in each economic analysis phase can be combined to form comprehensive alternative plans. Table 4-16 summarizes the average annual costs, benefits, and net benefits of these combined alternatives.

The plan that maximizes net benefits is composed of the four components, one selected in each economic analysis phase, which maximized net benefits for the different channel deepening and widening segments described above.

Table 4-16. Economic Summary of Alternative Combined Plans (AAEQ)

Plan Components	NED Benefits	NED Costs	Net NED Benefits	BCR
P1-M4 & P2-M4 & P3-M3 & P4-M1	$86,933,000	$15,069,000	$71,864,000	5.77
P1-M4 & P2-M4 & P3-M8 & P4-M1	$88,217,000	$16,381,000	$71,836,000	5.39
P1-M5 & P2-M4 & P3-M3 & P4-M1	$93,909,000	$18,512,000	$75,397,000	5.07
P1-M5 & P2-M5 & P3-M3 & P4-M1	***$94,964,000***	***$18,782,000***	***$76,182,000***	***5.06***
P1-M5 & P2-M4 & P3-M8 & P4-M1	$95,193,000	$19,824,000	$75,369,000	4.80
P1-M5 & P2-M5 & P3-M8 & P4-M1	$96,248,000	$20,094,000	$76,154,000	4.79
Recommended Plan:P1-M5 & P2-M5 & P3-M3 & P4-M1	**$94,964,000**	**$18,782,000**	**$76,182,000**	**5.06**

4.7 Recommended Selected Plan Selection

The Recommended Plan was developed by combining the selected measures from each economic analysis phase into a comprehensive plan addressing the operational constraints of interest in the current study, namely depth constraints that limit vessel loading and width constraints that prevent passing and increase wait times.

4.7.1 Plan Selection

The primary decision criteria for identifying the National Economic Development (NED) Plan includes reasonably maximizing net annual benefits while remaining consistent with the Federal objective of protecting the nation’s environment. Contributions to NED are increases in the net value of the national output of goods and services, expressed in monetary units. For this study, the contributions to NED are the direct net benefits that accrue in the planning area and the rest of the nation.

As shown in Table 4-16, net benefits for Segment 1 are reasonably maximized at a depth of -55 feet. The -55 foot run shown for Segment 2 in Table 4-16 shows the highest net benefits for -55 feet as well. Based on these results, the recommended NED plan is -55 feet for Segments 1 & 2, and 1200+1200 for the Wideners. In examination of the increment between -54 and -55 for Phase I is a little over 5.5 percent, plus it allows the project to accumulate another 14.65 percent in net benefits for Phase II. Altogether, -55 feet generates 6 percent more net benefits. For the two wideners within the Thimble Shoal channel, only TSCE at 1300 feet was shown to be the width that reasonably maximizes net benefits. The TSCW, while having positive benefits is currently justified at the 1,000 foot width. Anchorage F (Step 4) still needs to be complete and will be optimized to meet project requirements.

4.7.2 NED Plan

The National Economic Development Plan is the combination of measures that reasonably maximizes net benefits. The NED plan, which is also the Recommended Plan, and Preferred Alternative includes the following components:

- Deepening the Atlantic Ocean Channel (AOC) to a required depth of -59 feet;
- Deepening the Thimble Shoal Channel (TSC) to a required depth of -56 feet;
- Deepening the Norfolk Harbor Channel to a required depth of -55 feet;
- Deepening the Norfolk Harbor Entrance Channel to a required depth of -55 feet;
- Deepening the Newport News Channel to a required depth of -55 feet;
- Widening the TSC east of the Chesapeake Bay Bridge Tunnel to 1,300 feet;
- Widening Anchorage F to approximately 3,620 feet and associated modifications of the Approach Area;
- Deepening Anchorage F to a required depth of -51 feet;

Note that implementation of the Recommended Plan will result in an inner-harbor depth of -55 feet. Engineering considerations (e.g., vertical ship motion, etc.) necessitate additional depth beyond -55 feet in the harbor's entrance channels (AOC and Thimble Shoal Channel) to allow for use of the full -55 feet of depth in the inner harbor. In addition, no depths beyond -55 feet could be consider due to restrictions on the maximum depth of Thimble Shoal.

4.7.3 Deviations from the NED Plan

There is no planned deviations from the NED plan. For this study the NED is the Recommended Plan/ Preferred Alternative. There is no Locally Preferred Plan.

4.7.4 Recommended Plan/Proposed Action

The Recommended Plan results in a BCR of 5.3 Under section 4.7.4 the BCR of 5.05 is explain as follows and net NED benefits of approximately $96.5 million in AAEQ terms at FY18 price levels and using a discount rate of 2.75%. Costs for the Recommended Plan were provided by Norfolk Cost EN. The Interest During Construction (IDC) was calculated for a construction duration that includes a PED + construction period of 60 months for the recommended plan. Construction is assumed to begin in 2020 and be completed by the end of 2023 (See Appendix A for Recommended Plan construction schedule). Table 4-17 and Table 4-18 summarize the economic costs and benefits associated with the Norfolk Harbor Recommended Plan. Table 4-17 represents the results of the phased analysis. Each phase only represents the measures, cost, and port traffic needed to describe the benefits of that measure. The outcome of the deepening is the FWOP for the widening, and the outcome of the widening is the FWOP for the Anchorage F expansion. During the phased analysis, none of the phases has a true FWOP condition with all the traffic. The benefits and costs are summations of all the phases. Table 4-18 is based on a true FWOP condition, and the cost for the M5+M5+M3+M1 whereas table 4-17 shows a phased analysis of the each alternative. The benefits and costs are summations of all the phases. Table 4-17 shows the plan that most reasonably maximizes net NED benefits and is the National Economic Development (NED) as well as the Recommended Plan and Table 4-18 shows the plan based on a true FWOP conditions.

Table 4-17. Summary of Recommended Plan Costs and Benefits (AAEQ – 2.75%)

Plan Components	NED Benefits	NED Costs	Net NED Benefits	BCR
Recommended Plan: P1-M5 & P2-M5 & P3-M5	**$94,964,000**	**$18,782,000**	**$76,182,000**	**5.06**

Table 4-18. Equivalent Annual Costs and Benefits based on a true FWOP and FWP condition

Equivalent Annual Benefits and Costs FY2018 Price Levels 50-Year Period of Analysis / 2.75 % Discount Rate	
Project Costs	$291,825,000
Interest During Construction	$30,410,000
Total Economic Investment	**$322,235,000**
AAEQ Costs	
Economic Investment	$11,940,000
Increased O&M Costs	$6,140,000
Total AAEQ Costs	**$18,080,000**
AAEQ Benefits	
Transportation Cost Savings	$96,500,000
Total AAEQ benefits	**$96,500,000**
Net AAEQ Benefits	**$78,420,000**
Benefit-Cost Ratio (at 2.75%)	**5.3**

4.8 System of Accounts

Per ER 1105-2-100, Section 2-3 d(4), alternatives in the final array must be evaluated using three other accounts in addition to NED, including Regional Economic Development (RED), Environmental Quality (EQ), and Other Social Effects (OSE). However, in this study, all of the plans in the final array of alternatives are similar and there are not significant differences in the four accounts for these plans. NED benefits have already been discussed in this report and the RED, EQ, and OSE evaluations for the selected plan are presented below.

4.8.1 Regional Economic Development

The RED account was established by the Economic and Environmental Guidelines for Water and Related Land Resources Implementation Studies (U.S. Water Resources Council, 1983). The RED account identifies changes in the distribution of regional economic activity resulting from project alternatives and from the selected plan. The effects on the RED account for each of the alternatives considered are expected to be minor and do not have a material bearing on the plan selection process.

Changes to the RED account for the selected plan were assessed using the USACE Online Regional Economic System (RECONS). This modeling system provides estimates of regional, state, and national economic impacts of construction spending associated with a USACE Civil Works Navigation Project. The USACE is planning on expending $291,825,000 on the project. Of this total project expenditure $172,215,789 will be captured within the regional impact area. The rest will be leaked out to the state or the nation. The expenditures made by the USACE for various services and products are expected to generate additional economic activity in that can be measured in jobs, income, sales and gross regional product as summarized in the following table and includes impacts to the region, the State impact area, and the Nation..

Table 4-19. Overall Summary Economic Impacts

Impacts		Regional	State	National
Total Spending		$291,825,000	$291,825,000	$291,825,000
Direct Impact				
	Output	$172,215,789	$215,645,276	$284,374,140
	Job	2,041.75	2,349.95	2,655.30
	Labor Income	$109,698,461	$130,868,874	$151,741,162
	GRP	$125,931,700	$150,655,119	$180,688,421
Total Impact				
	Output	$298,069,725	$412,775,741	$765,385,455
	Job	2,971.89	3,794.90	5,527.47
	Labor Income	$151,287,240	$199,782,414	$308,734,996
	GRP	$202,585,760	$269,536,085	$451,484,012

The Port of Virginia is one of the major drivers of the regional economy. An analysis by the Mason School of Business, College of William and Mary (Pearson and Swan, 2014) identified the economic impact of the Port of Virginia on the State of Virginia. The total direct and indirect economic impact was $60.3 billion in Fiscal Year 2013. The estimated value added to the Gross State Product was $30.5 billion, which was 6.8% of the entire Gross State Product. The economic impact on wages was estimated as $17.5 billion paid to 374,000 Virginia employees, which generated $1.44 billion in state corporate and individual income taxes, general sales taxes, and real property taxes within the state.

4.8.2 Environmental Quality

The possible consequences of the Recommended Plan were considered in terms of probable environmental impact, social well-being, and economic factors. Endangered Species Act, Section 7 consultation was concluded with the U.S. Fish and Wildlife Service and ongoing with the National Marine Fisheries Service. NMFS Section 7 consultation is ongoing and expected to be completed in July 2018. Upon completion of formal consultation, the final BO will be inserted into Appendix I. Species Determinations were concluded based on anticipated impacts of the Action Alternative. Impacts to these species and any designated Critical habitat are not anticipated to be "significant," as defined by the significance thresholds in National Environmental Policy Act guidelines (40 CFR Parts 1500-1508). Best Management Practices and standard USACE protocols will be implemented for the protection of listed turtle and whale species, Atlantic Sturgeon, as well as other species protected by the Marine Mammal Protection Act to reduce any potential negative impacts of the project.

Environmental quality account information is contained within Section 6 of this integrated report and summarized in the FONSI within Section 10.

4.8.3 Other Social Effects

An increase in the amount of cargo moving through the port over time is expected to occur with or without navigation improvements associated with this project. Without improvements, more vessels would be required to transport the increased cargo volumes that are forecasted. However, with implementation of any of the recommended plan, the total number of vessels would decrease if no additional growth was anticipated. Channel improvements alone are predicted to reduce vessel traffic but it is also reasonable to expect annual growth of the port.

One of the main effects of the project will be beneficial effects to Military Readiness and Economic vitality of the region. The deepening and widening of the channel will reduce conflicts between commercial and US Naval operations and allow for more ship passing. The port is a key economic driver within the state of Virginia as over 9% of the state's residents have port related jobs.

Increased port activities will also create things like additional traffic, noise, or lighting. Such effects are likely to increase regardless of the project as the port itself continue to grow. As the VPA grows infrastructure throughout the region (i.e. roads, work force housing, and public utilities) will also continue to grow to meet the needs of associated VPA activity. Such impacts though are likely to occur without the project as VPA continues to grow.

5 RECOMMENDED PLAN/PROPOSED ACTION

5.1 Description of the Recommended Plan

The Recommended Plan deepens the Federal navigation channels from the Atlantic Ocean to Norfolk Harbor and Newport News and includes channel widening to allow large vessels to meet in the Thimble Shoal Channel. For the purpose of this study and to conform to NEPA requirements and Corps planning regulations the recommended plan may also be referred to as the preferred alternative.

5.1.1 General Navigation Features

ER 1105-2-100 defines the general navigation features. “General navigation features of harbor or waterway projects are channels, jetties or breakwaters, locks and dams, basins or water areas for vessel maneuvering, turning, passing, mooring or anchoring incidental to transit of the channels and locks. Also included are dredged material disposal areas (except those for the inland navigation system, the Atlantic Intracoastal Waterway and the Gulf Intracoastal Waterway) and sediment basins” (USACE, April 2000).

The recommended plan general navigation features include the following channels, areas for vessel passing, and dredged material disposal areas:

- Atlantic Ocean Channel;
- Thimble Shoal Channel (east and west of the Chesapeake Bay Bridge Tunnel);
- Thimble Shoal Channel Meeting Areas (east of the Chesapeake Bay Bridge Tunnel);
- Norfolk Harbor Entrance Reach;
- Norfolk Harbor Reach;
- Craney Island Reach;
- Newport News Channel;
- Anchorage F;
- Craney Island Dredged Material Management Area;
- Dan Neck Ocean Disposal Site; and
- Norfolk Ocean Disposal Site.

5.1.2 Channel Dimensions

Table 5-1 presents currently authorized, existing, and recommended channel dimensions.

Table 5-1. Recommended Plan Dimensions

	Channel Depth (feet below MLLW)		
	Authorized	**Existing**	**Recommended**
Atlantic Ocean Channel	-57	-52	-59
Thimble Shoal Channel	-55	-50	-56
Norfolk Harbor Entrance Reach	-55	-50	-55
Norfolk Harbor Reach	-55	-50	-55
Craney Island Reach	-55	-50	-55
Newport News Channel	-55	-50	-55
	Channel Width (feet)		
Atlantic Ocean Channel	1,300	1,300	1,300
Thimble Shoal Channel	1,000	1,000	1,000
Thimble Shoal Channel East Meeting	1000	1000	1,300
Norfolk Harbor Entrance Reach	1,500	1,000 – 1,440	1,000 – 1,440
Norfolk Harbor Reach	850 – 1,200	850 – 1,200	850 – 1,200
Craney Island Reach	800	800	800
Newport News Channel	800	800	800
	Channel Length (miles)		
Atlantic Ocean Channel	11.1	11.1	11.1
Thimble Shoal Channel	22.0	22.0	22.0
Thimble Shoal Channel East Meeting	NA	NA	17
Norfolk Harbor Entrance Reach	2.3	2.3	2.3
Norfolk Harbor Reach	3.8	3.8	3.8
Craney Island Reach	2.6	2.6	2.6
Newport News Channel	6.7	6.7	6.7

5.1.3 Anchorage F

Anchorage F is a one of a series of Anchorages located along the Norfolk Harbor Channel. The anchorage is currently authorized to a depth of -55 feet with a 3000 foot width. The anchorage was constructed in 1999. Anchorage F is recommended to deepen to -51 feet and widened to 3620 feet.

5.1.4 Eastern Meeting Area

Analyses were conducted for a 1300-foot wide meeting area at Thimble Shoal Channel east of the Chesapeake Bay Bridge and Tunnel. The meeting area will provide a 17 mile channel for vessels to pass one another within the Thimble Shoal Channel. It will be deepened to match the depth of the Thimble Shoal Channel.

5.1.5 Western Meeting Area

In addition to these improvements, economic and environmental analyses were conducted for a 1400-foot wide meeting area at Thimble Shoal Channel West of the Chesapeake Bay Bridge and Tunnel, which is the meeting area strongly preferred by the Pilots and the Virginia Port Authority. Although the west side meeting area generated positive benefits, benefits were not sufficient for inclusion in the NED Plan. Future changes in the fleet calling at Norfolk Harbor may improve the benefits generated by this project alternative.

5.1.6 Dredging and Dredged Material Management

Construction material dredged from the channels will be placed in CIDMMA and in the Dam Neck Ocean Disposal Site. Construction material from the Atlantic Ocean Channel, Thimble Shoal Channel (east of the CBBT), and the meeting area will be dredged by a hopper dredge with material dumped at the Dam Neck Ocean Disposal Site. The Dam Neck ODMDS is currently designed and managed to hold approximately 50 MCY of dredged material. The Dam Neck SMMP states that future evaluation and management could increase this quantity. For context, as detailed in the NHC Dredged Material Management Plan (reference Engineering Appendix A), the potential new work volume to be placed in Dam Neck is approximately 16 MCY.

Construction material from the Norfolk Harbor Entrance Reach, Norfolk Harbor Reach, Craney Island Reach, and the channel to Newport News will be hydraulically dredged by a cutter head dredge and pumped to CIDMMA. The potential new work volume to be placed in CIDMMA is anticipated to be approximately 9 MCY.

Maintenance material from the Atlantic Ocean Channel, Thimble Shoal Channel (east of the CBBT), and the meeting area will be placed at the Dam Neck Ocean Disposal Site. The recommended plan will add an estimated at 1 MCY of maintenance material to the Dam Neck Ocean Disposal Site on an annual basis. Maintenance material from the Norfolk Harbor Entrance Reach, Norfolk Harbor Reach, Craney Island Reach, and the Channel to Newport News will be placed in CIDMMA. The recommended plan will add approximately 1 MCY of annual maintenance material to CIDMMA on an annual basis. When CIDMMA reaches its capacity, material will be placed at the Norfolk Ocean Disposal Site. To date very few projects have placed material at the NODS leaving approximately 1,300 MCY capacity remaining. Appendix A (Engineering Appendix) provides additional details and descriptions of dredged material placement options.

5.1.7 Disposal Area Modifications

Placement of dredged material at CIDMMA is limited to users within the geographic area of Norfolk Harbor and adjacent waters. In general, this includes the navigable waters of the ports of Norfolk, Portsmouth, Chesapeake, Hampton, and Newport News. In accordance with the authorizing document, CIDMMA is to be used for the benefit of the maintenance and development of navigation improvements serving Government and private interests. CIDMMA is authorized to handle all types of navigational dredged material, including material suitable and unsuitable for open ocean disposal.

The current management strategy for operating CIDMMA is based on Section 148 of the Water Resources Development Act (WRDA) of 1976 (P.L. 94-587) that states the “Chief of Engineers, shall…extend the capacity and useful life of dredged material disposal areas such that the need for new dredged material disposal areas is kept to a minimum.”   CIDMMA storage capacity is periodically increased by raising the facility's dike height. Currently the dikes have been raised to elevations ranging from +36 to +40 feet above MLLW, with the interior dike heights currently ranging from +33 to +36 feet above MLLW, which maintains 3 to 4 feet of freeboard.

The dikes at CIDMMA will continue to be raised as appropriate for future capacity needs. No disposal area modifications are necessary for the Dam Neck Ocean Disposal Site or for the Norfolk Ocean Disposal Site.

5.1.8 Beneficial Use of Dredged Material

As discussed in section 2.1.2, three USACE Erosion Control and Hurricane Protection projects (for both the City of Norfolk and Virginia Beach) and the USACE Craney Island Eastward Expansion could potentially be available for uses as beneficial use sites. Such sites if utilized may require additional permits or additional NEPA documentation. In addition, if additional sites are available they may also be utilized if they conform to project timelines and meet all compliance requirements. Each site would also require authorization for such beneficial placement.

Table 5-2. NHC Deepening Project Potential Beneficial Use Sites

Project:	Description	NEPA/Permit Reference	Estimated Volume Needs
Big Beach	USACE/City of Virginia Beach Federally authorized hurricane protection project	Beach Erosion Control and Hurricane Protection Main Report and Supplemental EIS 1984 USACE	2 MCYs Estimated every 7 years
Sandbridge	USACE/City of Virginia Beach Federally authorized hurricane protection project	Sandbridge Beach, VA Erosion Control and Hurricane Protection EA 2009 USACE; 2012 BOEM	1.75 MCYs Estimated every 5 years
Willoughby Norfolk	USACE/City of Norfolk Federally authorized hurricane protection project	Willoughby Spit and Vicinity Norfolk Virginia Beach Erosion and Hurricane Protection Project, EIS 1983 USACE	1.2MCYs Estimated every 5 years

5.2 Environmental Mitigation

No compensatory environmental mitigation is anticipated to be required with implementation of the Recommended Plan. For a summary of avoidance and minimization measures to reduce any potential impacts to environmental resources please see Chapter 7: Summary of Proposed management Actions, Best Management Practices, and Compensatory Mitigation.

5.3 Operations and Maintenance Considerations

Operation and maintenance of the recommended plan will be a continuation of existing operation and maintenance practices. Maintenance dredging of the recommended plan will occur on a nearly annual basis, with individual channel reaches typically dredged on a cycle of every other year or longer so that dredging occurs most every year with channel reaches alternating from year to year. Dredged material placement will follow the historical pattern of CIDMMA receiving material from the inner channels and Dam Neck ODMDS receiving material from Thimble Shoal Channel and the Atlantic Ocean Channel.

The recommended plan will increase historical maintenance dredging volumes, with the largest increases in the Atlantic Ocean Channel and Thimble Shoal Channel (Table 5-3). Note that under with-project conditions, CIDMMA is projected to stop receiving dredged material by approximately 2038 and maintenance material from the inner channels will be placed at the Norfolk Ocean Disposal Site.

Table 5-3. Norfolk Harbor Project Recommended Plan Maintenance Dredging Volume

Segment	Reach	Current Annual Sedimentation, CY/Year	Estimated Annual Sedimentation, CY/Year
1	Atlantic Ocean Channel	164,359	303,822
1	Thimble Shoal Channel	325,577	486,630
1	Thimble Shoal Channel – Meeting Area #2, 1,300 foot width	n/a	19,350
1	Norfolk Harbor Sewells Point to Lamberts Bend	733,630	846,934
1	Anchorage F, expanded to 3,620 foot Dia.	137,036	137,117
2	Newport News Channel	109,624	133,526

5.4 Real Estate Considerations-Land Easements, Rights of Way, and Relocation Considerations

Project Area owned in fee by NFS

The entire dredging components of this project will be constructed and is located on the Norfolk Harbor Channel bottoms/bottomlands, Navigational Servitude will be exercised. The disposal sites at CIDMMA and DNODS, are owned in fee by the Federal Government; therefore, no acquisition of real property interests will be required of the NFS for the 'construction' phase of this Project.

No construction rights or interests are anticipated to be needed.

The standard Estate is Channel Improvement Easement, which is perpetual. The widening and deepening are in the federal channels. The lands required for construction are made available to the U.S. by the Commonwealth of Virginia whom owns the bottoms. The NFS will not be required to do any of the dredging, nor will the NFS be conducting any of the disposal of materials dredged from the channels. Navigational Servitude is available and will be used. Construction and maintenance of deepening and widening the Thimble Shoal Channel and Anchorage F and deepening the Atlantic Ocean Channel, the Norfolk Harbor Entrance Channel, the Norfolk Harbor Channel, and the Newport News Channel do not require any rights-of-entry or temporary easements because the river bottom in these areas is owned by the Commonwealth of Virginia.

Other related information

The U.S. Department of the Navy currently operates an active degaussing range in the Norfolk Harbor Channel. This degaussing range is located at a depth of approximately -57 feet Mean Lower Low Water. Therefore, the USACE will work to either avoid or request the U.S. Navy relocate the degaussing range out to the potential deepening area. The feasibility of avoidance or relocation will be determined during the Preconstruction, Engineering, and Design Phase of the project following completion of detailed depth surveys of this reach of the Norfolk Harbor.

There will be an alteration to the Chesapeake Bay Bridge Tunnel. Therefore, as described in the Description of Work in Section 7.0 of the Real Estate Plan, LERRDs credits are authorized. The NFS will remove the existing protective sand layer over the Chesapeake Bay Bridge Tunnel and re-arm it with rock that will provide the same level of protection. Because the Chesapeake Bay Bridge and Tunnel District infrastructure in the Project area is a "structure or facility owned in the performance of a governmental function" the modification of the tunnel qualifies under the substitution facility doctrine.

5.5 Implementation Requirements

This section defines implementation responsibilities necessary to insure that the Recommended Plan's goals and objectives are achieved. Included are discussions of the division of plan responsibilities between Federal and non-Federal interests, institutional requirements, cost sharing, analysis of non-Federal financial capability, a discussion of the Project Cost Agreement, and views of the non-Federal sponsor.

5.5.1 Cost Sharing

Cost sharing for the Recommended Plan will be done in accordance with Section 101 of the WRDA 1986, as amended, and cost shared as a General Navigation Feature. The Recommended Plan cost shares are based on all recommended channel depths being greater than -50 feet. Channel depths greater than -50 feet are cost shared 50 percent non-Federal and 50 percent Federal. The non-Federal sponsor will provide all LERRs. Disposal necessary for the Federal project is cost-shared as a general navigation feature. An additional 10 percent of the total costs of General Navigation Features will be repaid by the non-Federal sponsor over a period not to exceed 30-years. The sponsor's costs for LERRs, are credited against the additional cash contribution. The non-Federal sponsor shall also pay 50% of the excess cost of operation and maintenance of the project over that cost which the Secretary determines would be incurred for operation and maintenance if the project had a depth of 50 feet. The increase in operations and maintenance costs due to the recommended plan is $6,140,000 per year, which will be cost shared 50% ($3,070,000) by the non-Federal sponsor and 50% ($3,070,000) by the Federal government. A summary of cost shares is presented in Table 5-4.

Table 5-4. Recommended Plan Cost Shares

	Total Cost	Federal	Non-Federal
Dredging Cost (Including Mob / Demob)	$207,366,000	$103,683,000	$103,683,000
Environmental Mitigation	$-	$-	$-
Monitoring	$-	$-	$-
Construction Management	$10,963,000	$5,482,000	$5,482,000
PED	$16,910,000	$8,455,000	$8,455,000
Contingency (11.7%)	$27,523,000	$13,761,000	$13,761,000
Total Construction of GNF	$262,762,000	$131,381,000	$131,381,000
Lands & Damages	$9,060,000	$-	$9,060,000
Total Project First Costs	**$271,822,000**	**$131,381,000**	**$140,441,000**
Non-Federal Berthing Area Dredging Costs	$20,003,000	$-	$20,003,000
Relocating Aids to Navigation	$-	$-	$-
10% GNF Non-Federal	$-	$(17,216,000)	$17,216,000
Total Cost	$291,825,000	$114,165,000	$177,660,000

5.6 Financial Analysis of Non-Federal Sponsor's Capabilities

The non-Federal sponsor, the Virginia Port Authority, concurs with the financial responsibility as it pertains to the cost shares presented in Table 5-4, above. Under the WRDA 1986, as amended by Section 201 of WRDA 1996, Federal participation in navigation projects is limited to sharing costs for design and construction of the GNF consisting of breakwaters and jetties, entrance and primary access channels, widened channels, turning basins, anchorage areas, locks, and dredged material disposal areas with retaining dikes. The Virginia Port Authority provided this certification in a letter dated 8 March, 2018 (See Appendix I).

Non-Federal interests are responsible for and bear all costs for acquisition of necessary lands, easements, rights-of-way and relocations; terminal facilities; as well as dredging berthing areas and interior access channels to those berthing areas. Current policy requires the sponsor to document their ability to pay through submission of a self-certification of financial capability as described in CECW-PC memorandum dated 12 June 2007. The Virginia Port Authority provided this certification in a letter dated 8 March, 2018 (See Appendix I).

5.7 View of the Non-Federal Sponsor

The Virginia Port Authority fully supports the Recommend Plan and has agreed to the cost sharing as outlined above. Appendix I, Coordination, contains the sponsor's letter of intent for the final report dated 8 March, 2017. The letter of intent contains the Virginia Port Authority's acceptance of, or desired departures from, the terms of the applicable model Project Partnership Agreement (PPA), including: 1) applicable cost sharing and financial policies; 2) policies regarding provision and valuation of non-Federal lands, easements, rights-of-way, and disposal areas provided by the non-Federal sponsor; 3) policies governing non-Federal project construction; and 4) other provisions required by law and policy for new start construction projects.

5.8 Section 902 Limit

Because this project was authorized in WRDA 1986, the Section 902 limit on total project cost applies. The total project cost for the Norfolk Harbor navigation improvements included in this report ($271,822,000), as well as the current estimated cost for the Elizabeth River Southern Branch project ($128,828,000), is within the 902 limit (Table 5-5). The figures presented below includes costs for both projects since both of these projects are included in the same authorized cost amount. Hence, the Section 902 limit applies to the cost of both project elements.

Table 5-5. Maximum Cost Including Inflation through Construction (Thousands of Dollars)

Line 1		
a.	Current Project estimate at current price levels:	$400,650
b.	Current project estimate, inflated through construction:	$436,906
c.	Ratio: Line 1b / line 1a	1.0905
d.	Authorized cost at current price levels:	$1,171,607
	(Column (h) plus (i) from table G-3)	
e.	Authorized cost, inflated through construction:	$1,277,629
	(Line c x Line d)	
Line 2	Cost of modifications required by law:	$0
Line 3	20 percent of authorized cost:	$110,200
	.20 x (table G-3, columns (f) + (g)	
Line 4	Maximum cost limited by section 902:	$1,387,829
	Line 1e + line 2 + line 3	

5.9 Risk and Uncertainty

Risk and uncertainty exists in the potential fluctuation of the Federal interest rate, changes in vessel operating costs, changes in mitigation costs, and deviations from vessel or cargo forecasts. Interest rates, forecasts, and vessel operating costs are discussed further in the Appendix C (Economics). Cost contingencies, incremental costs, and estimates for the dredging costs are discussed in Appendices A (Engineering). There are also risks which were addressed during the study using a Risk Register. The purpose of the register is to apply a risk-based decision making approach throughout the study. The register was used to highlight areas of study risks and identify ways to address those risks, such as reducing the schedule, optimizing the study area, and identifying the optimum amount of modeling to make a risk-based decision.

Several assumptions applied to analyses during the study result in conservative cost and impact estimates and reduce cost risks. Of particular note is the application of Ship Simulation which will not be completed until the project enters Preliminary Engineering and Design (PED). To reduce the risk associated with the analysis, limited Ship Simulation was conducted by ERDC for the project and a CADET model was developed to determine the under keel clearance within Harborsym.

5.10 Sea Level Change and Navigation Structures

The potential impacts of future local relative sea level change (SLC) on navigation structures and the possible adaptations that can be developed to counteract these impacts must be considered in all USACE studies and projects located in tidally influenced waters. Current USACE guidance (ER 1100-2-8162 and ETL 1100-2-1) requires planning studies to consider SLC in the development and assessment of planning alternatives. ETL 1100-2-1 recommends that analyses assess the effects of SLC on the project at three future time periods post-construction, including 20 years, 50 years, and 100 years (Table 5-6). Since the rate of future SLC (i.e. feet per century) is uncertain, the guidance specifies that the evaluation should consider the three different SLC curves (low, intermediate, and high) included in the USACE's online SLC calculator. Figure 5-1 shows the curves from the USACE calculator, based on 8638610 Sewells Point, VA, using the relative sea level trend, published by NOAA as of 2016 of 4.61 mm/year or 0.1512 ft/year. The project start year was populated with 2016 to determine future sea level rise.

Table 5-6. Post construction future conditions.

Years Post Construction	Low	Intermediate	High
20 Years - 2043	0.51	0.74	1.48
50 Years - 2073	0.97	1.55	3.40
100 Years - 2123	1.72	3.25	8.08

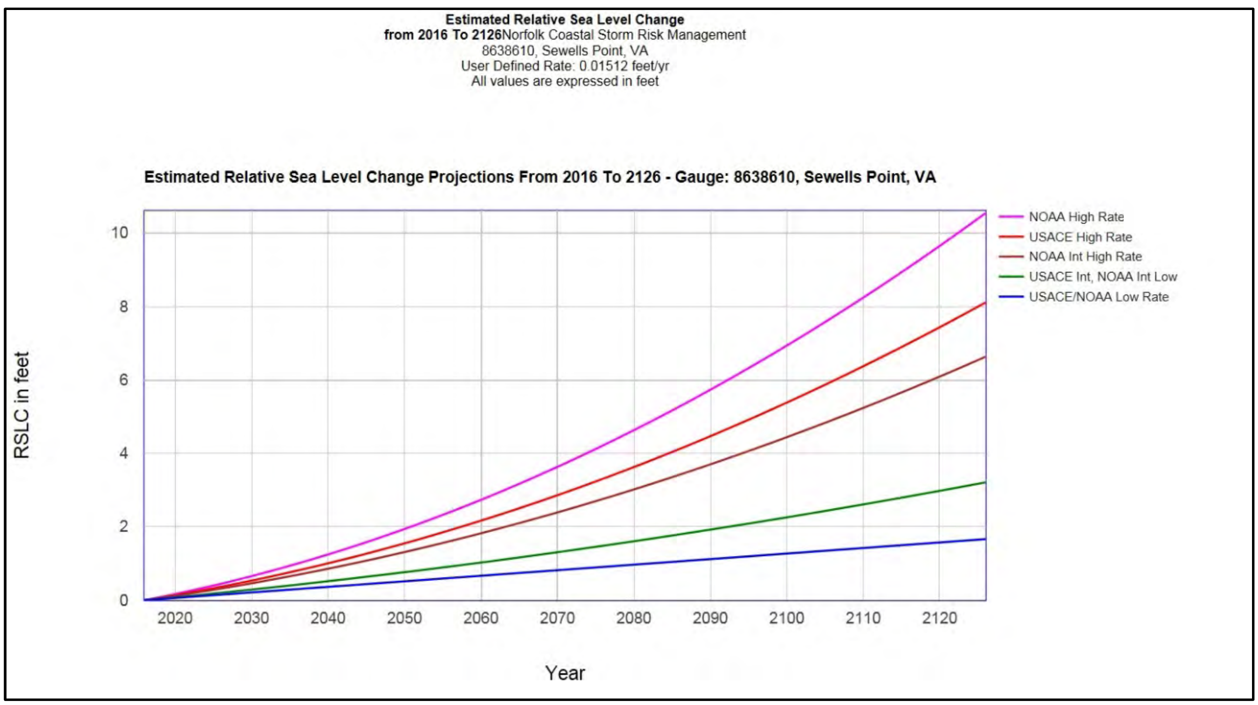

Figure 5-1. Projected sea level rise in the Region of Influence.

Sea level is projected to increase gradually under all three USACE scenarios. Two feet of sea level rise is not projected to occur until approximately 2141 under the low scenario and does not occur until approximately 2088 in the intermediate scenario. In the high scenario, sea level rise would increase by two feet by approximately 2053, which would be 30 years into the project's life. The general navigation features within this Federal project include navigation channels, an anchorage, and dredged material placement areas. The project does not include Federal locks, breakwaters, jetties, groins, revetments, or wave absorbers.

None of the project's Federal general navigation features is projected to be impacted to an extent that would impact functionality and the realization of project benefits. The most likely effect to Federal navigation channels and the anchorage would be that less maintenance dredging might be required in the out-years of the project's life. SLC effects to CIDDMA would be limited by CIDMMA's location in the inner harbor, which provides some protection from increased wave energy. Additionally, CIDMMA is projected to be an inactive placement area by the time sea level rise would increase to levels that might potentially affect operations. The CIDMMA Eastward Expansion project includes projected sea-level rise as a design condition. The offshore placement areas are unlikely to be substantially impacted by projected SLC, nonetheless routine 10-year assessments of ODMDS Site Management Plans, including site conditions and future capacity, will adjust future operations if necessary.

Non-Federal navigation features such as docks, wharfs, bulkheads, seawalls, dolphins, and berthing areas are projected to be functional throughout their currently planned useful lives and upon future rehabilitation or reconstruction are anticipated to be built to withstand the impacts of future sea level rise. Landside facilities that support project benefits, such as storage areas, warehouses, roads, rail, utilities, and bridges are projected to provide support services throughout their useful lives. Similar to non-Federal navigation features, upon future rehabilitation or reconstruction landside facilities that support project benefits are anticipated to be built to withstand the impacts of future sea level rise.

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6 ENVIRONMENTAL CONSEQUENCES OF THE ALTERNATIVES

This chapter describes the existing and projected future conditions for each of the resources that reasonably could be expected to be impacted by the project. Existing and projected future condition descriptions include physical, chemical, biological and sociological conditions. These conditions are described without implementation of the alternative actions and with implementation of the alternative actions. The comparison of without-project and with-project conditions defines the impacts of the alternatives. Table 6-1 provides a summary of the impacts for the resources that could be potentially affected by implementation of the project alternatives.

Table 6-1: Environmental consequences of the project alternatives summary table.

Resource	No Action Alternative/Future Without Project Alternative	Action Project Alternative
Geology, Physiography, and Topography	There would be no impacts to geology or physiography. Continued use of the potential dredged material placement/disposal sites would have an adverse, permanent and negligible to minor impact to topography. Continued maintenance of the channel system should have no effect on seismicity because the ROI is not within a seismically-active geologic setting.	There would be no impacts to geology or physiography. Impacts to topography would be at the same threshold level of impact as the NAA/FWO (adverse, permanent, and negligible to minor), but topography may change at a slightly higher rate at the CIDMMA because of increased dredging volumes placed/disposed at the CIDMMA.
Bathymetry, Hydrology, and Tidal Processes	There would be no anticipated effects to bathymetry, hydrology or tidal processes.	The additional channel dredging and widening will alter the bathymetry in the navigation channels, deepening it and removing all the sediments currently occupying this area. This may also potentially increase the tidal prism in the area of the channel. This bathymetric alteration may influence effects of the tides. These impacts would be adverse, permanent and minor.

Resource	No Action Alternative/Future Without Project Alternative	Action Project Alternative
Hazardous, Toxic, and Radioactive Waste (HTRW)	No releases of HTRW exceeding regulatory limits are anticipated with maintenance dredging or dredged material disposal/placement operations. Maintenance dredging would continue to have an adverse, temporary, negligible level of impact and will remain within dredged material placement/disposal limits at the CIDMMA and open ocean disposal sites.	Impacts would be at the same threshold level of impact as the NAA/FWO (adverse, temporary, and negligible). Any potential redistribution of contaminants resulting from dredging and dredged placement/disposal would be negligible and are not expected to have any substantive permanent adverse impacts.
Water Quality	Temporary increases in Total Suspended Solids, turbidity, and nutrients resulting from dredging and dredged material placement/disposal would continue. The dredging operations, material placement/disposal and the discharge of effluent from the CIDMMA would result in adverse, temporary impacts to water quality that are negligible to minor.	Temporary impacts to water quality would be at the same threshold level of impact as the NAA/FWO Project Alternative (adverse and negligible to minor), however, the relative level of impact with the Action Project Alternative would be slightly higher due to the increased duration of dredging and dredged material placement/disposal. Adverse salinity changes will be permanent, but negligible to minor and not significant. Implementation of the Action Project Alternative would result in adverse impacts to water quality that would be temporary to permanent and negligible to minor.

Resource	No Action Alternative/Future Without Project Alternative	Action Project Alternative
Vegetation, Wetlands, and Submerged Aquatic Vegetation	Dredging and dredged material placement/disposal would not impact any Submerged Aquatic Vegetation (SAV) or wetlands. Placement/disposal of dredged material may alter the topography and consequently vegetation cover at the CIDMMA. Placement of the dredged material may result in temporary to permanent, negligible, impacts to vegetation at the CIDMMA.	Similar to the NAA/FWO dredging and dredged material placement/disposal would not impact any SAV or wetlands. Similar to the NAA/FWO, placement/disposal of the dredged material may result in temporary to permanent, negligible, adverse impacts to vegetation at the CIDMMA.
Benthic Fauna	Dredging and dredged material placement/disposal operations would cause adverse, temporary, and minor impacts to the benthic community from removal of the benthic community, potential turbidity impacts and burial of sessile organisms. No impacts to oyster reefs are anticipated.	Impacts would be at the same threshold level of impact as the NAA/FWO (adverse, temporary, and minor), however, the relative level of impact with the Action Project Alternative would be slightly higher due to the increased duration of dredging and dredged material placement/disposal.
Plankton Community	Adverse, temporary and negligible impacts to the local plankton community that result from current dredging and navigation and dredged material placement/disposal operations include entrainment, burial/siltation, and reduced phytoplankton productivity would continue.	Impacts would be at the same threshold level of impact as the NAA/FWO (adverse, temporary, and negligible) however, the relative level of impact with the Action Project Alternative would be slightly higher due to the increased duration of dredging and dredged material placement/disposal.

