US Army Corps
of Engineers
Baltimore District

FINAL ENVIRONMENTAL ASSESSMENT

WOLF TRAP ALTERNATE OPEN WATER PLACEMENT SITE NORTHERN EXTENSION

VIRGINIA WATERS OF THE CHESAPEAKE BAY

December 18, 2019

Prepared by: **U.S. Army Corps of Engineers, Baltimore District**
2 Hopkins Plaza
Baltimore, Maryland 21201

WOLF TRAP ALTERNATE OPEN WATER PLACEMENT SITE NORTHERN EXTENSION FINAL ENVIRONMENTAL ASSESSMENT December 18, 2019

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

WOLF TRAP ALTERNATE OPEN WATER PLACEMENT SITE
NORTHERN EXTENSION
FINAL ENVIRONMENTAL ASSESSMENT
December 18, 2019

1.0 PROJECT BACKGROUND

The U.S. Army Corps of Engineers (USACE), Baltimore District, is responsible for maintaining the Baltimore Harbor and Channels 50-Foot Project (50-Foot Project) to allow large, deep-draft commercial shipping vessels to safely navigate the Chesapeake Bay to and from Baltimore Harbor. The 50-Foot Project was authorized in Section 101 of the River and Harbor Act of 1970 and provides for a 50-foot-deep main shipping channel that extends from the Virginia Capes to Fort McHenry in Baltimore Harbor, Maryland, and a series of branch channels that provide access to various public and private terminals serving the Port of Baltimore. The Maryland Port Administration (MPA) is the non-federal sponsor for the 50-Foot Project. For a comprehensive overview of the Baltimore Harbor and Channels Project, please refer to the 2017 Baltimore Harbor and Channels Dredged Material Management Plan Update (DMMP) (USACE, 2017a).

The York Spit Channel is part of the 50-Foot Project's Chesapeake Bay Approach Channels in Virginia. This channel is located near the center of the Bay, east of the York River Entrance Channel and north of the Chesapeake Bay Bridge Tunnel (Figure 1). The York Spit Channel is approximately 18.4 nautical miles (nm) long and maintained at 800 feet (ft) wide and 50 ft mean lower low water (MLLW). The channel is designed to accommodate vessels in the Ultra-Post Panamax class that routinely call on the Port of Baltimore. This vessel class has a maximum length overall of 1,220 ft, a beam of 161 ft, and a loaded draft of 49 ft. The York Spit Channel undergoes periodic maintenance dredging (typically every 4 years) and each maintenance cycle generates an average of 1.5 million cubic yards (mcy) of material. The channel was last dredged in 2015. To minimize adverse impacts to sea turtles, USACE makes every effort to avoid dredging in the York Spit Channel from September 1 through November 14 in accordance with the National Marine Fisheries Service (NMFS) 2018 Biological Opinion (F/NER/2018/14816) (NOAA, 2018a). Environmental effects resulting from maintenance dredging of the York Spit Channel are discussed in the 1981 General Design Memorandum (GDM) and Environmental Impact Statement (EIS) (USACE, 1981) and in the 1987 Supplemental Information Report #2 to the 1981 GDM and EIS (USACE, 1987). These documents are incorporated by reference, and not further discussed herein.

The authorized placement site for material dredged from the York Spit Channel is the Wolf Trap Alternate Open Water Placement Site (WTAPS)[1]. Environmental effects from placement of dredged material in WTAPS were evaluated in the 1987 Supplemental Information Report #2 to the 1981 General Design Memorandum (GDM) and Environmental Impact Statement (EIS) (USACE, 1987), and in the 2005 Baltimore Harbor and Channels (Maryland and Virginia) DMMP and Final Tiered EIS (USACE, 2005). The WTAPS covers approximately 2,300 acres and is

[1] As a point of clarification, the *existing* dredged material placement site, WTAPS, is termed "alternate" because it superseded a historic placement site further to the east called the Wolf Trap Primary Placement Site. That Wolf Trap Primary Placement Site is shown on the National Oceanic and Atmospheric Administration (NOAA) navigation charts, but has been inactive for decades.

located approximately 5 miles east of New Point Comfort and south of Wolf Trap Light, east of Mathews County, Virginia between the Piankatank River and Mobjack Bay. The USACE, Baltimore District has been placing dredged material from the York Spit Channel into WTAPS since the late 1980s. The USACE, Norfolk District has also placed dredged material from the York River Entrance Channel and the Wormley Creek Channel into WTAPS (Figure 1). The most recent placement event in WTAPS occurred in 2017 for placement of approximately 59,000 cubic yards (cy) of dredged material from the Wormley Creek Channel (Table 1). At this time, there are no future plans to place dredged material from the York River Entrance Channel or the Wormley Creek Channel into WTAPS. The remaining capacity of WTAPS is approximately 40 mcy, which assumes placement of dredged material within the site boundaries up to an approximate depth of -30 ft MLLW.

Table 1. Placement history in the Wolf Trap Alternate Open Water Placement Site from 1998 to 2017.

Year	Source Channel	Quantity (cubic yards)	USACE District
1998	York Spit	371K	Baltimore
1998/1999	York River Entrance	1.224M	Norfolk
2000	Wormley Creek	21K	Norfolk
2002	York Spit	1.3M	Baltimore
2003/2004	York River Entrance	380K	Norfolk
2004	York Spit	327K	Baltimore
2007	York Spit	500K	Baltimore
2009	York Spit	375K	Baltimore
2015	York Spit	1.5M	Baltimore
2017	Wormley Creek	59K	Norfolk

2.0 PROPOSED ACTION

The proposed action would establish an extension of WTAPS to the north, increasing the size of the placement site by approximately 3,900 acres, and is herein referred to as the "WTAPS Northern Extension" (WTAPSNE) (Figures 2-4). The WTAPSNE would serve as an open water placement site for dredged material primarily from the York Spit Channel, but may also be used as a placement site for other dredging projects in the lower Chesapeake Bay pending evaluation. At this time, there are no plans to place dredged material from the York River Entrance Channel or the Wormley Creek Channel into WTAPSNE.

The WTAPSNE has been recommended by agencies of the Commonwealth of Virginia as an alternative to the currently-used WTAPS due to the potential for a high abundance of female blue crab to overwinter in the southern portion of WTAPS. Coordinates for WTAPSNE were provided by the Commonwealth. Water depths shallower than in the proposed northern expansion site (which would govern placement capacity) and existing usage (deep draft anchorage and presence of Cape Charles Harbor channel) would likely rule out placing in other directions (east, south or west of WTAPS). Blue crab winter dredge survey data collected by the Virginia Institute of Marine Science (VIMS) between 2009 and 2016 indicate that WTAPSNE provides less suitable habitat for overwintering female blue crab than WTAPS (Lipcius & Knick, 2016 (Appendix F)). Placement of dredged material into either WTAPS or WTAPSNE while female crab are not overwintering (generally from early April to mid-November) presents a higher risk of adverse impacts to sea turtles. The increased risk is not related to the placement site, but to the use of hopper dredges during times of year when the water is warmer. Sea turtles are not present in the Chesapeake Bay during the coldest winter months (NOAA, 2018a).

The proposed action does not include any changes to the historic maintenance dredging activities. The only change to the project is the proposed use of the placement site extension. Impacts from maintenance dredging activities were evaluated in the EIS for the 2005 Baltimore Harbor and Channels (Maryland and Virginia) DMMP and other previous National Environmental Policy Act (NEPA) documents.

The capacity of WTAPSNE is over 30 mcy, which assumes placement of dredged material within the site boundaries up to an approximate depth of -30 ft MLLW. Approximately 2.6 mcy of dredged material from operation and maintenance (O&M) of the York Spit Channel would be placed into quadrant 1 of cell NE-6 in WTAPSNE (Figure 4) during the initial placement event that is expected to begin in the winter of 2020. After initial placement into WTAPSNE, it is anticipated that approximately 1.5 mcy of dredged material from the York Spit Channel would be placed into the site approximately every 4 years, or until another alternate placement site or method is identified, approved, and implemented. Each dredging cycle and the associated placement activities (mobilization to demobilization of the dredging operation) lasts for approximately 4½ months. Maintenance dredging would be allowed 24 hours per day and 7 days per week. Based on previous maintenance dredging, it is expected that approximately 15,000 cubic yards would be dredged per day, resulting in 2 to 5 loads of dredged material being placed at WTAPSNE per day. The USACE would make every effort to avoid placement into WTAPSNE during the dredge closure period for sea turtles, from September 1 through November 14.

Dredged material would be placed into WTAPSNE using a hopper dredge because they are better suited than other types of dredge vessels for maintaining the York Spit Channel. The volume and frequency of dredged material placement events during maintenance dredging is a function of the rate of dredging production, the number of hopper vessels in use, and their size, speed and capacity. Hopper dredge capacity is expected to range from 3,600 to 8,600 cy depending on the dredging contractor used. Depending on the amount of material dredged from the York Spit Channel during one maintenance dredging cycle, the thickness of the material that would be deposited in one cycle would range from 2 inches to 2 ft thick.

The dredging contractors open the hopper of hopper dredges while they are moving to assist in spreading the material. The hopper operators attempt to slowly release material, but the process is difficult to control and may take 5 to 10 minutes to completely empty, with about 75 percent or more of the material discharged within the first minute. If significant mounds are formed during placement, or if placement accumulates above the allowable depth, the contractor is required to drag the area to make the bottom more uniform. The USACE considered requiring the contractor to smooth all deposits to a roughly uniform thickness, but reworking the sediments in this way would be extremely costly, time consuming and likely ineffective.

A Phase I archaeological survey identified ten targets within WTAPSNE that could represent historic properties. Cells NE-1, NE-2, NE-3, and NE-5 had one target each within their boundaries. One of the targets was identified as the *Polynia*, a steam yacht later converted to a barge that sank in 1917. This target is immediately adjacent to Cell NE-5. The remaining five targets are located within the buffer area outside the placement cells. Section 7.0 discusses the historic and cultural resources of the project action area in greater detail.

The USACE is planning to only place dredged material in Cell NE-6 since this cell does not contain any historic properties. For future placement cycles that would place material in cells that contain potential historic properties, USACE developed a Programmatic Agreement (PA) in consultation with the Virginia Department of Historic Resources (VADHR). The PA addresses procedures for evaluating the project's effects to historic properties in future placement cycles outside of Cell NE-6. The PA was executed with VADHR on December 11, 2019, and is located in Appendix E.

A DMMP update process for the Virginia Channels will be initiated in 2020. The DMMP framework is a consistent and logical procedure by which dredged material management alternatives can be identified, evaluated, screened, and recommended so that dredged material placement operations are conducted in a timely, environmentally sensitive, and cost-effective manner. Any consideration of future placement options will include opportunities for the public, stakeholders, and agencies to provide their ideas and concerns for material placement during a scoping period and opportunities to comment on the draft management plan. Additional study and design may be necessary at the conclusion of the DMMP process in order to implement the recommended placement plan.

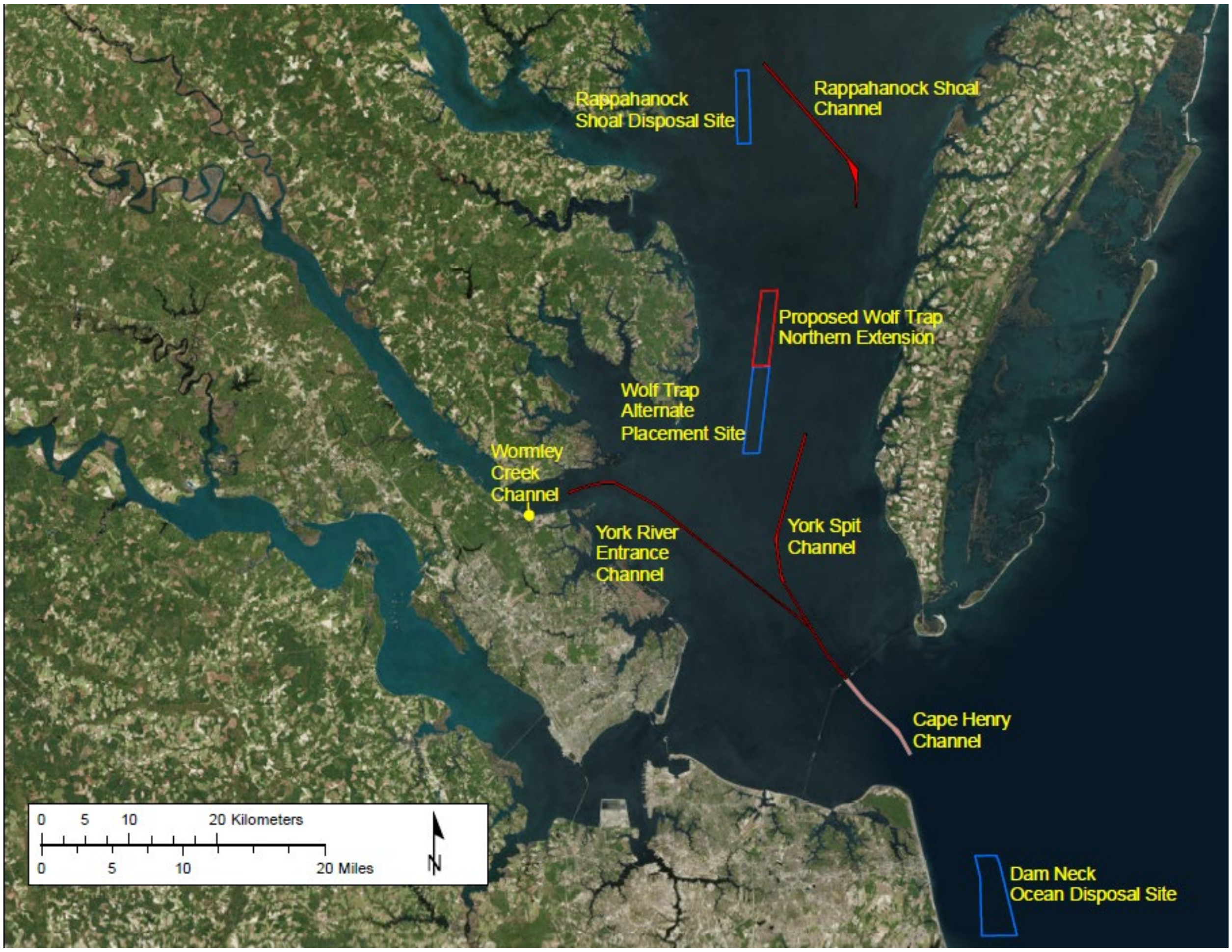

Figure 1. Map of the Baltimore Harbor and Channels Project Lower Bay Channels and Open Water Placement Sites and the York River Entrance and Wormley Creek Channels.