Resource	**No Action Alternative/Future Without Project Alternative**	**Action Project Alternative**
Fish and Fish Habitat	Current dredging and dredged material placement/disposal operations that may affect egg, larval, juvenile, and adult life stages of fishes include direct removal or burial, turbidity/siltation effects, shifts in dissolved oxygen and salinity, entrainment, visual and noise disturbances, and alteration of habitat would continue. The impacts to fish resources and habitat would be adverse, temporary and negligible to minor. While impacts to Essential Fish Habitat (EFH) would be adverse, they would not be substantive.	Similar to the NAA/FWO, impacts to fish and fish habitat would result in negligible to minor adverse impacts, including those to EFH. Impacts would range from mostly temporary impacts to some permanent impacts. No substantive adverse impacts to fish or fish habitat including EFH are anticipated. No population level impacts to any managed fish species or associated prey species would be anticipated.
Wildlife	Current dredging and dredged material/placement would have disturbance effects to wildlife and further dredged material placement/disposal at the CIDMMA would provide additional habitat for some wildlife species. Temporary to permanent impacts to wildlife that would range from adverse to beneficial impacts that are negligible to minor would be anticipated.	Impacts would be at the same threshold level of impact (adverse to beneficial, temporary to permanent, and negligible to minor) as the NAA/FWO, however, the relative level of impact with the Action Project Alternative would be slightly higher due to the increased duration of dredging and dredged material placement/disposal.

Resource	No Action Alternative/Future Without Project Alternative	Action Project Alternative
Special Status Species	Affect findings for Federally listed green sea turtles, Kemp's ridley sea turtles, leatherback sea turtles, loggerhead sea turtles, and Atlantic Sturgeon under the jurisdiction of the NMFS would be May Affect, Likely to Adversely Affect because of potential temporary dredging entrainment impacts and impacts to prey species. However, no population level impacts to Federally listed species or their prey would be anticipated. Temporary, adverse impacts to Atlantic Sturgeon Critical Habitat are anticipated due to the temporary loss of benthic foraging habitat. The affect finding for Federally listed whales with the potential to occur in the Action Area (fin, north Atlantic right, and sei) would be May Affect, Not Likely to Adversely Affect because of potential temporary, insignificant disturbance effects. Affect findings for the Federally listed northern long-eared bat, Indiana bat, blue whale, sperm whale, and hawksbill sea turtle would be No Affect as these species are not anticipated to occur in the Action Area. Only temporary, insignificant disturbances to marine mammals would be anticipated to occur from disturbance related impacts. No Level A or Level B harassment to marine mammals would be anticipated. Temporary to permanent impacts to migratory birds would be negligible to minor resulting from temporary disturbance impacts and temporary to permanent creation of wildlife habitat at the CIDMMA.	Impacts would be at the same threshold level of impact as the NAA/FWO, however, the relative level of impact with the Action Project Alternative would be slightly higher due to the increased duration of dredging and dredged material placement/disposal.

Resource	No Action Alternative/Future Without Project Alternative	Action Project Alternative
Air Quality	Current maintenance operations would continue to generate emissions from the combustion of fuel used to operate vessels and equipment (e.g., dredge operation, pumps, transportation, and final dredged material placement/disposal). There would be adverse, temporary, negligible to minor impacts to air quality.	Impacts would be at the same threshold level of impact (adverse, temporary, and negligible to minor) as the NAA/FWO, however, the relative level of impact with the Action Project Alternative would be slightly higher due to the increased duration of dredging and dredged material placement/disposal.
Climate Change	Current maintenance operations would continue to generate greenhouse gas emissions from the combustion of fuel used to operate vessels and equipment (e.g., dredge operation, pumps, transportation, and final dredged material placement/disposal). There would be adverse, temporary, negligible to minor contributing impacts to greenhouse gas emissions.	Impacts would be at the same threshold level of impact (adverse, temporary, and negligible to minor) as the NAA/FWO, however, the relative level of impact with the Action Project Alternative would be slightly higher due to the increased duration of dredging and dredged material placement/disposal. In future conditions with implementation of the Action Alternative we would anticipate fewer greenhouse gas emissions resulting from deep draft vessels as compared to future conditions without implementation of the Action Project Alternative.
Floodplains	Potential adverse impacts to floodplains from material placement/disposal operations would be adverse, temporary, and negligible. A CIDMMA dike breach/failure would be unlikely.	Impacts would be at the same threshold level of impact (adverse, temporary, and negligible) as the NAA/FWO.

Resource	No Action Alternative/Future Without Project Alternative	Action Project Alternative
Noise and Vibration	Implementation of the NAA/FWO is predicted to result in adverse, temporary, and minor noise and vibration impacts resulting from operation of dredging vessels and dredging and material placement/disposal equipment.	Impacts would be at the same threshold level of impact as the NAA/FWO, however, the relative level of impact with the Action Project Alternative would be slightly higher due to the increased duration of dredging and dredged material placement/disposal.
Occupational Safety and Health	Maintenance dredging and dredged material placement operations would continue and existing, adverse, temporary, safety risks that are at a negligible to minor level of impact would continue.	The duration of exposure to occupational safety and health risks would increase with implementation of the Action Project Alternative. Although the Action Project Alternative has slightly higher durations of exposures to occupational safety and health hazards, entailing slightly more risk than the NAA/FWO, the occupational safety and health risks would be very similar and remain at an adverse, temporary and negligible to minor level of impact.

Resource	No Action Alternative/Future Without Project Alternative	Action Project Alternative
Utilities	Existing utilities would remain intact and continued operations and maintenance would have no effect on utility infrastructure.	The Action Project Alternative would be anticipated to cause temporary, adverse impacts to the DeGaussing Range at Sewell's Point, but additional detailed channel studies will be conducted during the Preconstruction, Engineering, and Design (PED) Stage to verify this course of action. Any potential impacts would be avoided or fully mitigated by relocation of the range by the U.S. Department of the Navy (Navy), if deemed necessary. There would be no anticipated impacts to other utilities in the ROI.

Resource	No Action Alternative/Future Without Project Alternative	Action Project Alternative
Cultural Resources	There would be no anticipated direct, indirect, or cumulative effects to cultural resources. Unidentified sites could still be at slight risk to effects from maintenance dredging, although that potential is less than with implementation of the Action Project Alternative. The future without project could subject unidentified submerged archaeological sites to damage from ship strikes, groundings, and prop wash.	Effects to terrestrial architectural cultural resources would be adverse, temporary, and negligible. No submerged archaeological resources have been recorded within the Area of Potential Effect (APE) for dredging. Archaeological sites may exist within unsurveyed parts of the APE. Surveys will be conducted for these areas during the PED Stage of the project. A Programmatic Agreement with the State Historic Preservation Office has been concluded that sets forth procedures for mitigating adverse effects to historic properties if any are identified. Avoidance and minimization of impacts would be attempted where feasible, and mitigation of adverse effects (if applicable) would be evaluated and determined during the PED Stage.
Aesthetics	There would be no predicted changes to the existing aesthetic environment. The aesthetic environment would continue to be that of a working waterfront with a mix of adjacent land uses.	The aesthetic environment would be similar to the Action/FWO but temporary impacts to the viewshed would increase because of increased dredging and dredged material placement/disposal durations and dredging locations. Implementation of the Action Project Alternative would result in adverse, temporary and negligible impacts to the aesthetic environment.

Resource	No Action Alternative/Future Without Project Alternative	Action Project Alternative
Recreation	While maintenance dredging and dredged material placement/disposal activities are ongoing, areas adjacent to the dredging and dredged material placement/disposal actions would be unavailable for recreation and represent an adverse, temporary and negligible impact to recreation.	Impacts would be at the same threshold level of impact as the NAA/FWO (adverse, temporary, and negligible), however, the relative level of impact with the Action Project Alternative would be slightly higher due to the increased duration of dredging and dredged material placement/disposal.
Socioeconomics and Environmental Justice	There would not be substantive changes to demographic, socioeconomic, or Environmental Justice community trends. The effect on the socioeconomic character would be beneficial, temporary, and minor from existing dredging maintenance and dredged material placement/disposal operations.	The improved navigation channel would allow more efficient movement of the same quantity of cargo, but would not be anticipated to result in changes in the overall quantity of cargo being moved. Implementation of the Action Project Alternative would not result in measurable changes to environmental resources that individuals involved in subsistence fishing or hunting utilize and would not create disproportionately high and adverse human health or environmental effects on low-income populations, minority populations, or Native American tribes. The Action Project Alternative and would result in a temporary, beneficial increase in the local economy. Regional Economic Development benefits would be anticipated to be beneficial and temporary and in relation to the dredging cycle.

Resource	No Action Alternative/Future Without Project Alternative	Action Project Alternative
Land Use and Induced Development	There would be no temporary or permanent predicted changes to the existing land use or patterns of land use change.	There would be no effect on land use or patterns of land use change.
Transportation	There would be no anticipated changes to the regional traffic or surface road congestion.	Expected impacts to transportation would be similar to the NAA/FWO. The Action Project Alternative would not result in an increase in local traffic at points of access to, or egress from, Port of Virginia facilities and would not have a direct effect on traffic congestion or the burden of truck traffic on surrounding surface roads. The predicted number of deep draft vessel calls when comparing the future with project would be less than the future without project.

NAA/FWO = No Action Alternative/Future Without Project Alternative

One important consideration important in the environmental impact analysis is that the actual dredged depths can be deeper than the required channel depths. Required depths do not necessarily indicate the maximum, potential dredging depths which may also include Advanced Maintenance Dredging (1 foot), Paid Allowable Overdepth Dredging (2 feet), and Non-Pay Allowable Overdepth dredging (2 feet) for Norfolk Harbor. Please see Table 6-2 for an approximate estimate of estimated maximum, potential dredging depths that account for the overdepth and advanced maintenance dredging with implementation of the Preferred Alternative. For the purpose of the environmental impact analysis (as described in the Environmental Consequences sections), the full range of environmental impacts including the maximum, potential dredging depths were evaluated. The maximum potential dredging depths, durations, and volumes are provided in Table 6-2. The full range of potential environmental impacts, the maximum depths, volumes, and dredging durations in the environmental analysis are greater than those assumed in the economic analysis are being considered.

Table 6-2: Summary of estimated dredging depths (-), durations and volumes over the lifecycle of the No Action/Future Without Project Alternative and the Preferred Alternative (Action Alternative) for the Norfolk Harbor Navigation Improvements Project. Maximum depths listed for the Preferred Alternative are unlikely and not anticipated to be reached, but were identified to evaluate maximum environmental impacts. These depths will differ from those calculated for the NED Plan.

		Estimated Construction					Estimated Maintenance (50 Years)		Estimated Construction and Maintenance (50 Years)	
Alternative	Required Depth (feet)	Estimated Maximum Depth (feet)	Estimated Maximum Dredging Volume- all allowable and nonpay (cubic yards)	Estimated Maximum Dredging Duration (months)	Estimated Total Land Disturbance - Maximum (square feet)	Change/Delta (increase) in Land Disturbance - Maximum (square feet)	Estimated 50 Year Total of Maintenance Volume (cubic yards)	Estimated 50 Year Total - Maintenance Dredging Duration (months)	Estimated Maximum Volume- Total Allowable and Non-pay + Maintenance Volume (cubic yards)	Estimated Maximum Construction + 50-year Maintenance Dredging Duration (months)
NAA/FWOP-Segment 1 Atlantic Ocean Channel	52	57	2,152,820	6	76,166,690	0	8,217,950	33	10,370,770	39
NAA/FWOP-Segment 1 Thimble Shoals Channel	50	55	4,371,193	14	114,682,571	0	16,278,850	140	20,650,043	154
NAA/FWOP-Segment 1 Sewells Point to Lamberts Bend	50	55	4,460,147	4	52,664,951	0	36,681,500	68	41,141,647	72
NAA/FWOP-Segment 1 Anchorage F	50	55	210,956	2	24,930,676	0	6,851,800	14	7,062,756	15
NAA/FWOP-Segment 2 Newport News Channel	50	55	1,658,438	1	27,157,981	0	5,481,200	13	7,139,638	14

Total			**12,853,553**	**26**	**295,602,869**		**73,511,300**	**268**	**86,364,853**	**295**
PA-Segment 1 Atlantic Ocean Channel	59	64	16,074,736	42	78,738,613	2,571,924	15,191,112	62	31,265,848	104
PA-Segment 1 Thimble Shoals Channel	56	61	18,069,823	57	119,644,916	4,962,345	24,331,540	210	42,401,363	267
PA-Segment 1 Thimble Shoals Channel Meeting Area 2 (1,300 feet)	56	61	3,072,847	10	13,693,000	13,693,000	2,000,744	17	5,073,591	27
PA-Segment 1 Sewells Point to Lamberts Bend	55	60	12,147,318	11	57,012,805	4,347,854	42,346,689	78	54,494,008	89
PA-Segment 1 Anchorage F - 3,620 feet	51	56	2,522,500	19	27,984,077	3,053,401	6,858,836	14	9,381,336	33
PA-Segment 2 Newport News Channel	55	60	4,906,284	4	29,272,754	2,114,772	6,676,305	16	11,582,589	19
Total			**56,793,508**	**143**	**326,346,166**	**30,743,297**	**97,405,226**	**397**	**154,198,734**	**539**

NAA/FWOP=No Action Alternative, Future Without Project; PA=Preferred Alternative

6.1 Geology, Physiography, and Topography

6.1.1 No Action/Future Without Project Alternative

Existing maintenance dredging operations, dredged material placement/disposal, and navigation within the ROI would continue. The existing sediment within the dredging footprint in the channel would continue to be removed, most of which, from a geologic perspective, is recently-deposited fine sands, silts, mud, and unconsolidated clay.

Over time, the CIDMMA may fill with dredged material from the dredging of the Federal navigation channel in the Norfolk Harbor and from other projects using the CIDMMA as a dredged material placement/disposal site. Placement/disposal of dredged material may alter the topography of the open water placement sites as well. However, continued use of any of the potential dredged material placement/disposal sites will have a negligible to minor adverse effect on topography, geology, or physiography. Continued maintenance of the channel system should have no effect on seismicity because the ROI is not within a seismically-active geologic setting.

Virginia Port growth is anticipated to increase throughout the next 50 years, and a new port facility is planned, which may increase the number of vessels transiting the ROI. This may also increase the dredging demands within the waterway. Also, additional development, including construction of the Third Crossing and expansion of the Chesapeake Bay Bridge Tunnel, is planned in the future. New development within the ROI could increase impacts to geology, physiography, or topography by changing land uses, and altering or elevations and/or geologic landforms.

Climatic changes such as sea level rise and increasing global temperatures are predicted to continue in the future. Climate change impacts such as increased temperatures, ocean acidification, sea level rise, and changes in currents, upwelling and weather patterns have the potential to cause changes in the nature and character of the estuarine ecosystem in the ROI. Erosion and loss of estuarine and ocean beaches is anticipated to occur with sea level rise. Over the course of time, more landforms may become submerged, and other areas may become lower-lying and flood more frequently, particularly within the coastal physiographic province in which this project is located.

The No Action/Future Without Project Alternative is not predicted to substantially cumulatively or synergistically interact with climate change and/or other cumulative effects. Therefore, effects to the geology, physiography, seismicity, and topography from implementation of the No Action/Future Without Project Alternative are predicted to be negligible to minor and permanent.

6.1.2 Action Project Alternative

Impacts to geology, physiography, seismicity, and topography with implementation of Action Alternative, would be similar to those described for the No Action/Future Without Project Alternative.

With implementation of the Action Alternative, the channels, meeting areas, and Anchorage F will be deepened, and maintained to those depths. No geologically significant minerals would be affected, and the project would have no effect on seismicity or physiographic processes, such as the development of landforms. Because there are no bedrock or confining geologic layers within the ROI, none would be affected, and no blasting of the substrate will be conducted to achieve the proposed depths.

Compared to current operations, there would be increased material placement/disposal at the CIDMMA, DNODS, and NODS and associated topographic changes with implementation of the Action Alternative as compared to the No Action/Future Without Project Alternative. With implementation of the Action Alternative, there will be minor topographic increases in elevation in CIDMMA over the next 50 years, due to the project. Over time, the CIDMMA may fill with dredged material. However, as CIDMMA is a manmade facility, and used as such, topographic changes as a result of dredged material placement will not affect any natural geologic landforms. Placement of the dredged material at the CIDMMA, DNODS, and NODS is expected to have no adverse impact on seismology; no adverse impacts on geology and physiography; and permanent, negligible to minor, adverse impacts on topography. Although not anticipated, any potential contaminated materials dredged from the ROI would be carefully handled, and would be transported to lined landfills that currently exist and are functioning.

As described in the No Action/Future Without Project Alternative Section, potential cumulative impacts include increased development such as port growth, increased shipping traffic, and climate change. Implementation of the Action Alternative is not anticipated to substantially cumulatively or synergistically interact with climate change and/or other cumulative effects, including port growth.

6.2 Bathymetry, Hydrology, and Tidal Processes

6.2.1 No Action/Future Without Project Alternative

With implementation of the No Action/Future Without Project Alternative, there will be no effect to the local bathymetry, hydrology or tidal processes in the ROI. Larger ships will be unable to call at the port, and ongoing navigation issues occurring with multiple ships in the channel will continue. The square feet of benthic bottom disturbance associated with implementation of the Action Alternative are provided in Table 6-2. Periodic maintenance dredging and existing dredged material placement/disposal will be done as needed to maintain current channel depths and widths, as well as those of associated anchorages.

Rising seas due to climate change will, over time, slowly deepen the entire Chesapeake Bay including the ROI, though it is not expected that this rate of change will be sufficient to meet the needs described in this report. The tidal prism will increase as sea level continues to rise. Hydrologically, waters in the lower Chesapeake Bay in the project ROI may increase in salinity as the amount of oceanic water relative to freshwater input is altered, with greater seawater input. Vertical stratification could possibly increase in the region where the less saline waters of the lower James meet with the ocean waters of the Atlantic Ocean in the region of NHC.

The No Action Alternative will not alter the present channel and associated anchorages, therefore, there will be no cumulative impacts.

6.2.2 Action Project Alternative

The additional dredging that will occur with implementation of the Action Alternative will deepen the existing Thimble Shoal Channel (and the additional widened sections of the Thimble Shoal) from a required depth of approximately -50 feet to a required depth of -56 feet. The Norfolk Harbor Entrance Channel and the Newport News Channel will be deepened from a required depth of approximately -50 feet to a required depth of -55 feet. Anchorage F will be deepened from a required depth of -50 feet to a required depth of -51 feet. The additional dredging would deepen the existing Atlantic Ocean Channel from a required depth of -52 feet to a required depth of -59 feet. The estimated square feet of benthic bottom disturbance associated with implementation of the Action Alternative are provided in Table 6-2. The proposed dredging will alter the bathymetry in the navigation channels, deepening it and removing all the sediments currently occupying this area. This may also potentially increase the tidal prism in the area of the channel. This bathymetric alteration may influence effects of the tides, the benthic community, and/or water quality and these impacts are discussed further in the Water Quality and Benthic Fauna sections. The change in tidal prism is very minor compared to the size of the Chesapeake Bay/Atlantic Ocean confluence and no substantial impacts are expected resulting in a minor, permanent effect. The channel will be deepened to a maximum of approximately 10 percent, which could allow for a small (less than approximately one percent difference) change in bottom salinity in the channel area. This is a minor change in hydrology that will have a minor effect on local salinity and is not expected to substantially alter the salinity of lower Chesapeake Bay. It is expected that there will be a minor, permanent effect on salinity.

The tidal prism will increase as sea level continues to rise. Hydrologically, waters in the lower Chesapeake Bay in the project ROI may increase in salinity as the amount of oceanic water relative to freshwater input is altered, with greater seawater input. Vertical stratification could possibly increase in the region where the less saline waters of the lower James River meet with the ocean waters of the Atlantic Ocean in the region of the Norfolk Harbor. The Action Alternative slightly increases salinity in deep waters of the ROI and this will likely be additive with any changes in salinity induced by climate change (Wang et al 2017).

Although climate change has the potential to alter the tidal prism within the ROI, implementation of the Action Alternative is not predicted to substantially cumulatively or synergistically interact with climate change and/or other cumulative effects. Therefore, effects to bathymetry, hydrology, and tidal processes from implementation of the Action Alternative are predicted to be permanent and minor.

6.3 Hazardous, Toxic, and Radioactive Waste

6.3.1 No Action Alternative/Future Without Project

Current HTRW pathways will continue into the future that result from dredging operations, dredged material placement/disposal, navigation, and effluent discharges from the CIDMMA within the ROI. Existing and future dredging and dredged material placement/disposal may result in a shift in the location of sediment-bound contaminants. Detectable releases of contaminants from disturbed sediments into the water column are not anticipated as potential contaminants would be anticipated to remain bound to the sediment. Sediment within the ROI has been tested for placement/disposal and the dredged material is within established limits for placement/disposal at these sites. It is expected that future maintenance dredging will continue to have a similar, negligible level of impact and will remain within dredged material placement/disposal limits at the CIDMMA and open ocean disposal sites. This is not expected to have any substantive long-term adverse impacts in the ROI.

Continued development, shipping and other navigation operations, and stormwater discharges will continue within the ROI and adjacent areas. Virginia Port growth is anticipated to increase throughout the next 50 years and a new port facility is planned, which may increase the number of vessels transiting the Norfolk Harbor. Also, additional development including construction of the CIEE, Third Crossing and expansion of the Chesapeake Bay Bridge Tunnel is planned in the future. However, these future anticipated activities are not anticipated to result in any substantive generation or release of HTRW within the ROI.

Monitoring of NPL sites by the responsible party and the tracking of hazardous waste, toxic waste and radioactive waste generators throughout the ROI will continue through applicable state and Federal programs. Existing SMMPs and Ocean Dumping laws will continue to protect dredged material placement/disposal sites from receiving contaminated sediments that could impact the ROI.

6.3.2 Action Project Alternative

The implementation of the Action Alternative would not cause any substantial change in the chemical constituents or concentration of contaminants in the sediment or elutriate released from the CIDMMA or in the placement/disposal sites. Implementation of the Action Alternative is not anticipated to result in any generation or regulated release of a HTRW. However, dredging and dredged material placement/disposal may result in a shift in the location of sediment-bound contaminants. Detectable releases of contaminants from disturbed sediments into the water column are not anticipated as potential contaminants would be anticipated to remain bound to the sediment. Extensive sediment testing conducted over the last decade within the ROI has consistently met guidelines for upland and offshore ocean disposal sites. Any dredged material will be subject to existing disposal SMMPs, Ocean Dumping laws, and Section 103 MPRSA compliance. These guidelines along with the USACE Upland Testing Manual will continue to protect placement/disposal sites. Therefore, redistribution of contaminants resulting from dredging and dredged placement/disposal would be negligible and are not expected to have any substantive long-term adverse impacts in the ROI.

Continued development, shipping and other navigation operations, and stormwater discharges will continue within the ROI and adjacent areas. Virginia Port growth is anticipated to increase throughout the next 50 years and a new port facility is planned, which may increase the number of vessels transiting Norfolk Harbor. Also, additional development including construction of the CIEE, Third Crossing and expansion of the Chesapeake Bay Bridge Tunnel is planned in the future. However, these future anticipated activities are not anticipated to result in any substantive generation or release of HTRW within the ROI. Monitoring of NPL sites and the tracking of hazardous waste, toxic waste and radioactive waste generators throughout the ROI will continue through applicable state and Federal programs.

Implementation of the Action Alternative is not anticipated to synergistically interact with climate change and other cumulative effects to have any adverse effects resulting in generations or releases of HTRW into the ROI.

6.4 Water Quality

6.4.1 No Action Alternative/Future Without Project Alternative

Existing dredging operations, dredged material placement/disposal, effluent discharges from the CIDMMA, and navigation within the ROI would continue. Temporary and negligible to minor adverse impacts to water quality that result from current maintenance operations that include increased Total Suspended Solids, turbidity, and nutrient levels would continue. Overall impacts to water quality with current operations are temporary, adverse and negligible to minor.

All maintenance dredging activity would comply with current Water Quality Permits for Newport News Channel and Norfolk Harbor Channel. Sediments will be tested in accordance with the *Evaluation of Dredged Material for Discharge in Waters of the U.S.- Testing Manual* (USEPA 1998) and the USACE Manual, *Evaluation of Dredged Material Proposed for Disposal at Island, Nearshore, or Upland Confined Disposal Facilities – Testing Manual* (USACE 2003) prior to commencement of dredging to ensure appropriate placement/disposal of dredged material. Dredged material that meets sediment testing requirements for the CIDMMA would continue to be placed in the CIRB or directly into one of the containment cells at CIDMMA. Material would be transported to the upland containment cells at CIDMMA by hydraulic pipeline if hydraulically dredged or by barge/scow if mechanically dredged and bottom dumped at in CIRB or directly hydraulically offloaded and pumped into a containment cell at CIDMMA. Effluent discharge from the CIDMMA would continue to be discharged to the Elizabeth River via spillways. Effluent discharges would be visually monitored and tested for Total Suspended Solids. The dredging operations and the discharge of effluent from the CIDMMA would result in temporary, adverse impacts to water quality that are negligible to minor.

Any maintenance dredging within the TSC and AOC will comply with current SMMPs for NODS and DNODS and Section 103 of MPRSA. The USEPA will continue to monitor LPCs biannually at NODS and DNODS, and USACE will provide pre and post hydrographic surveys of ocean placement of maintenance materials. The placement of these maintenance materials would cause temporary, adverse impacts to the water quality of the placement sites; however, these impacts would be considered minor and within USEPA limits.

Continued development, shipping and other navigation operations, and stormwater discharges will continue to negatively impact water quality within the ROI and adjacent areas. Virginia Port growth is anticipated to increase throughout the next 50 years and a new port facility is planned, which may increase the number of vessels transiting Norfolk Harbor. Also, additional development including construction of the CIEE, Third Crossing and expansion of the Chesapeake Bay Bridge Tunnel is planned in the future which has the potential to impact water quality.

Climatic changes such as sea level rise and increasing global temperatures are predicted to continue. Predicted climate change impacts such as increased ocean temperatures, ocean acidification, sea level rise, and changes in currents, upwelling and weather patterns, have the potential to cause changes in the nature and character of the estuarine ecosystem in the ROI. The pH within surface waters will likely drop as ocean acidification occurs. Climate change is anticipated to potentially increase winter and spring nutrient loading into the Chesapeake Bay (Najjar et al. 2010). The higher temperatures, lower dissolved oxygen levels, and increased phytoplankton productivity may result in more frequent hypoxic conditions (low dissolved oxygen conditions) in the water column. The anticipated higher temperatures and carbon dioxide levels in the Chesapeake Bay may result in increases in harmful algal blooms (Najjar et al. 2010).

From the modeling results (Appendix J), most of larger salinity differences (2-3 ppt) occur near upstream of the estuary at the limit of salinity intrusion. The differences are smaller elsewhere (~ 1.5 ppt or less). In all scenarios, the bottom salinity exhibits more increase than does the surface salinity in moving upstream. The largest changes are expected in the Lower James River near and upstream of the proposed dredging/current navigation channel (Liu et al. 2017). Differences in Nitrogen (N), Phosphorus (P), and Chlorophyll a (Chla) (measure of phytoplankton productivity) all appear to be relatively minor due to sea level rise, with the exception of the region near the mouth of the Elizabeth River, where changes to N and Chla are significant, ~15%. As the N decreases, Chla increases by a similar amount near the mouth of the Elizabeth River. All of these changes will be permanent.

Implementation of the No Action/Future Without Project Alternative is not anticipated to substantially cumulatively or synergistically interact with climate change and/or other cumulative effects, including port growth to negatively impact water quality. The changes due to sea level rise will occur regardless.

6.4.2 Action Project Alternative

Implementation of the Action Alternative will result in a temporary increase in Total Suspended Solids and turbidity in the dredging footprint and adjacent areas following dredging activities. There may be a slight, temporary increase in the level of dissolved nutrients (N and P) in the water column as well following dredging activities. These adverse water quality impacts would be temporary in nature and are anticipated to result in minor levels of impact.

Changes in salinity and decreases in Dissolved Oxygen, and flushing rates are anticipated to cause permanent, adverse impacts to water quality that are negligible and minor in nature. The Action Alternative has the potential to alter the location of the salt wedge (the region where saltier water mixes with lighter, fresh water) and/or currents. The simulation modeling conducted by Liu et al. (2017), Shen et al. (2017) Zhang et al. (2017) and Wang et al. (2017) indicated that salinity in the river would experience a minor increase, approximately less than one ppt on average in both surface and bottom waters (Appendix J). Implementation of an action alternative is anticipated to cause less than a 0.5 mg/L percent change in average Dissolved Oxygen levels (Wang et al. 2017), which is not anticipated to result in ecological impacts in the ROI. This change is considered permanent but minor and not significant. Freshwater age is defined as the movement of fresh water in the waterbody. The modeling analyses indicated that with implementation of an action alternative, age increases slightly in the lower James while decreasing in tributaries to the Elizabeth River. Slightly improved flushing rates (decreases in age of the water) may result in lower bacterial levels in portions of the ROI. Saltwater age indicates the change of movement of saltwater in a waterbody. With implementation of an action alternative, the modeling indicated that saltwater age decreases in the lower James River and Elizabeth River slightly. Renewal time is the measure of the overall change in flushing time. Overall, with implementation of an action alternative, the modeling analyses indicated there is a decrease in flushing time in the lower James River.

The duration and volumes of expected dredged materials can be found in Appendix A. Sediment testing will be conducted in accordance with the *Evaluation of Dredged Material For Discharge in Waters of the U.S.- Testing Manual* (USEPA 1998) and the USACE Manual, *Evaluation of Dredged Material Proposed for Disposal at Island, Nearshore, or Upland Confined Disposal Facilities – Testing Manual* (USACE 2003) prior to the commencement of dredging would ensure that only dredged material that meets suitability criteria would be placed at the CIDMMA and at Ocean Disposal Areas (NODS and DNODS). The SMMPs for NODS and DNODS will continue to be implemented with USEPA monitoring LPCs biannually and USACE supplying pre and post hydrographic surveys of ocean placement of dredged materials. There would be temporary, adverse impacts to the water quality of the dredging locations and placement sites; however, these impacts would be minor and within USEPA LPC guidelines for Section 103 MPRSA regulations.

Dredged material which meets sediment testing requirements for placement at the CIDMMA will be placed in the Craney Island Re-Handling Basin (CIRB) or directly in one of the containment cells at the CIDMMA. Material would be transported to the upland containment cells at CIDMMA by hydraulic pipeline if hydraulically dredged or by barge/scow if mechanically dredged and bottom dumped in CIRB or directly hydraulically off-loaded and pumped into a containment cell at CIDMMA. Effluent discharge from the CIDMMA would continue to be discharged to the Elizabeth River via spillways. Effluent discharges would be visually monitored and regularly tested for Total Suspended Solids. The discharge of effluent from the CIDMMA may result in a temporary, negligible to minor increase in Total Suspended Solids and turbidity in the water column. The discharge of effluent from the CIDMMA may result in a temporary, negligible to minor increase in Total Suspended Solids and turbidity in the water column.

As described in the No Action/Future Without Project Alternative Section, potential cumulative impacts include increased development such as port growth, increased shipping traffic, and climate change. Although increased development and climate change have the potential to impact water levels in the project ROI, implementation of the Action Alternative is not anticipated to substantially, cumulatively or synergistically interact with climate change and/or other cumulative effects, including port growth.

Continued development, shipping and other navigation operations, and stormwater discharges will continue to negatively impact water quality within the ROI and adjacent areas. Virginia Port growth is anticipated to increase throughout the next 50 years and a new port facility is planned, which may increase the number of vessels transiting Norfolk Harbor. Also, additional development including construction of the CIEE, Third Crossing and expansion of the Chesapeake Bay Bridge Tunnel is planned in the future which has the potential to impact water quality.

Climatic changes such as sea level rise and increasing global temperatures are predicted to continue. Predicted climate change impacts such as increased ocean temperatures, ocean acidification, sea level rise, and changes in currents, upwelling and weather patterns, have the potential to cause changes in the nature and character of the estuarine ecosystem in the ROI. The pH within surface waters will likely drop as ocean acidification occurs. Climate change is anticipated to potentially increase winter and spring nutrient loading into the Chesapeake Bay (Najjar et al. 2010). The higher temperatures, lower dissolved oxygen levels, and increased phytoplankton productivity may result in more frequent hypoxic conditions (low dissolved oxygen conditions) in the water column. The anticipated higher temperatures and carbon dioxide levels in the Chesapeake Bay may result in increases in harmful algal blooms (Najjar et al. 2010). The exact intensity and threshold to water resulting from climatic change is relatively uncertain but has the potential to substantially alter water quality in the ROI.

Within the 50 year timeframe of the proposed project, rising seas will induce minor changes water quality, as it is expected that salinity will increase slightly due to increased Atlantic Ocean input. The additive impact of the proposed project on salinity in the future is trivial, no significant difference compared to the impacts caused by climate change alone, as described in the future without project condition. Changes to N, P, and Chla are in general minor (< 5%) and not significant in the Future With Project. The 15% decline in N at one location near the mouth of the Elizabeth River is notable and therefore, this local increase in Chla and concomitant decline in DIN may be due to the generally increased flushing rate at this location, which is quite narrow due to Craney Island on the western bank of the River and naval facilities on the eastern bank of the River. Phytoplankton in this area would be provided regular pulses of N rich fresh water at a faster rate than in other areas, which show a general trend towards increasing freshwater age. Due to the more rapid turnover of N-rich freshwater, which they can use to grow and replicate, Chla (phytoplankton) can more rapidly increasing in numbers while at the same time, taking DIN up in this local area.

Implementation of the Action Alternative is anticipated to result in adverse impacts that would be temporary to permanent and negligible to minor to water quality. Although impacts are adverse, it would not reach a threshold level of importance in the impact findings for water quality. Implementation of the Action Alternative will not substantially cumulatively or synergistically interact with climate change and/or other cumulative effects.

6.5 Vegetation, Wetlands, and Submerged Aquatic Vegetation

6.5.1 No Action /Future Without Project Alternative

Existing maintenance dredging operations, dredged material placement/disposal, and navigation within the ROI would continue. These operations can cause minor turbidity, siltation, and boat wakes within the ROI. However, because there is no SAV in the ROI, and because of the substantial distance from the current dredging and dredged material placement/disposal sites from any shoreline wetlands, no existing or future impacts to these resources resulting from dredging and dredged material placement operations are anticipated.

Placement/disposal of dredged material may alter the topography, and consequently alter any existing vegetation colonizing the CIDMMA. Over time, the CIDMMA may fill completely with dredged material, at which time, the site may become too dry to support wetland vegetation and may eventually become solely colonized with upland vegetation. Vegetation at CIDMMA may transition from early successional stages to habitats containing permanent vegetation cover in later successional stages. Therefore, placement/disposal of dredged material at the CIDMMA is anticipated to create both temporary and permanent, negligible, adverse impacts to vegetation at the CIDMMA. However, this is an existing dredged material facility that is ever-changing in response to new material discharges from many different navigation channels, rather than any type of natural wetland or riparian ecosystem. The environmental impacts of the development and use of CIEE, which is currently under construction, were already examined in an Environmental Impact Statement (EIS) for that project (2006) and impacts have been mitigated.

Virginia Port growth is anticipated to increase throughout the next 50 years, and a new port facility is planned, which may increase the number of vessels transiting the ROI. Also, additional development, including construction of the Third Crossing and expansion of the Chesapeake Bay Bridge Tunnel, is planned in the future. Additional development could increase impacts to wetlands along the shorelines or further inland, or to riparian vegetation. Wetlands along shorelines may be permanently filled or converted to create new docking facilities and/or shoreline stabilization measures. Continued development, shipping and navigation operations, and stormwater discharges will also continue to impact wetlands and vegetation within the ROI through boat wake erosion and nutrient inputs.

Climatic changes such as sea level rise and increasing global temperatures are predicted to continue in the future. Climate change impacts such as increased temperatures, ocean acidification, sea level rise, and changes in currents, upwelling and weather patterns have the potential to cause changes in the nature and character of the estuarine ecosystem in the ROI. In general, wetlands both inside and outside of ROI as well as SAV are at increased risk of damage and loss from potential increases in sea level rise and salinity shifts. The locations of these resources may shift in response to climate change and the ensuing sea level rise. Wetlands may erode further, or be at increased risk of becoming too inundated to support vegetation. As a result, they may transition into mudflats and/or subaqueous bottom. Alternatively, sea level rise may cause estuarine wetlands to retreat inland. In addition, higher salinity levels in waterways in combination with increased sea level may result in inundation of freshwater wetlands further inland, and conversion to estuarine wetlands.

The ROI itself is already a highly developed port with substantial navigation and shipping operations, with few wetland areas and modest vegetative cover. Therefore, continuing maintenance dredging operations would not likely cause substantial shifts to these community types in future conditions.

The No Action/Future Without Project Alternative is not predicted to substantially cumulatively or synergistically interact with climate change and/or other cumulative effects, including port growth. Therefore, with implementation of the No Action/Future Without Project Alternative, adverse impacts are temporary to permanent, and negligible.

6.5.2 Action Alternative

Similar to the No Action/Future Without Project Alternative, there would be no impacts to SAVs or shoreline wetlands with implementation of the Action Alternative.

The hydraulic and water quality modeling (please refer to Liu et al. (2017), Shen et al. (2017) Zhang et al. (2017), and Wang et al. (2017) provided in Appendix J) conducted to simulate conditions of the Action Alternative indicated that potential changes to water quality parameters would be negligible to minor. Therefore, we would not anticipate any potential impacts to water quality to result in an impact to shoreline wetlands.

Placement/disposal of dredged material would alter the topography and consequently any wetland and vegetation cover at the CIDMMA. Compared to the No Action Alternative, (current dredging operations), there would be increased material placement/disposal at the CIDMMA with implementation of the Action Alternative. However, as with the No Action Alternative, placement of the dredged material may result in temporary to permanent, negligible, adverse impacts to vegetation at the CIDMMA. The dredged material placement site would transition over time as the material dries and vegetation inhabits the site. Over time, the CIDMMA may fill with dredged material slightly faster, but that would be difficult to predict, as the CIDMMA and CIEE will also accept dredged material from many other future dredging projects within the Norfolk Harbor boundaries.