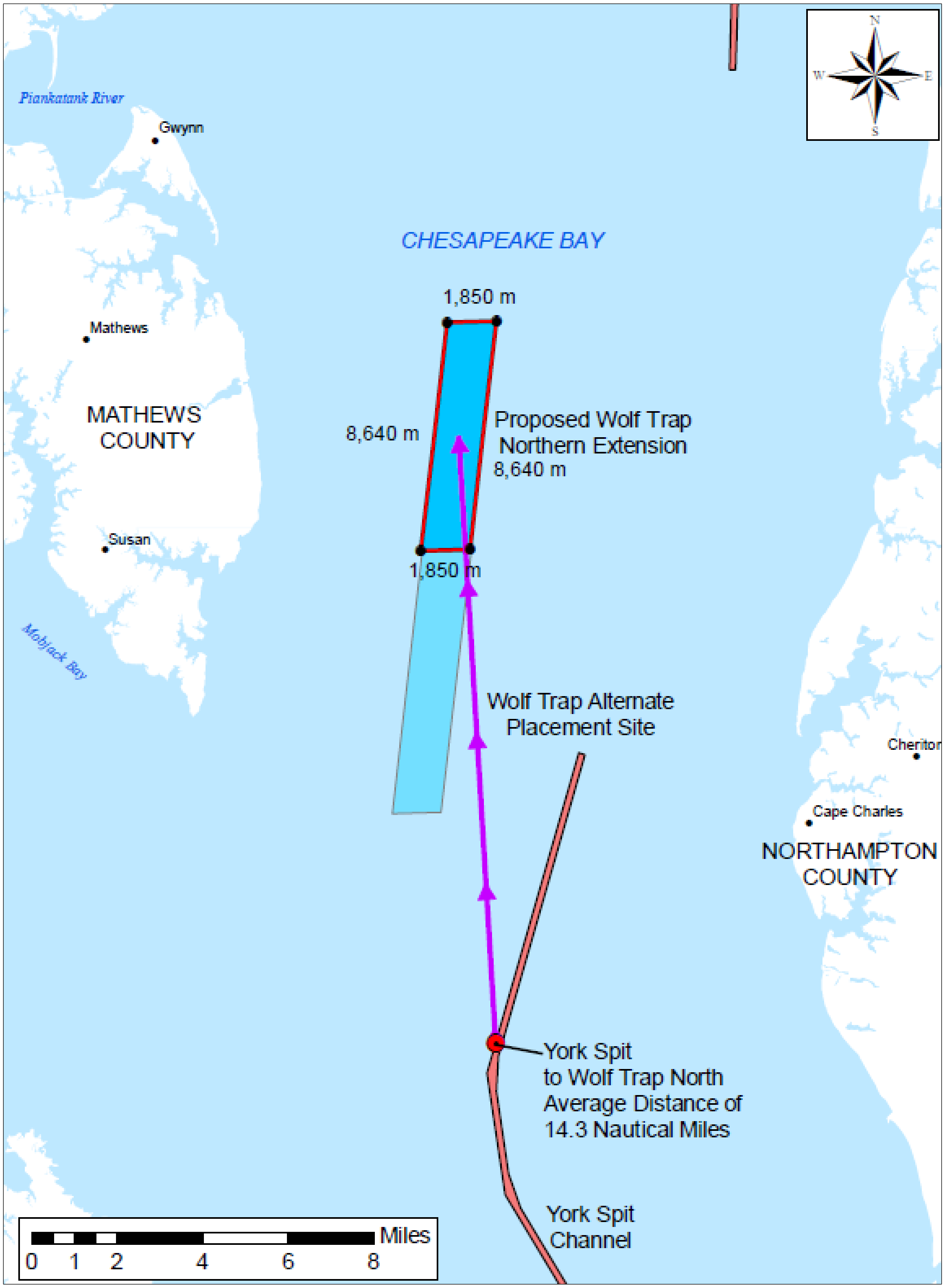

Figure 2. Dimensions of the Proposed Wolf Trap Alternate Open Water Placement Site Northern Extension.

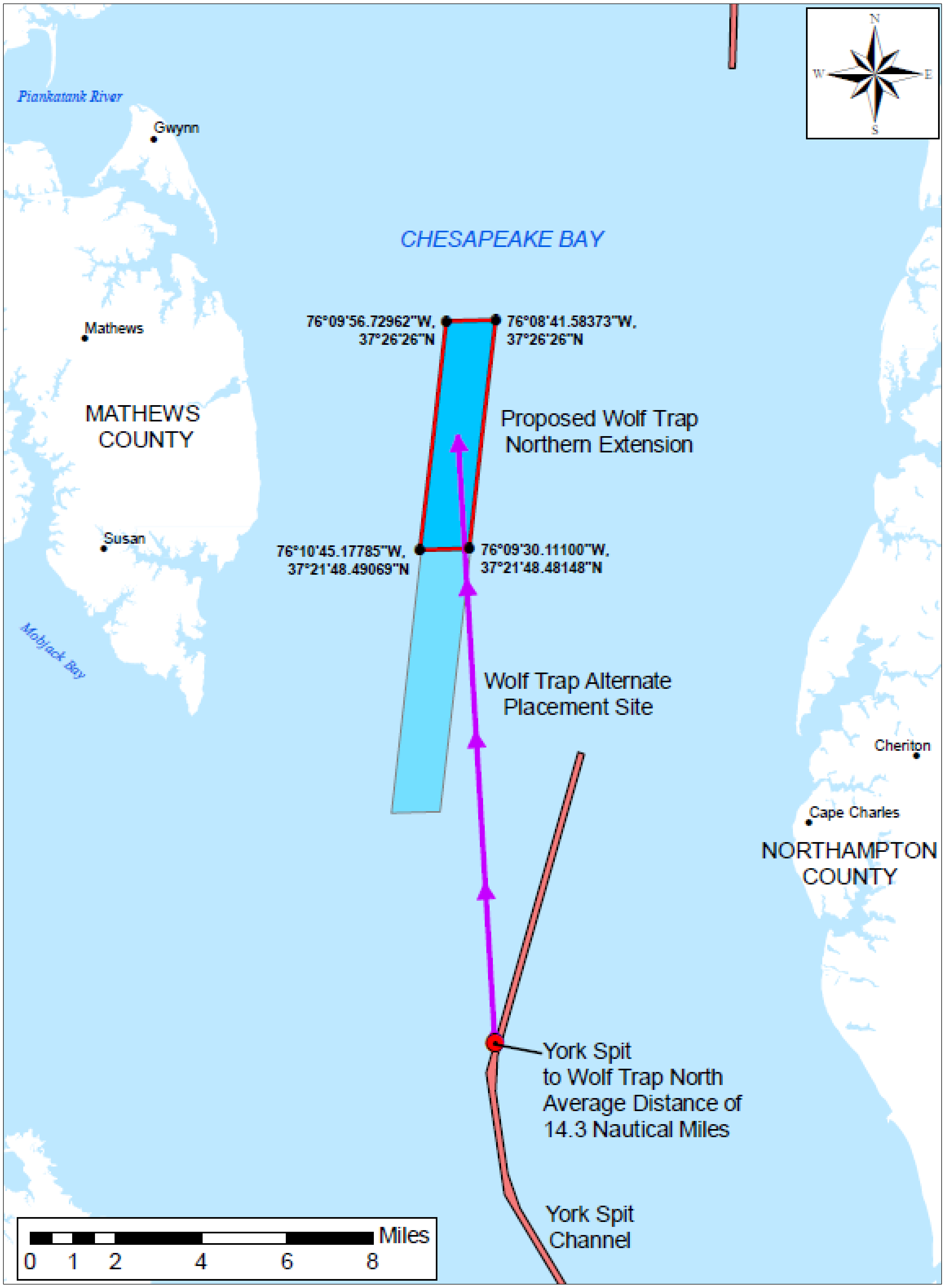

Figure 3. Coordinates of the proposed Wolf Trap Alternate Open Water Placement Site Northern Extension

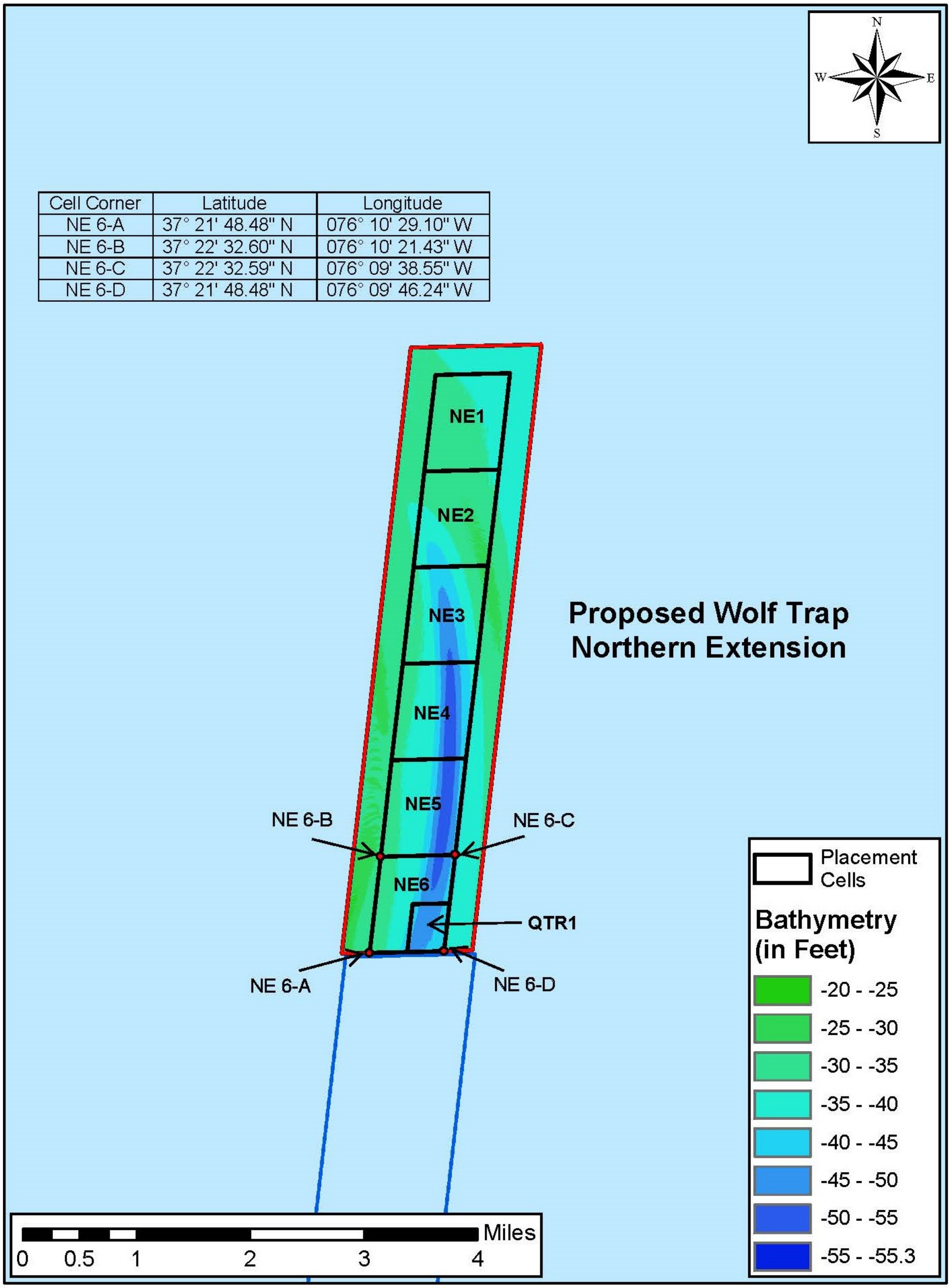

Figure 4. Placement Cells of the Proposed Wolf Trap Alternate Open Water Placement Site Northern Extension.

3.0 PURPOSE AND NEED

The purpose of the proposed action is to provide a cost-effective, environmentally-acceptable dredged material placement site that minimizes adverse impacts to overwintering female blue crab in response to a recommendation by agencies of the Commonwealth of Virginia. The proposed action is needed to provide safe, reliable, and efficient channels to maintain waterborne commerce and national defense.