As described in the No Action/Future Without Project Alternative Section, potential cumulative impacts include increased development such as port growth, increased shipping traffic, and climate change. Although increased development and climate change have the potential to adversely impact vegetation in the ROI, implementation of either of Action Alternative is not anticipated to substantially cumulatively or synergistically interact with climate change and/or other cumulative effects, including port growth.

6.6 Benthic Fauna

6.6.1 No Action /Future Without Project Alternative

Existing maintenance dredging operations, dredged material placement, and navigation within the ROI would continue. The existing and projected future adverse impacts to the benthic community resulting from dredging and dredged material placement/disposal are temporary with the impacted benthic community expected to rapidly recolonize after the dredging operations cease. The organisms that colonize the benthic community are typically a limited suite of small, opportunistic species with a short life cycle that are adapted to soft bottom environments with frequent disturbance. Within the warm-temperate waterbody in the ROI, recovery of the benthic community is expected in approximately two years or less (Wilbur et al. 2008; Stickney and Perlmutter 1975).

Additionally, benthic organisms outside the dredging footprint will be impacted temporarily by increased levels of Total Suspended Solids and turbidity from dredging and dredged material placement, some of which will settle on top of them, possibly burying them under a layer of silt several centimeters in depth. The siltation of benthic organisms may prevent or reduce respiration and/or foraging for filter-feeding organisms. However, the sediment plume during dredging operations is not significant enough to result in more than minor mortality of benthic life outside the channel, as quantities of Total Suspended Solids released should not result in burial of the benthos deep enough such that they will be unable to survive.

Dredging activities often generate no more increased suspended sediments than commercial shipping operations, bottom fishing or than those generated during severe storms (Parr et al. 1998). Furthermore, natural events such as storms, floods and large tides can increase suspended sediments over much larger areas and for longer periods than dredging operations (International Association of Dredging Companies 2015). It is therefore often very difficult to distinguish the environmental effects of dredging from those resulting from natural processes or normal navigation activities (Pennekamp et al. 1996).

Dredging and dredged material placement/disposal operations will cause minor, adverse impacts to the benthic community resulting from direct removal or entrainment of benthic organisms, strikes and crushing of benthic organisms, and turbidity/siltation effects that could include burial and potentially impact respiration of benthic organisms. Increased open ocean disposal would occur after CIDMMA reaches capacity. The existing and projected future adverse impacts to the benthic community are temporary.

No impacts to oyster reefs, the Newport News Middle Ground Artificial Reef, the Middle Ground Light Broodstock Sanctuary, Hampton Flats Hard Clam Harvest Area, or the Newport News Shellfish Management Area occur from existing dredging and dredged material placement/disposal operations. These resources are located far enough from existing operations that no significant direct or indirect impacts to these resources occur from existing dredging operations.

Virginia Port growth is anticipated to increase throughout the next 50 years, and a new port facility is planned, which may increase the number of vessels transiting the ROI. Also, additional development including construction of the Third Crossing and expansion of the Chesapeake Bay Bridge Tunnel, and construction of the CIEE is planned in the future. Additional development could increase impacts to the benthic community and associated habitat. Continued development, shipping and navigation operations, and stormwater discharges/nutrient inputs will continue to impact the benthic community within the ROI and adjacent coastal and estuarine waters.

Climatic changes such as sea level rise and increasing global temperatures are predicted to continue as a result of burning of fossil fuels and deforestation in the ROI over the next 50 years. Predicted climate change impacts such as increased ocean temperatures, ocean acidification, sea level rise, and changes in currents, upwelling and weather patterns, have the potential to cause changes in the nature and character of the estuarine ecosystem in the ROI. Due to impacts from climate change, it is possible the extent of waters high enough in salinity to support estuarine life will extend further up the tributaries of the Chesapeake Bay, including the Elizabeth River. Climate change is anticipated to potentially increase winter and spring nutrient loading into the Chesapeake Bay and may result in increased phytoplankton production (Najjar et al. 2010). The higher temperatures, lower dissolved oxygen levels, and increased phytoplankton productivity may result in more frequent hypoxic conditions (low dissolved oxygen conditions) which could impact benthic populations. The anticipated higher temperatures and carbon dioxide levels in the Chesapeake Bay may result in increases in harmful algal blooms (Najjar et al. 2010). Although the eastern oyster is fairly resilient to small changes in temperature and salinity, other benthic resources such as blue crabs, horseshoe crabs and clams could be more sensitive to these shifts in the estuarine system.

The No Action/Future Without Project Alternative is not predicted to substantially cumulatively or synergistically interact with climate change and/or other cumulative effects. Therefore, effects to the benthic community from implementation of the No Action/Future Without Project Alternative are predicted to be temporary and minor in nature.

6.6.2 Action Project Alternative

Impacts to the benthic community with implementation of the Action Project Alternative would be similar to those described for the No Action/Future Without Project Alternative. Following implementation of the Action Alternative, there would be little change in the composition and abundance of the benthic community, as Norfolk Harbor is already subject to recurring dredging and dredged material placement activities. Additional areas would be dredged including the meeting areas (200-400 feet adjacent to the channel footprint) and Anchorage F which would increase impacts to the benthic community. Also, impacts to the benthic community would slightly increase as open ocean disposal would increase with the Action Alternative.

Some permanent, potential shifts in salinity and Dissolved Oxygen may occur with implementation of the Action Alternative from the increased depths in the channel. This could potentially reduce the B-IBI, however, most species found in the channel are quite tolerant of lower Dissolved Oxygen than more motile life, such as fish and blue crabs. However, the hydraulic modeling (Wang et al. 2017) conducted to simulate conditions of the Action Alternative indicate that this change would be negligible to minor and would not result in a composition change in the benthic community. Therefore, with implementation of the Action Alternative we would anticipate impacts would remain to be adverse and minor and temporary.

No impacts to oyster reefs, the Newport News Middle Ground Artificial Reef, the Middle Ground Light Broodstock Sanctuary, Hampton Flats Hard Clam Harvest Area, or the Newport News

Shellfish Management Area would occur from implementation of the Action Alternative. These resources are located an acceptable distance (.3 - .8 miles) from proposed dredging operations and dredged material placement/disposal sites that no impacts to these resources are anticipated.

Virginia Port growth is anticipated to increase throughout the next 50 years, and a new port facility is planned, which may increase the number of vessels transiting the ROI. Also, additional development including construction of the Third Crossing and expansion of the Chesapeake Bay Bridge Tunnel and the CIEE is planned in the future. Additional development could increase impacts to the benthic community and associated habitat. Continued development, shipping and navigation operations, and stormwater discharges/nutrient inputs will continue to impact the benthic community within the ROI and adjacent coastal and estuarine waters.

Climatic changes such as sea level rise and increasing global temperatures are predicted to continue as a result of burning of fossil fuels and deforestation in the ROI over the next 50 years. Predicted climate change impacts such as increased ocean temperatures, ocean acidification, sea level rise, and changes in currents, upwelling and weather patterns, have the potential to cause changes in the nature and character of the estuarine ecosystem in the ROI. Due to impacts from climate change, it is possible the extent of waters high enough in salinity to support estuarine life will extend further up the tributaries of the Chesapeake Bay, including the Elizabeth River. Climate change is anticipated to potentially increase winter and spring nutrient loading into the Chesapeake Bay and may result in increased phytoplankton production (Najjar et al. 2010). The higher temperatures, lower dissolved oxygen levels, and increased phytoplankton productivity may result in more frequent hypoxic conditions (low dissolved oxygen conditions) which could impact benthic populations. The anticipated higher temperatures and carbon dioxide levels in the Chesapeake Bay may result in increases in harmful algal blooms (Najjar et al. 2010). Although the eastern oyster is fairly resilient to small changes in temperature and salinity, other benthic resources such as blue crabs, horseshoe crabs and clams could be more sensitive to these shifts in the estuarine system.

The implementation of the Action Alternative is not predicted to substantially cumulatively or synergically interact with climate change and/or other cumulative effects. Therefore, effects to the benthic community from implementation of the Action Alternative are predicted to be adverse, temporary and minor in nature.

6.7 Plankton Community

6.7.1 No Action/Future Without Project Alternative

Existing dredging operations, dredged material placement, and navigation would continue. Temporary and negligible adverse impacts to the plankton community that result from current dredging and navigation and dredged material placement/disposal operations include entrainment, burial/siltation, and reduced light levels that may affect phytoplankton productivity.

Continued development, shipping and other navigation operations, and stormwater discharges will continue to negatively impact plankton species composition and the local plankton community within the ROI. Virginia Port growth is anticipated to increase throughout the next 50 years and a new port facility is planned, which may increase the number of vessels transiting Norfolk Harbor. Also, additional development including construction of the Third Crossing and expansion of the Chesapeake Bay Bridge Tunnel and construction of the CIEE is planned in the future.

Climatic changes such as sea level rise and increasing global temperatures are predicted to continue as a result of burning of fossil fuels and deforestation. Predicted climate change impacts such as increased ocean temperatures, ocean acidification, sea level rise, and changes in currents, upwelling and weather patterns, have the potential to cause changes in the nature and character of the estuarine ecosystem in the ROI. Climate change is anticipated to potentially increase winter and spring nutrient loading into the Chesapeake Bay and may result in increased phytoplankton production (Najjar et al. 2010). The higher temperatures, lower dissolved oxygen levels, and increased phytoplankton productivity may result in more frequent hypoxic conditions (low dissolved oxygen conditions) in the water column. The anticipated higher temperatures and carbon dioxide levels in the Chesapeake Bay may result in increases in harmful algal blooms (Najjar et al. 2010). Climatic change has the potential to affect the plankton species composition and abundance of plankton populations within the ROI which in turn can affect higher level food chain composition and dynamics. The exact intensity and threshold to plankton populations resulting from climatic change is relatively uncertain but has the potential to substantially alter plankton populations in the ROI.

Although climate change has the potential to alter the plankton community composition as well as abundance, implementation of any of the No Action Alternative/Future Without Project Alternative is not predicted to substantially cumulatively or synergistically interact with climate change and/or other cumulative effects.

6.7.2 Action Project Alternative

Dredging construction and maintenance and dredged material placement/disposal is anticipated to cause additional entrainment and burial/siltation of the local plankton community as compared to current operations. With implementation of the action alternative, dredging construction, dredged material placement, and maintenance will cause temporary increases in Total Suspended Solids and turbidity and in the water column in the dredging footprint and nearby adjacent areas. The increases in Total Suspended Solids and turbidity are anticipated to last for a duration of approximately 24 hours following the cessation of dredging. The increase in Total Suspended Solids and turbidity will decrease light penetration in the water column and may temporarily impact phytoplankton productivity. Although dredging has the potential to release nutrients bound in the sediments into the water column, no phytoplankton blooms have been associated with dredging operations in the ROI based on more than 30 years of dredging history within the ROI and adjacent areas. While these adverse impacts may result in injury and mortality to the local plankton community, the impacts are temporary and negligible due to the limited area of impact relative to the Chesapeake Bay and its tributaries and the ability for the local plankton community to rapidly recover.

Continued development, shipping and other navigation operations, and stormwater discharges will continue to negatively impact plankton species composition and populations within the ROI and adjacent areas. Virginia Port growth is anticipated to increase throughout the next 50 years and a new port facility is planned, which may increase the number of vessels transiting Norfolk Harbor. Also, additional development, including construction of the Third Crossing and expansion of the Chesapeake Bay Bridge Tunnel, is planned in the future.

Climate change may lead to increased ocean temperatures, ocean acidification, sea level rise, and changes in currents, upwelling and weather patterns and has the potential to cause changes in the nature and character of the estuarine ecosystem in the ROI. Climate change is anticipated to potentially increase winter and spring nutrient loading into the Chesapeake Bay and may result in increased phytoplankton production (Najjar et al. 2010). The higher temperatures, lower dissolved oxygen levels, and increased phytoplankton productivity may result in more frequent hypoxic conditions (low dissolved oxygen conditions). The anticipated higher temperatures and carbon dioxide levels in the Chesapeake Bay may result in increases in harmful algal blooms (Najjar et al. 2010).

Climatic change has the potential to affect the plankton species composition and abundance of plankton populations within the ROI, which in turn can affect higher level food chain composition and dynamics. The exact intensity and threshold to plankton populations resulting from climatic change is relatively uncertain but has the potential to substantially alter plankton populations in the ROI.

Although climate change has the potential to shift the plankton community composition as well abundance, implementation of any of action alternative is not predicted to substantially cumulatively or synergistically interact with climate change and/or other cumulative effects. Therefore, adverse impacts to plankton populations from implementation of the action alternative are predicted to be temporary and negligible.

6.8 Fish and Fish Habitat

6.8.1 No Action/Future Without Project Alternative

Existing maintenance dredging and dredged material placement/disposal operations and navigation within the ROI would continue. Current dredging and navigation operations that may affect egg, larval, juvenile, and adult life stages of fishes within the ROI include direct removal or burial, turbidity/siltation effects, shifts in dissolved oxygen and salinity, entrainment, visual and noise disturbances, and alteration of habitat. Increased open ocean disposal would be anticipated after the CIDMMA is filled to capacity, which could increase impacts to fish resources. The impacts to fish resources would be negligible to minor and temporary.

Virginia Port growth is anticipated to increase throughout the next 50 years, and a new port facility is planned, which may increase the number of vessels transiting the ROI. Also, additional development, including construction of the Third Crossing and expansion of the Chesapeake Bay Bridge Tunnel is planned in the future. Additional development could increase impacts to fish resources and associated habitat occurring in the project area. Continued development, shipping and navigation operations, and stormwater discharges/nutrient inputs will impact fish resources and fish habitat within the ROI and adjacent coastal and estuarine waters.

As a result of climate change, global temperatures and sea level are expected to rise in the foreseeable future. Predicted climate change impacts such as increased ocean temperatures, ocean acidification, sea level rise, and changes in currents, upwelling, and weather patterns all have the potential to affect the nature and character of the estuarine and coastal ecosystem in the ROI.

Sea level rise may result in an increase in salinity in upstream areas that could affect breeding sites and survival of early life stages (eggs, larvae, and young of the year). There could be shifts in breeding habitat availability and timing, and the effects of this change on fish populations could be detrimental although relatively uncertain at this time. The shifts in salinity, temperature, and sea level rise all have the potential to result in shifts in prey species availability, which could also cause detrimental effects to fish resources and habitats.

6.8.2 Action Alternative

Potential impacts to fish and fish habitat from the Action Alternative result from dredging vessels transiting to dredging locations, dredging, and dredged material placement/disposal. Increased dredged material placement/disposal would occur at the CIDMMA, DNODS, and NODS as compared to current operations. Dredging and open ocean dredged material disposal can impact water quality. Decreases in light penetration in the water column can result in behavioral responses from fishes due to the disturbance effect and also potentially limit visibility. Increased depths from dredging in estuarine environments also has the potential to alter salinity levels within the dredging footprint and can also potentially result in changes in Dissolved Oxygen levels. Dredging and open ocean disposal also will alter fish habitat and can result in burial and smothering of some species. Dredging has the potential to release nutrients and/or contaminants from sediments, which can impact fishes, prey, and habitat. Fishes can also be impacted by potential strikes from dredging vessels/equipment. Fish may be impacted by noise disturbances which may cause species to flee the area of impact or potentially alter other behaviors, including foraging success. Fishes and their habitat could potentially be impacted by releases of MEC/UXO), although this would be highly unlikely. The extent of the impact depends on hydraulic processes, sediment texture and composition, chemical content of the sediment and pore water matrices, and the behavior and life stage of the fish species.

The temporary increase in Total Suspended Solids and turbidity in the water column at the dredging and the open ocean disposal sites has the potential to directly impact fishes and fish habitat. The impacts to fish species from Total Suspended Solids and turbidity are directly related to: the species tolerance, exposure rate, duration of the exposure, and life stage. Deposition of suspended sediments may induce impacts to fish eggs and larvae through deposition, abrasion, and or smothering, especially in the dredging and disposal areas (Wilbur and Clarke 2001). However, in species, such as the white perch, the deposition of particulate matter on eggs does not demonstrate any adverse effects. White perch eggs can tolerate concentrations of 500 mg/L of particulate matter without any adverse effects (Stanley and Danie 1983). In addition, non-motile, sessile benthic prey species have the potential to be buried and smothered during dredging and dredged material placement. Increases in Total Suspended Solids and turbidity can impact prey species' predator avoidance response due to visual impairments caused by decreased water clarity (Gregory and Northcote 1993; Wilbur and Clarke 2001). Turbid waters can also visually impair predator species that rely on sight to forage. Increased Total Suspended Solids and turbidity alters the ability for light to penetrate the water column; this impairs both physical and biological processes in the affected area (Johnston 1981; Wilbur and Clarke 2001). Increased turbidity can impact primary productivity and respiration of organisms within the project area. By limiting light availability in the water column, the rate of primary productivity has the potential to drop, and as an effect of the reduction in primary productivity, there is an overall reduction in Dissolved Oxygen availability. If Dissolved Oxygen levels drop significantly, anoxic conditions may ensue, which can result in stress induced illness or mortality. However, dredging operations have occurred in the ROI and adjacent areas for more than 30 years, no dredging operation has been recorded to result in an anoxic fish kill or harmful algal bloom. Therefore, anoxic or hypoxic conditions, or harmful algal blooms following dredging operations seems unlikely with implementation of the Action Alternative.

The behavioral response of estuarine fish species to Total Suspended Solids and turbidity has been documented in a number of studies; it has been found that the suspension of fine particles hinders gas exchange with the water by coating the respiratory epithelia of juvenile and adult fish (Clarke and Wilbur 2000). The larger suspended particles can be trapped in the gill filaments and fill the opercular cavity, which may lead to asphyxiation by prohibiting the passage of water through the gills (Johnston 1981; Clarke and Wilbur 2000). Even so, increased sediment loading in the water column is predicted to be temporary, with the effects subsiding within a few days or weeks of dredging or dredged material placement operations. Another behavioral response may be for fish and/or prey species to move away from the disturbance and visual effects. We anticipate that demersal species, especially those that could be foraging in the project area, such as flounder, to be most affected.

While dredging operations will temporarily increase Total Suspended Solids and turbidity, these impacts will be minor when compared to background levels. The flushing rate (due to the water exchange and tidal fluctuations) within the ROI will minimize potential Total Suspended Solids/turbidity plumes and cause them to disperse quickly, minimizing long term impacts to water quality. These factors combined with the operational controls on the dredge will help to minimize impacts to non-motile demersal species (Wilbur and Clarke 2001). Overall, adverse impacts to fishes and fish habitat are predicted to be temporary in duration, and based on the water quality modeling conducted for the project (Liu et al. 2017; Shen et al. 2017; Zhang et al. 2017; Wang et al. 2017), we would anticipate salinity and Dissolved Oxygen impacts to range from negligible to minor in intensity.

Dredging has the potential to disperse and release nutrients and contaminants in the sediment to the water column. Contaminant dispersal and release has the potential to negatively impact managed fish species and their prey by causing illness or mortality by uptake of contaminants in fish tissue. However, in the ROI, contaminated sediments will likely not be encountered, based on extensive sediment testing that has been previously conducted as required per the Marine Protection Research and Sanctuaries Act (MPRSA). However, sediment contaminant testing has not been conducted to the planned depths of sediment dredging anticipated for this project. Therefore, additional testing will be required during the Preconstruction, Engineering, and Design Phase of the project and will also be conducted approximately every three years or as otherwise required. Testing to date has supported the material being placed at the Offshore Disposal Sites.

Dredging and dredged material placement will alter benthic habitats by direct removal of sediment via dredging and placement of dredged material into designated open ocean disposal sites. Therefore, benthic habitats will become disturbed making them temporarily unsuitable for some sessile and/or benthic organisms. Ecological successional processes in these benthic habitats will be temporarily disturbed, but will normalize after dredging and dredged material placement is complete. There may be indirect effects on fish that utilize these benthic habitats.

Direct removal of suitable benthic substrate by dredging may impact fish habitat by removing important prey species (i.e. benthic organisms), food species (i.e. macroalgae), or by alteration of nursery and/or spawning areas. Re-colonization of the newly exposed substrate after dredging is not only a function of site-specific characteristics (i.e. bathymetry, tidal energy), but also of substrate requirements of the larvae of re-colonizing species (Rhoads and Germano 1982). Any deviation from the existing benthic floor changes the habitat complexion for smaller species that utilize the area for foraging and living space. Additionally, some demersal species require specific substrates for foraging and spawning. Therefore, dredging and dredged material placement/disposal will likely result in the temporary loss of some fish habitat, including foraging grounds.

It is anticipated that impacts to benthic habitats will involve the potential loss and displacement of non-motile benthic organisms at the open ocean disposal sites. McCauley et al. (1977) documented that the total abundance of benthic organisms at a dredging site returned to pre-dredging levels seven to 28 days after dredging was completed. This study also showed a similar pattern at the overboard dredged material placement area, with total abundance levels rebounding to pre-dredging numbers within seven days. In a similar study conducted on the nearby James River, Diaz (1994) revealed that almost all species of benthic organisms had re-colonized the disturbed areas within three weeks after the dredging was completed. Diaz (1994) also demonstrated that benthic organisms continued to sustain pre-disturbance population densities three months after a dredging event on the James River. Additionally, this study revealed similar population dynamics and species of benthic organisms in both the undisturbed areas and in the areas of dredged material placement. As described in the Water Quality Section 6.4, we do not anticipate the Action Alternative to cause any substantial impacts to salinity or Dissolved Oxygen and therefore, no substantial permanent impacts to the benthic species community composition are anticipated.

Entrainment is defined as the direct uptake of aquatic organisms by the suction field generated at the suction intake. We are also referring to the capture of organisms that could occur with mechanical dredging as entrainment. Entrainment can occur with either hydraulic cutterhead, mechanical, or hopper dredges, however we would anticipate entrainment to be most frequent and occur with a higher mortality rate with hopper dredges. The entrainment of fishes during dredging operations can lead to direct injury and/or death to the entrained fishes. During dredging, a possible impact to fish species is the entrainment of eggs, larvae, juveniles, and adult life stages. Life stages with limited or no swimming ability, especially eggs and larvae, have a higher potential to be entrained. Active dredging operations have a higher potential to entrain demersal fish species, such as flounder, or species that spawn in or near the dredging area. Foraging, rearing, and spawning habitat preferences impact the potential for various species to be entrained, but other criteria also play an important role.

The size and suction power of the dredge, the dimensions and extent of construction of the channel/meeting area/anchorage being dredged, and the method of dredging all relate to the potential and the ability of the dredge to entrain fish species (Reine and Clarke 1998). The suction power generated from the dredge and the diameter of the cutterhead pipe are the primary physical parameters that dictate the ability to entrain aquatic organisms. The risk of entrainment for many fish species is higher within a radius of 1.5 to two meters of the cutterhead, with one meter (from the cutterhead) posing the highest potential for entrainment (Boysen and Hoover 2009). Suction velocities decrease to less than 30 cm s^{-1} beyond two meters. The size of the pipe diameter also impacts the possibility of entrainment of finfish species.

Burton et al. (1992) used modeling software to predict the rate of entrainment of striped bass (*Morone saxatilis*), herring (*Alosa* spp.), and white perch (*Morone americana*) larvae. This simulation involved the continuous use of four hydraulic dredges to determine a conservative estimate of mortality and entrainment. Despite the large amount of material being dredged in this simulation, the authors concluded that less than one percent of the total larval fish population would be lost. In a separate study involving 15 species of commercial and sport fish, entrainment rates varied from 0.001 to 0.135 fish per cubic yard for both cutterhead and hopper dredging operations (Armstrong et al. 1992). Out of the entrained fish, approximately 37.6

percent of the fish were mortally entrained. Over a four year period, Larson and Moehl (1990) observed entrainment rates ranging from less than 0.001 to 0.341 fish entrained per cubic yard of material dredged, distributed among fourteen species of fish. As expected, the majority of the fish entrained during this study were demersal species.

Calculating entrainment rates for individual managed species within the ROI is difficult due to the limited entrainment data available for species within the anticipated affected area. Because life stages and species abundance can vary depending on location, it is important to calculate potential entrainment rates based on data collected within or near the affected area. Although we are unable to calculate the entrainment rate for each species in the ROI, we can roughly estimate entrainment rates for Atlantic sturgeon, as we have long-term entrainment data that has been collected for this species within and adjacent to the project area. This assessment is provided in the Biological Assessment that is provided in Appendix E.

The remaining factor influencing potential entrainment is based on the swimming stamina and size of the individual fish at risk (Boysen and Hoover 2009). Swimming stamina is positively correlated with total fish length. Entrainment of larger finfish is unlikely due to the increased swimming performance and the relatively small size of the cutterhead opening. Egg, larvae, and juvenile entrainment is possible depending on the location and time or year that dredging occurs. Typically, major concerns of juvenile entrainment relate to fish below 200 mm (Hoover et al. 2005; Boysen and Hoover 2009).

Entrainment rates for hydraulic cutterhead with pipeline dredging is anticipated to be lower than hopper dredging operations; however some level of entrainment could occur with either dredging method. Fish not able to move away from the dredge and located within the dredging area may be entrained. Entrainment and mortality rates are anticipated to range from negligible to minor for all fish species, especially when fish mortality is compared to the amount of material dredged and duration anticipated. Overall, impacts to any life stage of managed fish species are anticipated to be negligible to minor and temporary in duration.

Due to the open-water environment of the Norfolk Harbor, the likelihood of vessel strikes to managed fish species and their prey is possible, but is not anticipated to be a substantial threat due to the limited amount of time the dredging vessels/equipment will be operating and the ability of motile fishes to move away from dredging impacts. Eggs, larvae, and species with limited swimming ability would be at highest risk of strike impacts. Effects to managed fish species and their prey from dredging vessel equipment/strikes is anticipated to range from negligible to minor and be temporary in duration.

Hopper, mechanical and hydraulic cutterhead with pipeline dredges will be used in the ROI. When hopper dredges are used, the principle noise generating equipment includes, hydraulic winches, sediment pumps, and the ship's main engines (EDAW, Inc. 2002). Hopper dredges, along with other dredging vessels produce, on average, continuous, broadband sound frequencies varying from 20 – 1000 Hz that usually diminish below ambient noise levels within about 25 km of the dredges (Todd et al. 2015; Richardson et al. 1995). Throughout the dredging process, low frequency noise is produced, however, the highest level of noise occurs during the loading of dredged material onto the ship (Richardson et al. 1995).

Underwater sounds generated from hydraulic cutterhead suction dredges are typically low in intensity and frequency, but in some instances can emit higher frequencies (CEDA Position Paper, 7 November 2011). Hydraulic cutterhead suction dredging generally produces sound below 1,000 Hertz in frequency, with estimated source sound pressure levels ranging between

168 to 186 decibels (re 1 micro-Pascals) at one meter below the surface. The CEDA (2011) reported that cutterhead suction dredge estimated source sound pressure levels ranging between 172 to 185 decibels (re 1 micro-Pascals) at one meter below the surface. The majority of the sound produced by cutterhead suction dredges occur at the 70 Hertz to 1,000 Hertz range and peaks in the 100 to 110 decibel range (Clarke et al. 2002). Clarke et al. (2002) recorded sounds from a 10,000 horsepower, 24 inch cutterhead suction dredge during maintenance dredging operations in Mississippi. The findings from this study demonstrated that sounds emitted from hydraulic cutterhead suction dredges were rather muted when compared to other sound sources in the aquatic environment. In this example, the sounds attributed to the cutterhead suction dredge operation were virtually undetectable at 500 meters from the plant (Clarke et al. 2002).

The size of dredges to be used in the Norfolk Harbor Deepening project may be similar in size to those in the aforementioned study from Mississippi. Therefore, it is anticipated that the underwater sound levels associated with cutterhead dredging in the ROI will be similar to the levels previously discussed.

Underwater noise generated by dredging may impact fish species and the soundscape of the habitat in the project area, however, population-level impacts are not anticipated. Anthropogenic sources of underwater sound, and specifically dredging, have recently become the source of concern. However, despite these concerns, only a few studies have examined the sound levels of dredging equipment and the potential impacts these sound levels have on aquatic organisms. So, the influence of noise pollution on aquatic organisms, including fishes, is poorly understood. Research has predominantly looked at the potential impacts of dredging sound on marine mammals, with only a few documents examining potential impacts to fish species. However, preliminary research has provided valuable insight regarding the effect of disturbed marine soundscapes on spatially associated fish populations.

Of the marine fish species studied, nearly all fall within the spectrum of auditory sensitivity from 20 – 1000 Hz (outliers can sense up to 4000 Hz); there is a considerable amount of spectral overlap between the noise produced from dredging activities and fish auditory sensitivity (Kasumyan 2005; Nichols et al. 2015). Results from a study conducted by Nichols et al. (2015), provide evidence suggesting that random, intermittent noise, rather than continuous noise, produced by water craft raised the levels of cortisol – a stress hormone - in a variety of coastal fish species. Elevated cortisol levels in fishes, and especially in juvenile fishes, are correlated with negative effects, including increased susceptibility to infection, decreased growth rates, and reduced predator avoidance (Nichols et al. 2015; McCormick et al. 1998). Although the studies linking potential noise impacts to managed fish species from navigation, dredging, and dredged material placement/disposal are limited, implementation of the Action Alternative is not anticipated to substantially increase noise levels as they relate to impacts to managed fish species. Also, all impacts would be temporary in duration. Therefore, we would anticipate noise impacts to managed fish species or their prey to range from negligible to minor.

Depending on the method of dredging, measures can be implemented to minimize disturbances to the environment. For example, agitation and operation of the cutterhead of a dredge will not begin until the cutterhead is in immediate contact with the substrate. A similar measure will be taken for hopper dredges. The dredge operator will not begin dredging until the draghead is in direct contact with the substrate. For both types of hydraulic dredges, this measure reduces the intake of water, and the potential uptake and entrainment of eggs, larvae, juvenile, and adult fish species. By lowering the cutterhead/draghead to the bottom, before starting the agitation and suction of water and sediment, potential impacts and losses of fish species in the vicinity of the dredge are minimized. The USACE also deploys MEC/UXO screening devices on dredges where there is risk of MEC/UXO detonation.

Once dredging and dredged material placement/disposal is complete, impacted benthic areas will likely begin to re-colonize with organisms similar to those from adjacent non-impacted areas. However, benthic organisms and habitats are expected to recover to near pre-construction conditions following a dredging or dredged material placement/disposal event. Changes in salinity and Dissolved Oxygen in the ROI may be permanent but would be very similar to existing conditions and impacts would range from negligible to minor. Therefore, the adverse effects fish and fish habitats are expected to be minor and range from temporary to permanent impacts.

With implementation of either the No Action/Future Without Project Alternative or the Action Alternative, the overall number of vessel calls is anticipated to increase over time. However, the anticipated number of vessel calls with implementation of the Action Alternative would be less than with implementation of the Future Without Project. Virginia Port growth is anticipated to increase throughout the next 50 years, and a new port facility is planned. Also, additional development, including construction of the Third Crossing and expansion of the Chesapeake Bay Bridge Tunnel, and construction of the CIEE is planned for the future. Development could increase impacts to the managed species occurring in the project area. However, implementation of the Action Alternative, along with other past, present, and future actions, is not anticipated to substantively contribute to increased impacts.

Potential cumulative threats to managed species includes entrainment and exposure to contaminants. Another potential cumulative impact to consider is impacts that occur from fishery entanglement. While some of these threats have the potential to impact fish resources, implementation of the Action Alternative is not anticipated to significantly contribute cumulatively to injuries and mortalities.

Global climate change has the potential to affect fish populations that occur or could occur in the project area in the future. Sea level rise causes an increase in salinity in upstream areas that could affect breeding sites and survival of early life stages (eggs, larvae, and young of the year). There may be shifts in breeding habitat availability and timing and the effects of this change on fish populations could be detrimental although relatively uncertain at this time. The shifts in salinity, temperature, and sea level rise all have the potential to result in shifts in prey species availability which may also cause detrimental effects to fish populations. While continued development and climate change has the potential to impact fishes, implementation of the Action Alternative is not anticipated to substantially contribute cumulatively to injuries and/or mortalities resulting from these impacts.

Although climate change and continued use of the Norfolk Harbor has the potential to adversely affect fish and fish habitat (including EFH) in the ROI, implementation of the Action Alternative is not predicted to substantially cumulatively or synergistically interact with climate change, development, or other possible cumulative effects. Implementation of the Action Alternative is anticipated to result in negligible to minor adverse impacts to fish and fish habitat, including EFH. Impacts would range from mostly temporary impacts to some permanent impacts. However, no substantial adverse impacts to fish or fish habitat including EFH are anticipated and no impacts to the population level of any managed fish species or associated prey species are anticipated. The implementation of our proposed best management practices/mitigative measures will help to avoid and minimize impacts to fish species to the maximum practical extent.

6.9 Wildlife

6.9.1 No Action/Future Without Project Alternative

Existing maintenance dredging operations, dredged material placement/disposal, and navigation within the ROI would continue. Operation of vessels and dredging equipment may flush wildlife, such as birds, out of the area. The increased Total Suspended Solids and turbidity resulting from dredging operations may temporarily disrupt foraging abilities for some wildlife. This results in temporary, negligible to minor, adverse impacts to wildlife.

This dredging and dredged material placement/disposal potentially impacts some of the prey species of birds. However, because of the already disturbed nature of the majority of the ROI and the amount of other available habitat for prey species, current dredging does not have any substantial impact on any prey invertebrate or fish populations. The dredging and dredged material placement has a temporary, negligible to minor, adverse impact to invertebrates and fish.

Placement/disposal of dredged material may alter the topography and consequently the habitat and wildlife at the CIDMMA. Placement of the dredged material may flush wildlife out of the area resulting in temporary, negligible to minor, adverse impacts. The CIDMMA would transition over time as the material dries and vegetation inhabits the site. Over time, the CIDMMA may fill with dredged material. The lack of replacement of sandy material over time at the CIDMMA may negatively impact some avian species that utilize the sandy material for nesting and foraging habitat. However, increased upland habitat may provide greater foraging habitat for other types of avian species and mammals. Placement/disposal of dredged material at the CIDMMA is anticipated to create additional wildlife habitat, which will create permanent, minor, beneficial impacts to wildlife at the CIDMMA.

Virginia Port growth is anticipated to increase throughout the next 50 years, and a new port facility is planned, which is anticipated to increase the number of vessels calls in the ROI. Also, additional development, including construction of the Third Crossing and expansion of the Chesapeake Bay Bridge Tunnel, and construction of the CIEE is planned in the future. Additional development could increase impacts to wildlife and their habitats. Continued development, shipping and navigation operations, and stormwater discharges/nutrient inputs will continue to impact wildlife within the ROI.

Climatic changes such as sea level rise and increasing global temperatures are predicted to continue in the future. Climate change impacts such as increased temperatures, ocean acidification, sea level rise, and changes in currents, upwelling and weather patterns have the potential to cause changes in the nature and character of the estuarine ecosystem in the ROI. These impacts have the potential to affect the distribution and abundance of wildlife within the ROI. Loss of estuarine and ocean beaches is anticipated to occur with sea level rise; therefore, the importance and use of wildlife habitat at the CIDMMA will likely increase in future conditions. The negative impacts to wildlife from continued development, continuance of storm water discharges, and navigation and shipping operations will have some negative impacts to wildlife. However, because the ROI is already a highly developed port with substantial navigation and shipping operations, these increased pressures would not likely cause substantial shifts to wildlife in future conditions. Shifts in salinity, temperature, and sea level all have the potential to result in shifts in prey species availability, which could also detrimentally impact wildlife. The potential loss of tidal wetlands and marsh islands with sea level rise may result in the general loss of nesting and foraging habitats for wildlife along the Atlantic seaboard.

The No Action/Future Without Project Alternative is not predicted to substantially cumulatively or synergistically interact with climate change and/or other cumulative effects, including port growth. Therefore, with implementation of the No Action/Future Without Project Alternative, impacts are temporary to permanent, negligible to minor, and beneficial to adverse.

6.9.2 Action Project Alternative

Compared to current operations, operation of vessels and dredging equipment and dredged material placement/disposal could temporarily flush additional wildlife, such as birds, out of the area. The increased Total Suspended Solids and turbidity resulting from additional dredging operations with implementation of the Action Project Alternative may disrupt foraging abilities for some wildlife. This would result in temporary, negligible to minor, adverse impacts to wildlife.

The dredging and dredged material placement/disposal is anticipated to have a temporary, negligible to minor, adverse impact to benthic invertebrates and fish. This potentially impacts some of the prey species of birds. However, because of the already disturbed nature of the majority of the ROI and the amount of other available habitat for prey species, current additional dredging and dredged material placement/disposal is not anticipated to have any substantial impact on any prey invertebrate or fish populations.

Placement/disposal of dredged material may alter the topography and consequently the habitat and wildlife at the CIDMMA. Compared to current operations, there would be increased material placement/disposal at the CIDMMA with implementation of the Action Project Alternative as compared to the No Action/Future Without Project Alternative. Placement/disposal of the dredged material may result in temporary, negligible to minor, adverse impacts to wildlife at the CIDMMA. The dredged material placement site would transition over time as the material dries and vegetation inhabits the site. Over time, the CIDMMA may fill with dredged material. The lack of replacement of sandy material over time at CIDMMA may negatively impact some avian species that utilize the sandy material for nesting and foraging habitat. However, increased upland habitat may provide greater foraging habitat for other types of avian species and mammals. Placement/disposal of dredged material at the CIDMMA is anticipated to create additional permanent wildlife habitat, which will create permanent, minor, beneficial impacts to wildlife at the CIDMMA.

As described in the No Action/Future Without Project Alternative Section, potential cumulative impacts include increased development such as port growth, increased vessel calls, and climate change. Although increased development and climate change have the potential to adversely impact wildlife in the ROI, implementation of the Action Project Alternative is not anticipated to substantially cumulatively or synergistically interact with climate change and/or other cumulative effects, including port growth.

Therefore, implementation of the Action Project Alternative is anticipated to result in wildlife impacts that would be temporary to permanent, negligible to minor, and adverse to beneficial.

6.10 Special Status Species

6.10.1 No Action/Future Without Project Alternative

Federally Endangered and Threatened Species

Existing dredging operations and navigation within the ROI would continue and are anticipated to continue for the next 50 years. Adverse impacts to Federally listed species that range from no impact to minor, adverse impacts resulting from existing dredging operations will continue. Adverse impacts to Federally listed species that occur with the No Action/Future Without Project Alternative would be similar and at the same impact threshold to those that would occur with implementation of the Action Alternative but most impacts would be relatively less due to the reduced dredging volumes and dredging frequencies. However, potential vessel collision risks for whales and sea turtles with deep draft vessels would be relatively less with the Action Alternatives as compared to the No Action/Future Without Project Alternative because of the anticipated reduced vessel calls. We would anticipate impacts to state listed bats to be similar to impacts to the northern long-eared bat as described in the Biological Assessments, Appendix E1 and Appendix E2. Impacts to state listed birds would be at the same impact threshold as those described in the Action Alternative Section but would be relatively less. Cumulative impacts of the No Action/Future Without Project Alternative would be similar to those described with the Action Alternative. Substantial cumulative or synergistic impacts resulting from implementation of the No Action/Future Without Alternative with other cumulative impacts would not be not anticipated.

Marine Mammals

According to Todd et al. (2014), there are few studies on the effects of dredging on marine mammals due to dredging activities in isolation. In terms of direct effects, vessel collisions are possible, but improbable because dredges operate either in a stationary position or at low speeds. The risk of injury to marine mammals from collisions with dredge-related vessels is considered discountable considering the species mobility and slow speed of the dredge vessels (10 knots or less) and associated barges and scow. Also, trained personnel that know how to recognize the presence of threatened and endangered whale and sea turtle species are onboard at all times to help ensure that vessel interactions are avoided. No marine mammal strikes with dredge-related vessels has ever been reported to occur in the Action Area.

Within a noisy harbor area such as the Norfolk Harbor, ongoing exposure to underwater noise may cause causing a masking effect such that the noise of an oncoming vessel may not be detected (Whale and Dolphin Conservation Society 2006). Marine mammals may habituate to the noisy harbor and simply not respond to an oncoming vessel as they are so adapted to the sound of vessels (Whale and Dolphin Conservation Society 2006). In addition, the noise of the dredging vessel/equipment and also the vessels in the harbor itself has an adverse effect to listed whales in the Action Area and may interfere with their ability to communicate and forage for prey in addition to the vessel strike risks. Todd et al. (2014) noted that while dredging noise levels vary greatly and depend partly on the method and the material being dredged, limited data seem to indicate that dredging is unlikely to cause physiological damage to marine mammal auditory systems. In addition, effects of turbidity are often localized with minimal direct impact on marine mammals (Todd et al. 2014). No Level A or B harassment to marine mammals occurs with existing dredging and dredged material placement/disposal operations.

Todd et al. (2014) note that the indirect effects of dredging are more complex, and less understood. In general, literature has suggested that dredging can cause reductions in biomass and varying levels of prey availability, depending on the surrounding conditions. However, it is also noted that marine mammals can likely compensate for small-scale changes in prey by switching prey species or moving to other foraging areas (Todd et al. 2014).

Marine mammals that may occur in the ROI are accustomed to the busy harbor of which the ROI is a portion. They are also highly mobile and it is expected that they would move away from disturbance such as noise or equipment operations. The ROI is also limited relative to the surrounding area available for use; therefore the species are likely to move and forage elsewhere during the operation. Noise generated by bucket, cutterhead, or hopper dredge activities would not be expected to affect migration, nursing, breeding, feeding, or sheltering.

Another potential threat to marine mammals is injury or incidental take resulting from MEC/UXO detonation or contact with contaminants leaching from MEC/UXO that occur in the ROI. However, we would not anticipate this to be a substantial threat as the USACE deploys MEC/UXO screening devices on dredges where there is risk of MEC/UXO detonation.

Overall, no Level A or Level B harassment to marine mammals from implementation of the Action Alternative is anticipated. Overall, no substantive disruption of behavioral patterns to migration, breathing, nursing, breeding, feeding or sheltering would be anticipated.

Potential cumulative threats to marine mammals include ship strikes and noise impacts from commercial and recreational vessels and exposure to contaminants such as oil spills. Another potential cumulative impact to consider is impacts that occur from fishery entanglement. While some of these threats have the potential to impact marine mammal populations, implementation of the Action Alternative is not anticipated to substantially contribute cumulatively to injuries and mortalities resulting from these impacts.

Virginia Port growth is anticipated to increase throughout the next 50 years and a new port facility is planned, which is anticipated to increase the number of vessels calls in Norfolk Harbor. Also, additional development including construction of the Third Crossing and expansion of the Chesapeake Bay Bridge Tunnel, and construction of the CIEE is planned in the future. Additional development could increase the risks of marine mammal impacts from noise impacts and ship strikes. Substantial cumulative or synergistic impacts resulting from implementation of the No Action/Future Without Alternative with other cumulative impacts would not be not anticipated.

Species Protected under the Migratory Bird Treaty Act of 1918 and Executive Order 13186 (EO) and Other State Listed Bird Species

The CIDMMA is anticipated to be full of dredged material within the next 50 years and the CIEE is anticipated to be fully completed and potentially full by that time as well. Therefore, there could be additional dredged material placement at the NODS as compared to current operations in the future. The lack of replacement of sandy material over time at CIDMMA, may negatively impact some migratory birds that utilize the sandy material for nesting and foraging habitat. However, increased upland habitat may service to benefit foraging habitat for other types of migratory birds. Also, once fully constructed, and habitats are created, CIEE is anticipated to increase certain types of avian foraging, nesting, and resting habitats.

Although piping plovers previously nested at the CIDMMA, the nesting habitat there has degraded and is not currently suitable for piping plover nesting. No future plans to resume the nesting management program to improve the nesting habitat are anticipated. We would not anticipate bald eagle nesting at the CIDMMA in the future. Migratory birds (including all state listed avian species) will have the potential to forage, rest, and/or migrate through the ROI. The noise and temporary turbidity plume caused by current dredging and dredged material placement actions may cause migratory birds to move away from the disturbance; however, this is a negligible to minor, and temporary impact that does not substantially impact their long-term foraging or breeding success. The dredging and dredged material placement operations have a temporary, negligible to minor adverse impact to benthic invertebrates and fish. This potentially impacts some of the prey species of migratory birds. Future shifts in salinity, temperature, and sea level rise all have the potential to result in shifts in prey species availability which could also cause detrimental effects to migratory birds. However, because of the already disturbed nature of the majority of the ROI and the amount of other available habitat for prey species, current dredging and dredged material placement does not have any substantial impact on any prey invertebrate or fish populations.

Another potential threat to migratory birds from current operations is take resulting MEC/UXO detonation or contact with contaminants leaching from MEC/UXO that occur in the ROI. However, this is not a substantial threat as the USACE deploys MEC/UXO screening devices on dredges where there is risk of MEC/UXO detonation.

Virginia Port growth is anticipated to increase throughout the next 50 years and a new port facility is planned, which is anticipated to increase the number of vessel calls in the Norfolk Harbor. Also, additional development including construction of the Third Crossing and expansion of the Chesapeake Bay Bridge Tunnel, and construction of the CIEE is planned in the future. Additional development could increase migratory bird disturbance impacts. However, implementation of the No Action Alternative/Future Without Project Alternative is not anticipated to substantially contribute to those increased impacts to migratory birds.

The loss of barriers and beach nesting breeding and foraging habitat anticipated with sea level rise has the potential to impact migratory birds although the level of impact is relatively uncertain. However, substantial cumulative or synergistic impacts resulting from implementation of the No Action/Future Without Project Alternative with the impacts of climate change and other cumulative impacts is not anticipated.

6.10.2 Action Project Alternative

A detailed assessment of the potential impacts of implementation of the Action Project Alternative on Federally listed species and the designated Atlantic sturgeon critical habitat, is provided in the Biological Assessments provided in Appendix E1 and Appendix E2. The results of the impacts assessment are summarized in Table 6-3 and Table 6-4. Please note that best management practices/mitigation measures for Federally listed species are described in the Biological Assessments found in Appendix E1 and E2 as well. Although some adverse impacts to habitat and potential incidental take of Atlantic sturgeon and sea turtles (green, Kemp's ridley, leatherback, and loggerhead) are anticipated, these adverse impacts are not anticipated to jeopardize the continued existence of any Federally listed species. We would expect impacts to state listed bats to be similar to those described for the northern long-eared bat in the Biological Assessment, Appendix E1. Potential impacts to state listed birds would be the same as those described in the migratory birds section.

Table 6-3: Federally Listed Species Conclusions (Within the Jurisdiction of the National Marine Fisheries Service)

Species / Resource Name	Endangered Species Act Section 7 Determination	Notes / Documentation
Atlantic sturgeon	May Affect, Likely to Adversely Affect	Entrainment from hopper dredging may result in injury and mortality. Collisions with dredging vessels would be unlikely and discountable. Dredging would result in a temporary loss and impact to prey species. Dredging may result in a disturbance effect where sturgeon leave the Action Area from the increased levels of Total Suspended Solids, turbidity, and noise. Sea turtle relocation trawling could result in sturgeon captures causing a temporary stress effect.
Atlantic sturgeon Designated Critical habitat	May Affect, Likely to Adversely Affect	Dredging would result in temporary loss and impact to benthic prey species. Dredging would temporarily result in increased levels of Total Suspended Solids and turbidity in the water column.
Fin whale, north Atlantic right whale, and sei whale	May Affect, Not Likely to Adversely Affect	Collisions with dredging vessels would be unlikely. Dredging may impact prey species and cause whales to leave the Action Area from the dredging turbidity plume and noise disturbances. Effects would be insignificant and discountable.
Green sea turtle, Kemp's ridley sea turtle, leatherback sea turtle, and loggerhead sea turtle	May Affect, Likely to Adversely Affect	Entrainment in hopper dredging may result in injury and incidental take. Dredging may impact prey species and cause sea turtles to leave the Action Area from the dredging turbidity plume. No nesting locations are in the Action Area. Relocation trawling could result in injury, incidental take, or a temporary stress effect.

Table 6-4: Federally Listed Species Conclusions and Bald Eagle Determination (Within the Jurisdiction of the U.S. Fish and Wildlife Service)

Species / Resource Name	ESA Section 7 / Eagle Act Determination	Notes / Documentation
Piping plover, red knot, and roseate turn	May Affect, Not Likely to Adversely Affect	The project may slightly impact flight and foraging behaviors but would have a negligible to minor impact.
Red-cockaded woodpecker	No Effect	There is no habitat for this species in the Action Area and therefore, this species would not be anticipated to occur in the Action Area.
West Indian manatee	May Affect, Not Likely to Adversely Affect	Manatees would be transient species and would not likely occur in the Action Area. Effects would be discountable.
Northern long-eared bat and Indiana bat	No Effect	No suitable foraging or roosting habitat is located in the Action Area. There is no known hibernacula in the Action Area. The project would not be anticipated to affect flights if they occur in this area.
Sea turtles: green, Kemp's ridley, leatherback, and loggerhead	No Effect (within the jurisdiction of the U.S. Fish and Wildlife Service)	There is no nesting habitat in the Action Area.
Hawksbill sea turtle	No Effect (within the jurisdiction of the U.S. Fish and Wildlife Service)	There is no nesting habitat in the Action Area. There is no documented occurrence of the hawksbill sea turtle in the Action Area and there is no preferred habitat for this species in the Action Area. This species would not be anticipated to occur in the Action Area.

Species / Resource Name	ESA Section 7 / Eagle Act Determination	Notes / Documentation
Bald eagle	Unlikely to disturb nesting bald eagles. Does not intersect with eagle concentration area	No documented recent nesting in the project area (The Center for Conservation Biology 2017; Appendix B). Foraging may be temporarily disturbed during project construction.
Candidate species	No effect; No species present.	

Piping Plover, Red Knot, and Roseate Turn – Cumulative Effects

Virginia Port growth is anticipated to increase throughout the next 50 years and a new port facility is planned, which may increase the number of vessels transiting the Norfolk Harbor and Channels. Also, additional development including construction of the Third Crossing and expansion of the Chesapeake Bay Bridge Tunnel, and construction of the Craney Island Eastern Expansion (CIEE) is planned in the future. Additional development could increase avian disturbance impacts. However, implementation of the Preferred Alternative is not anticipated to substantially contribute to those increased impacts to listed avian species.

The loss of barriers and beach nesting breeding and foraging habitat anticipated with sea level rise has the potential to impact these species although the level of impact is relatively uncertain. However, substantial cumulative or synergistic impacts resulting from implementation of the Preferred Alternative with the impacts of climate change is not anticipated. No substantive cumulative or synergistic impacts of implementation the Preferred Alternative with other past, present, or future projects are anticipated.

Atlantic Sturgeon – Cumulative Effects

Potential cumulative threats to Atlantic sturgeon include ship strikes from commercial and recreational vessels as well as hopper dredging impacts and exposure to contaminants such as oil spills. Another potential cumulative impact to consider is impacts that occur from fishery entanglement. While some of these threats have the potential to impact Atlantic sturgeon populations, implementation of the Preferred Alternative is not anticipated to substantially contribute cumulatively to injuries and mortalities resulting from these impacts.

Virginia Port growth is anticipated to increase throughout the next 50 years and a new port facility is planned, which may increase the number of vessels transiting the Norfolk Harbor and Channels. Also, additional development including construction of the Third Crossing and expansion of the Chesapeake Bay Bridge Tunnel, and construction of the CIEE is planned in the future. Additional development could increase impacts to the Atlantic sturgeon. However, implementation of the Preferred Alternative is not anticipated to substantially contribute to those increased impacts to Atlantic sturgeon.

Global climate change has the potential to affect all DPSs of the Atlantic sturgeon in the future, however, the threat may be greatest to the South Atlantic and Carolina DPSs. Sea level rise may cause a rise in salinity in upstream areas that could affect breeding sites and survival of early life stages (eggs, larvae, and young of the year). There could be shifts in breeding habitat availability and timing and the effects of this change on the Atlantic sturgeon could be detrimental although relatively uncertain at this time. The shifts in salinity, temperature, and sea level rise all have the potential to result in shifts in prey species availability which could also cause detrimental effects to the Atlantic sturgeon.

West Indian Manatee – Cumulative Effects

Because the manatee is not anticipated to occur in the Action Area, no anticipated cumulative impacts would be anticipated.

Fin, North Atlantic Right, and Sei Whales – Cumulative Effects

Potential cumulative threats to whales include ship strikes and noise impacts from commercial and recreational vessels that occur throughout the entire range of the whales and exposure to contaminants such as oil spills. Another potential cumulative impact to consider is impacts that occur from fishery entanglement. While some of these threats have the potential to impact whale populations, implementation of the Preferred Alternative is not anticipated to substantially contribute cumulatively to injuries and mortalities resulting from these impacts.

Virginia Port growth is anticipated to increase throughout the next 50 years and a new port facility is planned, which is anticipated to increase the number of vessels transiting the Norfolk Harbor and Channels. Also, additional development including construction of the Third Crossing and expansion of the Chesapeake Bay Bridge Tunnel, and construction of the CIEE is planned in the future. Additional development could increase the risks of whale impacts from noise impacts and ship strikes. However, implementation of the Preferred Alternative is not anticipated to substantially contribute to those increased impacts to whales.

Northern Long-Eared Bat

There would be no effect to the northern long-eared bat, therefore, no cumulative impacts would be anticipated.

Green Sea Turtle, Kemp's Ridley Sea Turtle, Leatherback, and Loggerhead Sea Turtle – Cumulative Effects

Potential cumulative threats to sea turtles include ship strikes from commercial and recreational vessels that occur throughout the entire range of the sea turtles and exposure to contaminants such as oil spills. Another potential cumulative impact to consider is impacts that occur from fishery entanglement. While some of these threats have the potential to impact sea turtle populations, implementation of the Preferred Alternative is not anticipated to substantially contribute cumulatively to injuries and mortalities resulting from these impacts.

Virginia Port growth is anticipated to increase throughout the next 50 years and a new port facility is planned, which may increase the number of vessels transiting the Norfolk Harbor and Channels. Also, additional development including construction of the Third Crossing and expansion of the Chesapeake Bay Bridge Tunnel, and construction of the CIEE is planned in the future. Additional development could increase the risks of sea turtle impacts from disturbance, noise impacts and ship strikes. However, implementation of the Preferred Alternative is not anticipated to substantially contribute to those increased impacts to sea turtles.

Sea level rise may result in a loss of sea turtle beach nesting habitat. The future implications and amount of loss is uncertain at this time but pose an imminent threat to sea turtles who tend to return repeatedly to natal nesting locations. Impacts are further amplified by habitat loss that has occurred due to developing shorelines that also includes lighting impacts. Lighting along shorelines has the potential to disturb turtles from properly navigating to natal beach locations. There could also be shifts in foraging habitats as the aggregation off benthic communities and Submerged Aquatic Vegetation shift in response to sea level rise. Temperature shifts resulting from climate change have the potential to shift male/female proportions in sea turtle populations as temperature is a driving factor determining sex ratios at nesting sites. The shifts in salinity, temperature, and sea level rise all have the potential to result in shifts in prey species availability which could also cause detrimental effects to sea turtles. Overall, however, implementation of the Preferred Alternative is not anticipated to have substantial synergistic cumulative impacts with those caused by sea level rise.

Marine Mammals

According to Todd et al. (2014), there are few studies on the effects of dredging on marine mammals due to dredging activities in isolation. In terms of direct effects, vessel collisions with marine mammals are possible, but improbable because dredges operate either in a stationary position or at low speeds. We would anticipate a potentially higher risk of vessel interactions with marine mammals in the future either with or without implementation of the Action Project Alternative as compared to current conditions because the predicted number of vessel calls is anticipated to increase. In comparison of the future with and without implementation of the Action Project Alternative, we would anticipate the risk of vessel strikes is less with the Action Project Alternative because of the anticipated reduced deep draft vessel calls as compared to the future without Action Project Alternative. Because it is uncertain from the marine mammal and vessel interaction stranding where strikes have occurred, it is difficult to estimate potential future increases in vessel interactions that could potentially occur. Because vessel speeds are not anticipated to increase with implementation of the Action Project Alternative we would not anticipate that the strike risk hazard to increase from increased vessel speed but rather just the sheer potential of impact from the increased future number of vessel calls compared to existing conditions.

The risk of injury to listed whales from collisions with dredge-related vessels is considered discountable considering the species mobility and slow speed of the dredge vessels (10 knots or less) and associated barges and scow. Also, trained personnel that know how to recognize the presence of threatened and endangered whale and sea turtle species will be onboard at all times to help ensure that vessel interactions are avoided. No marine mammal strikes with dredge-related vessels has ever been reported to occur in the Action Area.

Within a noisy harbor area such as the Norfolk Harbor, ongoing exposure to underwater noise may cause causing a masking effect such that the noise of an oncoming vessel may not be detected (Whale and Dolphin Conservation Society 2006). Whales may often habituate to the noisy harbor and simply not respond to an oncoming vessel as they are so adapted to the sound of vessels (Whale and Dolphin Conservation Society 2006). According to Todd et al. (2014), there are few studies on the effects of dredging on marine mammals due to dredging activities in isolation. Todd et al. (2014) note that while dredging noise levels vary greatly and depend partly on the method and the material being dredged, limited data seem to indicate that dredging is unlikely to cause physiological damage to marine mammal auditory systems. They note that it is more likely to lead to temporary masking and behavioral disturbances. In addition, effects of turbidity are often localized with minimal direct impact on marine mammals (Todd et al. 2014).

In comparison of the future with and without implementation of the Action Project Alternative, we would anticipate the potential for noise related impacts to be relatively less with the Action Project Alternative because of the reduced vessel calls as compared to the future without project conditions. However, with implementation of either alternative, the risks increase over time because of the anticipated increase in vessel calls. However, the noise impacts associated with dredging operations would increase slightly with the Action Alternative as compared to the No Action/Future Without Project Alternative because of the increased dredging durations and frequencies. Noise generated by bucket, cutterhead, or hopper dredge activities would not be expected to affect migration, nursing, breeding, feeding, or sheltering. Marine mammals that may occur in the ROI are accustomed to the busy harbor of which the ROI is a portion. They are also highly mobile and it is expected that they would typically move away from dredging operations and noise. We would not anticipate any Level A or Level B harassment to marine mammals from noise-related impacts caused by implementation of the Action Project Alternative.

In addition, effects of turbidity are often localized with minimal direct impact on marine mammals (Todd et al. 2014). Todd et al. (2014) note that indirect effects are more complex, and less understood. In general, literature has suggested that dredging can cause reductions in biomass and varying levels of prey availability, depending on the surrounding conditions. However, it is also noted that marine mammals can likely compensate for small-scale changes in prey by switching prey species or moving to other foraging areas (Todd et al. 2014). The ROI for this project is also limited relative to the surrounding area available for use; therefore the species are likely to move and forage elsewhere during the operation.

Potential cumulative threats to marine mammals include ship strikes from commercial and recreational vessels as well as hopper dredging impacts that occur throughout the entire range of the marine mammals, and exposure to contaminants such as oil spills. Another potential cumulative impact to consider is impacts that occur from fishery entanglement. While some of these threats have the potential to impact populations of bottlenose dolphins, harbor porpoises, and harbor seals, implementation of the Action Alternative is not anticipated to substantially contribute cumulatively to injuries and mortalities resulting from these impacts.

The USACE has never documented a take of any marine mammals during its previous dredging operations in the ROI and no harassment is anticipated with the noise impacts generated by the implementation of the Project Action Alternative; therefore, an incidental take or harassment authorization in accordance with the MMPA is not anticipated. No further coordination under the MMPA is anticipated.

Species Protected under the Migratory Bird Treaty Act of 1918 and Executive Order 13186 (EO)

The CIDMMA is anticipated to be full of dredged material within the next 50 years. Therefore, there could be additional dredged material placement at the NODS as compared to current operations. The lack of replacement of sandy material over time at CIDMMA, may negatively impact some migratory birds that utilize the sandy material for nesting and foraging habitat. However, increased upland habitat may benefit foraging habitat for other types of migratory birds. Also, once fully constructed, and habitats are created, CIEE is anticipated to increase certain types of avian foraging, nesting, and resting habitats.

Although piping plovers previously nested at the CIDMMA, the nesting habitat there has degraded and is not currently suitable for piping plover nesting. No future plans to resume the nesting management program to improve the nesting habitat are anticipated. We would not anticipate bald eagle nesting at the CIDMMA in the future. Migratory birds will have the potential to forage, rest, and/or migrate through the ROI. The noise and temporary turbidity plume caused by dredging and dredged material placement actions may cause migratory birds to move away from the disturbance; however, we would expect this to be a negligible to minor, and temporary impact that would not substantially impact their long-term foraging or breeding success. The dredging and dredged material placement operations will have a temporary, negligible to minor adverse impact to benthic invertebrates and fish. This could potentially impact some of the prey species of migratory birds. The shifts in salinity, temperature, and sea level rise all have the potential to result in shifts in prey species availability which could also cause detrimental effects to migratory birds. However, because of the already disturbed nature of the majority of the ROI and the amount of other available habitat for prey species, we would not anticipate the Action Alternative to have any substantial impact on any prey invertebrate or fish populations.

Another potential threat to migratory birds is injury or incidental take resulting from MEC/UXO detonation or contact with contaminants leaching from MEC/UXO that occur in the ROI. However, we would not anticipate this to be a substantial threat as the USACE deploys MEC/UXO screening devices on dredges where there is risk of MEC/UXO detonation.

With implementation of the Action Alternative, dredging volumes and durations would increase and disturbances to migratory birds could increase slightly. Therefore, if migratory birds were in the Action Area we would anticipate a slight increase in disturbance effects that would range from negligible to minor impacts (birds temporarily moving away from the impact area) from implementation of the Action Project Alternative.

Virginia Port growth is anticipated to increase throughout the next 50 years and a new port facility is planned, which is anticipated to increase the number of vessels calls in the Norfolk Harbor. Also, additional development including construction of the Third Crossing and expansion of the Chesapeake Bay Bridge Tunnel, and construction of the CIEE is planned in the future. Additional development could increase migratory bird disturbance impacts. However, implementation of the Action Project Alternative is not anticipated to substantially contribute to those increased impacts to migratory birds.

The loss of barriers and beach nesting breeding and foraging habitat anticipated with sea level rise has the potential to impact migratory birds although the level of impact is relatively uncertain. However, substantial synergistic impacts resulting from implementation of the Action Alternative with the impacts of climate change and other cumulative impacts is not anticipated.

6.11 Air Quality

6.11.1 No Action/Future Without Project Alternative

Existing dredging operations, dredged material placement, and navigation would continue in the ROI. Current maintenance operations would continue to generate emissions from the combustion of fuel used to operate vessels and equipment (e.g., dredge operation, pumps, transportation, and final dredged material placement/disposal).

In addition, the existing emissions-producing activities within the ROI (e.g., transportation, industry, commerce, military, and recreation) would be expected to continue throughout the 50 year period of analysis. Emissions in the future either with or without implementation of the Action Alternative resulting from deep draft navigation would likely increase because of the anticipated increases in vessel calls. However, the long-term trends for all criteria air pollutants throughout the region have been decreasing slightly over time. Because the relative contribution to the regional trends is small from deep draft navigation in the Norfolk Harbor, these improving regional air quality trends would be predicted to continue under the No Action/Future Without Project alternative.

There are a number of large-scale construction projects within the ROI that would be expected to generate adverse, temporary, impacts to air quality from increased emissions including:

- Port growth including a new port facility;
- Construction of the Third Crossing;
- Expansion of the Chesapeake Bay Bridge Tunnel;
- Norfolk International Terminals Piers 1 and 2 removed, with area deepened to -50 feet;
- Construction of the CIEE;
- I-64 High Rise Bridge Corridor (City of Chesapeake 2014).

Implementation of the No Action/Future Without Project Alternative would result in adverse, temporary impacts to air quality that are negligible to minor. These temporary increases in emissions would not be predicted to result in measurable changes to the regional or global-climatic air quality. In addition, when considered in combination with other large-scale construction projects that may occur at the same time, the cumulative adverse effects to air quality in the ROI would be temporary and negligible to minor. Substantial cumulative or synergistic impacts resulting from implementation of the No Action/Future Without Project Alternative with the impacts of climate change and other cumulative impacts is not anticipated.

6.11.2 Action Project Alternative

Air emissions resulting from combustion of fuel during construction and maintenance operations would increase with implementation of the Action Project Alternative as compared to the No Action/Future Without Project Alternative because of the increased duration of construction and maintenance operations.

With implementation of either the No Action/Future Without Project Alternative or the Action Alternative, the overall number of vessel calls is anticipated to increase over time. Therefore, fuel combustion emissions resulting from deep draft navigation in the Norfolk Harbor would increase over time regardless of whether the Action Project Alternative is implemented. However, the anticipated number of vessel calls with implementation of the Action Alternative would be less than future conditions without implementation of the Action Alternative. This is because the existing, larger vessels in the fleet would transport the same quantity of cargo more efficiently (i.e., fewer trips to move the annual quantity of cargo). Therefore, in future conditions with implementation of the Action Alternative we would anticipate fewer emissions resulting from deep draft vessels as compared to future conditions without implementation of the Action Alternative.

Existing emissions-producing activities within the ROI (e.g., navigation and other transportation, industry, commerce, military, and recreation) would be expected to continue throughout the 50 year period of analysis. Virginia Port growth is anticipated to increase throughout the next 50 years, and a new port facility is planned. Also, additional development is planned as is described in the No Action/Future Without Project Alternative. The increased development would also be linked with increases in air emissions from combustion of fuel associated with construction and maintenance of development projects.

Overall, similar to the No Action/Future Without Project Alternative, implementation of the Action Project Alternative would overall, result in temporary, negligible to minor impacts to air quality. The increases in construction and maintenance-related emissions from implementing the Action Project Alternative would not be predicted to result in substantial changes to regional or global-climatic air quality.

The implementation of the Action Alternative is not predicted to substantially cumulatively or synergistically interact with climate change and/or other cumulative effects. Therefore, the cumulative adverse effects from implementation of the Action Project Alternative to air quality in the ROI would be adverse, temporary and negligible to minor.

6.12 Climate Change

6.12.1 No Action/Future Without Project Alternative

Existing dredging operations, dredged material placement, and navigation would continue in the ROI. Current maintenance operations would continue to generate emissions from the combustion of fuel used to operate vessels and equipment (e.g., dredge operation, pumps, transportation, and final dredged material placement/disposal).

Existing greenhouse gas-producing activities within the ROI (e.g., navigation and other transportation, industry, commerce, military, and recreation) would be expected to continue throughout the 50 year period of analysis. The following regional projects are assumed to be implemented under the No Action/Future Without Project alternative and would be expected to result in temporary, construction-related, increases in greenhouse gas emissions within the ROI:

- Chesapeake Bay Bridge Tunnel – Parallel Thimble Shoal Tunnel (CBBT 2016);
- Hampton Roads Bridge Tunnel – Parallel Tunnel (VDOT 2012a; VDOT 2016);
- Hampton Roads 3rd Crossing (Patriots Crossing) (VDOT 2001; VDOT 2016);
- I-664 Widening (ties to Patriots Crossing) (VDOT 2001; VDOT 2016); and
- Norfolk International Terminals Piers 1 and 2 removed and deepened to -50 feet.

The Center for Climate Strategies estimates that GHG emissions in Virginia will increase to 200 MMt by 2020, which is a 39-percent increase above 1990 levels and the transportation sector is projected to be the largest contributor to future emissions growth (CCS 2012).

With implementation of the No Action/Future Without Project alternative, climate change would be predicted to continue and relative sea level rise would be expected to continue to rise over the 50-year period of analysis. As previously described in the Air Quality Section, implementation of the No Action/Future Without Project Alternative does have minor impacts to air quality but this would not substantively impact global-climatic air quality.

6.12.2 Action Project Alternative

Greenhouse gas emissions resulting from combustion of fuel during construction and maintenance operations would increase with implementation of the Action Project Alternative as compared to the No Action/Future Without Project Alternative because of the increased duration of construction and maintenance operations.

With implementation of either the No Action/Future Without Project Alternative or the Action Alternative, the overall number of vessel calls is anticipated to increase over time. Therefore, greenhouse gas emissions resulting from deep draft navigation in the Norfolk Harbor would increase over time regardless of whether the Action Project Alternative is implemented. However, the anticipated number of vessel calls with implementation of the Action Alternative would be less than future conditions without implementation of the Action Alternative. This is because the existing, larger vessels in the fleet would transport the same quantity of cargo more efficiently (i.e., fewer trips to move the annual quantity of cargo). Therefore, in future conditions with implementation of the Action Alternative we would anticipate fewer greenhouse gas emissions resulting from deep draft vessels as compared to future conditions without implementation of the Action Alternative.

Existing greenhouse gas-producing activities within the ROI (e.g., navigation and other transportation, industry, commerce, military, and recreation) would be expected to continue throughout the 50 year period of analysis. Virginia Port growth is anticipated to increase throughout the next 50 years, and a new port facility is planned. Also, additional development is planned as is described in the No Action/Future Without Project Alternative. The increased development would also be linked with increases in greenhouse gas emissions from combustion of fuel associated with construction and maintenance of development projects.

Per our coordination with the Virginia Department of Environmental Quality and review of the EPA Greenbook Non-Attainment Areas, the Hampton Roads Intrastate Air Quality Control Region is in attainment for all criteria pollutants and therefore, an air conformity analysis is not required. Implementation of the Action Alternative would not substantively cumulatively or synergistically contribute to climate change-induced water quality effects as described in the Water Quality Section.

6.13 Floodplains

6.13.1 No Action/Future Without Project Alternative

Flooding can occur during tidal storm events and/or from heavy rainfall, usually associated with tropical systems, nor’easters, and heavy rainfall events. Flooding can be short term in duration, such as hurricanes, or long term duration, such as nor'easters. Typically slow moving and large in size, nor'easters can produce large amounts of rainfall and high water levels caused by storm surge that can stay elevated above normal astronomical tide cycles for long periods of time. These types of storms can cause inland flooding and significant beach and shoreline erosion from persistent wave action.

Tidal Flooding

Historical tidal flood events for the study area have mainly been from tropical storms, weak Category 1 hurricanes, or nor'easters; the area has not experienced a major hurricane on record. At the nearby Sewells Point tide gage located in Norfolk, in more recent time, Hurricane Isabel produced one of the highest storm tide elevations at 6.3 feet, NAVD88, approximately a 4% annual chance (25-year) flood event.

The August 2015 current effective 1% (light blue color) and 0.2% (pink color) annual chance floodplain boundaries established by the Federal Emergency Management Agency (FEMA) are shown on Figure 6-1 below. As shown, the interior containment areas of the dike are not impacted, noting the FEMA floodplains shown are based strictly on a tidal engineering analysis and do not account for impacts from rainfall. The 1% annual chance flood elevations range from 7.6 feet to 7.9 feet for stillwater conditions, and nine to 15 feet considering wave action, NAVD88. The 0.2% annual chance stillwater elevations range from 9.1 to 9.7 feet, NAVD88; wave height calculations were not completed for the 0.2% annual chance flood event. Note, some of the access roads to enter Craney Island, the lower road along the primary dike, staging areas, and docking facilities near and along the waterfront appear to be subject to flooding from the 1% and 0.2% annual chance flood events. Portions of the lower perimeter road and the main access entrance to enter the containment area have estimated top of road elevations at approximately five and six feet, NAVD88, respectively, using USACE topographic data. Portions of the perimeter road flooded during Hurricane Isabel.

Figure 6-1: FEMA, City of Portsmouth, Virginia, 1% and 0.2% ACE Floodplain

Although no flood damages were reported for buildings with past events, Craney Island also includes buildings that could be impacted by tidal flooding. As shown on Figure 6-2 below, a close-up view of Figure 6-1 near the southwest corner at the entrance to Craney Island, Buildings A: oil tank container sheds, B: outdoor lube pit for maintenance, C: main office/maintenance bay, D: equipment shed, E: emergency management equipment shed, and F: oil filter/supplies shed are located near or within the 1% (light blue color) and 0.2% (pink color) annual chance floodplains. Note, Buildings A, B, C, and F have a field-surveyed finished floor elevation at or higher than 14 feet, NAVD88, where the ground is elevated from a retaining wall on the north side of the structures, thus protecting the buildings from the 1% and 0.2 % annual chance floods. Finished floor elevations are not available for Buildings D and E, but lowest adjacent grade elevations are estimated from USACE topographic data at approximately seven and eight feet, NAVD88, respectively. If sensitive/critical equipment are stored within these buildings, if necessary, the equipment may need to be elevated above or located outside the 0.2% annual chance floodplain. A copied portion of the FEMA Flood Insurance Rate Map, City of Portsmouth, Virginia, Panel 5155290019D, effective August 3, 2015 is also shown in Figure 6-3.

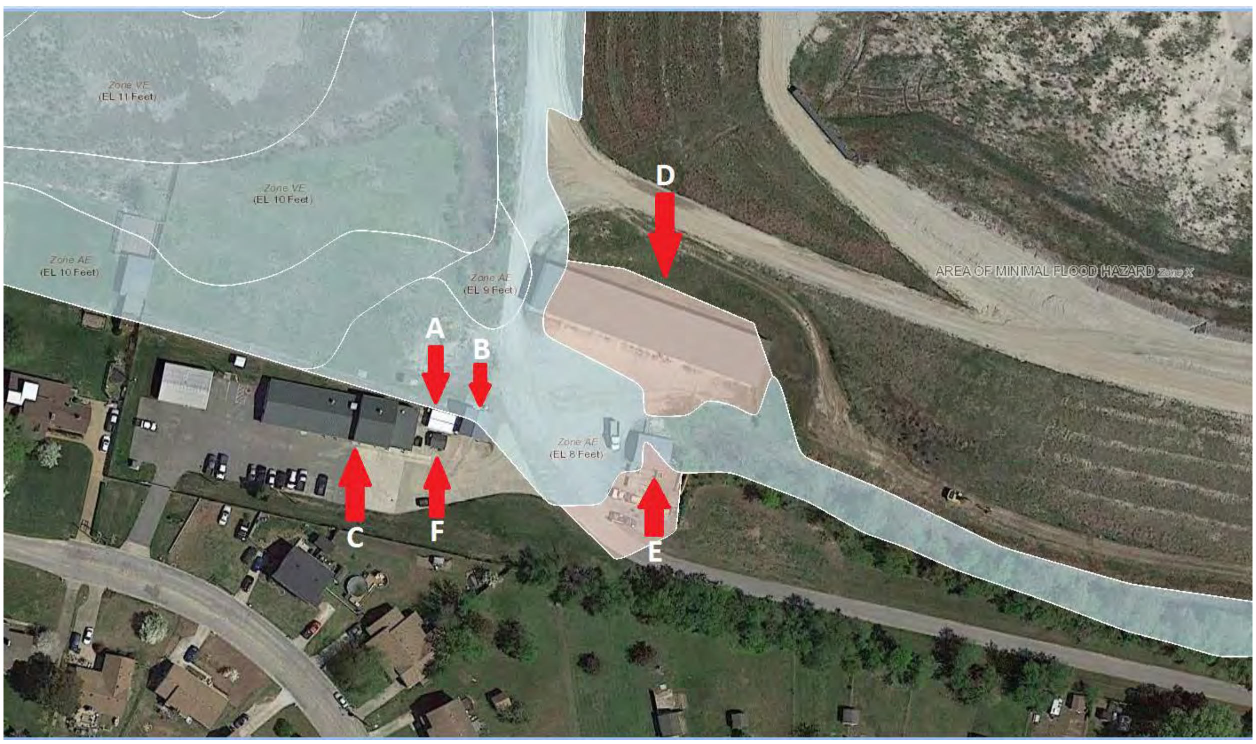

Figure 6-2: FEMA, City of Portsmouth, Virginia, 1% and 0.2% ACE Floodplain: Craney Island Buildings

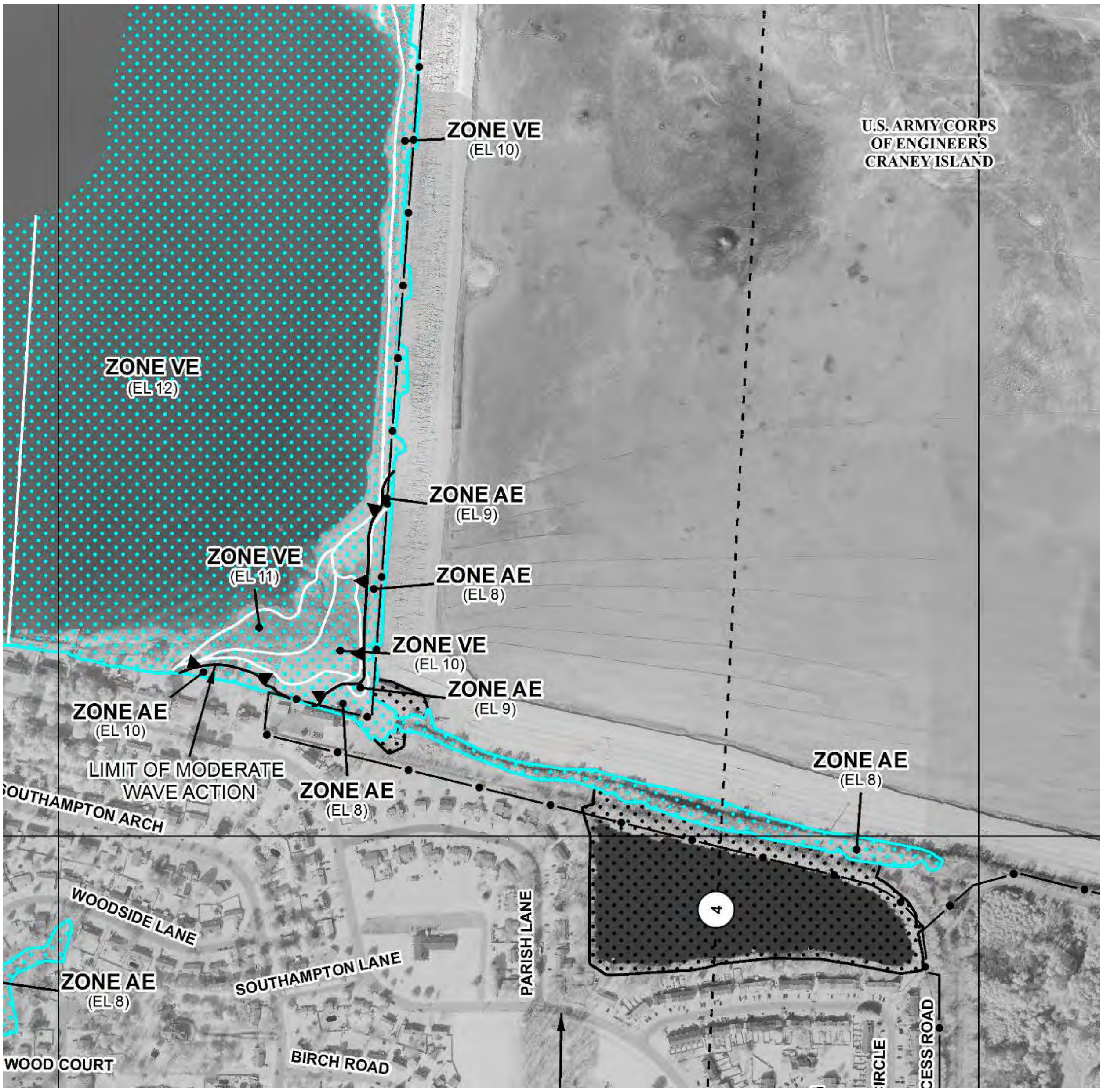

Figure 6-3: FEMA, City of Portsmouth, Virginia, FIRM, Panel 5155290019D

Wave Action

Being located along the waterfront, Craney Island can be exposed to the normal daily effects of wave action or from a severe tidal flood event. Looking at Figure 6-4 below and using more recent Google aerial imagery, to help protect Craney Island against wave action and coastal erosion, starting in 2012, there are currently 23 breakwater structures in place on the north and west sides. In addition, a stone revetment has been placed on the north shoreline.