4.0 SCOPE OF THE ENVIRONMENTAL ASSESSMENT

This document is intended to comply with NEPA of 1969, as amended, and the regulations for implementing NEPA promulgated by the Council on Environmental Quality (CEQ) (40 CFR 1500-1508) and USACE (33 CFR 230); USACE guidance promulgated by 33 C.F.R. §§ 335 – 338 for USACE dredging projects that involve the discharge of dredged material into waters of the U.S.; as well as the federal statutes and executive orders listed in Table 8.

The WTAPSNE is located east of Mathews County, Virginia in the Virginia waters of the Chesapeake Bay between the Piankatank River and Mobjack Bay. The WTAPSNE has been recommended by agencies of the Commonwealth of Virginia as an alternative to the currently-used WTAPS due to the potential for a high abundance of female blue crab to overwinter in the southern portion of WTAPS.

Resources that may be affected by the proposed action include fisheries, cultural resources, and fish and wildlife resources including threatened and endangered species, finfish, essential fish habitat, the benthic community, and blue crab. Effects to these resources are evaluated in Section 8.0. SAV and wetlands are not found in the proposed action area and are not evaluated in this EA.

5.0 AGENCY AND TRIBAL COORDINATION AND PUBLIC INVOLVEMENT

In February and April of 2019, USACE sent coordination letters to the following agencies soliciting comments on the proposed action: U.S. Environmental Protection Agency (USEPA); U.S. Fish and Wildlife Service (USFWS); NOAA NMFS; Virginia Department of Environmental Quality (VADEQ); Virginia Marine Resources Commission (VMRC); Virginia Department of Conservation and Recreation (VADCR), Virginia Department of Game and Inland Fisheries (VADGIF); VIMS; VADHR; Pamunkey Indian Tribe, and Delaware Nation. The coordination letters sent by Baltimore District and comments received from various agencies and tribal nations are located in Appendix A.

Consultation with NOAA NMFS and USFWS under the Endangered Species Act and the Magnuson-Stevens Act is documented in Appendix B: Endangered Species Act Coordination and Appendix C: Essential Fish Habitat Assessment.

A public notice was issued on July 19, 2019, soliciting public, agency and tribal input on the draft EA. A supplemental public notice that provided an opportunity to request a public hearing was issued on September 14, 2019. No public comments were received. The draft EA is available via a posting on the USACE website located at: https://www.nab.usace.army.mil/Missions/Civil-Works/Dredged-Material-Management-Plan-DMMP/

On July 19, 2019, the draft Finding of No Significant Impact (FONSI), EA and appendices were submitted to VADEQ's Office of Environmental Impact Review. A consistency determination with Virginia's Coastal Zone Management Plan and a request for a Section 401 Water Quality Certification (WQC) were also submitted to VADEQ. On September 17, 2019, VADEQ conditionally concurred that the proposed action is consistent with Virginia's CZM program. The Section 401 WQC requirements were met through the CZM consistency determination. The 2013 VADEQ Water Protection Permit with the Section 401 WQC authorizes use of current WTAPS, and is valid through October 2028.

6.0 ALTERNATIVES ANALYSIS

Pursuant to the requirements of NEPA and the regulations for implementing NEPA promulgated by CEQ (40 CFR 1500-1508) and USACE (33 CFR 230), this section presents alternatives to the proposed action, including the No-Action Alternative.

Alternative placement options for dredged material from the York Spit Channel were formulated in the 2005 Baltimore Harbor and Channels (Maryland and Virginia) DMMP and Final Tiered EIS (USACE, 2005). Those alternatives were revisited and were found to be infeasible and were not analyzed in this EA. These alternatives will be revisited and other placement options will be evaluated in the Virginia Channels DMMP. Those alternatives and a brief explanation of why they were not carried forward for further evaluation in this EA are listed in Table 2 below.

Table 2. Alternative Placement Sites from the 2005 DMMP and EIS Not Analyzed in this EA.

Alternative Name	Reason Not Carried Forward for Further Evaluation in this EA
Upland Placement – Craney Island Confined Disposal Facility	Dredged material from the Baltimore Harbor Channels is not permitted to be placed in this facility. Lack of non-federal sponsor to pay the costs above the federal standard.
Ocean Placement – Norfolk Ocean Open Water Site	This alternative would cost several million dollars more per dredging cycle than the No-Action Alternative. Lack of non-federal sponsor to pay the costs above the federal standard.
Beneficial Use – Beach Nourishment	The percentage of sand in the material from the York Spit Channel is below the percentage appropriate for beach nourishment. Lack of a non-federal sponsor to pay the costs above the federal standard. Preparation of an EIS may be required.
Beneficial Use – Shoreline Restoration	Lack of a non-federal sponsor to pay the costs above the federal standard. Preparation of an EIS may be required.
Beneficial Use – Large Island Restoration	Lack of a non-federal sponsor to pay the costs above the federal standard. Preparation of an EIS would be required.
Beneficial Use – Artificial Island Creation	Lack of a non-federal sponsor to pay the costs above the federal standard. Preparation of an EIS would be required.

The Federal Standard[2] for the placement of material dredged from the York Spit Channel is WTAPS. Any alternatives that increase costs above the Federal Standard would require a non-federal sponsor and cost sharing for the increment that exceeds the federal requirements for planning. Alternatives carried forward for further analysis are described in Sections 6.1 through 6.3 below.

6.1 ALTERNATIVE 1: NO ACTION

Inclusion of the No-Action Alternative is prescribed by CEQ regulations as the benchmark against which proposed federal actions are to be evaluated. The No-Action Alternative in this case is to continue placing dredged material in WTAPS. Average transport distance from the York Spit Channel to WTAPS is approximately 8.5 nm. The estimated cost (in FY 19 dollars) for this

[2] The Federal Standard is identified in USACE regulations under 33 CFR 335 through 338. Specifically, 33 CFR 335.7 defines the Federal Standard as follows: "Federal Standard means the dredged material disposal alternative or alternatives identified by the Corps which represent the least costly alternatives consistent with sound engineering practices and meeting the environmental standards established by the 404(b)(1) evaluation process or ocean dumping criteria."

alternative is approximately $13,409,000 per dredging cycle ($7.38 per cubic yard of dredged material), or $67 million over a 20-year planning period.[3] Adverse impacts to overwintering female blue crab in WTAPS are of concern to agencies of the Commonwealth of Virginia, and is the purpose for preparing this EA.

Alternative 1 (No Action) is the current Federal Standard for placement of dredged material from the York Spit Channel and has a non-federal sponsor. As such, it represents the least costly alternative consistent with sound engineering practices, and meets the environmental standards established by the 404(b)(1) evaluation process. This alternative is feasible and has been retained for further assessment. Impacts of the No-Action Alterative are compared to the impacts of implementing the Preferred Alternative in Section 8.0 below.

6.2 ALTERNATIVE 2: WOLF TRAP ALTERNATE OPEN WATER PLACEMENT SITE NORTHERN EXTENSION

Alternative 2 would establish an extension of the existing WTAPS site to the north, increasing the size of the placement site by approximately 3,900 acres. This alternative has been recommended by agencies of the Commonwealth of Virginia to minimize adverse impacts to overwintering female blue crab, which have the potential to be highly abundant in the southern portion of WTAPS. Aside from the increased travel distance (average distance of 14.3 nm vs. 8.5 nm), this alternative would otherwise be identical to the No-Action Alternative, and would rely upon the same methods, equipment, schedule and other factors. It would generate additional carbon emissions from project vessels, due to the increased travel distance, although the project area is in attainment for air quality standards. This alternative is not expected to have any other significantly different environmental impacts, relative to the No-Action Alternative. The estimated cost (in FY 19 dollars) for this alternative exceeds the No-Action Alternative by approximately $4.4 million per cycle ($10.30 per cubic yard of dredged material), or $21.9 million over a 20-year planning period, due to the increased travel distance and fuel consumption between the dredging and the placement site. WTAPSNE is being pursued as the non-federal sponsor's locally preferred plan under the condition that the sponsor pay any costs above placement at WTAPS (Federal Standard).

Alternative 2 is feasible, as it would rely on typical equipment and methods, and would be supported by the current non-federal sponsor (MPA). It would be environmentally preferable compared to the No-Action Alternative, as it would reduce the likelihood of adverse impacts to blue crab by making additional placement areas available, including the deeper, muddy channel, which are usually avoided as an overwintering habitat by blue crab (Lipcius and Knick, 2016). This alternative is feasible and has been retained for further assessment.

[3] Cost estimates presented for these alternatives include the estimated cost of dredging, which is not part of the proposed action. These estimates are for comparison only.

6.3 ALTERNATIVE 3: DEFER MAINTENANCE DREDGING OF THE YORK SPIT CHANNEL

Under this alternative, maintenance dredging of the York Spit Channel would be deferred indefinitely. No maintenance dredging would occur within the York Spit Channel to remove shoaled sediments and thus, no placement of dredged material would be required. Shoaling of sediment typically requires maintenance dredging every 4 years to remove about 1.5 mcy. Deferral of maintenance dredging would result in accumulation of sediment and reduction of the effective depth of the navigation channel. The York Spit Channel would become draft limiting for vessels transiting to and from Baltimore, which with regular channel maintenance can accommodate vessels with a loaded draft of 49 ft. A reduction in draft results in decreased shipping efficiency and ultimately a reduction in regional economic benefits. This alternative would forego potential regional and national economic benefits accruing from improvements in Port of Baltimore berth capacity.

Alternative 9 (defer maintenance dredging) is feasible if the Commonwealth of Virginia imposes restrictions above the Federal Standard and the non-federal sponsor does not pay the incremental cost difference above the Federal Standard. However, USACE finds this alternative unacceptable because it would result in draft restrictions for vessel traffic. Draft restrictions would reduce vessel efficiency and negatively impact regional and national economic development. This alternative would result in no direct environmental impacts from maintenance dredging or the placement of dredged material. Due to the large economic consequence of this alternative, it is not retained for further assessment.

7.0 AFFECTED ENVIRONMENT

This section describes the existing conditions of each environmental, cultural and social resource topic that may be affected by the proposed action. A combination of literature reviews, agency coordination and information from previous Baltimore and Norfolk District projects and NEPA documents were used to focus on relevant issues and sensitive resources to be addressed in this EA. Each environmental, cultural and social resource topic was reviewed for its applicability to the project. Through this analysis, resource topics clearly not applicable to the proposed action were eliminated for further evaluation (summarized in Table 3 below). Potential impacts to these resources would be negligible, localized, and most likely immeasurable.

Table 3. Resource topics not evaluated in this Environmental Assessment.

Resource Topic	Reason for Elimination
Aesthetics	Negligible impact. Temporary presence of one hopper dredge would occur during open water placement activities. The west side of the proposed expansion site is located approximately 3 nm east of the nearest shoreline (Mathews County, Virginia). The vessel would be noticeable from land; however, from this distance, the hopper dredge would most likely blend in with other large vessels (tug and tow vessels, large fishing boats, and cargo ships) transiting through the area. The proposed action would not permanently obstruct the view of the Bay.
Water Use	Negligible impact. Use of the proposed expansion site will temporarily change during open water placement activities as navigation through the area and recreation and fishing activities would be more limited. Effects to navigation, recreation and fisheries are described in Sections 8.8, 8.9 and 8.10, respectively. The proposed action would not permanently change the use of the water in the vicinity of the proposed expansion site.
SAV and Oysters	Not applicable. The VMRC identifies no SAV or oyster beds within the boundaries or adjacent to the proposed expansion site (VMRC, 2019). The SAV is typically limited to depths of less than 2 m, and oysters to depths of less than 8 m in Chesapeake Bay (VIMS, 2019a).
Wild and Scenic Rivers	Not applicable. The proposed expansion site is located in the mainstem of the Chesapeake Bay and there are no designated wild or scenic rivers adjacent to the proposed expansion site.
Climate Change	Negligible impact. USACE policy requires consideration of changes in river flow with climate change (USACE, 2018a). Climate change is anticipated to increase precipitation and change river flow into Chesapeake Bay. This may affect water quality in the lower and middle Bay somewhat, although magnitude of change is uncertain (CBP, 2008). Change over the next several decades appears unlikely to be of a magnitude that would have management implications for the proposed expansion site.
Hazard, Toxic and Radioactive Waste	Not applicable. No hazardous waste, brownfields, voluntary remediation programs, or federal Superfund sites are located in or adjacent to the proposed expansion site (VADEQ, 2019).

7.1 HYDROLOGY AND WATER QUALITY

7.1.1 Hydrology

Water levels in the Chesapeake Bay are dominated by a semi-diurnal tide. Due to its small depth-length ratio (bathymetry described in Section 7.2), the Bay accommodates more than one semidiurnal tidal wave at all times, which results in special tidal characteristics within the Bay. The mean tidal range decreases from 3 ft at the Bay's entrance to a minimum of 1 ft at Annapolis, Maryland, then rises to 2.3 ft at the head of the Bay. The typical tidal range in the action area is approximately 2.85 feet, although this varies significantly with time of the month (spring and neap tides) as well as storm activity, which can create significant storm surges well beyond the normal tidal range. Average tidal current amplitudes decrease from a maximum of 3.38 ft/second (s) at the mouth to a minimum of 0.43 ft/s in the middle Bay, and increase to 1.94 ft/s in the upper Bay (Xiong and Berger, 2010).