Figure 6-4: Google Image - Breakwater Structures

Rainfall Impacts

Aside from tidal flooding, the containment cells within Craney Island could also be impacted by heavy rainfall, where if there is not enough available storage, then overtopping could occur. A hydrologic/hydraulic analysis has not been conducted to evaluate storage and overtopping for various hypothetical rainfall events, considering empty and full pond conditions. However, there have been several past storm events, such as Hurricane Floyd in 1999, Tropical Storm Ernesto in 2006, Nor'Ida in 2009, Hurricane Irene in 2011, Super Storm Sandy in 2012, and most recently Hurricane Mathew in 2016, that have produced significant rainfall amounts of nine inches or more in a 24 hour period, approximately equivalent to a 1% annual chance event, where overtopping has not occurred. In addition, as a best management practice, if large amounts of rainfall are in the weather forecast and pumping operations have been ongoing, if possible, workers will draw down a working pond level using the two spillways (Figure 6-5 below) in a containment area to increase available storage. Considering the dike cross section/footprint size and scale relative to the interior containment areas, it appears a future dike breach/failure is considered unlikely.

Figure 6-5: Spillway Structure – Containment Area

Looking at Figure 6-3 above, although the tidal 1% and 0.2% floodplains are depicted, a pond is shown near the entrance to Craney Island, adjacent to Parish Lane. It is unknown about the volume capacity of the lake, the type or condition of the outlet structure, and where it drains, but if rainfall conditions were such that overtopping occurred or failure of the outlet structure or embankment (road) occurred, there is a possibility that some of the Craney Island buildings or access road could be impacted.

As a waterfront facility built within the harbor, Craney Island is located near/within the 1% annual chance tidal floodplain. As shown above using the FEMA floodplain boundaries, the perimeter road around the dike, some of the buildings, and some of the access roads to enter Craney Island could be impacted by tidal flooding, which could affect operations at Craney Island. Additionally, equipment that is stored in buildings and is considered critical should be elevated above or located outside the 0.2% floodplain. Continued proactive measures using breakwater and revetment structures will help protect the shoreline against wave action.

Although not shown as a mapped floodplain by FEMA, dike overtopping from heavy rainfall is possible, which could impact people, property, and the environment, but appears to be unlikely as the facility has been tested from several significant rainfall flood events going back to Hurricane Floyd in 1999 and most recently Hurricane Mathew. As a best management practice, spillways are used to draw down water levels if a large rainfall event is forecasted. Considering the dike cross section/footprint size and scale relative to the interior containment areas, it appears a future dike breach/failure is also considered unlikely. If overtopping or a breach/failure occurred, it appears most of the spillage would most likely be contained on site as sheet flow, as there is a buffer of land from the dikes to the adjacent body of water or properties at a minimum of 300 feet.

With inspections, operation, maintenance, and safety plans that are in place at Craney Island, there should be minimal threats to loss of life and injury, damage to property, and impacts to the environment. There is strict guidance in place for safety and accident prevention, sediment and erosion control, spill prevention and cleanup, environmental compliance and protection, historic preservation, and procedures for placing dredged material, operating the spillways, and maintaining adequate freeboard for normal pumping operations and also for rain and wind events.

Therefore, with the No Action/Future Without Project Alternative, we would anticipate any potential adverse impacts to the floodplains to be negligible and temporary.

Existing navigational uses, such as industry, commerce, military, and recreation activities, will continue within the ROI, including existing dredging operations and dredged material placement. Virginia Port growth is anticipated to increase throughout the next 50 years, which may increase the number of vessels transiting Norfolk Harbor. Craney Island will continue to function and operate as a dredged material management area due to its location and as a low cost option for placement of dredged material. Users of Craney Island include Federal, state, and local governments and private dredging projects.

Climatic changes, such as sea level rise and changes in weather patterns, have the potential to impact Craney Island. Over the 50 year horizon, the amount of dry land bordering Craney Island is anticipated to decrease with a projected increase in sea level rise. In addition, an increase in sea level also means the possibility of higher wave heights, shoreline erosion, and potential damage. The perimeter road may need to be eventually elevated and the shoreline further protected from wave action. If more rainfall or intense storms occur due to changes in weather patterns, then more attention will be needed for dike raising, release of water through the spillways, adequate freeboard, dewatering operations, etc.

We would not anticipate the No Action/Future Without Project Alternative to substantively cumulatively or synergistically interact with other present, past, or future actions.

6.13.2 Action Project Alternative

With respect to encouraging development in the floodplain, deepening of the existing navigation channel would allow more efficient use of the existing waterfront, but would not lead to changes in adjacent land use or allow development to occur that is not already planned or under construction.

As a waterfront facility built within the harbor, Craney Island is located near/within the 1% annual chance tidal floodplain. As shown above using the FEMA floodplain boundaries, the perimeter road around the dike, some of the buildings, and some of the access roads to enter Craney Island could be impacted by tidal flooding, which could affect operations at Craney Island. Additionally, equipment that is stored in buildings and is considered critical should be elevated above or located outside the 0.2% floodplain. Continued proactive measures using breakwater and revetment structures will help protect the shoreline against wave action.

Although not shown as a mapped floodplain by FEMA, dike overtopping from heavy rainfall is possible, which could impact people, property, and the environment, but appears to be unlikely as the facility has been tested from several significant rainfall flood events going back to Hurricane Floyd in 1999 and most recently Hurricane Mathew. As a best management practice, spillways are used to draw down water levels if a large rainfall event is forecasted. Considering the dike cross section/footprint size and scale relative to the interior containment areas, it appears a future dike breach/failure is also considered unlikely. If overtopping or a breach/failure occurred, it appears most of the spillage would most likely be contained on site as sheet flow, as there is a buffer of land from the dikes to the adjacent body of water or properties at a minimum of 300 feet.

With inspections, operation, maintenance, and safety plans that are in place at Craney Island, there should be minimal threats to loss of life and injury, damage to property, and impacts to the environment. There is strict guidance in place for safety and accident prevention, sediment and erosion control, spill prevention and cleanup, environmental compliance and protection, historic preservation, and procedures for placing dredge material, operating the spillways, and maintaining adequate freeboard for normal pumping operations and also for rain and wind events.

Therefore, with implementation of the Action Alternative, we would anticipate any potential adverse impacts to the floodplains to be negligible and temporary.

Existing navigational uses, such as industry, commerce, military, and recreation activities, will continue within the ROI, including existing dredging operations and dredged material placement. Virginia Port growth is anticipated to increase throughout the next 50 years, which may increase the number of vessels transiting Norfolk Harbor. Craney Island will continue to function and operate as a dredged material management area due to its location and as a low cost option for placement of dredged material.

Climatic changes, such as sea level rise and changes in weather patterns, have the potential to impact Craney Island. Over the 50 year horizon, the amount of dry land bordering Craney Island is anticipated to decrease with a projected increase in sea level rise. In addition, an increase in sea level also means the possibility of higher wave heights, shoreline erosion, and potential damage. The perimeter road may need to be eventually elevated and the shoreline further protected from wave action. If more rainfall or intense storms occur due to changes in weather patterns, then more attention will be needed for dike raising, release of water through the spillways, adequate freeboard, dewatering operations, etc.

We would not anticipate the Action Alternative to substantively cumulatively or synergistically interact with other present, past, or future actions.

6.14 Noise and Vibration

6.14.1 No Action/Future Without Project Alternative

Existing dredging operations, dredged material placement/disposal, and navigation within the ROI would continue. Maintenance of existing channel depths, to include dredging and dredged material placement/disposal would continue to produce intermittent noise and vibration within the ROI. There would be no increase in the duration of current maintenance operations, and noise generated from dredging would dissipate relatively quickly. Therefore, adverse impacts with implementation of the No Action/Future Without Project Alternative would be considered to be temporary and minor.

In the future, with or without implementation of an action alternative, vessel calls are anticipated to increase as compared to current conditions, thus increasing noise and vibration within the ROI over time. Virginia Port growth is anticipated to expand throughout the next 50 years, and a new port facility is planned. The following regional projects are assumed to be constructed either with or without No Action/Future Without Project Alternative:

- Chesapeake Bay Bridge Tunnel – Parallel Thimble Shoal Tunnel (CBBT 2016);
- Hampton Roads Bridge Tunnel – Parallel Tunnel (VDOT 2012; VDOT 2016);
- Hampton Roads 3rd Crossing (Patriots Crossing) (VDOT 2001; VDOT 2016);
- I-664 Widening (ties to Patriots Crossing) (VDOT 2001; VDOT 2016);
- Norfolk International Terminals Piers 1 and 2 removed, with area deepened to -50 feet, and
- Craney Island Eastward Expansion – full build-out (USACE 2006).

The timing for completion of these projects is uncertain, and construction of these projects are anticipated to produce minor and temporary adverse impacts to ambient noise levels within the ROI, though these impacts are not likely to substantively synergistically or cumulatively interact.

Implementation of the No Action/Future Without Project Alternative is predicted to result in temporary, minor adverse noise and vibration impacts within the ROI.

6.14.2 Action Project Alternative

Compared to the No Action/Future Without Project Alternative, implementation of the Action Project Alternative would result in an increase in the duration of dredging operations, to include dredging, dredged material placement/disposal, and transiting of navigation channels within the ROI. The noise and vibration produced by dredging vessels is predicted to dissipate a relatively short distance from the dredging operations, though this may be dependent on wind speed and direction. However, it is anticipated that noise inputs from project implementation would not significantly increase ambient noise levels in the human environment or affect sensitive noise receptors. It is anticipated that implementation of the Action Project Alternative would result in temporary and minor adverse noise and vibration impacts within the ROI.

Vessel noise, both with and without implementation of the Action Project Alternative Would increase over time because vessel calls are expected to rise in the coming years. However, overall noise and vibration impacts associated vessel calls would decrease with implementation of the Action Project Alternative; the same existing fleet of vessels would continue to call, but some of the smaller vessel size classes would be used less due to the fact that larger vessel classes are more efficient. Virginia port growth is anticipated to expand throughout the next 50 years, and a new port facility is planned. The following regional projects are assumed to be constructed either with or without implementation of the Action Project Alternative:

- Chesapeake Bay Bridge Tunnel – Parallel Thimble Shoal Tunnel (CBBT 2016);
- Hampton Roads Bridge Tunnel – Parallel Tunnel (VDOT 2012; VDOT 2016);
- Hampton Roads 3rd Crossing (Patriots Crossing) (VDOT 2001; VDOT 2016);
- I-664 Widening (ties to Patriots Crossing) (VDOT 2001; VDOT 2016);
- Norfolk International Terminals Piers 1 and 2 removed, with area deepened to -50 feet, and
- Craney Island Eastward Expansion – full build-out (USACE 2006).

The timing for completion of these projects is uncertain, and construction of these projects are anticipated to produce minor and temporary adverse impacts to ambient noise levels within the ROI, though these impacts are not likely to synergistically or cumulatively interact.

Implementation of the Action Project Alternative is predicted to result in temporary, minor adverse noise and vibration impacts within the ROI.

6.15 Occupational Safety and Health

6.15.1 Future Without Project Condition/No Action Alternative

With implementation of the No Action/Future Without Project Alternative, maintenance dredging would continue and existing, temporary safety risks described in the Affected Environment Section that are at a negligible to minor level of impact would continue. Existing safety risks would be mitigated to the maximum, extent practical through following a Work Safety Plan that incorporates standard work practices for screening/handling MEC/UXO, avoidance of slip and fall hazards, handling contaminated sediment, and wearing appropriate Personal Protective Equipment (PPE). With implementation of the No Action/Future Without Project Alternative, there would be continued maintenance dredging, but this would be at a lower level of duration than implementation of an Action Project Alternative. Because maintenance dredging would be less disturbing to the sediment profile, there would be a lesser likelihood of encountering contaminated sediments or MEC/UXO than with implementation of the Action Project Alternative.

6.15.2 Action Project Alternative

Construction dredging is assumed to present similar occupational health and safety risks as maintenance dredging. However, the duration of exposure to occupational safety and health risks would increase with implementation of the Action Project Alternative as compared to the No Action/Future Without Project Alternative. The increased level of dredging and dredged material placement/disposal activities, and exposure to occupational health and safety hazards would be mitigated to the extent practical through adherence to an approved Work Safety Plan that incorporates standard work practices for handling contaminated sediments, screening/handling MEC/UXO, avoidance of slip and fall hazards, handling contaminated sediment, and wearing PPE. Hazards from MEC/UXO’s can be mitigated through identification by reviewing magnetometer surveys of past and new archaeological surveys. Ordnance identified could then be avoided or disposed of with assistance of qualified explosive ordnance disposal personnel. Implementation of the Action Alternative as compared to the No Action/Future Without Project Alternative would have increased potential exposure to chemical and ordnance hazards should they be encountered, but to date all contaminated sediments and ordnance encountered by dredging in the area has been safely handled. In addition, based on existing MPRSA sediment testing conducted within portions of the ROI, no contaminated sediments are known to occur in the ROI. Although the Action Alternative has slightly higher durations of exposures to occupational safety and health hazards, entailing slightly more risk than the No Action/Future Without Project Alternative, the occupational safety and health risks would be very similar and remain at a temporary and negligible to minor level of impact.

6.16 Utilities

6.16.1 No Action/Future Without Project Alternative

Existing maintenance dredging operations, dredged material placement/disposal, and navigation within the ROI would continue. Existing utilities would remain intact and continued maintenance of the channel system should have no effect on utility infrastructure. No adverse impacts to the City of Norfolk Utility Crossings or to the U.S. Navy DeGaussing Range are anticipated as a result of the No Action Alternative. The MAREA and BRUSA utility lines do not intersect the Atlantic Ocean Channel and would not be impacted by dredging operations.

Placement/disposal of dredged material may alter the topography of the open water placement sites. By 2018, both of these fiber optic utility lines will be fully operational. To date, the MAREA cable is installed 1.5 meters below the existing bottom until it exits the 100 foot wide perimeter around DNODS. Any placement of material over these utility lines would have no impact on these resources. In addition, the placement of these lines should not be impacted by the routine sampling USEPA collects at DNODS. In addition, positional data of the cable (geodetic markers) are provided to USEPA to avoid impact to either cable line.

Virginia Port growth is anticipated to increase throughout the next 50 years, and a new port facility is planned, which may increase the number of vessels transiting the ROI. This may also increase the dredging demands within the waterway. Also, additional development, including construction of the Third Crossing and expansion of the Chesapeake Bay Bridge Tunnel, is planned in the future.

Climatic changes such as sea level rise and increasing global temperatures are predicted to continue in the future. Climate change impacts such as increased temperatures, ocean acidification, sea level rise, and changes in currents, upwelling and weather patterns have the potential to cause changes in the nature and character of the estuarine ecosystem in the ROI. Erosion and loss of estuarine and ocean beaches is anticipated to occur with sea level rise. Over the course of time, more landforms may become submerged, and other areas may become lower-lying and flood more frequently, particularly within the coastal physiographic province in which this project is located.

The No Action/Future Without Project Alternative is not predicted to substantially cumulatively or synergistically interact with climate change and/or other cumulative effects. Therefore, no effect to utilities from implementation of the No Action/Future Without Project Alternative is anticipated.

6.16.2 Action Project Alternative

Impacts to Utilities in the ROI with implementation of Action Alternative, would be similar to those described for the No Action/Future Without Project Alternative. Although some utilities were found in the ROI, much of those are already well below the areas to be dredged or can be mitigated by relocation, if determined necessary.

All of the sanitary sewer outfalls in the City of Norfolk are within the project area, but are outside the limit of disturbance for the increased width and depth of the channel (Plate 6, Appendix A). The Norfolk Harbor Project will have no effect on these sewer utility crossings. In addition, the MAREA and BRUSA fiber optic cable lines will not be impacted by channel deepening because they are located a minimum of .7 miles from the AOC.

Based on available information, it appears the 55 Foot Channel in the Norfolk Harbor Entrance Reach may have the potential for temporary, adverse impacts to the DeGaussing Range with its sensors at -57 feet. With a project channel depth of -55 feet, Paid Allowable Overdepth Dredging (-1 foot) and Non-Pay Allowable Overdepth dredging (-1 foot), there could be temporary impacts to the DeGaussing Range if the total project depth reaches -57 feet. Any potential impacts to the Degaussing Range would be avoided or fully mitigated. If the USN determines the will be at risk to the Range from dredging operations, future deeply laden ships or anchor drag, under conditions of their Corps permit, the USN would be required to relocate the sensors to deeper depths to accommodate the channel, at USN expense. There will be no requirements or cost included in the USACE's plan for relocating the DeGaussing Range sensors. During detailed surveys and channel design studies to be performed during the Preconstruction Engineering and Design phase, additional coordination among the project team and USN representatives will be conducted to validate project dredging requirements with respect to the Navy's needs.

The Action Alternative is anticipated to cause temporary, adverse impacts to the DeGaussing Range if relocation is necessary, but additional detailed channel studies and coordination will be conducted in PED to verify this course of action. Any potential impacts would be avoided or fully mitigated by relocation of the range by the Navy.

Compared to current operations, there would be increased material placement/disposal at the CIDMMA, DNODS, and NODS and associated topographic changes with implementation of the Action Alternative as compared to the No Action/Future Without Project Alternative. With implementation of the Action Alternative, placement of the dredged material at the CIDMMA, DNODS, and NODS is expected to have no effect on utility infrastructure.

It is not anticipated that the Norfolk Harbor Project and placement activities at DNODS will have adverse impacts on the MAREA and BRUSA fiber optic lines because both the deepening of the channel and the crossing of DNODS was a consideration in the design of the utility installation. Any impact to the cable lines would be negligible and fully mitigated by relocation at the owner's expense per coordination with USACE under Nationwide Permit 12.

As described in the No Action/Future Without Project Alternative Section, potential cumulative impacts include increased development such as port growth, increased shipping traffic, and climate change. Implementation of the Action Alternative is not anticipated to substantially cumulatively or synergistically interact with climate change and/or other cumulative effects, including port growth.

6.17 Cultural Resources

6.17.1 No Action/Future Without Project Alternative

Terrestrial archaeological and architectural historic properties would not be affected whether a project is constructed or not. No direct, indirect, or cumulative effects would be expected to these properties in either future without or future with implementation of the Action Alternative. Submerged archaeological properties would be less subject to effects without the project. Currently, no significant submerged archaeological resources have been identified in the APE of the project, but substantial areas remain unsurveyed. In the future without project condition, unidentified sites might still be subject to effects from maintenance dredging, although that potential is less than dredging for deeper or expanded channels. The future without project could subject unidentified submerged archaeological sites to damage from ship strikes, groundings, and prop wash.

6.17.2 Action Project Alternative

Survey is needed for shallower sections of the Atlantic Ocean Channel, although some sections have had previous survey. There will be a need for minor survey for deepening of the other segments where survey would be needed only to the extent the channels would be widened to accommodate the deepening. Previous surveys of Anchorage F and Meeting Area 2 found no sites and no survey will be needed in these areas. The north side of the channel of Meeting Area 1 has been surveyed, but it could require additional survey depending on the design. The greatest potential for identifying NRHP eligible sites that would be affected by the Action Project Alternative is in unsurveyed areas of the Atlantic Ocean and Newport News Channels.

Effects to terrestrial architectural cultural resources would be negligible. Noise and visual effects from dredging would be transitory and distant from land areas. This and changes to navigation, the addition of larger vessels, would be a negligible effect. Terrestrial archaeological resources along shorelines and submerged archaeological resources away from the channels would not suffer from effects from increased wakes because vessels would not be travelling at wake producing speeds.

No submerged archaeological resources have been recorded within the APE for dredging. Although the wrecks of the USS Cumberland and CSS Florida are within the Federal Navigation Channel, they are beyond the Newport News coal piers, the upriver extent of the proposed deepening, and no dredging is planned for this area. The unidentified steel hulled vessel wreck (44NN0335) is in the Federal Navigation Channel off the Newport News coal piers, however at 65 feet it lies in waters much deeper than the proposed project and no dredging would be necessary in this area. Therefore, all three of these sites are not within the APE. Archaeological sites may exist within unsurveyed parts of the APE. Surveys will be conducted for these areas during the Preconstruction Engineering and Design stage after the appropriation of funds for this project. A Programmatic Agreement with the State Historic Preservation Office has been concluded which allows the surveys to be deferred with a Finding of No Significant Impact

(FONSI). The agreement also sets forth procedures for mitigating adverse effects to historic properties if any are identified. Consequently, the impact intensity of the direct effects of construction on submerged archaeological resources are unknown at this time. Avoidance and minimization of effects would be attempted, and mitigation of adverse effects implemented for any NRHP eligible sites that may be identified in the APE.

6.18 Aesthetics

6.18.1 No Action/Future Without Project Alternative

Existing dredging operations, dredged material placement, and navigation would continue in the ROI. When completed, the Craney Island Eastward Expansion will change the appearance of the CIDMMA from a dredged material handling and placement area, to a working port facility including bulkheads, wharves, vessel berths, containers, and cranes (USACE 2006). This addition of the Eastward Expansion infrastructure will be similar to many other views of Port of Virginia and U.S. Navy facilities operating within the ROI (USACE 2006).

The following regional projects are assumed to be implemented at some future time within the ROI. While being built, views from adjacent areas would include construction equipment and activities until the projects are completed.

- Chesapeake Bay Bridge Tunnel – Parallel Thimble Shoal Tunnel (CBBT 2016);
- Hampton Roads Bridge Tunnel – Parallel Tunnel (VDOT 2012a; VDOT 2016);
- Hampton Roads 3rd Crossing (Patriots Crossing) (VDOT 2001; VDOT 2016);
- I-664 Widening (ties to Patriots Crossing) (VDOT 2001; VDOT 2016); and
- Norfolk International Terminals Piers 1 and 2 removed and deepened to -50 feet.

Implementation of the No Action/Future Without Project alternative would result in no predicted changes to the visual resources within the ROI and the aesthetic environment of the ROI would continue to be that of a working waterfront with a mix of adjacent land uses. Routine maintenance dredging of the Norfolk Harbor would be expected to occur nearly every year during the 50-year period of analysis with approximately 1.5 million CY removed and disposed of per year.

6.18.2 Action Project Alternative

During initial construction and subsequent maintenance dredging over the 50-year period of analysis, dredging equipment and equipment used for material placement would be operating within the ROI viewshed. The temporary viewshed impacts resulting from dredging operations with implementation of the Action Alternative as compared to the No Action/Future Without Project Alternative would increase because of the increased dredging durations and frequencies. As such, the presence of the equipment within the viewshed would not represent any new feature in the visual landscape that is not already present under the No Action/Future Without Project alternative. Potential cumulative effects would be similar to those described in the No Action/Future Without Project Alternative. Therefore, the effect of implementing Action Project Alternative on the aesthetic resources within the ROI would be adverse, temporary and negligible.

6.19 Recreation

6.19.1 No Action/Future Without Project Alternative

Existing dredging operations, dredged material placement, and navigation would continue in the ROI.

The following regional projects are assumed to be implemented at some future time within the ROI. While being built, adjacent areas may not be available for recreation because of the presence of construction equipment and activities until the projects are completed.

- Chesapeake Bay Bridge Tunnel – Parallel Thimble Shoal Tunnel (CBBT 2016);
- Hampton Roads Bridge Tunnel – Parallel Tunnel (VDOT 2012a; VDOT 2016);
- Hampton Roads 3rd Crossing (Patriots Crossing) (VDOT 2001; VDOT 2016);
- I-664 Widening (ties to Patriots Crossing) (VDOT 2001; VDOT 2016); and
- Norfolk International Terminals Piers 1 and 2 removed and deepened to -50 feet.

While maintenance dredging and material placement activities are ongoing, areas adjacent to the dredging and placement actions would be unavailable for recreation and represent a temporary and negligible loss of recreation within the ROI. Implementation of the No Action/Future Without Project alternative would result in no permanent changes to the recreational opportunities within the ROI. Recreation within the ROI would be predicted to continue to be primarily influenced by the busy waterborne traffic and 'working waterfront' of the Norfolk Harbor project.

6.19.2 Action Project Alternative

During initial construction and subsequent maintenance dredging over the 50-year period of analysis, dredging and material placement operations would be within approximately the same geographic area as would be affected under the No Action/Future Without Project alternative. Additionally, the dredging equipment and methods would expected to be the same as, or similar to, the equipment currently used for maintenance dredging of the Norfolk Harbor project. As such, any interference with recreation within the ROI would be essentially the same as under the No Action/Future Without Project alternative, but for a longer duration. The effect of implementing Action Project Alternative on the recreational resources within the ROI would be adverse, temporary and negligible for the original construction and permanent and negligible for the maintenance actions over the 50-year period of analysis. Implementation of the Action

Alternative is not anticipated to synergistically interact with other cumulative effects to have any adverse effects resulting in impacts to recreation resources.

6.20 Socioeconomics

6.20.1 No Action/Future Without Project Alternative

Long-term forecasts for the region indicate continued growth of both population and employment, but at slower rates than has been experienced in the past decades. The HRPDC's Hampton Roads 2040 Socioeconomic Forecast predicts that the population and employment within the Hampton Roads MSA will both increase by 2040 (HRPDC 2013a). The HRPDC has estimated population growth for the constituent counties and cities as listed in Table 6-5; the total population is projected to increase from 1,666,310 in 2010 to 2,037,000 (approximately 22-percent) by 2040 (HRPDC 2013a).

Table 6-5: HRPDC Predicted Population Change Between 2010 and 2040

City or County	2010 Population	2040 Population Forecast	Percent Change
Chesapeake	222,209	314,600	41.58
Hampton	137,436	137,200	-0.17
Newport News	180,719	189,100	4.64
Norfolk	242,803	253,200	4.28
Poquoson	12,150	12,400	2.06
Portsmouth	95,535	98,200	2.79
Suffolk	84,585	182,700	116.00
Virginia Beach	437,994	497,500	13.59
Williamsburg	14,068	17,200	22.26
Gloucester Co., VA	36,858	40,200	9.07
Isle of Wight Co., VA	35,270	62,800	78.06
James City Co., VA	67,009	104,200	55.50
York Co., VA	65,464	82,700	26.33

Within the ROI, there are a number of larger-scale construction projects that would be expected to generate short-term, localized, negligible increases in the economy under the No Action/Future Without Project alternative including:

- Chesapeake Bay Bridge Tunnel – Parallel Thimble Shoal Tunnel (CBBT 2016);
- Hampton Roads Bridge Tunnel – Parallel Tunnel (VDOT 2012a; VDOT 2016);
- Hampton Roads 3rd Crossing (Patriots Crossing) (VDOT 2001; VDOT 2016);
- I-664 Widening (ties to Patriots Crossing) (VDOT 2001; VDOT 2016);
- Port expansion; and
- Norfolk International Terminals Piers 1 and 2 removed and deepened to -50 feet.

None of these actions would be expected to individually or cumulatively substantively change the demographic, socioeconomic, or EJ community trends that are present within the ROI; the effect on the socioeconomic character of the ROI from implementing the No Action/Future Without Project alternative would be beneficial and minor from existing dredging maintenance and dredged material placement/disposal operations.

6.20.2 Action Project Alternative

Implementation of the Action Project Alternative would result in increases in dredging durations and frequencies as compared to implementation of the No Action/Future Without Project Alternative and would result in a temporary, beneficial increase in the local economy within the ROI. There would be no substantive predicted influx of new people hired, no substantive changes in local employment, and no substantive changes to income within the ROI.

Regional Economic Development benefits would be anticipated to be beneficial and temporary and in relation to the dredging cycle. The improved navigation channel would allow more efficient movement of cargo.

Compliance with Executive Order 12898 on EJ requires an evaluation of the nature of the proposed actions and the human context into which those actions would be undertaken. In order to have potential EJ impacts, a proposal must have potential for disproportionately high and adverse human health or environmental effects on low-income populations, minority populations, or Native American tribes. Implementation of the Action Project Alternative would not result in measurable changes to environmental resources that individuals involved in subsistence fishing or hunting utilize and would not create disproportionately high and adverse human health or environmental effects on low-income populations, minority populations, or Native American tribes.

Potential cumulative effects would be similar to those described in the No Action/Future Without Project Alternative Section. None of these actions would be expected to individually or cumulatively substantively change the demographic, socioeconomic, or EJ community trends that are present within the ROI; the effect on the socioeconomic character of the ROI from implementing the Action Alternative would be beneficial and minor.

6.21 Land Use and Induced Development

6.21.1 No Action/Future Without Project Alternative

Existing dredging operations, dredged material placement, and navigation would continue in the ROI. When completed, the CIEE will change the land use of the CIDMMA from the current designation as Parks, Open Space & Greenways to Industrial, because it will be a working port facility including bulkheads, wharves, vessel berths, containers, and cranes (USACE 2006). This addition of the Eastward Expansion infrastructure will be similar to the Port of Virginia's industrial land use within the ROI (USACE 2006).

Virginia Port growth is anticipated to increase throughout the next 50 years and a new port facility is planned, which is anticipated to increase the number of vessel calls in the Norfolk Harbor. Also, additional development including construction of the Third Crossing and expansion of the Chesapeake Bay Bridge Tunnel, the Interstate-64 Widening and High Rise Bridge Expansion, and construction of the CIEE is planned in the future. However, none of these projects would be expected to substantively alter land use in the ROI.

Implementation of the No Action/Future Without Project Alternative is not anticipated to cumulatively or synergistically interact with other potential cumulative effects to cause changes to land use in the ROI.

6.21.2 Action Project Alternative

Existing land use, future land use, and potential cumulative effects for the Action Alternative would be as those described for the No Action/Future Without Project Alternative.

Implementation of the Action Alternative is not anticipated to cumulatively or synergistically interact with other potential cumulative effects to cause changes to land use in the ROI.

6.22 Transportation

6.22.1 No Action/Future Without Project Alternative

Existing dredging operations, dredged material placement, and navigation would continue in the ROI. Maintaining the existing channels would not require any road-based transportation aside from employees driving to and from work during construction.

In addition, the existing activities that lead to highway and road traffic within the ROI would be expected to continue throughout the 50-year period of analysis. Under the No Action/Future Without Project Alternative, there are a number of larger-scale construction projects within the ROI that, if built, may cumulatively help alleviate traffic congestion problems:

- Chesapeake Bay Bridge Tunnel – Parallel Thimble Shoal Tunnel (CBBT 2016);
- Hampton Roads Bridge Tunnel – Parallel Tunnel (VDOT 2012a; VDOT 2016);
- Hampton Roads 3rd Crossing (Patriots Crossing) (VDOT 2001; VDOT 2016); and
- I-664 Widening (ties to Patriots Crossing) (VDOT 2001; VDOT 2016).

Continued efforts by the Port of Virginia, in coordination with local municipalities, to identify and implement ways of decreasing traffic associated with routine Port operations would be expected to continue. Because the Port of Virginia anticipates that the share of freight transported by truck will continue to decrease in the future (e.g., 40 to 50-percent of cargo handled by the Port may eventually be transported by rail (HRTPO 2015b)), the burden of truck traffic on surrounding surface roads would be predicted to proportionally decrease under the No Action/Future Without Project alternative. Implementing the No Action/Future Without Project alternative would be predicted to result in no changes to the regional traffic and surface road congestion within the ROI.

6.22.2 Action Project Alternative

The dredging equipment and methods utilized to construct and maintain the Action Project Alternative would expected to be the same as, or similar to, the equipment currently used for maintenance dredging of the Norfolk Harbor project. Because all of the dredged material generated would be placed in CIDMMA, NODS, or Dam Neck for disposal, implementing the Action Project Alternative would have no direct effect on traffic congestion.

Over the period of analysis, implementing the Action Project Alternative would result in fewer, but marginally larger vessels calling on the Port of Virginia facilities. In the future, larger vessels would transport the same quantity of cargo more efficiently (i.e., fewer trips to move the annual quantity of cargo). The infrastructure at the Port of Virginia is already of sufficient size and capacity to accommodate the larger vessels and efficiently move cargo to or from vessels. As such, implementing the Action Project Alternative would not result in an increase in local traffic at points of access to, or egress from, Port of Virginia facilities.

As with the No Action/Future Without Project alternative, continued efforts by the Port of Virginia, in coordination with local municipalities, to identify and implement ways of decreasing traffic associated with routine Port operations would be expected to continue. Because the Port of Virginia anticipates that the share of freight transported by truck will continue to decrease in the future (e.g., 40 to 50-percent of cargo handled by the Port may eventually be transported by rail), the burden of truck traffic on surrounding surface roads would be predicted to not be affected by implementing the Action Project Alternative.

7 SUMMARY OF BEST MANAGEMENT PRACTICES/MITIGATION MEASURES

Impact evaluations conducted during preparation of this EA have determined that no significant impacts would result from implementation of the Recommended Plan (also referred to as the Action Alternative or Preferred Alternative). This determination is based on a thorough review and analysis of existing resource information and coordination with knowledgeable, responsible personnel from the USACE and relevant local, state, and Federal agencies. No onsite compensatory wetland or other type of mitigation is anticipated to be required for this project. Below is a listing of planned best management practices/mitigation measures that are impact avoidance and minimization measures that would be implemented with the Action Alternative to the maximum, practical extent.

- Best management practices will be implemented during dredging to minimize disturbances to the environment. For example, agitation and operation of the cutterhead of a dredge will not begin until the cutterhead is in immediate contact with the substrate. A similar measure will be taken for hopper dredges. The dredge operator will not begin dredging until the draghead is in direct contact with the substrate. For both types of hydraulic dredges, this measure reduces the intake of water, and the potential uptake and entrainment of eggs, larvae, juvenile, and adult fish species. By lowering the cutterhead/draghead to the bottom, before starting the agitation and suction of water and sediment, potential impacts and losses of fish species and sea turtle entrainment in the vicinity of the dredge are minimized.
- To minimize air emissions associated with dredging vessels and dredge-related equipment, vessels and equipment will not be allowed to run idle and will be shut off to the extent practical when not in use.
- The NMFS will be contacted three days prior to the commencement of any dredging operations to ensure all appropriate reporting forms will be used.
- To minimize entrainment during dredging operations Turtle Excluder Devices will be used on dragheads for hopper dredges. Turtle Exclusion Devises create a sand wave in front of the draghead and will "roll" a resting sea turtle on the bottom off to the side and out of the path of the draghead.
- National Marine Fisheries Service-approved observers will be present on all hopper dredges and perform 100% inspection of inflow and/or inspection of dragheads and turtle excluder devices when MEC/UXO screens are utilized.
- All dredge operators will be trained on measures of dredge operation that will minimize the take of sea turtles. All personnel performing dredging operations will be notified of the potential presence of sea turtles and the need to avoid collisions with sea turtles. All personnel are responsible for observing water-related activities for the presence of these species. All personnel shall be notified that there are civil and criminal penalties for harming, harassing, or killing listed or other protected species.
- If a sea turtle is observed within 100 yards (300 feet) of the active daily construction/dredging operation or vessel movement, all appropriate precautions shall be implemented to ensure its protection. These precautions shall include cessation of operation of any moving equipment closer than 50 feet of a sea turtle. Operation of any mechanical construction equipment shall cease immediately if a sea turtle is observed

within a 50-foot radius of the equipment. Activities may not resume until the sea turtle has departed the project area of its own volition.

- Any collision with and/or injury to a sea turtle shall be reported within 24 hours to the NMFS's Protected Resources Division.
- The USACE will ensure all appropriate measures are taken to protect any sea turtles or listed sturgeon that survive hopper dredging entrainment. Although most sea turtles would not likely survive entrainment in hopper dredges, if a sea turtle were to survive the entrainment, the guidelines and procedures for handling live sea turtles entrained in hopper dredges as outlined in 50 CFR 223.206(d)(1) will be followed.
- Sea turtle relocation trawling will be initiated following the take of two sea turtles in a 24-hour period or four turtles within a two month period.
- UXO screening devices shall be used on dredging equipment in locations with a potential threat of UXO detonation as defined by the USACE.
- Exposure to occupational health and safety hazards would be mitigated to the extent practical through adherence to an approved Work Safety Plan that incorporates standard work practices for handling contaminated sediments, screening/handling UXO, avoidance of slip and fall hazards, handling contaminated sediment, and wearing PPE.

8 ENVIRONMENTAL COMPLIANCE

Compliance with the following environmental laws (and implementing regulations) and Executive Orders is required for the project alternatives under consideration (Table 8-1) (note: this is not necessarily an exhaustive list of all applicable environmental requirements).

8.1 Table of Environmental Compliance, Executive Orders, and Permitting Requirements

Table 8-1. Table of Environmental Compliance

Title of Law	U.S. Code	Compliance Status
Abandoned Shipwreck Act of 1987	43 United States Code (U.S.C.) 2101	Full Compliance
American Bald and Golden Eagle Protection Act of 1962, as amended	16 U.S.C. 668	Full Compliance
American Indian Religious Freedom Act of 1978	Public Law No. 95-341, 42 U.S.C. 1996	Full Compliance
Anadromous Fish Conservation Act of 1965	16 U.S.C. 757 a et seq	Full Compliance
Archaeological and Historic Preservation Act of 1974	Public Law 93-291 and 16 U.S.C.469-469c	Full Compliance
Archaeological Resources Protection Act of 1979	16 U.S.C. 470aa–470mm,	Full Compliance
Clean Air Act of 1972, as amended	42 U.S.C. 7401 et seq	Full Compliance
Coastal Barrier Resources Act of 1982	Public Law 114-314	The project is not located in a designated coastal barrier zone and therefore, no coordination is necessary.
Clean Water Act of 1972, as amended	33 U.S.C. 1251 et seq	Full Compliance
Coastal Zone Management Act of 1972, as amended	16 U.S.C. 1451 et seq	Full Compliance
Comprehensive Environmental Responses, Compensation and Liability Act of 1980	42 U.S.C. 9601	Full Compliance
Deepwater Port Act of 1974, as amended	33 U.S.C. 1501	Full Compliance
Emergency Wetlands Resources Act	16 U.S.C. 3901-3932	N/A

Title of Law	U.S. Code	Compliance Status
Endangered Species Act of 1973	16 U.S.C. 1531	Full Compliance with USFWS and NMFS.
Estuary Protection Act of 1968	16 U.S.C. 1221 et seq	N/A
Fish and Wildlife Coordination Act of 1958, as amended	16 U.S.C. 661	Full Compliance
Flood Control Act of 1970	33 U.S.C. 549	Full Compliance
Land and Water Conservation Act	16 U.S.C. 460	Full Compliance
Magnuson-Stevens Fishery Conservation and Management Act	16 U.S.C. 1801	Full Compliance
Marine Mammal Protection Act of 1972, as amended	16 U.S.C. 1361	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, awaiting signature of the FONSI
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 of 1990	25 U.S.C. 3001	Full Compliance
Noise Control Act of 1972, as amended	42 U.S.C. 4901	Full Compliance
Resource Conservation and Recovery Act of 1976	42 U.S.C. 6901 et seq	Full Compliance
River and Harbor Act of 1888, Section 11	33 U.S.C. 608	Full Compliance

Title of Law	U.S. Code	Compliance Status
River and Harbor Act of 1899	33 U.S.C. 401 et seq	Full Compliance
Safe Drinking Water Act of 1974, as amended	42 U.S.C. 300	Full Compliance
Submerged Lands Act of 1953	43 U.S.C. 1301 et seq	Full Compliance
Toxic Substances Control Act of 1976	15 U.S.C. 2601	Full Compliance

Table 8-2. Table of Executive Orders

Title of Executive Order	Executive Order Number	Compliance Status
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
Offshore Oil Spill Pollution	12123	Full Compliance
Federal Compliance with Right-to-Know Laws and Pollution Prevention	12856	N/A
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	N/A
Consultation and Coordination with Indian Tribal Governments	13175	Full Compliance
Responsibilities of Federal Agencies to Protect Migratory Birds	13186	Coordination with the USFWS is complete

Facilitation of Cooperative Conservation	13352	N/A
Preparing the United States for Impacts of Climate Change	13659	Full Compliance
Planning for Federal Sustainability in the Next Decade (2015)	13693	Full Compliance

Table 8-3. Table of Permitting Requirements

Law	**Agency Responsible**	**Permit, Agreement, Authorization, or Notification Required**
American Bald and Golden Eagle Protection Act of 1962, as amended	USFWS	"Take" permit if any eagles are accidentally harmed or killed; no take permit is required
Comprehensive Environmental Responses, Compensation and Liability Act of 1980, as amended	U.S. Environmental Protection Agency (USEPA)	Full Compliance
Clean Water Act, Section 401*	VDEQ	401 Water Quality Certification
Coastal Zone Management Act (CZMA)	VDEQ	CZMA Federal Consistency Concurrence
Endangered Species Act of 1973	NMFS	Biological Opinion with Incidental Take statement (Formal Consultation)
Endangered Species Act of 1973	USFWS	Concurrence Determination (Informal Consultation)
Fish and Wildlife Coordination Act (FWCA)	USFWS	FWCA Report
Magnuson-Stevens Fishery Conservation and Management Act	NMFS	Notification of any noncompliance; none anticipated
Marine Mammal Protection Act of 1972, as amended	NMFS	No Incidental Take Authorization anticipated
Marine Protection, Research, and Sanctuaries Act of 1972*	USEPA	Concurrence documentation with the USEPA
Migratory Bird Treaty Act of 1918, as amended	USFWS	"Take" permit; no take permit is required

Law	Agency Responsible	Permit, Agreement, Authorization, or Notification Required
National Historic Preservation Act of 1966, as amended	Advisory Council on Historic Preservation, Virginia Department of Historic Resources	Programmatic Agreement in place
Noise Control Act of 1972	USEPA	Notification of any noncompliance; none anticipated
Resource Conservation and Recovery Act of 1976	USEPA, VDEQ	Testing, quantification, and notification for any hazardous materials.

N/A = Not Applicable; VDEQ = Virginia Department of Environmental Quality; NMFS = National Marine Fisheries Service; USEPA = U.S. Environmental Protection Agency; USFWS = U.S. Fish and Wildlife Service

8.2 National Environmental Policy Act of 1969, as amended, 42 U.S.C. 4321 *et seq.*

The NEPA requires that all Federal agencies use a systematic, interdisciplinary approach to protect the human environment. This approach promotes the integrated use of natural and social sciences in planning and decision-making that could have an impact on the environment. NEPA requires the preparation of an environmental impact statement (EIS) for any major Federal action that could have a significant impact on quality of the human environment and the preparation of an Environmental Assessment (EA) for those Federal actions that do not cause a significant impact but do not qualify for a categorical exclusion. The NEPA regulations issued by CEQ provide for a scoping process to identify and the scope and significance of environmental issues associated with a project. The process identifies and eliminates from further detailed study issues that are not significant. As previously stated, the USACE used this process to comply with NEPA and focus this Integrated General Reevaluation Report/EA (GRR/EA) on the issues most relevant to the environment and the decision making process. For a description of the agency, tribal, and public coordination completed to date and information on the NEPA scoping that was completed, please refer to the Section 1.9, National Environmental Policy Act Scoping and Public, Resource Agency, and Tribal Coordination. A 30-day agency, tribal, and public review of the Draft GRR/EA was completed on December 10, 2017. All comments/edits have been addressed in the Final GRR/EA and the comment responses are provided in the Final GRR/EA. The Final GRR/EA, including all appendices and supporting documentation fulfills the requirements of the NEPA for the Norfolk Harbor Navigation Improvements Project. Upon completion of the Final GRR/EA, which is signified by the signing of the Finding of No Significant Impact, the project will be in full compliance with the NEPA.

8.3 Clean Water Act

The USACE will obtain a Water Quality Certification from the Commonwealth of Virginia pursuant to the Clean Water Act (CWA). This GRR/EA contains sufficient information to demonstrate that the recommended plan is in compliance with the CWA. All dredged material placement actions will comply with the Commonwealth of Virginia water quality standards and

Commanders Policy WRD-01 which governs operation of CIDMMA. Prior to commencement of construction, dredged material will undergo evaluation procedures including chemical and biological testing in accordance with Federal guidance and regulations to provide information to reach a factual determination concerning Clean Water Act, Section 404 requirements (40 CFR 230.11) and applicable state water quality standards.

8.4 Wetlands

Section 404 of the CWA and 33 C.F.R. 336(c)(4) and 33 C.F.R. 320.4(b) require the USACE to avoid, minimize, and mitigate impacts to wetlands. No direct or indirect impacts to jurisdictional wetlands are anticipated with implementation of this project.

8.5 Federal Coastal Zone Management Act, 16 U.S.C. 1451 *et seq.*

The Federal Coastal Zone Management Act (CZMA) requires each Federal agency activity performed within or outside the coastal zone (including development projects) that affects land or water use, or natural resources of the coastal zone to be carried out in a manner which is consistent to the maximum extent practicable, i.e. fully consistent, with the enforceable policies of approved state management programs unless full consistency is prohibited by existing law applicable to the Federal agency.

To implement the CZMA and to establish procedures for compliance with its Federal consistency provisions, the U.S. Department of Commerce, National Oceanic and Atmospheric Administration (NOAA), promulgated regulations which are contained in 15 C.F.R. Part 930. As per 15 CFR 930.37, a Federal agency may use its NEPA documents as a vehicle for its consistency determination.

The Virginia Coastal Management Program was established under the guidelines of the national Coastal Zone Management Act (1972) as a state-Federal partnership to comprehensively manage coastal resources. The VDEQ is the designated state coastal management agency and is responsible for the implementation of the state’s Coastal Management Program. Implementation includes the direct regulation of impacts to coastal resources within the critical areas of the state including coastal waters, tidelands, beaches and beach dune systems; and indirect certification authority over Federal actions and state permit decisions within the eight coastal counties.

The goals of the Virginia Coastal Management Program are attained by enforcement of the policies of the State as codified within the Virginia Code of Regulations. "Policy" or "policies" of the Virginia Coastal Management Program means the enforceable provisions of present or future applicable statutes of the Commonwealth of Virginia. The statutes cited as policies of the Program were selected because they reflect the overall program goals of developing and implementing a balanced program for the protection of the natural resources, as well as promoting sustainable economic development of the coastal area. In accordance with the CZMA, it has been determined that the proposed deepening of the Federal navigation channel would be carried out in a manner that is fully consistent with the enforceable policies of the Virginia CMP (The Federal Consistency Determination with the CZMA is provided in Appendix G).

8.6 Clean Air Act, as amended, 42U.S.C. 7401 *et seq.*

There will be negligible, temporary increases in air emissions from operation of construction equipment during construction and maintenance operations. These emissions will be below *de minimis* levels. A Record of Non-Applicability (RONA) was developed and the signed document is located in Appendix I of the Environmental Appendix. The Hampton Roads Intrastate Air Quality Control Region is in attainment with all National Ambient Air Quality Standards, therefore, no conformity analysis is required for this project.

8.7 U.S. Fish and Wildlife Coordination Act, 16 U.S.C.661-666(c)

Coordination with the U.S. Fish and Wildlife Service and the Commonwealth of Virginia is complete. A Fish and Wildlife Coordination Act Report has been prepared by the U.S. Fish and Wildlife Service.

8.8 Endangered Species Act

Biological Assessments that evaluate the potential impacts of the proposed action on endangered and threatened species are provided in Appendix E. Two Biological Assessments have been prepared, one for those species under the jurisdiction of the USFWS and one for those species under the jurisdiction of the NMFS. A small segment of the Newport News channel is located within Atlantic Sturgeon Critical habitat. Coordination with the USFWS and the NMFS pursuant to Section 7 of the ESA for the species provided in Table 8-4a and Table 8-4b below. Section 7 consultation is ongoing with NMFS and expected to be completed in July 2018. Upon completion of formal consultation, the final BO will be inserted into Appendix I.

Formal consultation with the NMFS is required because of the potential adverse affects to Atlantic Sturgeon, Atlantic Sturgeon Critical Habitat, and sea turtles (green sea turtles, Kemp's ridley sea turtles, leatherback sea turtles, and loggerhead sea turtles) resulting from potential entrainment impacts and temporary loss of Atlantic Sturgeon benthic foraging habitat in the Action Area. Other effects to Federally listed species are all either no affect or may affect, not likely to adversely affect determinations and the analysis and findings are described in detail in the Special Status Species Section and in the Biological Assessments (Appendix E1 and Appendix E2).

Table 8-4a. Federally Listed Species Known or with the Potential to Occur in the Action Area Under the Jurisdiction of the National Marine Fisheries Service

Taxonomic Category/Common Name	Scientific Name	Status	Critical Habitat	Affect Determination
Fish				
Atlantic sturgeon (all DPSs)	*Acipenser oxyrinchus oxyrinchus*	T, E	Y	May Affect, Likely to Adversely Affect

Taxonomic Category/Common Name	Scientific Name	Status	Critical Habitat	Affect Determination
Atlantic Sturgeon Critical Habitat				May Affect, Likely to Adversely Affect
Mammals				
Fin whale	*Balaenoptera physalus*	E	N	May Affect, Not Likely to Adversely Affect
North Atlantic right whale	*Eubalaena glacialis*	E	Y*	May Affect, Not Likely to Adversely Affect
Sei whale	*Balaenoptera borealis*	E	N	May Affect, Not Likely to Adversely Affect
Reptiles				
Green sea turtle (North Atlantic DPS)	*Chelonia mydas*	T	Y*	May Affect, Likely to Adversely Affect
Hawksbill sea turtle	*Eretmochelys imbricata*	E	Y*	No Affect
Kemp's Ridley sea turtle	*Lepidochelys kempii*	E	N	May Affect, Likely to Adversely Affect
Leatherback sea turtle	*Dermochelys coriacea*	E	Y*	May Affect, Likely to Adversely Affect
Loggerhead sea turtle (Northwest Atlantic DPS)	*Caretta caretta*	T	Y*	May Affect, Likely to Adversely Affect

DPS = Distinct Population Segment; T = Threatened; E = Endangered; Y = Yes; N = No; ^Species status is reported as it pertains to the DPS/Action Area; *Critical Habitat not located in Action Area

Table 8-5a. Federally Listed Species Known or with the Potential to Occur in the Action Area Under the Jurisdiction of the U.S. Fish and Wildlife Service

Taxonomic Category/Common Name	**Scientific Name**	**Status**	**Critical Habitat**	**Affect Determination**
Birds				
Piping Plover	*Charadrius melodus*	T	Y*	May Affect, Not Likely to Adversely Affect
Red-cockaded woodpecker	*Picoides borealis*	E	N	No Affect
Red Knot	*Calidris canatus rufa*	T	N	May Affect, Not Likely to Adversely Affect
Roseate Tern	*Sterna dougallii*	Y	N	May Affect, Not Likely to Adversely Affect
Mammals				
Northern long-eared bat	*Myotis septentrionalis*	T	N	No Affect
Indiana bat	*Myotis sodalis*	E	Y*	No Affect
West Indian manatee	*Trichechus manatus*	T	Y*	May Affect, Not Likely to Adversely Affect
Reptiles				
Green sea turtle (North Atlantic DPS)	*Chelonia mydas*	T	Y*	No Affect
Hawksbill sea turtle	*Eretmochelys imbricata*	E	Y*	No Affect
Kemp's Ridley sea turtle	*Lepidochelys kempii*	E	N	No Affect
Leatherback sea turtle	*Dermochelys coriacea*	E	Y*	No Affect

Taxonomic Category/Common Name	Scientific Name	Status	Critical Habitat	Affect Determination
Loggerhead sea turtle (Northwest Atlantic DPS)	*Caretta caretta*	T	Y*	No Affect

DPS = Distinct Population Segment; T = Threatened; E = Endangered; Y = Yes; N = No; ^Species status is reported as it pertains to the DPS/Action Area; *Critical Habitat not located in Action Area

8.9 Magnuson-Stevens Fishery Conservation and Management Act (MSA), 16 U.S.C.1801 *et seq*.

This Act requires Federal action agencies to consult with the National Marine Fisheries Service (NMFS) if a proposed action may affect Essential Fish Habitat (EFH). The USACE evaluated potential project impacts on NMFS-managed fish species and their Essential Fish Habitats (Appendix H). Negligible to minor, adverse impacts to some EFH is anticipated, however no impacts are anticipated to substantively impact EFH. Coordination with the NMFS is complete.

8.10 Anadromous Fish Conservation Act, 16 U.S.C. 757, *et seq.*

The project considered habitat impacts to the anadromous fish listed below in Table 8-6. Mitigation would not be required for the negligible to minor, adverse effects on these species due to water quality changes and/or habitat displacement. Coordination with the NMFS is complete.

Table 8-6. Anadromous Fish

Common Name	Scientific Name
Atlantic sturgeon	*Acipenser oxyrinchus oxyrinchus*
Alewife	*Alosa pseudoharengus*
American shad	*Alosa sapidissima*
Blueback herring	*Alosa aestivalis*
Hickory shad	*Alosa mediocris*
Striped bass	*Morone saxatilis*
Yellow perch	*Perca flavescens*

8.11 Marine Mammal Protection Act, 16 U.S.C. 1631 et seq.

The Marine Mammal Protection Act (MMPA) prohibits the take of marine mammals including the West Indian manatee, and all cetaceans found in the ROI. The project is being coordinated with

USFWS and NMFS. No Incidental Take Authorization from the NMFS is anticipated with implementation of the Preferred Alternative.

8.12 Section 106 and 110(f) of the National Historic Preservation Act, 16 U.S.C. 470 *et seq.*

The National Historic Preservation Act (NHPA) applies to properties listed in or eligible for listing in the National Register of Historic Places (NRHP); these are referred to as "historic properties." Historic properties eligible for listing in the NRHP include prehistoric and historic sites, structures, buildings, objects, and collections of these in districts. Section 106 of the NHPA and its implementing regulations at 36 CFR Part 800, require the lead Federal agency to assess the potential effects of an undertaking on historic properties that are within the proposed project's Area of Potential Effect (APE), which is defined as "the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist" (36 C.F.R. § 800.16[d]).

The USACE evaluated the potential for adverse impacts to archaeological or historic resources. No submerged archaeological resources have been recorded within the APE for dredging. Archaeological sites may exist within unsurveyed parts of the APE. As per a Programmatic Agreement with the Virginia State Historic Preservation Office signed on June 7, 2017, surveys will be conducted for these areas during the Preconstruction, Engineering, and Design (PED) Phase of the Project. The procedures for any mitigation if adverse effects to NRHP eligible properties are identified are also described in the Programmatic Agreement. The Virginia Department of Historic Resources concurred that no adverse effects to historic properties would result from visual or noise effects of construction, and this is also documented in the Programmatic Agreement.

8.13 Resource Conservation and Recovery Act, as amended, 42 U.S.C. 6901 *et seq*.

The Resource Conservation and Recovery Act (RCRA) RCRA controls the management and disposal of hazardous waste. "Hazardous and/or toxic wastes", classified by the Resource Conservation and Recovery Act (RCRA), are materials that may pose a potential hazard to human health or the environment due to quantity, concentration, chemical characteristics, or physical characteristics. This applies to discarded or spent materials that are listed in 40 CFR 261.31-.34 and/or that exhibit one of the following characteristics: ignitable, corrosive, reactive, or toxic. Radioactive wastes are materials contaminated with radioactive isotopes from anthropogenic sources (e.g., generated by fission reactions) or naturally occurring radioactive materials (e.g., radon gas, uranium ore).

For a description of MPRSA for LPC and CWA testing for CIDMMA, refer to the HTRW section. Dredging within the ROI of the NHC project is not anticipated to generate material with chemical contamination based on historical testing in the proposed dredged areas.

8.14 Comprehensive Environmental Response, Compensation and Liability Act, 42 U.S.C. 9601 *et seq*.

The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA or Superfund) governs the liability, compensation, cleanup, and emergency response for hazardous substances released into the environment and the cleanup of inactive hazardous substance disposal sites.

There are CERCLA/Superfund sites bordering, but not within, the ROI; and this project constitutes a navigation improvement project, rather than a clean-up effort under CERCLA. However, contamination from these sites may be present within the dredging limits of the ROI, and if so, it will be handled as described in Part 6.12 above and as described in the Sediments and HTRW Section.

8.15 Marine Protection, Research and Sanctuaries Act

The Act has two essential aims: to regulate intentional ocean disposal of materials, and to authorize any related research. While the MPRSA regulates the ocean dumping of waste and provides for a research program on ocean dumping, it also provides for the designation and regulation of marine sanctuaries.

Ocean dredged material placement is regulated under Section 103 of the Marine Protection Resources and Sanctuaries Act of 1972, Public Law 92-532 (MPRSA). The law states that any proposed placement of dredged material into ocean waters must be evaluated through the use of criteria published by the USEPA in Title 40 of the Code of Federal Regulations, Parts 220-228 (40 CFR 220-228). The primary purpose of Section 103 of the MPRSA is to limit and regulate adverse environmental impacts of ocean placement of dredged material. Dredged material proposed for ocean placement must comply with 40 CFR 220-228 (Ocean Dumping Regulations) and 33 CFR 320-330 and 335-338 (USACE Regulations for discharge of dredged materials into waters of the U.S.) prior to being issued an ocean placement permit. The technical evaluation of potential contaminant-related impacts that may be associated with ocean placement of dredged material is conducted in accordance with 40 CFR 220-228, the Ocean Testing Manual, and the Evaluation of Dredged Material Proposed for Disposal at Island, Nearshore.

All dredged material will be tested for LPC standards as established by the MPRSA. Materials from dredge activities in the AOC and TSC are expected to be placed at DNODS and materials from the Norfolk Inner Harbor Channel, Craney Island Reach and Newport News Channel could be placed at NODS and/or at CIDMMA, depending upon future capacity constraints. All required testing for placement at these authorized locations will be followed and confirmed during PED.

8.16 Executive Order 11988, Floodplain Management

This EO states that Federal agencies 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 floodplains in carrying out agency responsibilities. The proposed project would have only negligible and temporary impacts to the floodplain.

8.17 Executive Order 11990, Protection of Wetlands

This EO directs all Federal agencies to minimize the destruction, loss, or degradation of wetlands; and preserve and enhance the natural beneficial values of wetlands in the conduct of the agency's responsibilities. No direct or indirect impacts to jurisdictional wetlands are anticipated with implementation of this project.

8.18 Executive Order 13112, Invasive Species

Under this EO, the introduction of invasive species has been evaluated in Section 6.22. The project would not induce the introduction or spread of invasive species to the project area.

8.19 Executive Order 12898, Federal Actions to Address Environmental Justice

In accordance with this EO, the USACE has determined that no group of people would bear a disproportionately high share of adverse environmental consequences resulting from the proposed work.

8.20 Executive Order 13045, Protection of Children from Environmental and Safety Risks

This EO ensures that all Federal actions address the unique vulnerabilities of children. In accordance with this EO, the USACE has determined that no children would bear a disproportionately high share of adverse environmental consequences resulting from the proposed work.

8.21 Migratory Bird Treaty Act, 16 U.S.C. 703 *et seq*.; Executive Order 13186, Responsibilities of Federal Agencies to Protect Migratory Birds

This Act makes it illegal for anyone to take, possess, import, export, transport, sell, purchase, barter, or offer for sale, purchase, or barter, any migratory bird, or the parts, nests, or eggs of such a bird except under the terms of a valid permit issued pursuant to Federal regulations. Temporary to permanent impacts to migratory birds would range from adverse to beneficial effects that would range from a negligible to a minor level of impact.

8.22 LIST OF PREPARERS

The project delivery team for the study was extensive. It comprised team members from District's in the USACE North Atlantic and South Atlantic Division (Norfolk, Jacksonville, and Mobile). The team members listed below provided substantial text to the Integrated Feasibility Report/Environmental Impact Statement.

Table 8-7. List of Preparers

Name	Contribution/Education	Affiliation	Years of Experience
John Haynes	Cultural Resources/MA, Anthropology	USACE	28
Alicia Logalbo	Environmental Analyst/MS, Biology	USACE	18
Jason O'Neal	GIS Mapping/BS, Geology	USACE	12
Miranda Ryan	Environmental Analyst/BS, Biology	USACE	2

Name	Contribution/Education	Affiliation	Years of Experience
David Schulte	Environmental Analysis/MS, Marine Science	USACE	18
Todd Nettles	Economic Analysis/BS, Economics	USACE	17
Jerry Diamantides	Plan Formulation & Economics/Ph.D. Economics	DMA	30
Idris Dobbs	Economic Analysis/BS, Economics	USACE	10
Courtney Jackson	Economic Analysis/BS, Economics	USACE	4
Michael McGarry	Environmental Analysis/B.S. Biology	DMA	22
Laura Evans	Environmental Analysis/B.S. Biology & J.D.	DMA	12
Dan Hughes	Plan Formulation/Ph.D. Applied Anthropology	USACE	27
Kimberly Koelsch	Biologist, B.A. Urban Affairs and Planning	USACE	6
Robert Pretlow	Plan Formulation/MS, Civil Engineering	USACE	42
Ira Brotman	Engineering and Costs/BS, Civil Engineering	Moffatt and Nichol	25
Rachel Haug	Plan Formulation/B.S. Environmental Policy and Planning	USACE	8

9 AGENCIES, TRIBAL GOVERNMENTS AND PERSONS CONSULTED

Table 9-1 list the Agencies consulted with during this project. Consultation will be ongoing through the length of this study.

Table 9-1: Agencies consulted.

Agency/Government	Name of Contact People
Advisory Council on Historic Preservation (ACHP)	Brian Lusher, Christopher Daniel
U.S. Navy (USN)	ADM John Scorby, USN, Michael King, Brian Ballard, Steve Jones, Mercedes Holland
U.S. Coast Guard (USCG)	Barbara Wilke, Ken Koestecki, Anthony Lloyd
US Coast Guard Sector Hampton Roads	CPT Christopher Keane, USCG
National Marine Fisheries Service (NMFS)	Christine Vaccaro, David O'Brien, Brian Hopper
U.S. Environmental Protection Agency (USEPA)	Barbara Rudnick, Kevin Magerr
U.S. Fish and Wildlife Service (USFWS)	Troy Andersen, Chris Guy, Chelsey Stephenson
Virginia Department of Environmental Quality (VDEQ)	Bert Parolari, Bettina Sullivan, David Paylor, Melanoe Davenport, Maria Nold, Sherri Kattan
Virginia Marine Resources Commission (VMRC)	John Bull, Rob O’Reilly, Tony Watkinson, Rachael Peabody
Virginia Department of Agriculture and Consumer Services (VDACS)	Keith Tignor
Virginia Department of Historic Resources (VDHR)	Marc Holma, Greg LaBudde
Virginia Department of Game and Inland Fisheries (VDGIF)	Amy Ewing, David Whitehurst
Virginia Department of Conservation and Recreation (VDCR)	Ali Baird, Charley Banks, Bob Duncan, David Whitehearst, Renee Hypes
Virginia Institute of Marine Science (VIMS)	Pam Mason, Lyle Varnell
Catawba Indian Nation	Wenonah Haire
Pamunkey Tribal Government	Ashley Atkins-Spivey

Agency/Government	Name of Contact People
Delaware Nation	Nekole Alligood
Delaware Tribe of Indians	Susan Bachor
Narragansett Indian Tribe	Matthew Thomas
Shinnecock Indian Nation	Bryan Polite
Naval History and Heritage Command	Robert Neyland
Norfolk Historical Society	Peggy McPhillips
City of Portsmouth, Virginia	Kenneth Wright, Mayor Elizabeth Psimas, Vice Mayor William E. Moody, City Council Paige D. Cherry, City Council Curtis E. Edmonds, Sr., City Council Danny W. Meeks, City Council Mark M. Whitaker, City Council Robert Baldwin
City or Norfolk, Virginia	Paul Fraim, Mayor Mamie Johnson, City Council Andrew Protogyrou, City Council Theresa Whibley, City Council Paul Riddick, City Council Thomas Smigiel, Jr., City Council Barclay Winn, City Council Angelia Williams Graves, City Council Len Newcomb, Susan McBride, Lee Perkins, Marcus D. Jones, Lori Crouch
City of Chesapeake, Virginia	Diane Kaufman, Jay Tate, Wanda Barnard-Bailey, Michael Barber, David Jurgens, Andrew Fox, Lennie Luke, Curtis Byrd, Steven Wright
City of Hampton, Virginia	George E. Wallace, Mayor Linda Curtis, Vice Mayor W.H. Hobbs, City Council Will Moffett, City Council Teresa Schmidt, City Council Chris Osby Snead, City Council Donnie Tuck, City Council Keith Cannady
City of Newport News, Virginia	City Council (General) McKinley Price, Mayor Everett Skipper, Louis Bott Sheila McCallister
Chesapeake Bay Foundation	Christy Everett
Elizabeth River Project	Marjorie Mayfield Jackson Joe Rieger

Agency/Government	Name of Contact People
Wetlands Watch	Skip Stiles
Environmental Protection Agency	Barbara Rudnick, Nora Theodore
Maritime History	David Howe
State of Virginia	Scott Rigell, U.S. Congressmen, District 2 Bobby Scott, U.S. Congressmen, District 3 Randy Forbes, U.S. Congressmen, District 4 Hayes Framme, Secretary of Commerce and Trade Russ Baxter, Secretary of Natural Resources Erin Carter
City of Virginia Beach, Virginia	Mark Reed
Chesapeake Beach City League	Bruce Johnson
Center For Biological Diversity	Nicholas Whipps, Catherine Kilduff
Virginia Department of Mines, Minerals, and Energy	Al Christopher
Chesapeake Bay Bridge Tunnel District	Mike Crist
Norfolk's Environmental Commission	KNB@norfolk.gov
Friends of Norfolk's Environment	foneonline@gmail.com

Companies	Name of Contact People
Altria	George Adams
TowneBank/Towne Insurance	Judy Barrett
Ramsay Agencies	Jeffrey Bennett
STIHL, Incorporated	R. Murray Bishop
Atlantic Intermodal Services, LLC	Frank Borum
Independent Consultant	Frank Bouchard
CP&O LLC	George Brown
MeadWestvaco	Kevin Bulman, Artemas Leslie
Livingston International	Katie Carney
COSCO Container Lines Americas, Inc.	Billie Chester
Vandeventer Black LLP	Mark Coberly
Virginia Pilot Association	J. William Cofer

Companies	Name of Contact People
CV International, Inc.	Michael W. Coleman
"K" Line America, Inc.	Homer C. Crane, Jr.
Crofton Construction Services	Kenny Crofton
Cita Shipping Agency	Vladimir Cruz
Kinder Morgan Terminals - Mid Atlantic Region	Joseph DeMatteo
JAD Maritime Consulting	Joseph. A. Dorto
McAllister Towing of Virginia, Inc.	William R. Douglas
Turkon America, Inc.	Rick Downing
Mediterranean Shipping Co. (USA)	Kevin Durrenberger
NYK Line (North America), Inc.	Louis Ferrer
Ace Hardware Corporation	Scott A. Flanders
Willcox & Savage, P.C.	Leonard Fleisig
BWF Port Logistics LLC	Bill Franks
Hampton Roads Shipping Association	Roger J. Giesinger
Colonna's Shipyard, Inc.	Thomas W. Godfrey, Jr.
Inchcape Shipping Services	Steve Hagen
Wallenius Wilhelmsen Logistics America, LLC	Cindy Harris
Norfolk Southern Corporation	Jeffrey S. Heller
Givens Logistics, LC	Keith Helton
MOL America, Inc.	Ted Holt
T. Parker Host, Inc.	Thomas P. Host, III
Branscome, Inc.	W. Dewey Hurley
CMA CGM (America) LLC	Brian Jeffreys
Norton Lilly International	Frank A. Johnson, Jr.
Evergreen Shipping Agency (America) Corporation	Andersen Kao
Newport News Shipbuilding	Robert Kelso
Virginia Maritime Association	Janice Klasek, Asley McLeod, Arthur Moye, David White, Susan Wisniewski
Massimo Zanetti Beverage USA	John Kobus

Companies	Name of Contact People
Marfret USA Inc. Marfret Lines	JoAnne Latham
LBH USA dba Celtic Int'l Shipping Agency LLC	Don Maney
Universal Leaf Tobacco Co., Inc.	Mark Mantiply
Target	Barrett Miller
Hapag-Lloyd (America), Inc.	Ramond A. Newlon
Hasler Group	Carl D. Parker, III
Lumber Liquidators Services	Holly Pearce
Artemus Transportation Solutions	Steve Pniewski
Hooker Furniture Corp.	Scott Prillaman
CSX Transportation	Bryan Rhode
Gilco Properties t/a Gilco Trucking, Inc.	Shirley G. Roebuck
Anders Williams Ship Agency	Scott Schubart
T. Parker Host, Inc.	Bobby Scott
Top Guard Security	Christopher G. Stuart
The Suarez Firm	Evelyn M. Suarez
Maersk Line	Kevin Thompson
Svenson Environmental	Nick Tompkins
Host Terminals, Inc.	Cees van de Mortel
Moran Towing Corporation	Mark Vanty
Maritime Pilotage Consultant	George E. Watkins
Bay Diesel Corporation	Scott Wheeler
Anders Williams Ship Agency	Rolf A. Williams
CBRE Hampton Roads	Lang Williams
Stanley Furniture Company	Stephen Wolfe
Atlantic Container Line	Dave Wooley
Norfolk Southern Corporation	Jeffrey Yates

10 RECOMMENDATIONS

I concur with the findings presented in this report. The Recommended Plan developed is technically sound, economically justified, and socially and environmentally acceptable.

I recommend that the existing deep-draft navigation project at Norfolk Harbor be modified to provide for implementation of a Federal project for deeper draft vessels in accordance with the recommended plan selected herein, with such further modifications thereto as in the discretion of the Chief of Engineers, may be advisable. Based on a review of existing data and coordination with Federal, state, and local agencies, there is no environmental mitigation required for construction of the Recommended Plan. The relocation of aids to navigation would be provided at 100% Federal cost. For the purpose of calculating the Section 902 limit, the estimated first cost of the project is $271,822,000 including an estimated Federal share of $131,381,000 and an estimated non-Federal share of 140,441,000. The average annual costs are $18,080,000. Average annual benefits are $96,500,000 with a benefit to cost ratio of 5.3.

The Recommended Plan conforms to the essential elements of the U.S. Water Resources Council's Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies and complies with other Administration and legislative policies and guidelines on project development. If the project were to receive funds for Federal implementation, it would be implemented subject to the cost sharing, financing, and other applicable requirements of Federal law and policy for navigation projects including WRDA 1986, as amended; and would be implemented with such modifications, as the Chief of Engineers deems advisable within his discretionary authority. Aids to navigation are to be funded by the U.S. Coast Guard. Federal implementation of the recommended project would be subject to the non-Federal sponsor agreeing to comply with Federal laws and policies, including but not limited to:

Provide, during the periods of design and construction, funds necessary to make its total contribution for commercial navigation equal to:

- 50 percent of the cost of design and construction of the general navigation features (GNFs) and mitigation (including mitigation LERR);

Provide all lands, easements, rights-of-way, relocations, and disposal areas (LERRs), including those necessary for the borrowing of material and the disposal of dredged or excavated material, and perform or assure the performance of all relocations, including utility relocations, all as determined by the Federal government to be necessary for the construction or operation and maintenance of the GNFs. Provide and maintain during the authorized life of the project the mitigation lands determined required for mitigation due to wetland impacts for the project.

Pay with interest, over a period not to exceed 30 years following completion of the period of construction of the GNFs, an additional amount equal to 10 percent of the total cost of construction of the GNFs less the amount of credit afforded by the Government for the value of the LERR is provided by the sponsor for the GNFs. If the amount of credit afforded by the Government for the value of LERR, and relocations, including utility relocations, provided by the sponsor equals or exceeds 10 percent of the total cost of construction of the GNFs, the sponsor shall not be required to make any contribution under this paragraph, nor shall it be entitled to any refund for the value of LERR and relocations, including utility relocations, in excess of 10 percent of the total cost of construction of the GNFs.

Provide 50 percent of the excess cost of operation and maintenance of the project over that cost which the Secretary determines would be incurred for operation and maintenance if the project had a depth of 50 feet;

Prevent obstructions or encroachments on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) such as any new developments on project lands, easements, and rights-of-way or the addition of facilities which might reduce the outputs produced by the project, hinder operation and maintenance of the project, or interfere with the project's proper function;

Provide, operate, and maintain, at no cost to the Government, the local service facilities in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and state laws and regulations and any specific directions prescribed by the Federal government.

Accomplish all removals determined necessary by the Federal government other than those removals specifically assigned to the Federal government;

Give the Federal government a right to enter, at reasonable times and in a reasonable manner, upon property that the Sponsor owns or controls for access to the project for the purpose of completing, inspecting, operating and maintaining the GNFs.

Hold and save the United States free from all damages arising from the construction or operation and maintenance of the project, any betterments, and the local service facilities, except for damages due to the fault or negligence of the United States or its contractors.

Keep, and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project, for a minimum of 3 years after completion of the accounting for which such books, records, documents, and other evidence are required, to the extent and in such detail as will properly reflect total cost of the project, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and local governments at 32 CFR, Section 33.20.

Perform, or ensure performance of, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 USC 9601–9675, that may exist in, on, or under LERR that the Federal government determines to be necessary for the construction or operation and maintenance of the GNFs. However, for lands, easements, or rights-of-way that the Government determines to be subject to the navigation servitude, only the Government shall perform such investigations unless the Federal government provides the sponsor with prior specific written direction, in which case the sponsor shall perform such investigations in accordance with such written direction.

Assume complete financial responsibility, as between the Federal government and the sponsor, for all necessary cleanup and response costs of any hazardous substances regulated under

CERCLA that are located in, on, or under LERR that the Federal government determined to be necessary for the construction or operation and maintenance of the project.

Agree, as between the Federal Government and the non-Federal Sponsor, that the non-Federal Sponsor shall be considered the operator of the local service facilities for the purpose of CERCLA liability.

To the maximum extent practicable, perform its obligations in a manner that will not cause liability to arise under CERCLA.

Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended, (42U.S.C. 1962d-5b) and Section 101(e) of the WRDA 86, Public Law 99-662, as amended, (33 U.S.C. 2211(e)) which provide that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until the sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element.

Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended, (42 U.S.C. 4601-4655) and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way necessary for construction, operation, and maintenance of the project including those necessary for relocations, the borrowing of material, or the disposal of dredged or excavated material; and inform all affected persons of applicable benefits, policies, and procedures in connection with said act.

Comply with all applicable Federal and state laws and regulations, including, but not limited to: Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d), and Department of Defense Directive 5500.11 issued pursuant thereto; Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army"; and all applicable Federal labor standards requirements including, but not limited to, 40 U.S.C. 3141-3148 and 40 U.S.C. 3701-3708 (revising, codifying and enacting without substantive change the provisions of the Davis-Bacon Act (formerly 40 U.S.C. 276a et seq.), the Contract Work Hours and Safety Standards Act (formerly 40 U.S.C. 327 et seq.), and the Copeland Anti-Kickback Act (formerly 40 U.S.C. 276c)).

Provide the non-Federal share of that portion of the costs of mitigation and data recovery activities associated with historic preservation, that are in excess of 1 percent of the total amount authorized to be appropriated for the project.

Not use funds from other Federal programs, including any non-Federal contribution required as a matching share therefore, to meet any of the sponsor's obligations for the project unless the Federal agency providing the Federal portion of such funds verifies in writing that such funds are authorized to be used to carry out the project.

The recommendations contained herein reflect the information available at this time and current departmental policies governing formulation of individual projects. It does not reflect program and budgeting priorities inherent in the formulation of a national civil works construction program or the perspective of higher review levels within the executive branch. Consequently, the recommendation may be modified before it is transmitted to the Congress as a proposal for authorization and implementation funding. However, prior to transmittal to the Congress, the State of Virginia, the Virginia Port Authority (the non-Federal Sponsor), interested Federal agencies, and other parties will be advised of any significant modifications and will be afforded an opportunity to comment further.

Jason Kelly, PMP
Colonel, U. S. Army
District Commander

11 FINDING OF NO SIGNIFICANT IMPACT

FINDING OF NO SIGNIFICANT IMPACT

NORFOLK HARBOR NAVIGATION IMPROVEMENTS,

VIRGINIA

The U.S. Army Corps of Engineers, Norfolk District (Corps) has conducted an environmental analysis in accordance with the National Environmental Policy Act of 1969, as amended. The Final General Reevaluation Report/Environmental Assessment (GRR/EA) dated June 2018, for the Norfolk Harbor Navigation Improvements, Virginia Project addresses whether the authorized plan is still in the Federal interest and to evaluate measures which would improve the current and future operational efficiency of commercial vessels using the Norfolk Harbor in Virginia. The final recommendation is contained in the report of the Chief of Engineers, dated 29 June 2018.