Wright et al. (1987) found that bay-stem plains and channels experience relatively strong near-bottom tidal currents. At an elevation of 20 cm above the bed, the tidal current velocity maxima exceed 20 cm/sec while at 1 m above the bed they exceed 40 cm/sec. Also, waves from the ocean (ocean swell) can extend into the Bay about as far north as the mouth of the Potomac River (Boon et al., 1996). Thus under conditions when this occurs, ocean waves could contribute energy moving bottom sediments in WTAPS and the proposed placement area. Past benthic monitoring has not focused on the impacts of sediment movement within WTAPS, though reference sites to the south of placement areas monitored by Schaffner (2010) and monitored sites in WTAPS showed evidence that non-local processes influenced patterns of benthic community recovery. A quarter-mile buffer area has been established for disposal activities at WTAPS, which may limit sediment dispersal to areas outside the designated disposal area.

Water circulation in the Bay is primarily driven by the downstream movement of fresh water from rivers and the upstream movement of salt water from the ocean. A gradient of increasing salinity is produced proceeding oceanward. Generally, salinity in the lower Chesapeake Bay Mainstem is characterized as polyhaline (salinity between 18 and 30 parts per thousand (ppt)), salinity in the middle to upper Bay Mainstem is characterized as mesohaline (salinity between 5 and 18 ppt), and salinity in the upper Bay Mainstem is characterized as oligohaline (0.5 and 5 ppt) and tidal fresh (0 and 0.5 ppt) (Figure 5) (Center for Conservation Biology, 2010). Tides pump water into and out of the Bay. In addition to salinity differences, the earth's rotation affects Bay circulation. Inflowing ocean water hugs the eastern shore, while outflowing Bay water hugs the western shore. Wind can mix the Bay's waters and occasionally reverse the direction of the flows. Major storm and flood events cause general circulation patterns to break down (CBP, 2019a).

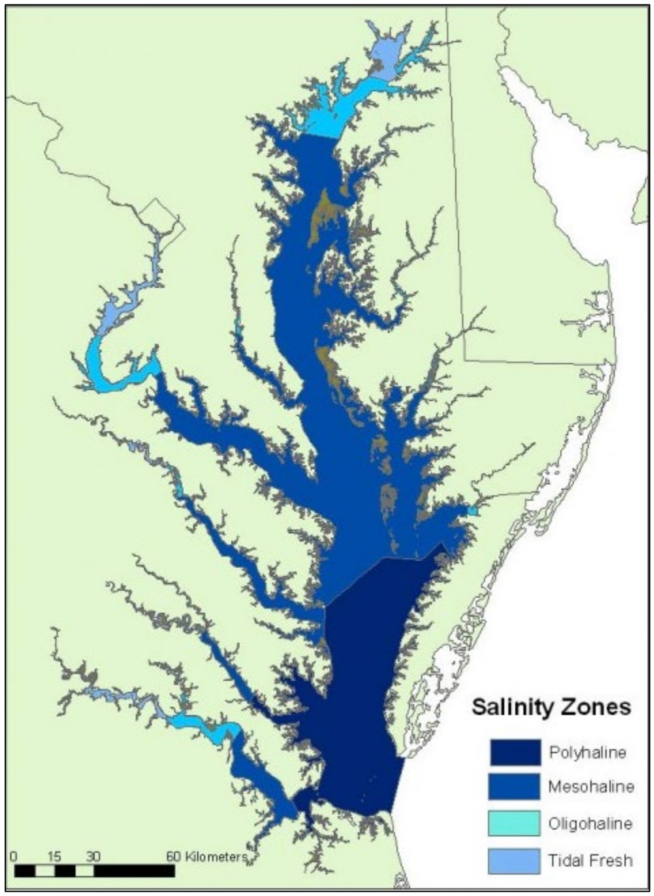

Figure 5. Salinity gradients in the Chesapeake Bay.

Less dense, fresher surface water layers are seasonally separated from saltier and denser water below by a zone of rapid vertical change in salinity known as the pycnocline. The pycnocline plays an important role in Bay water quality acting to prevent deeper water from being reoxygenated from above. Pycnocline depth varies in the Bay as a function of several factors. It shows general long-term geographic patterns, but varies over shorter time periods as a function of precipitation and winds. When substantial freshwater inflow occurs during warm weather months, it promotes stronger stratification that can last for extended periods during a year. Conversely, sustained winds in a single direction for several days can cause the pycnocline to tilt, bringing deeper water up into shallows on the margins of the Bay (CBP, 2019a).

Because of this partial seasonal separation into layers, or strata, the Bay is classified as a partially stratified estuary. Division of surface from deeper waters varies depending on the season, temperature, precipitation, and winds. In late winter and early spring, melting snow and high streamflow increase the amount of fresh water flowing into the Bay, initiating stratification for the calendar year. During spring and summer, the Bay's surface waters warm more quickly than deep waters, and a pronounced temperature difference forms between surface and bottom waters, strengthening stratification. In autumn, fresher surface waters cool faster than deeper waters and freshwater runoff is at its minimum. The cooler surface water layer sinks and the two layers mix rapidly, aided by winds. During the winter, relatively constant water temperature and salinity occurs from the surface to the bottom (CBP, 2019a).

Seasonal stratification produces vertical salinity differences in warm weather months in the middle and lower Bay. Waters below the pycnocline may be several to more than 10 ppt greater in salinity than surface waters in warm water conditions. Vertical salinity differences are greatest when substantial freshwater inflow occurs during warm weather months (Maryland BayStat, 2019).

7.1.2 Water Quality

Water quality information for the proposed expansion site was obtained using the Watershed Assessment, Tracking and Environmental Results System (WATERS) GeoViewer and Water Quality Assessment Report from the USEPA Office of Water (USEPA, 2019b; USEPA, 2019d). The proposed expansion site is located in segment "CB6PH", which is located in the northeastern half of the Virginia portion of the Chesapeake Bay between the mouths of the James and Rappahannock Rivers, hydrologic unit code (HUC) 02080101. Segment CB6PH is listed as impaired under USEPA's 303d list for reporting year 2014. The causes of impairment in this segment are dissolved oxygen and polychlorinated biphenyls (PCBs)[4] in fish tissue. A total maximum daily load (TMDL) has been developed for segment CB6PH for nutrients (nitrogen and phosphorus) resulting in decreased levels of dissolved oxygen. Probable sources contributing to the dissolved oxygen impairment include agriculture, atmospheric deposition – nitrogen, industrial point source discharge, internal nutrient recycling, loss of riparian habitat, municipal point source discharges, unspecified non-point source discharge, sources outside state jurisdiction, and wet weather discharges (point source and combination of stormwater). The source of the PCB impairment is unknown (USEPA, 2019b).

Long-term dissolved oxygen (DO) data, salinity and temperature data for the proposed expansion site was obtained from the Virginia Estuarine and Coastal Observing System (VECOS). Data was obtained from monitoring station "CB6.3 – Lower West Central Chesapeake Bay", which is located in the center of the proposed expansion site (VIMS, 2019b).

Dissolved Oxygen

The DO is critical to aquatic life in the Chesapeake Bay. Aquatic creatures, other than some microbes, need oxygen to survive. The DO concentrations vary depending on location and time of year, and are based on temperature, salinity, nutrient levels, and biological uptake. Many factors interact to determine the DO content of Chesapeake Bay tidal waters. Nutrient loading, water column stratification, wind and tidal mixing, and water temperatures are important factors (CBP, 2019a).

The DO concentrations of 5 mg/L (milligrams per liter) or greater allow Bay aquatic life to thrive. At DO levels below 2 mg/L, the water is considered hypoxic, and when DO drops below 0.2 mg/L,

---

[4] PCBs are a class of man-made compounds manufactured in the 20th century until 1979 that were used for a variety of industrial applications. PCBs are suspected human carcinogens. PCBs in sediments can be resuspended into the water column. PCBs bioaccumulate and biomagnify in some aquatic organisms, with accumulations/concentrations of concern occurring in bottom-oriented fish (ICPRB, 2007).

it is considered anoxic. The DO levels tolerable by aquatic life vary; with some organisms being more tolerant of low DO than others. Non-mobile and poorly mobile organisms, such as oysters, clams, and benthic invertebrates such as some worms, are unable to relocate when low DO conditions occur. Mobile organisms, such as fish and crab, can avoid low DO waters. However, chronically low levels of DO in the Chesapeake Bay reduces availability of inhabitable deep-channel and deep open-water habitat on a large scale. Availability of associated forage food for demersal (bottom-dwelling) fish species is also consequently reduced substantially. Hypoxia (low oxygen) consequently reduces the numbers and catch of demersal fish species (Buchheister et al., 2013). Severe near-absence of oxygen conditions (anoxia) occur perennially in the deep channel (below 39 feet in depth) in the middle Bay and in certain bowl-shaped areas of the Bay's bottom (CBP, 2019a; Versar, 2017). The WTAPSNE site is closer to the middle Bay areas with chronic low DO problems than is the WTAPS site.

Data from monitoring station CB6.3 show that typical bottom DO levels in the proposed expansion site reach near-hypoxic levels below 4 milligrams/liter (mg/l) during the summer months while surface DO remains above hypoxic levels at 6 mg/l during the summer months. DO levels potentially reach severe lower oxygen levels in the deeper channel during the summer months. During the winter months, both the surface and the bottom DO levels remain above hypoxic levels with a typical range of 8 to 12 mg/l at the bottom and a range of 10 to 12 mg/l at the surface (VIMS, 2019). Figure 6 shows the average surface and bottom DO levels in the proposed expansion site from 1984 to 2018 (CBP, 2019a).

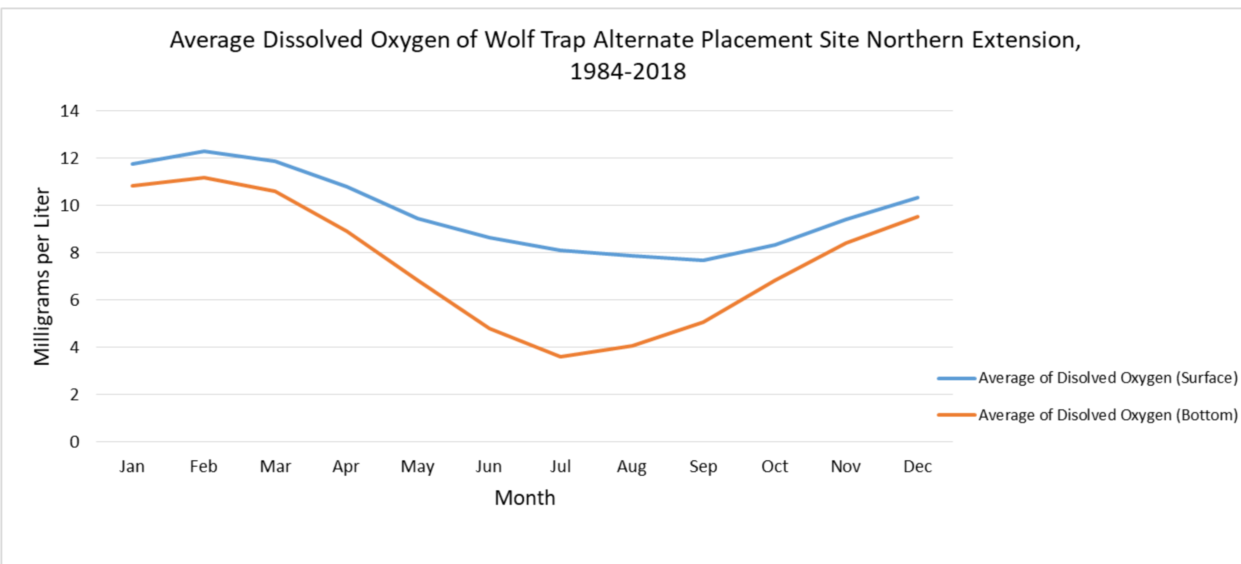

Figure 6. Average surface and bottom dissolved oxygen levels in the proposed Wolf Trap Alternate Open Water Placement Site Northern Extension from 1984 to 2018.

Water Temperature
Water temperatures in the Chesapeake Bay fluctuate widely throughout the year, ranging from 1° Celsius (C) in the winter to 29°C in the summer. Changes in water temperature influence when fish and crab feed, reproduce and migrate (CBP, 2019a). Figure 7 shows the average surface and bottom temperatures in the proposed expansion site from 1984 to 2018 (CBP, 2019a).

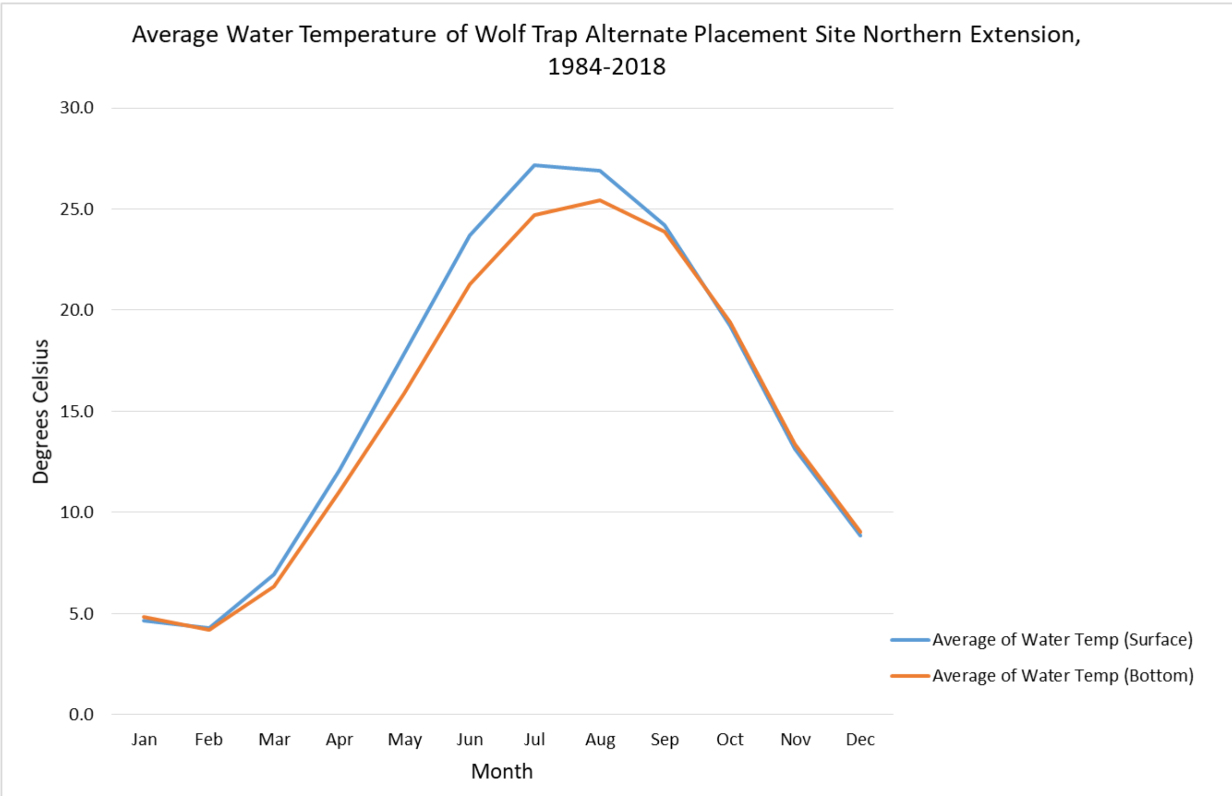

Figure 7. Average surface and bottom water temperatures in the proposed Wolf Trap Alternate Open Water Placement Site Northern Extension from 1984 to 2018.

Salinity
Salinity in the Chesapeake Bay varies from season to season and year to year depending largely on the amount of freshwater flowing into the Bay. Generally, salinity in the lower Chesapeake Bay is characterized as polyhaline (between 18 and 30 ppt) (The Center for Conservation Biology, 2010), illustrated in Figure 5. Normal surface salinities in the proposed expansion site vary from 10 to 24 ppt, with an average of 17.9 ppt. Normal bottom salinities vary from 14 to 28 ppt, with an average of 22.2 ppt. Figure 8 shows the average surface and bottom salinities in the proposed expansion site from 1984 to 2018 (CBP, 2019a).

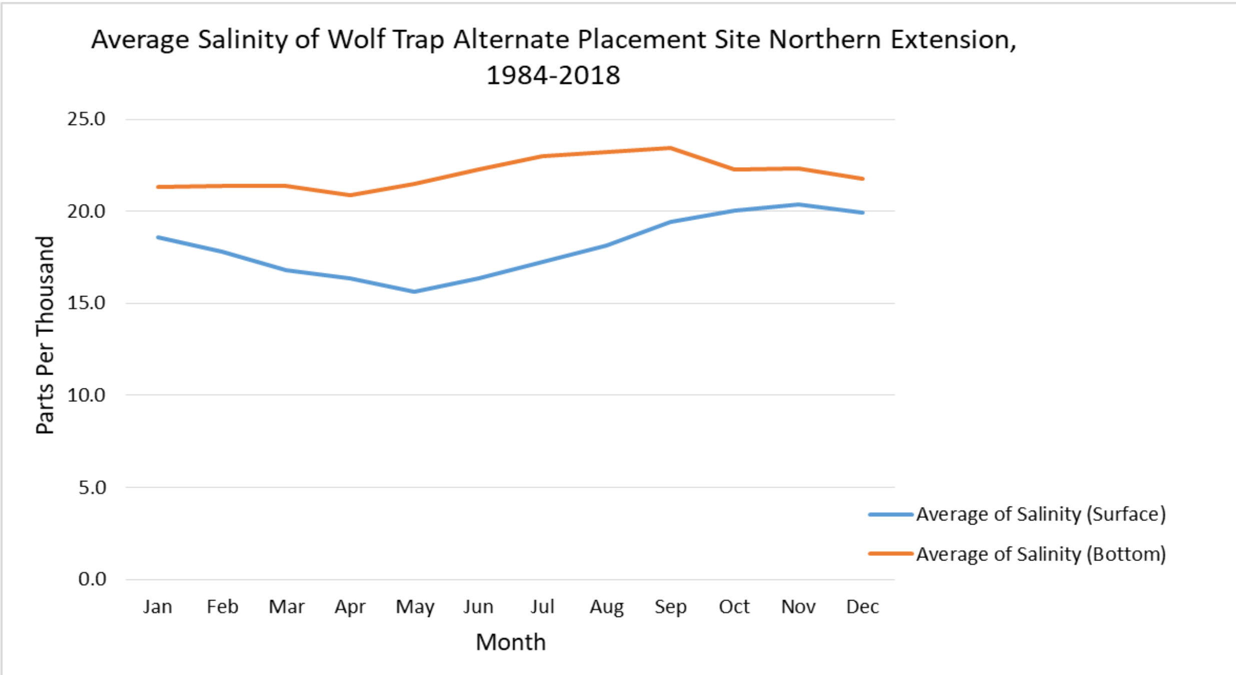

Figure 8. Average surface and bottom salinities in the proposed Wolf Trap Alternate Open Water Placement Site Northern Extension from 1984 to 2018.

7.2 BATHYMETRY

The Chesapeake Bay is located in the middle Atlantic Coastal Plain Province and is a large drowned river valley. Water depths in the Bay are relatively shallow; approximately 50 percent of the Bay is less than 20 ft deep, 35 percent has depths greater than 30 ft, 18 percent greater than 40 ft, and only 8 percent greater than 60 ft (Xiong and Berger, 2010).

The bottom of the proposed expansion site is characterized as a flat, relatively featureless plain (termed bay-stem plains by Wright et al. 1987) with a deep channel running lengthwise through the site (termed bay-stem channel by Wright et al. 1987) (Figure 9). Based on bathymetric surveys conducted by Baltimore District in April, July and August of 2017, water depths at the proposed expansion site range from 23 ft to 55 ft MLLW, with an average depth of 36 ft MLLW (Figure 10).

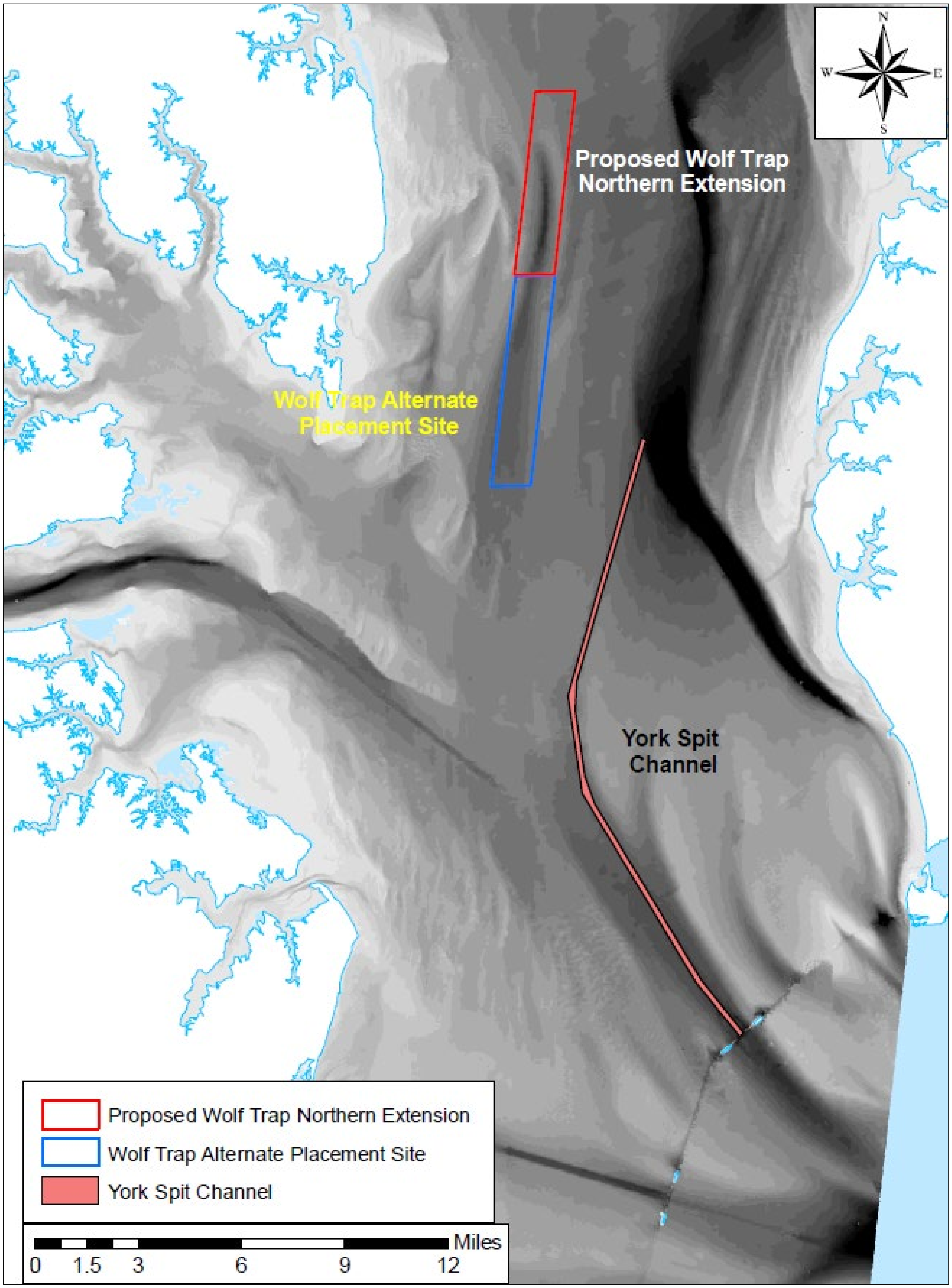

Figure 9. Bottom contours in the proposed Wolf Trap Alternate Open Water Placement Site Northern Extension. Background bathymetry data published by NOAA in 1998.

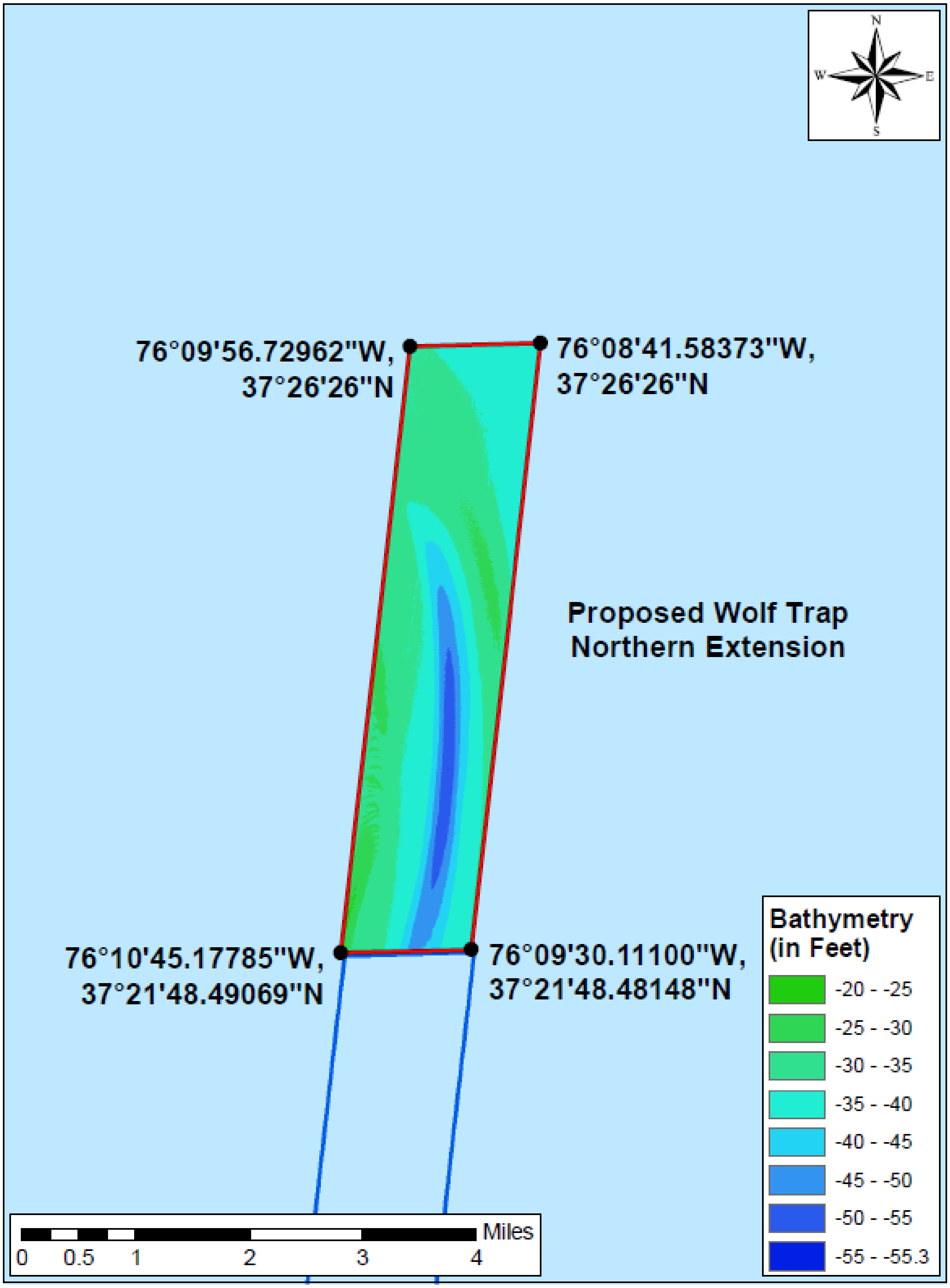

Figure 10. Bathymetry (in feet) in the proposed Wolf Trap Alternate Open Water Placement Site Northern Extension. Data collected by USACE in 2017.