The Final GRR/EA, incorporated herein by reference, evaluated various alternatives that would reasonably maximize the contribution that the Norfolk Harbor Navigation Improvements Project provides to National Economic Development (NED) that is consistent with protecting the environment. The Final GRR/EA addresses the physical constraints and inefficiencies in the existing navigation system's ability to safely and efficiently serve the forecasted vessel fleet and process the forecasted cargo volumes. Specific objectives for this study would be to reduce cargo transportation costs for the existing and future fleet over the period of analysis at Norfolk Harbor and to reduce navigation operational constraints caused by one-way traffic in certain reaches for the existing and future commercial fleet over the period of analysis at Norfolk Harbor.

The Preferred Alternative is the National Economic Development (NED) Plan which includes the following major components:

- Deepening the Atlantic Ocean Channel to a required depth of -59 feet;
- Deepening the Thimble Shoal Channel to a required depth of -56 feet;
- Deepening the Norfolk Harbor Channel to a required depth of -55 feet;
- Deepening the Norfolk Harbor Entrance Channel to a required depth of -55 feet;
- Deepening the Newport News Channel to a required depth of -55 feet;
- Widening the Thimble Shoal Channel east of the Chesapeake Bay Bridge Tunnel to 1,300 feet;
- Widening Anchorage F to 3,620 feet and associated modifications of the Approach Area;
- Deepening Anchorage F to a required depth of -51 feet;
- Reducing the 10 feet sand cover of the Chesapeake Bay Bridge Tunnel to five feet. The materials covering the tunnel would be sand or potentially sand and rock;
- Placing/disposing dredged material at the Dam Neck Ocean Disposal Site, the Norfolk Ocean Disposal Site, the Craney Island Dredged Material Management Area, and/or upland disposal sites for this project (if needed); and
- Conducting associated operation and maintenance activities.

In addition to a "no action" plan, five alternatives were evaluated.[5] The alternatives included:

Alternative Plan	Components
Alt 1	No Action
Alt 2	Segment 1+2 Deepening Plan + No widening
Alt 3	Segment 1+2 Deepening Plan + Widening Meeting Area 1
Alt 4	Segment 1+2 Deepening Plan + Widening Meeting Area 2
Alt 5	Segment 1+2 Deepening Plan + Widening Meeting Area 1 and 2
Alt 6	Segment 1+2 Deepening Plan + Widening Plan + Anchorage F

A detailed description of the deepening and widening areas assessed, the focused array of alternatives, and a comparison of alternatives is provided in Chapter 4 of the Final GRR/EA. For all alternatives evaluated in detail, potential effects to the following resources were evaluated:

	In-depth evaluation conducted	Brief evaluation due to minor effects	Resource unaffected by action
Aesthetics	☐	☒	☐
Air quality	☐	☒	☐
Aquatic resources/wetlands	☒	☐	☐
Invasive species	☐	☐	☒
Fish and wildlife habitat	☒	☐	☐

[5] 40 CFR 1505.2(b) requires a summary of the alternatives considered.

Threatened/Endangered species	☒	☐	☐
Historic properties	☒	☐	☐
Floodplains	☒	☐	☐
Hazardous, toxic & radioactive waste	☐	☐	☒
Hydrology	☒	☐	☐
Land use	☐	☐	☒
Navigation	☒	☐	☐
Noise levels	☒	☐	☐
Public infrastructure	☐	☐	☒
Socio-economics	☒	☐	☐
Environmental justice	☐	☐	☒
Sediments	☒	☐	☐
Tribal trust resources	☐	☐	☒
Water quality	☒	☐	☐
Climate change	☒	☐	☐

All practical means to avoid or minimize adverse environmental effects were analyzed and incorporated into the Preferred Alternative. Best management practices (BMPs) as detailed in Chapter 7 of the Final GRR/EA would be implemented to minimize impacts. No natural resource compensatory mitigation would be required. The following avoidance and minimization practices would be implemented with the Action Alternative to the maximum, practical extent.

- Best management practices would be implemented during dredging to minimize disturbances to the environment. For example, agitation and operation of the cutterhead of a dredge would not begin until the cutterhead is in immediate contact with the substrate. A similar measure would be taken for hopper dredges. The dredge operator would not begin dredging until the draghead is in direct contact with the substrate. For both types of hydraulic dredges, this measure would reduce the intake of water, and the potential uptake and entrainment of eggs, larvae, juvenile, and adult fish species. By lowering the cutterhead/draghead to the bottom, before starting the agitation and suction of water and sediment, potential impacts and losses of fish species and sea turtle entrainment in the vicinity of the dredge would be minimized.

- To minimize air emissions associated with dredging vessels and dredge-related equipment, vessels and equipment would not be allowed to run idle and will be shut off to the extent practical when not in use.
- The National Marine Fisheries Service (NMFS) would be contacted three days prior to the commencement of any dredging operations to ensure all appropriate reporting forms would be used.
- To minimize entrainment during dredging operations Turtle Excluder Devices would be used on dragheads for hopper dredges. Turtle Exclusion Devises would create a sand wave in front of the draghead and would "roll" a resting sea turtle on the bottom off to the side and out of the path of the draghead.
- NMFS-approved observers would be present on all hopper dredges and perform 100% inspection of inflow and/or inspection of dragheads and turtle excluder devices when Munitions of Explosive Concern/Unexploded Ordinance (MEC/UXO) screens are utilized.
- All dredge operators would be trained on measures of dredge operation that would minimize the take of sea turtles. All personnel performing dredging operations will be notified of the potential presence of sea turtles and the need to avoid collisions with sea turtles. All personnel would be responsible for observing water-related activities for the presence of these species. All personnel shall be notified that there are civil and criminal penalties for harming, harassing, or killing listed or other protected species.
- If a sea turtle is observed within 100 yards (300 feet) of the active daily construction/dredging operation or vessel movement, all appropriate precautions shall be implemented to ensure its protection. These precautions would include cessation of operation of any moving equipment closer than 50 feet of a sea turtle. Operation of any mechanical construction equipment shall cease immediately if a sea turtle is observed within a 50-foot radius of the equipment. Activities would not resume until the sea turtle has departed the project area of its own volition.
- Any collision with and/or injury to a sea turtle shall be reported within 24 hours to the NMFS's Protected Resources Division.
- The Corps would ensure all appropriate measures are taken to protect any sea turtles or listed sturgeon that survive hopper dredging entrainment. Although most sea turtles would not likely survive entrainment in hopper dredges, if a sea turtle were to survive the entrainment, the guidelines and procedures for handling live sea turtles entrained in hopper dredges as outlined in 50 CFR 223.206(d)(1) would be followed.

- Sea turtle relocation trawling would be initiated following the take of two sea turtles in a 24-hour period or four turtles within a two month period.
- MEC/UXO screening devices shall be used on dredging equipment in locations with a potential threat of MEC/UXO detonation as defined by the Corps.
- Exposure to occupational health and safety hazards would be mitigated to the extent practical through adherence to an approved Work Safety Plan that incorporates standard work practices for handling contaminated sediments, screening/handling MEC/UXO, avoidance of slip and fall hazards, handling contaminated sediment, and wearing Personal Protective Equipment.

The GRR/EA, pursuant to Section 7 of the Endangered Species Act of 1973, as amended, was coordinated with the NMFS and U.S. Fish and Wildlife Service (FWS). The biological opinion that was issued by the NMFS, dated 5 October 2018, states the Preferred Alternative may affect, and is likely to adversely affect the following federally listed species: Atlantic sturgeon, green sea turtle, Kemp's ridley sea turtle, and loggerhead sea turtle. Per the NMFS Biological Opinion there would be no adverse effects to Atlantic Sturgeon Critical Habitat. Per the NMFS Biological Opinion, the Preferred Alternative may affect, but is not likely adversely affect the blue whale, fin whale, hawksbill sea turtle, leatherback sea turtle, north Atlantic right whale, sei whale, shortnose sturgeon, and sperm whale. Terms and conditions and reasonable and prudent alternatives and measures resulting from this consultation shall be implemented in order to minimize take of endangered species and avoid jeopardizing the species.

Pursuant to Section 7 of the Endangered Species Act of 1973, as amended, the Corps determined through coordination with the FWS the Preferred Alternative may affect, but is not likely to adversely affect, the piping plover, red knot, roseate tern, and West Indian manatee. The Preferred Alternative would have no effect on the red-cockaded woodpecker, northern long-eared bat, and Indiana bat. There would be no effect to sea turtles under the jurisdiction of the FWS as no nesting occurs in the Action Area.

Pursuant to Section 106 of the National Historic Preservation Act of 1966, as amended, a programmatic agreement was coordinated and signed by the Corps, Virginia Port Authority and the Virginia State Historic Preservation Officer in June 2017. Under the programmatic agreement the identification of historic properties would be completed and any adverse effects to historic properties would be mitigated. The design of the project would include no dredging or changes to navigation upriver of the Kinder Morgan Bulk Terminals (Newport News coal piers) and a buffer would be applied to protect two National Register of Historic Places listed sites; the wreck of the CSS Florida (44NN0072) and the USS Cumberland (44NN0073), which lie at depths of 51 feet and 56 feet, respectively, in the Newport News channel upriver of the coal piers.

Pursuant to the Clean Water Act of 1972, as amended, the discharge of dredged or fill material associated with the Preferred Alternative has been found to be compliant with section 404(b)(1) Guidelines (40 CFR 230). The Clean Water Act Section 404(b)(1) Guidelines evaluation is found in Appendix F of the GRR/EA.

A water quality certification pursuant to section 401 of the Clean Water Act was obtained from the Virginia Department of Environmental Quality through the Coastal Zone Management Act Federal Consistency Determination that was received on 10 January 2018. All conditions of the water quality certification shall be implemented in order to minimize adverse impacts to water quality.

A determination of consistency with the Virginia Coastal Zone Management Program pursuant to the Coastal Zone Management Act of 1972 was obtained from the Virginia Department of Environmental Quality. All conditions of the consistency determination, Appendix G in the Final GRR/EA, shall be implemented in order to minimize adverse impacts to the coastal zone.

Public review of the Draft GRR/EA was completed on 9 December 2018. All comments submitted during the public comment period were responded to in the Final GRR/EA. A 30-day state and agency review of the Final GRR/EA was completed on 11 June 2018. Comments from state and federal agency review did not result in any changes to the Final GRR/EA.

Technical, environmental, economic, and cost effectiveness criteria used in the formulation of alternative plans were those specified in the Water Resources Council's 1983 Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies. All applicable laws, executive orders, regulations, and local government plans were considered in evaluation of alternatives. Based on the Final GRR/EA, the reviews by other Federal, State and local agencies, Tribes, input of the public, and the review by my staff, it is my determination that the Preferred Alternative would not significantly affect the human environment; therefore, preparation of an Environmental Impact Statement is not required.

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Date	Patrick V. Kinsman, P.E. Colonel, Corps of Engineers District Commander

12 REFERENCES

Albright, Richard, 2013, Death of the Chesapeake: A History of the Military's Role in Polluting the Bay. Scrivener Publishing and John Wiley & Sons, Inc., Hoboken, NJ.

American National Standards Institute (ANSI/ASSE A10.15-1995 (R2011) Safety Requirements for Dredging

Anderson, Karl, 2016, USACE Dredging Safety Update, http://operations.usace.army.mil/nav/05junndc/Andersonsafety.pdf, accessed June 28, 2016

Armstrong, M.P., Musick, J.A., Colvoresses, J.A. 1992. Age, growth, and reproduction of the goosefish *Lophius Americanus* (Pices: Lophiiformes). U.S. Fish. Bull. 90, 217-230.

Aschettino, J. M., Engelhaupt, D., Engelhaupt, A., Richlen, M. 2017. Final mid-Atlantic humpback whale monitoring, Virginia Beach, Virginia: 2016/17 Annual Progress Report. Submitted by HDR, Virginia Beach, Virginia to Naval Facilities Engineering Command Atlantic.

Aschettino, J. M., Engelhaupt, D., Engelhaupt, A., Richlen, M. 2016. Mid-Atlantic humpback whale monitoring, Virginia Beach, Virginia: 2015/16 Annual Progress Report. Submitted by HDR, Virginia Beach, Virginia to Naval Facilities Engineering Command Atlantic.

Aschettino, J. M., Engelhaupt, D., Engelhaupt, A. 2015. Final mid-Atlantic humpback whale monitoring, Virginia Beach, Virginia: 2015/16 Annual Progress Report. Submitted by HDR, Virginia Beach, Virginia to Naval Facilities Engineering Command Atlantic.

Ballard, B. S., and W. Abbott. Osmotic accommodation in Callinectes sapidus Rathbun. 1969. Comparative Biochemistry and Physiology 29: 671–687.

Barco, S.B., Swingle, M. 2014. Marine mammal species likely to be encountered in the coastal waters of Virginia from analysis of stranding data. Prepared for the Virginia Department of Mines, Minerals, and Energy. Retrieved from http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0ahUKEwjL87763bWAhUIWCYKHf3qALgQFggoMAA&url=http%3A%2F%2Fwind.jmu.edu%2Foffshore%2Fvowda%2Fdocuments%2FVAQF_Scientific_Report_2014-07a_Marine%2520Mammals%2520.pdf&usg=AOvVaw0f_VXjD6D4y2L11nAmM0qN.

Bass, R. J., and J. W. Avault, Jr. 1975. Food habits, length-weight relationship, condition factor, and growth of juvenile red drum, Sciaenops ocellata, in Louisiana. Transactions of the American Fisheries Society 104: 35–45.

Blair, Clay, 1996, Hitler's U-Boat War: The Hunters 1939-1942, Modern Library, New York.

Boon, J.D., H.V. Wang, S.C. Kim, A.Y. Kuo, and G. M. Sisson. 1999. Three-Dimensional Hydrodynamic–Sedimentation Modeling Study: Hampton Roads Crossing, Lower James River, Virginia. A Report to the Virginia Department of Transportation. Virginia Institute of Marine Science. Special Report No. 354 in Applied Marine Science and Ocean Engineering. 36 pp. & Appendices.

Boon, John D., John M. Brubaker, and David R. Forrest. 2010. Chesapeake Bay Land Subsidence and Sea Level Change: An Evaluation of Past and Present Trends and Future Outlook. Virginia Institute of Marine Science for the U.S. Army Corps of

Engineers Norfolk District. Retrieved from: http://www.vims.edu/GreyLit/VIMS/sramsoe425.pdf.

Boysen, K.A. and J.J. Hoover. 2009. Swimming performance of juvenile white sturgeon (*Acipenser transmontanus*): training and the probability of entrainment due to dredging. J. Appl. Ichthyol. 25, Suppl. 2, 54–59.

Bratton, J.F., Colman, S.M., Thieler, E.R. and Seal, R.R., 2002. Birth of the modern Chesapeake Bay estuary between 7.4 and 8.2 ka and implications for global sea-level rise. Geo-Marine Letters, 22(4), pp.188-197.

Bureau of Labor Statistics, 2015, Employer-Reported Workplace Injuries and Illnesses – 2014, U.S. Department of Labor, Washington, D.C.

Burton, W., Weisberg, S., and P. Jacobson. 1992. Entrainment effects of maintenance hydraulic dredging in the Delaware River Estuary on Striped Bass Ichthyoplankton, report submitted to the Delaware Basin Fish and Wildlife Management Cooperative, Trenton, NJ, by Versar, Inc.

Byrne, R.J. 1993. Report of the Virginia Institute of Marine Science on Beneficial Uses of Dredged Materials in Hampton Roads, Virginia. To the Governor and the General Assembly of Virginia. House Document No. 16, Richmond, Virginia.

Calhoun, Gordon, James S. Schmidt, and Michael V. Taylor. 2007. The Loss of a U.S. Navy Frigate: Archaeological Investigations of USS *Cumberland* (44NN73). Department of the Navy, Naval Historical Center, Underwater Archaeology Branch, Washington Navy Yard, DC

Center for Climate Strategies (CSS). 2012. Preparation of Virginia Greenhouse Gas Reference Case Inventory and Forecast. Retrieved from: http://www.climatestrategies.us/library/library/view/956.

Central Dredging Association (CEDA). 2011. “Underwater sound in relation to dredging”. CEDA Position Paper, Prepared by the CEDA Working Group on Underwater Sound under the remit of the CEDA Environment Commission. Retrieved from www.dredgingtoday.org/news_details.asp.

Cerco, C.F. Kuo., A.Y. 1981. Real-Time Water Quality Model of the Elizabeth River System. Special Report No. 215 in Applied Marine Science and Ocean Engineering, Virginia Institute of Marine Science, School of Marine Science, College of William and Mary, Gloucester Point, Virginia. 104 pp.

Chesapeake Bay Bridge Tunnel (CBBT). 2016. Parallel Thimble Shoal Tunnel Overview website. Retrieved from: http://www.cbbt.com/whats-new/projects/parallel-thimble-tunnel-overview/.

Chesapeake Bay Foundation. 2015. Retrieved from http://www.chesapeakebay.net/discover/bayecosystem/plankton.

Chesapeake Bay Program (CBP). 2016a. Bay Benthic Habitat Integration. Retrieved from http://www.chesapeakebay.net/data/downloads/baywide_benthic_database.

Chesapeake Bay Program (CBP). 2016. Field Guide: Fish. Retrieved from http://www.chesapeakebay.net/fieldguide/categories/category/fish.

Chesapeake Bay Program (CBP). 2016. Retrieved from http://www.chesapeakebay.net/issues/issue/nutrients#inline.

Clarke, D.G., and D. H. Wilber. 2000. Assessment of potential impacts of dredging operations due to sediment resuspension. DOER Technical Notes Collection (ERDC TN-DOER-E9), U.S. Army Engineer Research and Development Center, Vicksburg, MS. Retrieved from www.wes.army.mil/el/dots/doer.

Clarke, D.G., Dickerson, C., and K. Reine. 2002. Characterization of underwater sounds produced by dredges. Dredging 2002, American Society of Civil Engineers, Orlando, Florida, USA, p 64-81.

College of William and Mary. 2006. Coastal Plain Province. Retrieved from http://web.wm.edu/geology/virginia/provinces/coastalplain/coastal_plain.html.

Commonwealth of Virginia. 2013. Hazard Mitigation Plan. VA Department of Emergency Management and the Virginia Tech Center for Geospatial Information Technology. Retrieved from http://www.vaemergency.gov/webfm_send/875/Section3-13-Earthquake.pdf

Conrad, C.F. and Chisholm-Brause, C.J., 2004. Spatial survey of trace metal contaminants in the sediments of the Elizabeth River, Virginia. Marine Pollution Bulletin, 49(4), pp.319-324.

Costlow, J. D., Jr., and C. G. Bookhout. 1959. The larval development of Callinectes sapidus Rathbun reared in the laboratory. Biological Bulletin (Woods Hole) 116: 373–396.

Cottrell Construction Corporation. 2015 Accident Prevention Plan, Norfolk Harbor & Craney Island Reaches & NIT, VA, contract W91236-15-C-0061

Council on Environmental Quality (CEQ). 2016. Final Guidance for Federal Departments and Agencies on Consideration of Greenhouse Gas Emissions and the Effects of Climate Change in National Environmental Policy Act Reviews. Retrieved from: https://www.whitehouse.gov/sites/whitehouse.gov/files/documents/nepa_final_ghg_guidance.pdf

Council on Environmental Quality (CEQ). 1997. Environmental Justice Guidance Under the National Environmental Policy Act. Executive Office of the President. Washington, D.C. Received from: http://www.energy.gov/sites/prod/files/nepapub/nepa_documents/RedDont/G-CEQ-EJGuidance.pdf.

Cowardin, LM, V Carter. 1979. Classification of Wetlands and Deepwater Habitats of the United States.

Davis, C. C. 1965. A study of the hatching process in aquatic invertebrates: XX. The blue crab, Callinectes sapidus, Rathbun, XXI. The nemerean, Carcinonemertes carcinophila (Kolliker). Chesapeake Science 6: 201–208.

Dauer, D. M. 2008. Benthic Biological Monitoring Program of the Elizabeth River Watershed 2007. Old Dominion University, Department of Biological Sciences.

DeVries, M. C., R. A. Tankersley, R. B. Forward, W. W. Kirby-Smith, and R. A. Luettich Jr. 1994. Abundance of estuarine crab larvae is associated with tidal hydrologic variables. Marine Biology 118: 403–413.

Diaz, R.J. 1994. Response of tidal freshwater macrobenthos to sediment disturbance. Hydrobiologia 278, 201-212. Virginia Institute of Marine Science. College of William and Mary. Gloucester Point, Virginia.

DiGuilio, R. T., Clark, B. W. 2015. The Elizabeth River Story: A Case Study in Evolutionary Toxicology. Journal of Toxicology and Environmental Health, 259-298. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4733656/.

EA Engineering, Science, and Technology Inc. 2011. Section 103 Report: Evaluation of Dredged Material Proposed for Ocean Placement. Midtown Tunnel/Downtown Tunnel/MLK Expressway. Prepared for U.S. Army Corps of Engineers Norfolk District.

EA Engineering, Science, and Technology, Inc. 2010a. Evaluation of Dredged Material Proposed for Ocean Placement Norfolk Harbor Channel Norfolk Harbor Reach and Craney Island Reach. Prepared for U.S. Army Corps of Engineers Norfolk District.

EA Engineering, Science, and Technology, Inc. 2010b. Norfolk Harbor Approach Channels: Atlantic Ocean Channel Final. Prepared for U.S. Army Corps of Engineers – Norfolk District.

EA Engineering, Science, and Technology, Inc. 2015a. Evaluation of Dredged Material Norfolk Harbor Approach Channels: Atlantic Ocean Channel. Prepared for U.S. Army Corps of Engineers Norfolk District.

EA Engineering, Science, and Technology, Inc. 2015b. Evaluation of Dredged Material: Norfolk Harbor Approach Channels, Thimble Shoal Channel. Prepared for U.S. Army Corps of Engineers Norfolk District.

EDAW, Inc. 2002. Draft: Environmental Impact Statement/ Environmental Impact Report for San Diego Harbor Deepening (Central Navigation Channel). Retrieved from https://books.google.com/books?id=gzc0AQAAMAAJandpg=RA1-PR99andlpg=RA1-PR99anddq=hopper+dredging+noise+levels+and+operating+statusandsource=blandots=7BwoshjhPeandsig=sHM04DvIP7KMVOSXaq6umcusMJoandhl=enandsa=Xandved=0ahUKEwi37Ny24P_NAhVPw2MKHT5TAtUQ6AEINjAE#v=snippetandq=Army%20Corpsandf=false.

Egerton, T.A., Marshall, H.G. 2014. Assessing Phytoplankton Composition, Abundance, and Biomass and HAB Relationships to Chlorophyll a of the James, Elizabeth and Lafayette Rivers: 2013 monitoring season. Data Report To Virginia Department of Environmental Quality. Retrieved from http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&ved=0ahUKEwih6qzL6u7NAhVW1GMKHQCYDsUQFggjMAE&url=http%3A%2F%2Fwww.deq.virginia.gov%2FPortals%2F0%2FDEQ%2FWater%2FWaterQualityStandards%2FJames%2520River%2520Chl%2520A%2520Study%2FSAP_Reports%2FPhyto_Characterization-Final%2520Report-ODU-2013.pdf&usg=AFQjCNFvKkMBU0AEHgIiOxd2fWvDp9Knxg&sig2=JCCc-fBQAkTxanV-d95xtQ&bvm=bv.126993452,d.cGc.

Elizabeth River Project (ERP). 2014. State of the River Report, 2014. Elizabeth River State of the River Steering Committee 2014, Convened by Virginia Department of Environmental Quality and The Elizabeth River Project. Retrieved from http://media.wix.com/ugd/8de0fd_6fd8647352d84f91a842eaf0c37da40a.pdf.

Engelhaupt, A., J. Aschettino, T.A. Jefferson, M. Richlen, and D. Engelhaupt. 2015. *Occurrence, Distribution, and Density of Marine Mammals Near Naval Station Norfolk & Virginia Beach, VA: Annual Progress Report. Final Report.* Prepared for U.S. Fleet Forces Command. Submitted to Naval Facilities Engineering Command Atlantic, Norfolk, Virginia, under Contract No. N62470-10-3011, Task Orders 031 and 043, issued to HDR Inc., Virginia Beach, Virginia. 07 August 2015.

Environmental Protection Agency (EPA). 2016. CERCLIS Search. Retrieved from https://www.epa.gov/enviro/cerclis-searchList of Superfund Sites.

EPA News Release. 2016, June 15. Construction Complete at JEB Little Creek Superfund Site. Retrieved from https://www.epa.gov/newsreleases/construction-completed-jeb-little-creek-superfund-site.

Epifanio, C. E. 1995. Transport of blue crab (Callinectes sapidus) larvae in the waters off Mid-Atlantic states. Bulletin of Marine Science 57: 713-725.

Epifanio, C. E. 2007. Biology of larvae. Pages 513–533 in V. S. Kennedy and L. E. Cronin, editors. The Blue Crab: Callinectes sapidus.

Epifanio, C. E., and R. W. Garvine. 2001. Larval transport on the Atlantic continental shelf of North America: a review. Estuarine Coastal And Shelf Science 52: 51–77.

Epifanio, C. E., A. K. Masse, and R. W. Garvine. 1989. Transport of blue crab larvae by surface currents off Delaware Bay, USA. Marine Ecology Progress Series 54:35–41.

Epifanio, C. E., C. C. Valenti, and A. E. Pembroke. 1984. Dispersal and recruitment of blue crab larvae in Delaware Bay, U.S.A. Estuarine, Coastal and Shelf Science 18: 1-12.

Etherington, L. L., and D. B. Eggleston. 2000. Large-scale blue crab recruitment: linking postlarval transport, post-settlement planktonic dispersal, and multiple nursery habitats. Marine Ecology Progress Series 204: 179–198.

Executive Office of the President (Executive Order). 1994. Federal Actions to Address Environmental Justice in Minority Population and Low-Income Populations. Executive Order 12898, 59 Fed. Reg. 7629. Received from: https://www.archives.gov/Federal-register/executive-orders/pdf/12898.pdf.

Farcas, A., P.M. Thompson, and N.D. Merchant. 2016. Underwater Noise Modelling for Environmental Impact Assessment. Environmental Impact Assessment Review 57, 114-122.

Federal Highway Administration (FHA). 2001. Hampton Roads Crossing Study, Final Environmental Impact Statement. Virginia Department of Transportation. Retrieved from: http://www.vdot.virginia.gov/projects/resources/studyhro-crossing-feis.pdf

Federal Highway Administration (FHA). 2014. U.S. Route 460 Draft Supplemental Environmental Impact Statement and Draft Section 4(F) Evaluation.

Fort Monroe Authority (FMA). 2011. Historic Preservation Manual and Design Standards. Retrieved from: http://www.fmauthority.com/wp-content/uploads/Design-Standards-Aug2011_Volume1_compressed.pdf

Forward, R. B., Jr, J. Swanson, and R. Tankersely. 1997. Endogenous swimming rhythms of blue crab, Callinectes sapidus, megalopae: effects of offshore and estuarine cues. Marine Biology 127: 621–628.

Forward, R. B., Jr, R. A. Tankersley, and J. M. Welch. 2003. Selective tidal-stream transport of the blue crab Callinectes sapidus: an overview. Bulletin of Marine Science 72: 347–365.

Frye, Keith. 1986. Roadside Geology of Virginia. Mountain Press Publishing Company, Missoula, MT.

Goodrich, D.M., 1988. On meteorologically induced flushing in three US east coast estuaries. Estuarine and Coast Shelf. Science 26, 11–121.

Guerin, J. L., and W. B. Stickle. 1992. Effects of salinity gradients on the tolerance and bioenergetics of juvenile blue crabs (Callinectes sapidus) from waters of different environmental salinities. Marine Biology 114: 391–396.

Guillory, V., and P. Prejean. 2001. Red drum predation on blue crabs. In Proceedings of the Blue Crab Mortality Symposium, Gulf States Marine Fisheries Commission, Ocean Springs, Mississippi. Foodweb—References (pp. 93-104).

Gregory, R.S., and T.G. Northcote. 1993. Surface, planktonic, and benthic foraging by juvenile Chinook salmon (*Oncorhynchus tshawytscha*) in turbid laboratory conditions. Canadian Journal of Fisheries and Aquatic Sciences 50, 233-240.

Hampton Roads Planning District Commission (HRPDC). 2011. Climate Change in Hampton Roads Phase II: Storm Surge Vulnerability and Public Outreach. Retrieved from: http://www.deq.virginia.gov/portals/0/deq/coastalzonemanagement/task12-04-09.pdf.

Hampton Roads Planning District Commission (HRPDC). 2012. Climate Change in Hampton Roads: Phase III: Sea Level Rise. Retrieved from: http://www.hrpdcva.gov/news/article/july/01/2012/climate-change-in-hampton-roads:phase-iii-sea-level-rise-in-hampton-roads.

Hampton Roads Planning District Commission (HRPDC). 2013. Coastal Resiliency: Adapting to Climate Change in Hampton Roads. Retrieved from: http://www.hrpdcva.gov/uploads/docs/07182013-PDC-E9I.pdf.

Hampton Roads Planning District Commission (HPRDC). 2014. Hampton Roads Regional Benchmarking Study, 9th Edition. Retrieved from: http://www.hrpdcva.gov/uploads/docs/Hampton%20Roads%20Benchmarking%20Study%202014.pdf.

Hampton Roads Planning District Commission (HRPDC). 2015. Hampton Roads Regional Benchmarking Study, 10th Edition. Retrieved from: http://www.hrpdcva.gov/uploads/docs/Hampton%20Roads%20Benchmarking%20Study%202015.pdf

Hampton Roads Planning District Commission. 2011. Southside Hampton Roads Hazard Mitigation Plan. Retrieved from http://www.hrpdcva.gov/uploads/docs/2011%20Southside%20HR%20Hazard%20Mitigation%20Plan.pdf.

Hampton Roads Transportation Planning Organization (HRTPO). 2011. Hampton Roads Regional Land Use Map. Retrieved from: http://www.hrpdcva.gov/uploads/docs/Hampton%20Roads%20Regional%20Land%20Use%20Map%20Report.pdf.

Hampton Roads Transportation Planning Organization (HRTPO). 2012. Hampton Roads Regional Freight Study: 2012 Update. Retrieved from: http://www.hrtpo.org/uploads/t12_12.pdf

Hampton Roads Transportation Planning Organization (HRTPO). 2013. Hampton Roads Military Transportation Needs Study: Roadways Serving the Military and Sea Level Rise/Storm Surge. Retrieved from: http://www.hrtpo.org/uploads/docs/Roadways%20Serving%20the%20Military%20&%20Sea%20Level%20Rise-Storm%20Surge%20Report.pdf.

Hampton Roads Transportation Planning Organization (HRTPO). 2013. Existing and Future Truck Delay in Hampton Roads. Retrieved from: http://www.hrtpo.org/uploads/docs/Existing%20and%20Future%20Truck%20Delay%20in%20HR%20DRAFT%20Report.pdf

Hampton Roads Transportation Planning Organization (HRTPO). 2014. Positioning Hampton Roads for Freight Infrastructure Funding, MAP-21 and Beyond. Retrieved from: http://hrtpo.org/uploads/docs/Positioning%20HR%20for%20Freight%20Infrastructure%20Funding%20-%20Final%20Report.pdf

Hampton Roads Transportation Planning Organization (HRTPO). 2015a. Volumes, Speeds, and Congestion on Major Roadways in Hampton Roads. Retrieved from: http://www.hrtpo.org/uploads/docs/CMP%20Volumes%20and%20Speeds%202014%20-%20Final%20Report.pdf

Hampton Roads Transportation Planning Organization (HRTPO). 2015b. State of Transportation in Hampton Roads 2015. Retrieved from: http://www.hrtpo.org/uploads/docs/State%20of%20Transportation%202015%20Final%20Report.pdf

Harbor Seal (*Phoca vitulina). Retrieved from http://www.fisheries.noaa.gov/pr/species/mammals/seals/harbor-seal.html.*National Oceanic and Atmospheric Administration, National Marine Fisheries Service. 2016m. Bottlenose Dolphin (*Tursiops truncatus). Retrieved from http://www.fisheries.noaa.gov/pr/species/mammals/dolphins/bottlenose-dolphin.html.*

Hoover, J.J., Killgore, K.J., Clarke, D.G., Smith, H., Turnage, A., and Beard, J. 2005. Paddlefish and sturgeon entrainment by dredges: Swimming performance as an indicator of risk. DOER Technical Notes Collection (ERDC-TN-DOER-E22), U.S. Army Engineer Research and Development Center, Vicksburg, MS.

IAN Press. 2015. Chesapeake Bay – Indicator Details: Chlorophyll a. Retrieved from http://ian.umces.edu/ecocheck/report-cards/chesapeake-bay/2013/indicators/chlorophyll_a/.

Inkley, Doug, PhD. 2013, June 18. Shifting Skies: Migratory Birds in a Warming World Urgent Action Needed to Protect Birds and their Habitats. National Wildlife Federation. Retrieved from: http://www.nwf.org/News-and-Magazines/Media-Center/Reports/Archive/2013/06-18-13-Migratory-Birds-in-a-Warming-World.aspx.

Intergovernmental Panel on Climate Change (IPCC). 2014. Climate Change 2014 Synthesis Report. Retrieved from: http://www.ipcc.ch/pdf/assessment-report/ar5/syr/AR5_SYR_FINAL_All_Topics.pdf.

Intergovernmental Panel on Climate Change. 2014. Climate Change 2014 Synthesis Report. Retrieved from http://www.ipcc.ch/pdf/assessmentreport/ar5/syr/AR5_SYR_FINAL_All_Topics.pdf.

Jaworski, E. 1972. The blue crab fishery, Barataria Estuary, Louisiana. Louisiana State University, Sea Grant Publication. LSU-SG-72-01. 112 p.

Jensen, A.S. and G.K. Silber. 2003. Large Whale Ship Strike Database. U.S. Department ofCommerce, NOAA Technical Memorandum. NMFS-OPR- , 37 pp.

Johnston, S.A. 1981. Estuarine dredge and fill activities: A Review of Impacts. Journal of Environmental Management Vol. 5, No. 5, pp. 427-440.

Jones, C. M., J. R. McConaugha, P. J. Greer, and M. H. Prager. 1990. Estimates of spawning size of blue crab, Callinectes sapidus, in Chesapeake Bay, 1986-1987. Bulletin of Marine Science 46: 159-169.

Kasumyan, A. O. 2005. Structure and Function of the Auditory System in Fishes. Journal of Ichthyology, 45(2), S223-S270.

Klauda, R.J., Fischer, L.W., Hall, Jr. L.W. and Sullivan J.A. 1991a. Alewife and Blueback Herring. In: S.L. Funderburk, S.J. Jordan, J.A. Mibursky, and D. Riley, eds., Habitat Requirements for Chesapeake Bay Living Resources, Second Edition. Habitat Objectives Workgroup, Living Resources Subcommittee, Chesapeake Research Consortium, Inc., Solomons, Maryland.

Klauda, R.J., Fischer, L.W., Hall, Jr. L.W. and Sullivan J.A. 1991b. American Shad and Hickory Shad. In: S.L. Funderburk, S.J. Jordan, J.A. Mibursky, and D. Riley, eds., Habitat Requirements for Chesapeake Bay Living Resources, Second Edition. Habitat Objectives Workgroup, Living Resources Subcommittee, Chesapeake Research Consortium, Inc., Solomons, Maryland.

Lafayette River Oyster Working Group, 2016. Lafayette Restoration Planning Working Papers on Existing Oyster Resources in the Lafayette River.

Larson, K., and C. Moehl. 1990. Fish entrainment by dredges in Grays Harbor, Washington. Effects of dredging on anadromous Pacific Coast fishes. CA Simenstad, ed., Washington Sea Grant Program, University of Washington, Seattle 102-12.

Liu Z., Wang H. and Ye F. 2017. Incorporating Sea Level Change Scenarios into Norfolk Harbor Channels Deepening and Elizabeth River Southern Branch ,Navigation Improvements Study, Final Report. Virginia Institute of Marine Science, Special Report No. 457 In Applied Marine Science and Ocean Engineering. DOJ:10.21220/V5BX49.

Mann, R. and Southworth M. 2015. The Status of Virginia's Public Oyster Resource 2015. Retrieved from http://www.vims.edu/research/units/labgroups/molluscan_ecology/_docs/2015annualreport_03082016.pdf.

Mann, R. Harding, J., Southworth, M., and Wesson, J. 2005. Northern Quahog (Hard Clam) Mercenaria Mercenaria Abundance And Habitat Use In Chesapeake Bay. Journal of Shellfish Research 24(2):509-516.

Manooch, C. S., III. 1973. Food habits of yearling and adult striped bass, Morone saxatilis (Walbaum),from Albemarle Sound, North Carolina. Chesapeake Science 14: 73–86.

Mayfield, D. 2016, February 21. Shyly but surely, harbor seals have warmed up to Virginia waters. Virginian Pilot. Retrieved from: http://pilotonline.com/news/local/environment/shyly-but-surely-harbor-seals-have-warmed-up-to-virginia/article_bb204a4b-07cd-5f36-9fb9-21d90a56c872.html.

McCauley, J.E., Parr, R.A., and D.R. Hancock. 1977. Benthic infauna and maintenance dredging: A case study. Water Research. Vol. 11, pp. 233-242.

McConaugha, J. R. 1988. Export and reinvasion of larvae as regulators of estuarine decapod populations. American Fisheries Society Symposium 3: 90–103.

McConaugha, J. R., D. F. Johnson, A. J. Provenzano, and R. C. Maris. 1983. Seasonal distribution of larvae of Callinectes sapidus (Crustacea: Decopoda) in the waters adjacent to Chesapeake Bay. Journal of Crustacean Biology 3: 582-591.

McCormick, S.D., Shrimpton, J.M., Carey, J.B., O'Dea, M.F., Sloan, K.E., Moriyama, S., Bjornsson, B. Th. 1998. Repeated acute stress reduces the growth rate of Atlantic salmon parr and alters plasma levels of growth hormone, inulin-like growth factor I and cortisol. Aquaculture 186, 221-235.

McGovern, Terrance, 2008, The Coastal Defenses of Chesapeake Bay During World War Two. Fort Volume 36. NOAA.

Metcalf, K S, and R. N. Lipcius. 1992. Relationship of habitat and spatial scale physiological state and settlement of blue crab postlarvae in Chesapeake Bay. Marine Ecology Progress Series 82: 143–150.

Millikin, M. R, and A. B. Williams. 1984. Synopsis of biological data on the blue crab Callinectes sapidus Rathbun. NOAA. NOAA Technical Report.

Moser, M.L. and S.W. Ross. 1995. Habitat use and Movements of Shortnose and AtlanticSturgeons in the Lower Cape Fear River, North Carolina. Transactions of the AmericanFisheries Society 124:225-234.

Najjar, R.G., Pyke, C.R., Adams, M.B., Breitburg, D., Hershner, C., Kemp, M., Howarth, R., Mulholland, M. R., Paolisso, M., Secor, D., Sellner, K., Wardrop, D., Wood, R. 2010. Potential climate-change impacts on the Chesapeake Bay. Estuarine, Coastal and Shelf Science 86, 1-20.