7.3 GEOLOGY AND SEDIMENTS

Naturally deep channels in the lower Chesapeake Bay within the vicinity of the proposed expansion area are remnant features reflecting the Bay's geological evolution. At the time of maximum glaciation in the last Ice Age, what is today the Bay was a large, above sea-level valley of the ancient Susquehanna River and its tributaries. Sea level-rise following the end of the Ice Age to the present flooded the valley. Sediments infilled the valley where major sediment sources were available from rivers and eroding shorelines, or from sediment transported into the Bay from the ocean. The deep channels are far from these major sediment sources, and thus have remained deeper (USGS, 2003). While some bottom scour does occur in the area of interest, the naturally deep channels are not formed or maintained by modern scour processes.

The two bottom types found in the proposed expansion site, bay-stem plains and bay-stem channels, are typically composed of mud or fine sand with silt and clay filling interstices (Wright et al., 1987). No sediment testing has been conducted by USACE in the proposed expansion site. However, sediments in WTAPS are composed of very fine/fine sand and silts consistently throughout the entire site. In the west boundary of WTAPS, grain sizes were smaller with lower percentages of medium sand than in the east boundary (USACE, 2016a). Throughout the lower Bay, bottom sediments are routinely resuspended due to high energy flows from tidal currents. Sediment transport, deposition, and resuspension will vary within the lower Bay by bed variability (Wright et al., 1987).

The USACE conducted physical and chemical sampling of the York Spit Channel O&M material in June 2013 using methods outlined in the Inland Testing Manual, which is national guidance developed by the USEPA and USACE. Sediments from the northern part of York Spit Channel were predominantly comprised of silt and clays (79.5 percent) and were most similar to the sediments at WTAPS (78.4 percent silt/clay). Sediments from the southern part of the York Spit Channel were predominately comprised of sand (81.9 percent) (USACE, 2014).

Concentrations of detected analytes[5] in sediment samples from the York Spit Channel were compared to sediment quality guidelines (SQGs) for marine sediments to assess the sediment quality of the material proposed for dredging. The SQGs were used to identify potential adverse biological effects associated with contaminated sediments. Threshold effects levels (TELs) typically represent concentrations below which adverse biological effects are rarely observed, while probable effects levels (PELs) typically represent concentrations in the middle of the effects range and above which effects are more frequently observed (USACE, 2014).

Of the 18 tested metals[6], 9 of them – arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver, and zinc – have TEL and PEL values. All of the tested metals were detected in each sediment sample from the York Spit Channel; however, none of the concentrations exceeded TEL

[5] A substance whose chemical constituents are identified and measured.
[6] Rationale for testing these metals is derived from: USEPA/USACE. 1998. (EPA-823-B-98-004). Evaluation of Dredged Material Proposed for Discharge in Waters of the U.S. – Testing Manual.

or PEL concentrations. In addition to comparing sediment results to sediment quality guidelines, the acid volatile sulfide (AVS) / Simultaneously Extracted Metals (SEM) ratio was calculated to assess the bioavailability of the five simultaneously extracted metals included in the analysis (cadmium, copper, lead, nickel, and zinc). The AVS/SEM ratios for sediments from the York Spit Channel indicated that these metals would most likely be bound to organic matter[7] and would not be expected to be bioavailable to aquatic organisms in these locations. None of the tested polycyclic aromatic hydrocarbons (PAHs)[8] were detected in site water, receiving water, or in the standard elutriates samples taken from the York Spit Channel. This indicates that PAHs are tightly bound to sediments and are not likely to be released into the water column during open water placement. Total PCB concentrations in the York Spit Channel sediments did not exceed TEL values (USACE, 2014).

7.4 AIR QUALITY

The Clean Air Act of 1970 requires the USEPA to set National Ambient Air Quality Standards (NAAQS) for six common air pollutants including ground-level ozone, particulate matter, carbon monoxide, lead, sulfur dioxide, and nitrogen dioxide. The USEPA calls these "criteria air pollutants" because their levels in outdoor air need to be limited based on health criteria. These pollutants are found all over the United States and may cause health problems, harm the environment, and cause property damage (USDOE, 2000). Mathews County, Virginia (the closest county to the proposed expansion site) and neighboring Virginia counties including Gloucester, York and Northampton Counties are all currently in attainment (as of October 2, 2019) with the NAAQS (40 CFR Part 50) for the six principal pollutants. Attainment means that an area is meeting or is below a given safe standard set by the USEPA for the particular criteria pollutant (USEPA, 2019c).

7.5 FISH AND WILDLIFE

7.5.1 Threatened and Endangered Species

Federally-listed Species

Table 4 lists the federally-listed threatened and endangered species under the purview of NMFS as having the potential to occur in the proposed expansion site. No listed species critical habitat is located within the proposed expansion site. This species list was verified by NMFS Protected Resource Division Staff (B. Hopper, pers. comm. April 4, 2019). More details on the species listed in the table below can be found in Appendix B: Endangered Species Act Coordination.

[7] Matter composed of organic compounds that have come from the remains of organisms such as plants and animals and their waste products in the environment.

[8] PAHs form when gas, coal and oil are burned. PAHs are detected at varying concentrations across the watershed, with the highest reported in or near Baltimore Harbor and the Anacostia and Elizabeth rivers (CBP, 2019a).

Table 4. Federally-listed threatened and endangered species under the purview of NMFS that have the potential to be affected by the proposed Wolf Trap Alternate Open Water Placement Site Northern Extension.

Species	Distinct Population Segment (DPS)	Federal Status
Loggerhead Sea Turtle (*Caretta caretta*)	Northwest Atlantic	threatened
Green Sea Turtle (*Chelonia mydas*)	North Atlantic	threatened
Leatherback Sea Turtle (*Dermochelys coriacea*)	n/a	endangered
Kemp's Ridley Sea Turtle (*Lepidochelys kempii*)	n/a	endangered
Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*)	Gulf of Maine Carolina New York Bight Chesapeake Bay South Atlantic	Gulf of Maine – threatened; all other DPSs are endangered
Shortnose Sturgeon (*Acipenser brevirostrum*)	n/a	endangered

The USFWS Environmental Conservation Online System Information for Planning and Consultation (ECOS-IPaC) Website (USFWS, 2019) was used to identify any species under USFWS purview that has the potential to occur in the proposed expansion site. The ECOS-IPaC identified the northern long-eared bat (*Myotis septentrionalis*) as having the potential to occur in the proposed expansion site.

State-listed Species

Table 5 identifies the state-listed threatened and endangered species that have the potential to occur in the proposed expansion site (VADGIF, 2019). More details on the species listed in the table below can be found in Appendix B: Endangered Species Act Coordination.

Table 5. State-listed threatened and endangered species that have the potential to be affected by the proposed Wolf Trap Alternate Open Water Placement Site Northern Extension.

Species	State Status
Loggerhead Sea Turtle (*Caretta caretta*)	threatened
Green Sea Turtle (*Chelonia mydas*)	threatened
Leatherback Sea Turtle (*Dermochelys coriacea*)	endangered
Kemp's Ridley Sea Turtle (*Lepidochelys kempii*)	endangered
Hawksbill Sea Turtle (*(Eretmochelys imbricate)*	endangered
Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*)	endangered
West Indian Manatee (*Trichechus manatus*)	endangered

7.5.2 Finfish

Fish species occurring along the length of the Bay differ as a function of salinity and other factors. The middle and lower regions of the Bay have a greater biomass of fish species that spawn on the Continental Shelf, as well as sharks and rays, as compared to the upper Bay. The upper Bay contains a greater biomass of anadromous species that spawn in low salinity waters. Generally, the lower and middle Bay regions have more diverse and changing fish assemblages than the upper Bay throughout the year, primarily because of migration of many species. However, the upper Bay typically has more fish species occurring at any one place throughout the year because there is less turnover of species (Buccheister et al., 2013).

Low DO levels limit distribution and abundance of fish because fish avoid waters where DO drops below 4 mg/L. Demersal (bottom-oriented) fish of the Bay have had a substantial seasonal reduction in habitat availability with onset of vast anthropogenic hypoxia or anoxia. Forage for demersal fish in the middle Bay is reduced due to hypoxia and eutrophication stress, likely detrimentally affecting Atlantic croaker, white perch, and spot (Buccheister et al., 2013).

The Chesapeake Bay supports 348 species of finfish, 32 of which are year-round residents of the Bay (USACE, 2005; CBP, 2015). Many species enter the Bay either from freshwater streams or the Atlantic Ocean to feed, reproduce, and find shelter. Highly abundant species such as the Bay anchovy (*Anchoa mitchilli*) form a critical link in the food web, serving as the dietary basis for other species, including a variety of birds and mammals. The sport fish most commonly caught in the Chesapeake Bay in 2015 included white perch, striped bass, Atlantic croaker, freshwater catfish, spot, herring, summer flounder, and kingfishes (NMFS, 2015).

In November 2014, a total of 33,546 finfish were collected during bottom trawl sampling in WTAPS. Fish assemblages were dominated by bay anchovies, Atlantic croaker, northern kingfish, smallmouth flounder, and weakfish, which collectively accounted for 99 percent of all finfish collected. Bay anchovy alone accounted for 95 percent of the total number of fish collected. In June 2015, total finfish abundance was lower (2,307), and fish assemblages were dominated by bay anchovies, northern sea robins, weakfish, spotted hake, and Atlantic croaker, which collectively accounted for 84 percent of all fish collected. Total fish abundance in November 2015 (895) was lower than November 2014, primarily because of low bay anchovy abundances in November 2015 (USACE, 2016b).

7.5.3 Essential Fish Habitat

As shown in Table 7 below, 14 species have been identified as having Essential Fish Habitat (EFH) in the proposed expansion site, including the sandbar shark, which has Habitat Areas of Particular Concern[9] (HAPC) in the proposed expansion site. The sand tiger and dusky sharks *do not* have EFH within the proposed expansion site, but are Species of Concern with potential EFH in the

[9] EFH that is judged to be particularly important to the long-term productivity of populations of one or more managed species, or to be particularly vulnerable to degradation may also be identified by Fisheries Management Councils and NOAA Fisheries as HAPC. Areas of EFH considered HAPC must be proven to be important to the ecological function provided by the habitat for the managed species. The extent to which the habitat is sensitive to human-induced environmental degradation, including development activities that stress the habitat and the rarity of the habitat are considered.

lower Chesapeake Bay, in the vicinity of the proposed expansion site. These designations are based on the NOAA Estuarine Living Marine Resource (ELMR) program, the EFH habitat mapper tool, and NOAA EFH source documents. Based on salinity information presented in Section 7.1.2, the proposed expansion site is generally in the mixed/brackish ("M") zone, but occasionally rises past the 25 ppt threshold into seawater ("S") salinity zone (NOAA, 2018a; NOAA, 2019a; NOAA, 2019b). Please refer to Appendix C: Essential Fish Habitat Assessment for detailed descriptions of the species identified in Table 7 and their EFH.

Table 6. Summary of federally-managed species with Essential Fish Habitat in the proposed Wolf Trap Alternate Open Water Placement Site Northern Extension.

	Life Stage			
Species	**Eggs**	**Larvae**	**Juveniles**	**Adults**
Red hake (*Urophycis chuss*)			S	S
Windowpane flounder (*Scopthalmus aquosus*)			M,S	M,S
Summer flounder (*Paralicthys dentatus*)		M,S	M,S	M,S
Bluefish (*Pomatomus saltatrix*)			M,S	M,S
Atlantic butterfish (*Peprilus triacanthus*)	M,S	M,S	M,S	M,S
Scup (*Stenotomus chrysops*)			S	S
Black sea bass (*Centropristus striata*)			M,S	M,S
King mackerel (*Scomberomorus cavalla*)	X	X	X	X
Spanish mackerel (*Scomberomorus maculatus*)	X	X	X	X
Atlantic sea herring *(Clupea harengus)*				S
Sand tiger shark *(Carcharias taurus*)*			S	S
Sandbar shark *(Carcharhimus plumbeus*)			S	S
Dusky shark *(Carcharhinus obscurus)**				S
Clearnose skate (*Raja eglanteria*)			M,S	M,S
Little skate (*Leucoraja erinacea*)			M,S	M,S
Winter skate (*Leucoraja ocellata*)			M,S	M,S
S = Includes the seawater salinity zone (salinity ≥ 25.0‰). M = Includes the mixing water/brackish salinity zone (0.5‰ < salinity < 25.0‰). X = EFH has been designated for a given species and life stage.				

* The project area is not mapped as potential EFH for the sand tiger or dusky sharks; however, both species are included in Appendix C: Essential Fish Habitat Assessment because they are NOAA Species of Concern, and have potential EFH mapped in the lower Chesapeake Bay, a few miles south of the project location.