National Land Cover Database, accessed through CorpsMap.

National Oceanic and Atmospheric Administration, National Marine Fisheries Service. 2016. Guide to Essential Fish Habitat Designations in the Northeastern United States. Retrieved from https://www.greateratlantic.fisheries.noaa.gov/hcd/STATES4/DelaNJ.htm.

National Oceanic and Atmospheric Administration, National Marine Fisheries Service. 2016a. Atlantic Sturgeon Recovery Program. Retrieved from http://www.greateratlantic.fisheries.noaa.gov/protected/atlsturgeon/index.html.

National Oceanic and Atmospheric Administration, National Marine Fisheries Service. 2016b. Blue Whale (Balaenoptera musculus) Retrieved from http://www.fisheries.noaa.gov/pr/species/mammals/whales/blue-whale.html.

National Oceanic and Atmospheric Administration, National Marine Fisheries Service. 2016c. Humpback Whale (*Megaptera novaeangliae*). 2016 (May). Retrieved from http://www.nmfs.noaa.gov/pr/species/mammals/whales/humpback-whale.html.

National Oceanic and Atmospheric Administration, National Marine Fisheries Service. 2016d. Loggerhead Turtle (*Caretta caretta*). Retrieved from http://www.nmfs.noaa.gov/pr/species/turtles/loggerhead.html.

National Oceanic and Atmospheric Administration, National Marine Fisheries Service. 2016e. North Atlantic Right Whales (*Eubalaena glacialis*). 2016. Retrieved from http://www.nmfs.noaa.gov/pr/species/mammals/whales/north-atlantic-right-whale.html.

National Oceanic and Atmospheric Administration, National Marine Fisheries Service. 2016f. North Atlantic Right Whale (*Eubalaena glacialis*) Western Atlantic Stock. 2016 (May). Retrieved from http://www.nmfs.noaa.gov/pr/sars/species.htm#largewhales.

National Oceanic and Atmospheric Administration, National Marine Fisheries Service. 2016g. Sea Turtle Program Managing, conserving, and rebuilding populations of sea turtles in the Greater Atlantic waters. Retrieved from http://www.greateratlantic.fisheries.noaa.gov/Protected/seaturtles/.

National Oceanic and Atmospheric Administration, National Marine Fisheries Service. 2016h. Sei Whale (*Balaenoptera borealis*). 2016. Retrieved from: http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/seiwhale.htm.

National Oceanic and Atmospheric Administration, National Marine Fisheries Service. 2016i. Shortnose Sturgeon (*Acipenser brevirostrum).* Retrieved from http://www.fisheries.noaa.gov/pr/species/fish/shortnose-sturgeon.html.

National Oceanic and Atmospheric Administration, National Marine Fisheries Service. 2016j. Sperm Whale (*Physeter macrocephalus*). Retrieved from http://www.fisheries.noaa.gov/pr/species/mammals/whales/sperm-whale.html.

National Oceanic and Atmospheric Administration, National Marine Fisheries Service. 2016k. Harbor Porpoise (*Phocoena). Retrieved fro*m http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/harborporpoise.htm

National Oceanic and Atmospheric Administration, National Marine Fisheries Service. 2016l.

National Oceanic and Atmospheric Administration, National Marine Fisheries Service. 2014. Minke Whale (*Balaenoptera acutorostrata*). Retrieved from http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/minkewhale.htm.

National Oceanic and Atmospheric Administration, National Marine Fisheries Service. 2013. Fin Whale (*Balaenoptera physalus*). Retrieved from http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/finwhale.htm.

National Oceanic and Atmospheric Administration, National Marine Fisheries Service. 2012. Endangered Species Act Biological Opinion: Maintenance of Chesapeake Bay Entrance Channels and use of sand borrow areas for beach nourishment. Dated 16 November 2012.

National Oceanic and Atmospheric Administration, National Marine Fisheries Service. 1998. Final Recovery Plan for the Shortnose Sturgeon (*Acipenser brevirostrum)*. Retrieved from http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=8&ved=0ahUKEwiiy

qXZw_HOAhXI5SYKHbaQBcUQFghBMAc&url=http%3A%2F%2Fwww.nmfs.noaa.gov%2Fpr%2Fpdfs%2Frecovery%2Fsturgeon_shortnose.pdf&usg=AFQjCNEWRZl6lcm2tkbZdvavxzMbvPYDAA&sig2=j5FXDsDXngzIxWyn7unnOQ&bvm=bv.131783435,d.eWE.

National Park Service (NPS). 2015. Foundation Document, Fort Monroe National Monument, Virginia. U.S. Department of the Interior. Retrieved from: https://www.nps.gov/fomr/learn/management/upload/FOMR_FD_2015.pdf

National Wildlife Foundation. 2016. Chesapeake Bay. Retrieved from http://www.nwf.org/Wildlife/Wild-Places/Chesapeake-Bay.aspx.

Neilson B. N., Fang., C.S. 1975. A Hydrographical and Water Quality Study During the Construction of Second Hampton Roads Bridge-Tunnel. A Report to the Virginia Department of Highways. Virginia Institute of Marine Science, The College of William and Mary, Gloucester Point, Virginia.

Nichols, M. M., Howard-Strobel, M. M. 1991. Evolution of an urban estuarine harbor: Norfolk, Virginia. Journal of Coastal Research, 745-757.

Nichols, T.A., Anderson, T.W., and Sirovic, A. 2015. Intermittent Noise Induces Physiological Stress in a Coastal Marine Fish. PLoS One 10(9) 1-13.

Nightingale, B. and C.A. Simenstad. 2001. Dredging Activities: Marine Issues. Washington State Transportation Center (TRAC). White Paper, Research Project T1803, Task 35. University of Washington, Seattle. Retrieved from: http://www.wsdot.wa.gov/research/reports/fullreports/507.1.pdf

NOAA Sea Level Rise Maps, 0-6 feet MHHL, as incorporated into CorpsMap GIS database. Retrieved from www.csc.noaa/gov/slr.

Occupational Safety & Health Administration (OSHA). 2016. General Industry Noise Exposure Standard, App. II:A. Retrieved from: https://www.osha.gov/dts/osta/otm/noise/standards_more.html.

Overstreet, R. M., and R. W. Heard. 1978a. Food of the red drum, Sciaenops ocellata, from Mississippi Sound. Gulf Research Report 6: 131–135.

Overstreet, R. M., and R. W. Heard.1978b. Food of the Atlantic croaker, Micropogonias undulates, from Mississippi Sound and the Gulf of Mexico. Gulf Research Report 6: 145–152.

Pearson, Roy L. and K. Scott Swan. 2014 The Fiscal Year 2013 Virginia Economic Impacts for the Port of Virginia. Mason School of Business, College of William and Mary.

Perry, J.E., T.A. Barnard, Jr., J.G. Bradshaw, C.T. Friedrichs, K.J. Havens, P.A. Mason, W.I. Priest III, and G.M. Silberhorn. 2001. Creating Tidal Salt Marshes in the Chesapeake Bay. Journal of Coastal Research, Special Issue No. 27, 170-191. Virginia Institute of Marine Science.

Port of Virginia (POV). 2015. Annual Report, 2015. Retrieved from: http://www.portofvirginia.com/wp-content/uploads/2016/01/2015-Annual-Report-Final.pdf

Priest, W., 1981. A Study of Dredging Effects in Hampton Roads, Virginia. Special report No.247 in Applied Marine Science and Ocean Engineering. Virginia Institute of Marine Science, School of Marine Science, College of William and Mary, Gloucester Point, Virginia.

Pyle, R., and E. Cronin. 1950. The general anatomy of the blue crab Callinectes sapidus Rathbun. Chesapeake Biological Laboratory Publication 87, 40 p.

Reine, K., and Clarke, D. 1998. Entrainment by hydraulic dredges–A review of potential impacts. Technical Note DOER-E1. U.S. Army Engineer Research and Development Center, Vicksburg, MS.

Reshetiloff, K. 1997. Tiny organisms determine if life in Bay sinks or swims. Bay Journal. Retrieved from http://www.bayjournal.com/article/tiny_organisms_determine_if_life_in_bay_sinks_or_swims.

Rhoads, D.C. and J.D. Germano. 1982. Characterization of Benthic Processes Using Sediment Profile Imaging: an Efficient Method of Remote Ecological Monitoring on the Seafloor (REMOTS System). Marine Ecology Process Series 8, 115-128

Richardson, J.W., Greene, C. R. Jr., Malme C. I., and Thomson, D. H. 1995. *Marine Mammals and Noise*. San Diego, CA: Academic Press.

Rudloe, A. 1981. Aspects of the biology or juvenile horseshoe crabs, Limulus Polyphemus. Bulleting on Marine Science 31: 125-133.

Sallenger, A. H., K.S. Doran, and P.A. Howd. 2012. Hotspot of Accelerated Sea-Level Rise on the Atlantic Coast of North America. Nature Climate Change. 884-888. Abstract online at: http://www.nature.com/nclimate/journal/v2/n12/full/nclimate1597.html.

Sandoz, M., and R. Rogers. 1944. The effect of environmental factors on hatching, moulting, and survival of zoea larvae of the blue crab Callinectes sapidus Rathbun. Ecology 25: 216–228.

Schaffner, L. C., and R. J. Diaz. 1988. Distribution and abundance of overwintering blue crabs, Callinectes sapidus, in the lower Chesapeake Bay. Estuaries 11: 68–72.

Scharf, F. S., and K. K. Schlicht. 2000. Feeding habits of red drum (Sciaenops ocellatus) in Galveston Bay, Texas: Seasonal diet variation and predator-prey size relationships. Estuaries 23: 128–139.

Schulte, D. M., Dridge, K. M., and Hudgins, M. H. 2015. Climate Change and the Evolution and Fate of the Tangier Islands of Chesapeake Bay, USA. Nature Scientific Reports 5, 17890. Retrieved from http://www.nature.com/articles/srep17890.

Setzler-Hamilton, E.M., 1991a. White Perch. IN: S.L. Funderburk, S.J. Jordan, J.A. Mihursky, and D. Riley, eds., Habitat Requirements for Chesapeake Bay Living Resources, Second Edition. Habitat Objectives Workgrou, Living Resources Subcommittee, Chesapeake Research Consortium, Inc. Solomons, Maryland.

Setzler-Hamilton, E.M., 1991b. Striped Bass. IN: S.L. Funderburk, S.J. Jordan, J.A. Mihursky, and D. Riley, eds., Habitat Requirements for Chesapeake Bay Living Resources, Second Edition. Habitat Objectives Workgrou, Living Resources Subcommittee.

Shen, J., Wang, R., Sisson, M. 2017. Assessment of hydrodynamic and water quality impacts for channel deepening in the Thimble Shoals, Norfolk Harbor, and Elizabeth River Channels. Final Report submitted to Moffatt and Nickol and U.S. Army Corps of Engineers. Virginia Institute of Marine Science.

Shomette, Donald G., 2007, Shipwrecks, Sea Raiders, and Maritime Disasters along the Delmarva Coast, 1632-2004, Johns Hopkins University Press, Baltimore.

Sisson, M., H. Wang, and Y.P. Wang. 2005. Additional Assessments of the Craney Island Eastward Expansion in the Elizabeth River and Hampton Roads – Hydrodynamic Model Study. Final Report to the U.S. Army Corps of Engineers, Norfolk District and the Virginia Port Authority. Virginia Institute of Marine Science. Special Report No. 388 in Applied Marine Science and Ocean Engineering. 31 pp. & Appendices.

Stanley, J. G. and D. S. Danie. 1983. Species profiles: life histories and environmental requirements of coastal fisheries and invertebrates (North Atlantic) -- white perch. U.S. Fish and Wildlife Service. Biological Report 82 (11.7), U.S. Army Corps of Engineers, TR-EL-82-4. 12 pp.

Sunda, W.G. Tester, P.A., Huntsman, S.A. 1990. Toxicity of trace metals to *Acartia tonsa* in the Elizabeth River and southern Chesapeake Bay. Estuarine, Coastal and Shelf Science, 30, 207-221.

Swingle, W.M., Barco, S.G., Costidis, A.M., Bates, E.B., Mallette, S.D., Phillips, K.M., Rose, S.A., Williams, K.M. 2017. Virginia Sea Turtle and Marine Mammal Stranding Network 2016 Grant Report: VAQF Scientific Report (Vol 2017 No. 1). Retrieved from: http://www.deq.virginia.gov/Portals/0/DEQ/CoastalZoneManagement/FundsInitiativesProjects/task49-15.pdf?ver=2017-05-16-074848-097.

Swingle, W.M., Barco, S.G., Bates, E.B., Lockhart, G.G., Phillips, K.M., Rodrique, K.R., Rose, S.A., Williams, K.M. 2016. Virginia Sea Turtle and Marine Mammal Stranding Network 2015 Grant Report: VAQF Scientific Report (Volume 2016 No. 01). Retrieved from: http://www.deq.virginia.gov/Portals/0/DEQ/CoastalZoneManagement/FundsInitiativesProjects/task49-14.pdf.

Swingle, W.M., Lynott, M.C., Bates, E.B., Lockhart, G.G., Phillips, K.M., Rodrique, K.R., Rose, S.A., Williams, K.M. 2015. Virginia Sea Turtle and Marine Mammal Stranding Network 2014 Grant Report: VAQF Scientific Report (Volume 2015 No. 01). Retrieved from: http://www.deq.virginia.gov/Portals/0/DEQ/CoastalZoneManagement/FundsInitiativesProjects/task49-13.pdf.

Swingle, W.M., Lynott, M.C., Bates, E.B., D'Eri, L.R., Lockhart, G.G., Phillips, K.M., Thomas, M.D. 2014. Virginia Sea Turtle and Marine Mammal Stranding Network 2013 Grant Report: VAQF Scientific Report (Volume 2014 No. 02). Retrieved from: http://www.deq.virginia.gov/Portals/0/DEQ/CoastalZoneManagement/FundsInitiativesProjects/task49-12.pdf.

Swingle, W.M., Trapani, C.M., D'Eri, L.R., Lynott, M.C. 2013. Marine Mammal and Sea Turtle Stranding Response 2012 Grant Report: VAQF Scientific Report (Volume 2013 No. 01). Retrieved from: https://www.virginiaaquarium.com/conserve/Documents/2012-Stranding-Network-Report.pdf.

Swingle, W.M., Trapani, C.M., D'Eri, L.R., Lynott, M.C. 2012. Marine Mammal and Sea Turtle Stranding Response 2011 Grant Report: VAQF Scientific Report (Volume 2012 No. 02). Retrieved from: http://www.deq.virginia.gov/Portals/0/DEQ/CoastalZoneManagement/FundsInitiativesProjects/task49-10.pdf.

Swingle, W.M., Trapani, C.M., Cook, M.L. 2011. Marine Mammal and Sea Turtle Stranding Response 2010 Grant Report: VAQF Scientific Report (Volume 2011 No. 01). Retrieved from: http://www.deq.virginia.gov/Portals/0/DEQ/CoastalZoneManagement/task49-09.pdf.

Swingle, W.M., Trapani, C.M., Cook, M.L. 2010. Marine Mammal and Sea Turtle Stranding Response 2009 Grant Report: VAQF Scientific Report (Volume 2010 No. 01). Retrieved from: http://www.deq.virginia.gov/Portals/0/DEQ/CoastalZoneManagement/task49-08.pdf.

Tagatz, M. E. 1971. Osmoregulatory ability of blue crabs in different temperature-salinity combinations. Chesapeake Science 12: 14–17.

Tan, E., and W. A. Van Engel. 1966. Osmoregulation in the adult blue crab, Callinectes sapidus Rathbun. Chesapeake Science 7: 30–35.

The Center of Biology Conservation. CCB Mapping Portal. VA Eagle Nest Locator. 2016. Retrieved from http://www.ccbbirds.org/maps/.

The Port of Virginia (POV). 2015. Consulting Engineer's Report. Moffatt & Nichol.

Thompson, M. 1998. Assessments of the population biology and critical habitat for the horseshoe crab, Limulus polyphemus, in the South Atlantic Bight. M.S. Thesis. University of Charleston, Charleston, South Carolina.

Todd, V. L. G., Todd, I. B., Gardiner, J. C., Morrin, E. C. N., Macpherson, N. A., DiMarzio, N. A., Thomsen, F. 2015. A review of impacts of marine dredging activities on marine mammals. ICES Journal of Marine Science, 72(2), 328-340.

Todd, Victoria L.G., I.B. Todd, J.C. Gardiner, E.C. N. Morrin, N.A. MacPherson, N.A. DiMarzio, and F. Thomsen. 2014. A Review of Impacts of Marine Dredging Activities on Marine Mammals. ICES Journal of Marine Science. Retrieved from http://www.osc.co.uk/wp-content/uploads/2015/01/Todd_2015_DredgingReview.pdf.

Tuttle, Michael C. 2000. Underwater Archaeological Diver Services at the Thimble Shoals and Cape Henry Borrow Areas Near Virginia Beach, Virginia. Panamerican Maritime, L.L.C., Memphis, Tennessee.

Tuttle, Michael C. 2001. Archaeological Remote Sensing Survey of Selected Channels, Chesapeake Bay and Norfolk Harbor, Virginia. Panamerican Maritime, L.L.C., Memphis, Tennessee.

Tuttle, Michael C. 2002. Archaeological Remote Sensing if the Virginia Beach Hurricane Protection Borrow Area. Panamerican Maritime, L.L.C., Memphis, Tennessee.

Tuttle, Michael C., and Andrew Lydecker. 2000. Phase I Archaeological Remote Sensing Survey East of the Craney Island, Elizabeth River, Virginia. Panamerican Maritime, L.L.C., Memphis, Tennessee.

University of Maryland Center for Environmental Science (UMCES). Integration and Application Network: Ecocheck. 2013. Chesapeake Bay Benthic Index of Biotic Integrity data: Retrieved from http://ian.umces.edu/ecocheck/report cards/chesapeakebay/2013/indicators/benthic_index/.

U. S. Department of the Navy. 2009. Final Environmental Impact Statement for the Proposed Dredging of Norfolk Harbor Channel, Norfolk and Portsmouth, Virginia. July. Lead Agency: U. S. Department of the Navy, Commander Navy Region Mid-Atlantic, with the assistance of the U.S. Army Corps of Engineers.

U.S. Fish and Wildlife Service (USFWS). 2015a. Federal Register. Vol. 80. No. 63. 50 CFR Part 17. 50 CFR Part 17. Endangered and Threatened Wildlife and Plants; Threatened Species Status for the Northern Long-Eared Bat With 4(d) Rule; Final Rule and Interim Rule. Retrieved from: http://www.fws.gov/midwest/endangered/mammals/nleb/pdf/FRnlebFinalListing02April2015.pdf

U.S. Fish and Wildlife Service (USFWS). 2015b. Northern Long-Eared Bat Interim 4(d) Rule White-Nose Syndrome Buffer Zone Around WNS/Pd Positive Counties/Districts. Retrieved from http://www.fws.gov/mountain-prairie/ea/NLEBMap_March2015.pdf.

U.S. Fish and Wildlife Service (USFWS). 2007. National Bald Eagle Management Guidelines, Retrieved from https://www.fws.gov/southdakotafieldoffice/NationalBaldEagleManagementGuidelines.pdf

U.S. Army Corps of Engineers (USACE), Norfolk District, 2000. Formulation analysis notebook: Elizabeth River Basin, Virginia: Elizabeth River environmental restoration--feasibility investigation. 173 pp. w/Appendices.

U.S. Army Corps of Engineers (USACE). 2003. Evaluation of dredged material proposed for disposal at island, nearshore, or upland confined disposal facilities – testing manual. Technical Report ERDC/EL TR-03-1, U.S. Army Engineer Research and Development Center, Vicksburg, MS.

U.S. Army Corps of Engineers (USACE). 2005. Hydrodynamic modeling final report executive summary. Retrieved from http://www.nao.usace.army.mil/gis/craneyee/index.asp.

U.S. Army Corps of Engineers (USACE). 1983. Dredging and Dredged Material Disposal. Engineer Manual 1110-2-5025, Office, Chief of Engineers, Washington, DC.

U.S. Army Corps of Engineers (USACE). 1999. Navigation Management Plan, Appendix C Shoreline Use.

U.S. Army Corps of Engineers (USACE). 2006. Craney Island Eastward Expansion Norfolk Harbor and Channels Virginia. Final Environmental Impact Statement. Norfolk District.

U.S. Army Corps of Engineers (USACE). 2010. Fort Monroe Historic Image Report. Engineer Research and Development Center, Champaign IL, Construction Engineering Research Laboratory. ERDC/CERL SR-10-8.

U.S. Army Corps of Engineers (USACE). 2013. Incorporating Sea Level Change in Civil Works Programs. Regulation No. 1100-2-8162. Retrieved from: http://www.publications.usace.army.mil/Portals/76/Publications/EngineerRegulations/ER_1100-2-8162.pdf.

U.S. Army Corps of Engineers (USACE). 2014. Procedures to Evaluate Sea Level Change: Impacts, Responses, and Adaptation. Technical Letter No. 1100-2-1. Retrieved from: http://www.publications.usace.army.mil/Portals/76/Publications/EngineerTechnicalLetters/ETL_1100-2-1.pdf.

U.S. Army Corps of Engineers (USACE). n.d. Craney Island Dredged Material Management Area. Brochure. Office, Craney Island Project, Portsmouth, VA.

U.S. Army Corps of Engineers, 1983. Dredging and Dredged Material Disposal. Engineer Manual 1110-2-5025, Office, Chief of Engineers, Washington, D.C.

U.S. Army Corps of Engineers (USACE), Norfolk District. 2000. Formulation Analysis Notebook: Elizabeth River Basin, Virginia: Elizabeth River Environmental Restoration--Feasibility Investigation. 173 pp. w/Appendices.

U.S. Army Corps of Engineers (USACE). 2002. Final Limited Reevaluation Report. Norfolk Harbor and Channels. 50-foot Channel Project, 50-foot Inbound Element. Norfolk District. Norfolk, VA.

U.S. Army Corps of Engineers (USACE). 2005. Craney Island Eastward Expansion Draft Feasibility Report. Norfolk District. Norfolk, VA.

U.S. Army Corps of Engineers (USACE). 2006. Craney Island Easterward Expansion Final Environmental Impact Statement, Norfolk Harbor and Channels, Virginia. Norfolk District. Norfolk, VA.

U.S. Army Corps of Engineers (USACE). 2009(a) Site Management Plan for the Dam Neck Ocean Dredged Material Disposal Site. Norfolk District. Norfolk, VA.

U.S. Army Corps of Engineers. 2009(b) Site Management Plan for the Norfolk Ocean Dredged Material Disposal Site. Norfolk District. Norfolk, VA.

U.S. Army Corps of Engineers. 1983. Dredging and Dredged Material Disposal. Engineer Manual 1110-2-5025, Office, Chief of Engineers, Washington, DC.

U.S. Army Corps of Engineers. 2003. Evaluation of Dredged Material Proposed for Disposal at Island, Nearshore, or Upland Confined Disposal Facilities — Testing Manual, Environmental Testing Laboratory, ERDC/EL TR-03-1.

U.S. Army Corps of Engineers. 2014. Procedures to Evaluate Sea Level Change: Impacts, Responses, and Adaptation. Technical Letter 1100-2-1.

U.S. Census Bureau. 2014. ACS Selected Economic Characteristics, Virginia Beach-Norfolk-Newport News, VA-NC Metro Area. Retrieved from: http://www.hrpdcva.gov/uploads/docs/Economic%20Characteristics.pdf

U.S. Department of the Navy (Navy). 2009. Final Environmental Impact Statement for the Proposed Dredging of Norfolk Harbor Channel, Norfolk and Portsmouth, Virginia.

U.S. Department of the Navy. 2009. Final Environmental Impact Statement for the Proposed Dredging of Norfolk Harbor Channel Norfolk and Portsmouth, Virginia. Navy Region Mid-Atlantic.

U.S. Department of Transportation (USDOT). 2005. High-Speed Ground Transportation Noise and Vibration Impact Assessment. Federal Railroad Administration. Retrieved from: https://www.fra.dot.gov/eLib/Details/L02562

U.S. Environmental Protection Agency (a), 2009. Site Management and Monitoring Plan for the Dam Neck Ocean Disposal Site.

U.S. Environmental Protection Agency (b), 2009. Site Management and Monitoring Plan for Norfolk Ocean Disposal Site.

U.S. Environmental Protection Agency (USEPA). 1998. Evaluation of dredged material proposed for discharge in waters of the U.S. – testing manual, inland testing manual. Prepared by Environmental Protection Agency, Office of Water, Office of Science and Technology, Washington, D.C. ad Department of the Army, U.S. Army Corps of Engineers, Operations, Construction, and Readiness Division, Washington, D.C.

U.S. Environmental Protection Agency (USEPA). 2004. Air Quality Designations and Classifications for the 8-Hour Ozone National Ambient Air Quality Standards; Early Action Compact Areas with Deferred Effective Dates; Final Rule, 40 CFR Part 81. 69 FR 23858, April 30, 2004. Retrieved from: https://Federalregister.gov/a/04-9152.

U.S. Environmental Protection Agency (USEPA). 2007. Approval and Promulgation of Air Quality Implementation Plans; Virginia; Redesignation of the Hampton Roads 8-Hour Ozone Nonattainment Area to Attainment and Approval of the Area's Maintenance Plan and 2002 Base-Year Inventory; Final Rule, 40 CFR Parts 52 and 81. 72 FR 30490, June 1, 2007. Retrieved from: https://Federalregister.gov/a/E7-10581/.

U.S. Environmental Protection Agency (USEPA). 2010. Revisions to the General Conformity Regulations; Final Rule, 40 CFR Parts 51 and 93. 75 FR 17253. April 5, 2010. Retrieved from: https://Federalregister.gov/a/2010-7047.

U.S. Environmental Protection Agency (USEPA). 2012. Air Quality Designations for the 2008 Ozone National Ambient Air Quality Standards; Final Rule, 40 CFR Part 81. 77 FR 30087, May 21, 2012. Retrieved from: https://Federalregister.gov/a/2012-11618.

U.S. Environmental Protection Agency (USEPA). 2015. Implementation of the 2008 National Ambient Air Quality Standards for Ozone: State Implementation Plan Requirements; Final Rule, 40 CFR Parts 50, 51, 52, 70, and 71. 80 FR 12263, March 6, 2015. Retrieved from: https://Federalregister.gov/a/2015-04012.

U.S. Environmental Protection Agency (USEPA). 2015. Virginia Nonattainment/Maintenance Status for Each County by Year for All Criteria Pollutants. Retrieved from: http://www3.epa.gov/airquality/greenbook/anayo_va.html.

U.S. Environmental Protection Agency (USEPA). 2016. CERCLIS Search. Retrieved May 1, 2016 from https://www.epa.gov/enviro/cerclis-searchList of Superfund Sites.

U.S. Environmental Protection Agency (USEPA). 2016. "What Are Wetland Functions?" Retrieved from https://www.epa.gov/wetlands/what-are-wetland-functions.

U.S. Fish and Wildlife Service (USFWS). 2002. Craney Island Expansion Feasibility Study. Planning Aid Report: Baseline Biological Conditions and Impacts of the Eastward Expansion. Prepared for the U.S. Army Corps of Engineers Norfolk District.

U.S. Fish and Wildlife Service, Chesapeake Bay Field Office. 2016c. Migratory Birds. https://www.fws.gov/chesapeakebay/migbird.html.

U.S. Fish and Wildlife Service, Environmental Conservation Online System. 2016d. Bald Eagle (*Haliaeetus leucocephalus*). Retrieved from http://ecos.fws.gov/ecp0/profile/speciesProfile?sId=1626#lifeHistory.

U.S. Fish and Wildlife Service, Environmental Conservation Online System. 2016e. Roseate tern: North American Subspecies (Sterna dougallii dougallii). Retrieved from http://ecos.fws.gov/ecp0/profile/speciesProfile?spcode=B07O.

U.S. Fish and Wildlife Service. 2002. Craney Island Expansion Study Planning Aid Report: Baseline Biological Conditions and Impacts of the Eastward Expansion. Prepared for the U.S. Army Corps of Engineers.

U.S. Fish and Wildlife Service. 2013. Fishes of the Chesapeake Bay. July 2. Retrieved from https://www.fws.gov/chesapeakebay/fishpage.html.

U.S. Fish and Wildlife Service. 2016a. Information for Planning and Conservation Database. Retrieved from http://www.fws.gov/northeast/virginiafield/endangered/projectreviews_step2.html.

U.S. Fish and Wildlife Service. 2016b. Rufa Red Knot. Retrieved from: https://www.fws.gov/northeast/redknot/.

U.S. Fish and Wildlife Service. 1996. Piping plover (*Charadrius melodus*) Atlantic Coast Population Revised Recovery Plan. Retrieved from https://www.google.com/?gws_rd=ssl#q=piping%20plover%20winters%20atlantic%20coast%20population%20revised%20recovery%20plan.

U.S. Fish and Wildlife Service. West Indian Manatee (*Trichechus manatus*), 2008. Retrieved from https://www.fws.gov/endangered/esa-library/pdf/manatee.pdf.

U.S. National Climate Assessment. 2012. Global Sea Level Rise Scenarios for the United States National Climate Assessment. Retrieved from: http://scenarios.globalchange.gov/sites/default/files/NOAA_SLR_r3_0.pdf.

U.S. Water Resources Council. 1983. Economic and Environmental Guidelines for Water and Related Land Resources Implementation Studies.

United States Army Corps of Engineers (USACE). 2006. *Craney Island Expansion: Norfolk Harbor and Channels, Virginia, Final Environmental Impact Statement.* Norfolk.

United States Army Corps of Engineers. 1983. Dredging and Dredged Material Disposal. Engineer Manual 1110-2-5025, Office, Chief of Engineers, Washington, DC.

Valle-Levinson, A., Wong, K. C., & Bosley, K. T. 2002. Response of the lower Chesapeake Bay to forcing from Hurricane Floyd. Continental Shelf Research, *22*(11), 1715-1729.

Van Engel, W. A. 1958. The blue crab and its fishery in Chesapeake Bay. Part 1-Reproduction, early development, growth, and migration. Commercial Fisheries Review 20: 6–17.

Virginia Department of Conservation and Recreation (DCR). 2016. Virginia Natural Heritage Data Explorer. https://vanhde.org/.

Virginia Department of Conservation and Recreation, Division of Natural Heritage. 2016a. Overview of the physiography and vegetation of Virginia. Document abridged from Fleming, G.P. 2012. The Nature of the Virginia Flora. Pages 24-75 in A.S. Weakley, J.C. Ludwig, Townsend, J.F. Flora of Virginia. Bland Crowder, Ed. Foundation of the Virginia Flora Project, Inc., Richmond.

Virginia Department of Environmental Quality (VDEQ). 2014. Final 2014 305(b)/303(d) Water Quality Assessment Integrated Report. Retrieved from http://www.deq.virginia.gov/Programs/Water/WaterQualityInformationTMDLs/WaterQualityAssessments/2014305(b)303(d)IntegratedReport.aspx.

Virginia Department of Environmental Quality (VDEQ). 2015. Air Quality Monitoring Network Assessment. Office of Air Quality Monitoring. Retrieved from: https://www3.epa.gov/ttn/amtic/files/networkplans/VAassess2015.pdf

Virginia Department of Environmental Quality, 2008 Fish Tissue Analysis Data. Retrieved from http://www.deq.virginia.gov/Programs/Water/WaterQualityInformationTMDLs/WaterQualityMonitoring/FishTissueMonitoring.aspx.

Virginia Department of Environmental Quality. 2014. VA 2014 Toxics Release Inventory Report. Retrieved from http://www.deq.virginia.gov/Programs/Air/AirQualityPlanningEmissions/SARATitleIII/SARA313ToxicsReleaseInventory/VA2014ToxicsReleaseInventoryReport.aspx.

Virginia Department of Environmental Quality. 2000. Sediment Testing Results for PCBs, pesticides, and metals. Retrieved from http://www.deq.virginia.gov/Programs/Water/WaterQualityInformationTMDLs/WaterQualityMonitoring/FishTissueMonitoring/SedimentResults.aspx.

Virginia Department of Environmental Quality. 2012 Virginia Toxic Release Inventory Report. Retrieved from http://www.deq.virginia.gov/Programs/Air/AirQualityPlanningEmissions/SARATitleIII/SARA313ToxicsReleaseInventory/VA2012ToxicsReleaseInventoryReport.aspx

Virginia Department of Game and Inland Fisheries. 2016a. Piping Plovers in Virginia. Retrieved from https://www.dgif.virginia.gov/wildlife/birds/piping-plovers/.

Virginia Department of Game and Inland Fisheries. 2016b. Virginia Fish and Wildlife Information Service. Three mile radius search around point 37.4074460, -79.1069085. http://vafwis.org/fwis/?Menu=Home.__By+Coordinates.

Virginia Department of Health. 2016. Fish Consumption Advisories Retrieved from http://www.vdh.virginia.gov/environmental-epidemiology/public-health-toxicology/fish-consumption-advisories/.

Virginia Department of Historic Resources. (2016) Virginia Cultural Resource Information System. Retrieved from https://vcris.dhr.virginia.gov/vcris/Account/Login?ReturnUrl=%2fvcris.

Virginia Department of Transportation (VDOT). 2016. Hampton Roads Crossing Study SEIS website. Retrieved from: http://hamptonroadscrossingstudy.org/default.asp.

Virginia Department of Transportation (VDOT). 2001. Hampton Roads Crossing Study Final Environmental Impact Statement. Retrieved from: http://www.vdot.virginia.gov/projects/resources/studyhro-crossing-feis.pdf.

Virginia Department of Transportation (VDOT). 2011. Reevaluation of Hampton Roads Crossing Study: Selected Alternative CBA 9 - Segment 1 & Segment 3, Draft Noise Analysis Technical Report. State Project 0064-114-F12, PE-102.

Virginia Department of Transportation (VDOT). 2012. Hampton Roads Bridge Tunnel EIS Technical Memorandum. Retrieved from: http://www.virginiadot.org/projects/resources/hampton_roads/HRBT_EIS/TechReports/Visual_Resources_Tech_Memo.pdf.

Virginia Department of Transportation (VDOT). 2012. I-64 Hampton Roads Bridge Tunnel Draft Environmental Impact Statement and Draft Section 4(f) Evaluation. Retrieved from: http://www.virginiadot.org/projects/resources/hampton_roads/64_deis/I-64_Hampton_Roads_Bridge-Tunnel_Draft_EIS_December2012.pdf.

Virginia Department of Transportation (VDOT). 2016. Hampton Roads Crossing Study SEIS website. Retrieved from: http://hamptonroadscrossingstudy.org/default.asp.

Virginia Institute of Marine Science (VIMS). 1993. Beneficial Uses of Dredged Materials in Hampton Roads, Virginia. House Document No. 16. Commonwealth of Virginia.

Virginia Maritime Association (VMA). 2015. The Ports of Virginia Annual 2015. Retrieved from: http://www.vamaritime.com/?page=2012PortAnnual.

Virginia Marine Resource Commission. 2016a. Artificial Reef Program. Retrieved from http://www.mrc.virginia.gov/vsrfdf/reef.shtm.

Virginia Marine Resources Commission. 2016b. Newport News Middle Ground Reef. Retrieved from http://www.mrc.virginia.gov/vsrfdf/nnmiddleground_reef.shtm.

Virginia Marine Resources Commission. 2016c. Regulation (4 VAC 20-561-10 et. Seq.) "Pertaining to the Hampton Flats Hard Clam Harvest Area." Retrieved from http://www.mrc.virginia.gov/regulations/fr561.shtm.

Virginia Port Authority (VPA). 2008. 2040 Master Plan. Retrieved from: http://www.hrp.org/Site/docs/ResourceLibrary/2040_Master_Plan_Executive_Summary.pdf

VPDES General and Individual Permits list. 2015. Retrieved from http://www.deq.virginia.gov/Programs/Water/PermittingCompliance/PollutionDischargeElimination/PermitsFees.aspx#GGPs.

Walter, J. F., and H. M. Austin. 2003. Diet composition of large striped bass (Morone saxatilis) in Chesapeake Bay. Fishery Bulletin 101: 414–423.

Walter, J. F., A. S. Overton, K.H. Ferry, and M. E. Mather. 2003. Atlantic coast feeding habits of striped bass: a synthesis supporting a coast-wide understanding of trophic biology. Fisheries Management and Ecology, 10: 349–360.

Wang, H.V., Kim, S.C., Boon, J.D., Kuo, A.Y., Sisson, G.M. Brubaker, J.M. and Maa, J.P-Y. 2001. Three dimensional hydrodynamic modeling study, Craney Island Eastward Expansion, lower James River and Elizabeth River, Virginia. Special Report No. 372 in Applied Marine Science and Ocean Engineering.

Wang, R., Shen, J., Sisson, M. 2017. Incorporation of sea level change scenarios into Norfolk Harbor Channels Deepening Study & Elizabeth River Southern Branch Navigation Improvements Study. Draft Report submitted to the Moffatt and Nickol and the U.S. Army Corps of Engineers. Virginia Institute of Marine Science.

Zhang, J., Wang, H., Ye, F., and Wang Z. 2017. Assessment of Hydrodynamic and Water Quality Impacts for Channel Deepening in the Thimble Shoals, Norfolk Harbor, and Elizabeth River Channels, Final report on the “hydrodynamic modeling.” Special Report No. 455 In Applied Marine Science and Ocean Engineering, Virginia Institute of Marine Science. DOJ:10.21220/V5MF0F

Water Resources Council (WRC). 1983. Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies, March 10, 1983.

Watts, Gordon P. 1996a. Historical Documentation and Archaeological Remote Sensing Survey at Hampton Roads, Norfolk Harbor, Virginia. Tidewater Atlantic Research, Inc. Washington, North Carolina.

Watts, Gordon P. 1996b. Underwater Archaeological Survey of Hampton Roads Channels, Norfolk Harbor, Virginia. Tidewater Atlantic Research, Inc. Washington, North Carolina.

Watts, Gordon P. 2000. Phase I Archaeological Remote Survey of the Virginia Beach and Fort Story Hurricane Protection Borrow Areas, Virginia. Tidewater Atlantic Research, Inc. Washington, North Carolina.

Watts, Gordon P. 2007.An Intensive Ordnance and Submerged Cultural Resource Remote-Sensing Survey of Proposed Borrow Areas Off Willoughby Bank and Thimble Shoal Channel Chesapeake Bay, Virginia. Tidewater Atlantic Research, Inc. Washington, North Carolina.

Welsh, S.A., Mangold, M.F., Skjeveland, J.E. 2002. Distribution and movement of shortnose sturgeon (*Acipenser brevirostrum*) in the Chesapeake Bay. Estuaries 25, 101.

Wilbur, D.H. and D.G. Clarke. 2001. Biological effects of suspended sediments: A review of suspended sediment impacts on fish and shellfish with relation to dredging activities in estuaries. North American Journal of Fisheries Management 21:4, 855-875.

Wenner, C. A., and J. A. Musick. 1975. Food habits and seasonal abundance of the American eel, Anguilla rostrata, from the lower Chesapeake Bay. Chesapeake Science 16: 62–66.