7.5.4 Benthic Community

Benthos is the community of organisms that live in or on the bottom sediment of water bodies. Benthos includes mobile and immobile organisms. Benthic invertebrates are animals without a backbone that live on top of or within bottom sediments in aquatic ecosystems. They are often used as indicators of water quality and ecological health due to their abundance, known pollution tolerances, and limited mobility. A typical healthy benthic community includes species characteristic of unstressed communities. In a polluted environment, these species would be replaced by species more tolerant of pollution. Most degraded communities would also tend to have fewer species, fewer large organisms deep in the sediment, and a lower total mass of organisms (Versar, 2013).

The benthic environment in the lower Chesapeake Bay is generally considered to be a more stable environment than what is observed in the middle and upper Bay. Lower Bay temperature and salinity are relatively stable compared to conditions in the upper Bay. Therefore, the biomass of benthic species is greater in the lower Bay (Nilson et al., 1982). The Benthic Index of Biotic Integrity (IBI) measures the condition of the benthic community living in or on the soft bottom areas of the Bay (UMCES, 2013). The Benthic IBI average annual score for the sampling station located in the proposed expansion site and in the existing WTAPS is considered good (CBP, 2015).

Bay-stem plains (the primary bottom type in the proposed expansion site) are colonized by high densities of tube dwellers including the annelid, *Euclymene zonalis*, the anemone, *Ceriantheopsis sp.*, and the amphipod crustacean, *Ampelisca abdita*. Sediment reworking by *Euclymene zonalis*, a "conveyor-belt" species, produces a hummocky bed surface (Wright et al, 1987). The benthic community in the bay-stem channel that runs lengthwise through the proposed expansion site may differ from the benthic community in the bay-stem plains due to limited near-bottom water exchange and greater seasonal oxygen stress.

In November 2014, samples were collected of the benthic macrofaunal assemblages in WTAPS. It is expected that this area has benthos similar to that of WTAPSNE. The WTAPS study showed the area was numerically dominated by Spionid polychaetes worms, which accounted for 42.5 percent of all individuals collected. Other common taxa included arthropods of the amphipod crustacean families Ischyroceridae and Caprellidae. Benthic biomass was dominated by mollusks in the northeast area of WTAPS. Mollusks were not a major component of the southern area of WTAPS, which had a large number of Chaetopterus annelid worms. The bivalves *Anaitides mucosa* and *Nucula proxima* were common in the northern half of WTAPS. Sampling of WTAPS in June 2015 found benthic macrofaunal assemblages were numerically dominated by Spionid polychaetes, which accounted for 31.9 percent of all individuals collected within WTAPS, followed by Capitellid polychaetes (17.4 percent) and Ampelisca amphipods (15.8 percent). Benthic biomass was fairly even across all of areas of WTAPS, with no peaks caused by relatively large-bodied bivalves (USACE, 2016b). Furthermore, sampling in November 2015 found that Spionid polychaetes were again the numerically dominant taxon, accounting for 51.7 percent of all individuals collected. Ampeliscid (9 percent) and Ischyrocerid (6.7 percent) amphipods were the next two most abundant taxa (USACE, 2016b).

The benthic community in WTAPSNE is not likely to be fundamentally different than the benthic community in WTAPS (except for the abundance of blue crab). However, the benthic community in WTAPSNE is likely to be colonized by species that are more tolerant of greater seasonal oxygen stress, silty conditions and deeper water depths.

7.5.5 Blue Crab

Blue crab are not federally-managed or listed, but they are a NOAA trust resource species[10] because of their ecological and economic significance. They are the most valuable commercial fishery in the Chesapeake Bay, and are important prey for many finfish species that have EFH in the project area. Cobia and red drum prey on adult and larger juvenile blue crab while summer flounder and sandbar shark prey on young juvenile blue crab (Maryland Sea Grant, 2011).

Blue crab habitat includes shallow and brackish waters, eelgrass beds, and muddy bottoms. In the Chesapeake Bay, mating occurs within shallow tributaries between May and October. After mating, female blue crab migrate from sub-estuaries to spawning areas in the lower Chesapeake Bay. When water temperatures fall below 10°C (typically December through March), blue crab activity ceases (e.g., movement and foraging) and the crab burrow into the sediment and begin a period of overwintering dormancy. In the Chesapeake Bay, most females go through an overwintering stage and produce broods of eggs the following spring (USACE, 2017b). In the tidal waters of Virginia, commercial harvest of crab by crab pot is not allowed from December 1 through March 16 (beginning in 2018), and the commercial harvest of crab using commercial gear is prohibited from November 1 through March 30 (VMRC, 2017). Juvenile blue crab utilize grass beds for nursery areas, and throughout the life stages of blue crab, grass beds are utilized for foraging.

VMRC has previously raised concerns regarding potential effects to overwintering female blue crab due to usage of the WTAPS, which is located to the south of the proposed expansion site. Lipcius and Knick (2016) analyzed data from the blue crab winter dredge survey conducted from 2009 to 2016 in WTAPS and the Rappahannock Shoal Placement Site. Lipcius and Knick (2016) reported a high abundance of overwintering female blue crab in the southern portion of WTAPS, moderate abundance in the north portion of the site, and low abundance in the middle of the site (Figure 11, note that actual densities are exaggerated by factor of 1,000 for visual clarity). They also reported considerable annual variability in female blue crab density at WTAPS, with low densities in 2012 and 2014 and high densities in 2013 and 2016 (Lipcius and Knick, 2016).

[10] NOAA trust resources are living marine resources that include: Commercial and recreational fishery resources (marine fish and shellfish and their habitats); Anadromous species (fish, such as salmon and striped bass, that spawn in freshwater and then migrate to the sea); Endangered and threatened marine species and their habitats; Marine mammals, turtles, and their habitats; Marshes, mangroves, seagrass beds, coral reefs, and other coastal habitats; and Resources associated with National Marine Sanctuaries and National Estuarine Research Reserves.

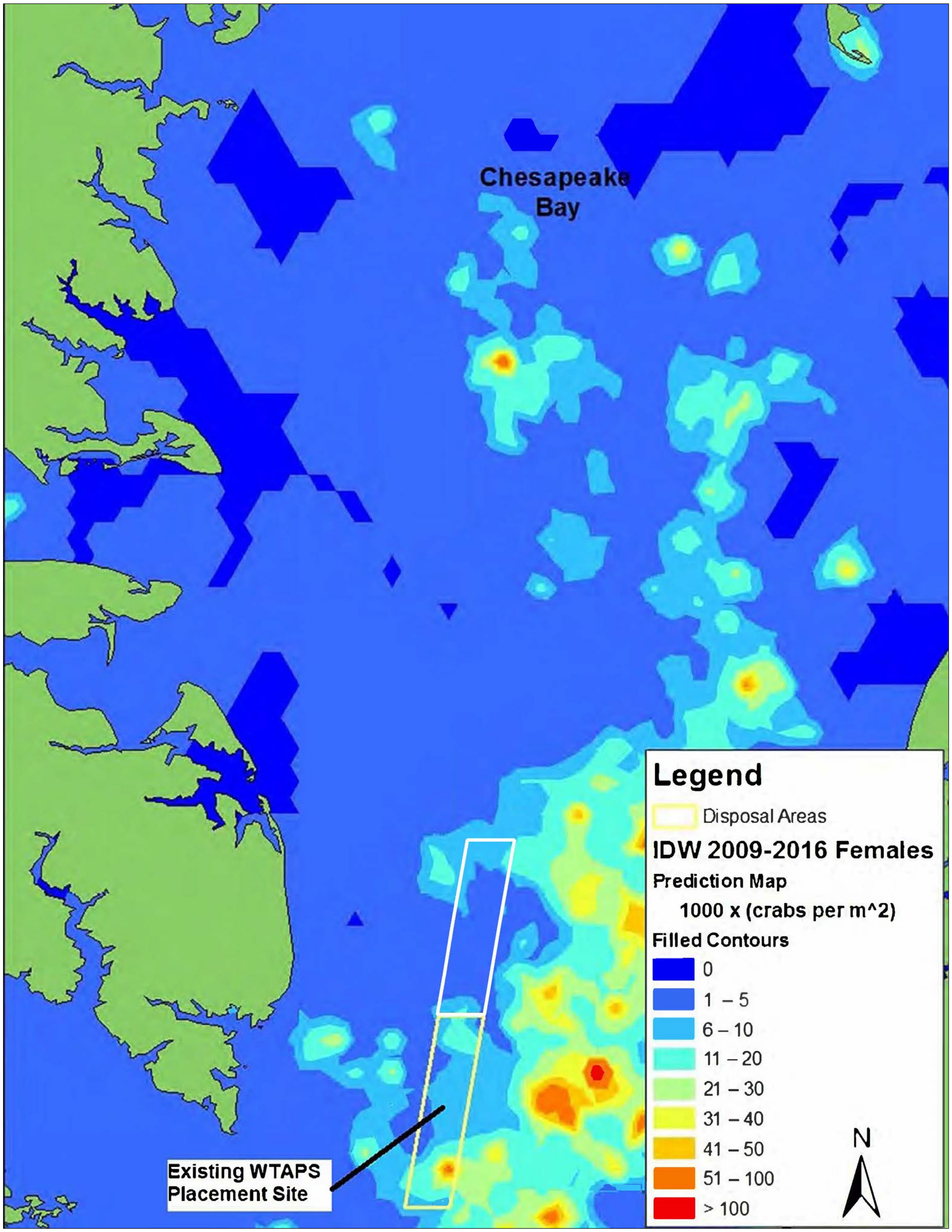

Figure 11. Relative density of overwintering female blue crab from 2009 to 2016. Density multiplied by a factor of 1,000 for clarity (modified from Lipcius and Knick, 2016).

7.6 CULTURAL RESOURCES

Cultural resources are locations of human activity, use, or occupation. They can be defined by expressions of human culture in this physical environment, such as prehistoric or historic archaeological sites, buildings, structures, objects, districts, or sacred sites among others. Cultural resources may also include natural features, plants, and animals that are deemed important or significant to a cultural group or community.

It is important to note that historic properties, as defined by 36 CFR 800, and the implementing regulations of Section 106 of the National Historic Preservation Act (NHPA) of 1966, as amended, are cultural resources that are eligible for inclusion in the National Register of Historic Places (NRHP). Historic properties may include districts, sites, buildings, structures, artifacts, ruins, objects, works of art, properties of traditional religious and cultural importance, or natural features important in human history at the national, state, or local level.

Section 106 of the NHPA requires consultation with the State Historic Preservation Office (SHPO) for proposed actions that may affect historic properties. The Virginia Department of Historic Resources (VDHR) is designated as the SHPO for Virginia. Consultation with the VDHR and federally-recognized Native American tribes is currently ongoing to identify cultural resources that may be impacted by the proposed action.

As part of Section 106 coordination, an area of potential effect (APE) was defined to evaluate any potential cultural resources that could be affected by the proposed action. The APE includes those areas where direct impacts are proposed, as well as areas within which the undertaking may directly or indirectly cause alterations in the character or use of historic properties, including visual effects. For this project, the APE includes the boundaries of the proposed expansion site.

The Virginia Cultural Resources Information System (V-CRIS) was utilized to identify previously mapped cultural resources within 1 mile of the project area (V-CRIS, 2019). According to the VCRIS, no cultural resources have been previously mapped within this radius; however, three Phase I and two Phase II archaeological surveys were conducted by Underwater Archaeological Joint Ventures in the 1980s within 1 mile of the project area. These were all in association with WTAPS. The Phase II investigations identified two sites, 44MT0035 and 44MT0036; the former is associated with a 20th century railroad tank car and the latter a 19th or 20th century ship or barge. Neither of these sites are affected by the placement activities at WTAPS.

Additionally, NOAA's Automated Wreck and Obstruction Information System (AWOIS) was utilized to identify any previously identified submerged wrecks or obstructions within the proposed expansion site. Neither of these were observed within the proposed expansion site, although an abandoned lighthouse is noted approximately 1 mile west of the site.

Given the history of the area and that previous archaeological surveys have observed multiple targets, a Phase I archaeological survey was recommended for the proposed expansion site. In June 2019, USACE contracted SEARCH to survey the proposed expansion site. The survey was conducted in accordance with the most recent version of the *Guidelines for Conducting Historic*

Resource Surveys in Virginia (VDHR, 2017). It was also performed by a professional archaeologist meeting the Secretary of Interior's Professional Qualifications Standards for Archaeology, as stated in 36 CFR 61.

The Phase I archeological survey report was finalized in October 2019. The survey identified ten targets (four are located within the northern expansion site placement cells) that could represent potential historic properties. One of the targets (adjacent to Cell NE-5) was identified as the *Polynia*, a steam yacht later converted to a barge that sank in 1917.

7.7 NOISE

The proposed expansion site is located in open water of the mainstem of the Chesapeake Bay. Daily noise levels are expected to be typical of an open water bay setting (i.e., recreational boating and commercial fishing activities). Large vessel traffic in the navigation channel located east of the proposed expansion site provides occasional noise as vessels pass through. The west boundary of the proposed expansion site is located approximately 3 nm from the nearest shoreline and any noise from the area is dissipated by wind, waves, and distance before it reaches land.

7.8 NAVIGATION

There are no marked navigation channels in or adjacent to the proposed expansion site (NOAA, 2018). Cargo vessel traffic follows a naturally-deep area of the Bay that is located approximately 4 nm east of the east side of the proposed expansion site. The proposed expansion site is used by fishing and recreational boaters, as well as a high density of tug and towing vessels that transit through the area (NOAA, 2019c). There are no navigational obstructions in the proposed expansion site (NOAA, 2018c). Water depths at the proposed expansion site proposed expansion site range from 23 ft to 55 ft MLLW, with an average depth of 36 ft MLLW, providing adequate water depth for recreational and fishing vessels as well as tug and tow vessels.

7.9 RECREATION

Recreational activities in the proposed expansion site include boating and fishing. Sport fish commonly caught in the Chesapeake Bay include striped bass, Atlantic croaker, spot, herring, summer flounder, and kingfishes (NMFS, 2015). Striped bass, also referred to as rockfish, are the top recreational sportfish in the Chesapeake Bay (NOAA, 2019). No oyster sites or artificial reef dive sites are located in the proposed expansion site.

7.10 FISHERIES

Chesapeake Bay fisheries play a critical role in the culture, economy, and ecology of the region. These species are ecologically and economically important for the Chesapeake Bay and may potentially be fished for in the proposed expansion site: blue crab (discussed in Section 7.5.5), menhaden, striped bass, and river herrings (including American shad, hickory shad, blueback herring, and alewife).

Blue Crab
(See Section 7.5.5)

Menhaden
In the past century, all but one Atlantic Coast state gradually banned the large scale fishing of menhaden. Today, Virginia is the only state that allows "reduction" (industrial) menhaden fishing, which takes about 80 percent of the catch coastwide. This reduction fishery removes approximately 80,000 tons of menhaden from the Virginia part of the Bay each year (CBF, 2019a).

In 2006, the Atlantic States Marine Fisheries Commission (ASMFC) capped the annual industrial catch in the Chesapeake based on concerns about malnutrition in striped bass and the need to protect the Bay ecosystem from localized depletion. This included a cap on the reduction harvest. In November 2011, the ASMFC decided to set new standards for menhaden management. In November 2017, the ASMFC approved Amendment 3 which included a management action to decrease the reduction fishery harvest cap in the Chesapeake Bay by 41.5 percent, to 51,000 metric tons, protecting important nursery habitat (CBF, 2019a).

Striped Bass
The striped bass is one of the most sought-after commercial and recreational fish in the Chesapeake Bay. A number of environmental challenges in the Chesapeake Bay threaten striped bass, including habitat loss, lack of prey, pollution, hypoxia and disease. Climate-driven changes in temperature and rain patterns may further impact striped bass' ability to bounce back from declines. Striped bass experienced a severe decline in the 1970s and 1980s that scientists attributed to overfishing, which may have made striped bass more susceptible to pollution and other stresses. In response to this downturn, Congress passed the Atlantic Striped Bass Conservation Act in 1984. Maryland and Delaware imposed a fishing moratoria on striped bass from 1985 through 1989, and Virginia imposed a 1 year moratorium in 1989. The Chesapeake fishery reopened in 1990 (CBP, 2019b). In order to reduce fish mortality and restore a thriving striped bass population, the ASMFC recently voted to begin developing changes to the Interstate Fishery Management Plan for the striped bass harvest coastwide (CBF, 2019b).

River Herrings
Alosines are anadromous—they migrate from the ocean waters into fresh waters to spawn. Commercial landings for all these species have declined dramatically from historic highs. Currently, there is a moratorium on the harvest of American shad from Virginia's waters that has been in place since 1994. American shad stock does not appear to be recovering and are at record lows. A harvest moratorium for river herring in Virginia has been in place since 2012 (NOAA, 2016).

8.0 ENVIRONMENTAL EFFECTS

This section presents the effects from the No-Action Alternative (Alternative 1) and the Preferred Alternative (Alternative 2) on each resource topic discussed in Section 7.0 above. For this analysis, the No-Action Alternative would mean the proposed action would not take place and dredged material would continue to be placed in the WTAPS. The resulting environmental effects from continued placement in the WTAPS would be compared with the effects anticipated from the proposed action (Alternative 2). The environmental effects of the No-Action Alternative are expected to be similar to the environmental effects of Alternative 2, with the exception of effects on overwintering female blue crab.

Table 7 provides a summary of the potential effects of implementing the No-Action Alternative (Alternative 1) and the Preferred Alternative (Alternative 2). Impacts of the No-Action Alternative are not evaluated in this section. These impacts were evaluated in in the 1987 Supplemental Information Report #2 to the 1981 General Design Memorandum (GDM) and Environmental Impact Statement (EIS) (USACE, 1987), and in the 2005 Baltimore Harbor and Channels (Maryland and Virginia) DMMP and Final Tiered EIS (USACE, 2005).

Table 7. Summary of potential effects from Alternative 1 (No-Action) and Alternative 2 (Preferred Alternative).

Resource Topic	Alternative 1 – No Action	Alternative 2 – Preferred Alternative
Hydrology and Water Quality	Overall water circulation is expected to be unimpacted. Minor, short-term turbidity impacts. Suspended particles are expected to settle out within a short time, with no long-term measurable effects on water quality	Overall water circulation is expected to be unimpacted. Minor, short-term turbidity impacts. Suspended particles are expected to settle out within a short time, with no long-term measurable effects on water quality.
Bathymetry	Over the life of the project, the depth of the site could change from an average depth of -35 ft MLLW to -30 ft MLLW. No changes to physiography.	Over the life of the project (until 2100), the depth of the site could change from an average depth of -36 ft MLLW to -30 ft MLLW. Infilling the trough with dredged material would change this area from a bay-stem channel to a bay-stem plain.
Geology and Sediments	No geologic changes are expected.	No geologic changes are expected.
Air Quality	Minor, short-term, localized impacts associated with the transport of dredged material to the placement site. No long term effects anticipated. Adjacent counties are in attainment with the Clean Air Act.	Minor, short-term, localized impacts associated with the transport of dredged material to the placement site. No long term effects anticipated. Adjacent counties are in attainment with the Clean Air Act.
Federally-Listed Threatened and Endangered Species	Species under NMFS purview - may adversely affect, but is not likely to jeopardize the continued existence of any DPS of Atlantic sturgeon, Kemp's ridley or green sea turtles, or the Northwest Atlantic DPS of loggerhead sea turtles. Not likely to adversely affect leatherback sea turtles or shortnose sturgeon. Species under USFWS purview – No effect on the Northern long-eared bat.	Species under NMFS purview - may adversely affect, but is not likely to jeopardize the continued existence of any DPS of Atlantic sturgeon, Kemp's ridley or green sea turtles, or the Northwest Atlantic DPS of loggerhead sea turtles. Not likely to adversely affect leatherback sea turtle or shortnose sturgeon. Species under USFWS purview – No effect on the Northern long-eared bat.
State-Listed Threatened and Endangered Species	May adversely affect, but is not likely to jeopardize the continued existence of Atlantic sturgeon, Kemp's ridley or loggerhead sea turtles. Not likely to adversely affect leatherback sea turtles. No effect on the hawksbill sea turtle or the West Indian Manatee.	May adversely affect, but is not likely to jeopardize the continued existence of Atlantic sturgeon, Kemp's ridley or loggerhead sea turtles. Not likely to adversely affect leatherback sea turtles. No effect on the hawksbill sea turtle or the West Indian Manatee.

Resource Topic	Alternative 1 – No Action	Alternative 2 – Preferred Alternative
Finfish	Some slow-moving benthic individuals, as well as eggs and larvae would be buried by sediment. Adverse impacts to the bottom feeder finfish population are expected to be negligible. Turbidity may cause temporarily disorientation for some finfish. Most finfish are expected to be able to avoid being directly impacted by placement activities, and would be temporarily displaced during placement operation. No significant impacts to finfish expected.	Some slow-moving benthic individuals, as well as eggs and larvae would be buried by sediment. Adverse impacts to the bottom feeder finfish population are expected to be negligible. Turbidity may cause temporarily disorientation for some finfish. Most finfish are expected to be able to avoid being directly impacted by placement activities, and would be temporarily displaced during placement operation. No significant impacts to finfish expected.
Essential Fish Habitat	Habitats for managed species and their prey would be temporarily effected during placement activities.	Habitats for managed species and their prey would be temporarily effected during placement activities.
Benthic Community	It is expected that the benthic community will recolonize within 1.5 years and that the community will have an opportunity to fully recover following each dredged material placement event and prior to the subsequent such event.	It is expected that the benthic community will recolonize within 1.5 years and that the community will have an opportunity to fully recover following each dredged material placement event and prior to the subsequent such event.
Blue Crab	Potential adverse effects depending on the density of crab in the area during placement activities. Direct mortality, by burial or asphyxiation, of overwintering female crab, when these crab are present within the dredged material placement area, especially in overburden thicknesses greater than 30 cm.	Minor to negligible adverse effects. WTAPSNE is believed to support significantly fewer overwintering female crab than WTAPS, and thus the project would constitute, overall, a net reduction of the effect to blue crab.
Cultural Resources	Phase II investigations identified two sites, 44MT0035 and 44MT0036; the former is associated with a 20th century railroad tank car and the latter a 19th or 20th century ship or barge. Neither of these sites are affected by placement activities at WTAPS.	The Phase I archeological survey report identified ten targets (four are located within the northern expansion site cells) that could represent potential historic properties. To avoid any potential adverse effects to historic properties, USACE plans to place material only in Cell NE-6, which does not contain any potential historic properties. USACE developed

Resource Topic	Alternative 1 – No Action	Alternative 2 – Preferred Alternative
		a PA in consultation with VADHR that includes procedures for evaluating the project's effects to historic properties in future placement cycles outside of Cell NE-6.
Noise	Short-term and restricted to the immediate vicinity of the activity.	Short-term and restricted to the immediate vicinity of the activity.
Navigation	The hopper dredge will not impede navigation in a marked navigation channel. To minimize the risk of collision, USACE would require the contractor to comply with USCG regulations.	The hopper dredge will not impede navigation in a marked navigation channel. To minimize the risk of collision, USACE would require the contractor to comply with USCG regulations.
Recreation	Temporary impacts to recreation during placement activities. The public will be able to access the area shortly after placement activities occur.	Temporary impacts to recreation during placement activities. The public will be able to access the area shortly after placement activities occur.
Fisheries	Fishing would be shifted elsewhere during placement activities. The proposed action would be expected to have a negligible or minor impact on fisheries.	Fishing would be shifted elsewhere during placement activities. The proposed action would be expected to have a negligible or minor impact on fisheries.
Environmental Justice	No disproportionally high and adverse human health or environmental effects on minority populations and low-income populations in the United States.	No disproportionally high and adverse human health or environmental effects on minority populations and low-income populations in the United States.

8.1 HYDROLOGY AND WATER QUALITY

Upon placement, dredged material will partition into a main cloud, which will descend vertically. The main cloud would descend to the bottom at a high velocity, leaving behind a turbidity cloud (USACE, 2005).

Open water placement activities are expected to create some degree of turbidity in excess of ambient conditions up to 6,500 ft from the discharge location. During placement activities, suspended sediment levels can be as high as 500 mg/l within 250 feet of the discharge location, decreasing to background levels (i.e., 15 to 100 mg/l depending on location and sea conditions) within 1,000 to 6,500 feet of the discharge location. Total suspended solids (TSS) concentrations near the center of the plume created by the placement of dredged material have been observed to reach near background levels in 35 to 45 minutes (NOAA, 2017). Furthermore, the high flushing rate (due to the water exchange and tidal fluctuations) of the Chesapeake Bay is anticipated to minimize potential turbidity plumes and cause them to be more quickly dispersed, with no long-term measurable impacts to water quality.

The proposed expansion site is susceptible to wave-induced velocities that may cause sediments to become resuspended in the water column. The site is relatively shallow, with an average depth of 36 ft, and the area can experience wind speeds of 35 miles per hour or greater. The combination of water depth and high wind speeds may cause wave-induced velocities that could resuspend deposited materials. This generally occurs less than 48 hours per year. Material eroded out of this placement site would be expected to move northward in the Bay or locally to deeper parts of the Bay floor (USACE, 1981).

Based on the sampling results, the placement of dredged material from the York Spit Channel into WTAPSNE would not be toxic to marine life. Metals of concern and PAHs occur at low levels, and would likely settle out onto the bottom remaining adsorbed to sediment and not be released into the water column.

Overall water circulation is expected to be unimpacted. No measurable changes in temperature, salinity, oxygen content or other chemical characteristics are expected. It is possible that infilling the trough with dredged material could reduce hypoxic conditions in the proposed expansion site. Water quality impacts during open water placement activities are expected to be temporary, minimal and similar to conditions of past placement events in WTAPS. Suspended particles are expected to settle out within a short time, with no long-term measurable effects on water quality. Thus, the proposed action would not result in any significant adverse impacts to water quality.

8.2 BATHYMETRY

Placement of dredged material into the proposed expansion site will change the bathymetry of the site. Depending on the amount of material dredged from the York Spit Channel during one maintenance dredging cycle, the thickness of the material that would be deposited in one cycle would range from 2 inches to 2 ft thick. It is expected that over time, some of the material will erode out of the placement site. Past benthic monitoring has not focused on the impacts of sediment movement within WTAPS, though reference sites to the south of the placement area monitored by Schaffner (2010) and monitored sites in WTAPS showed evidence that non-local processes influenced patterns of benthic community recovery. A quarter-mile buffer area has been established for placement activities at the northern expansion site, which may limit sediment dispersal to areas outside the designated placement cells. The capacity of WTAPSNE is over 30 mcy, which assumes placement of dredged material within the site boundaries up to an approximate depth of -30 ft MLLW. Over the life of the project (until 2100), the depth of the site could change from an average depth of -36 ft MLLW to -30 ft MLLW.

A deep trough with a maximum depth of -55 ft MLLW termed “bay-stem channel” runs lengthwise through the site. If this channel was filled with dredged material, this area would change from a bay-stem channel to a bay-stem plain. As stated in Section 8.1 above, it is possible that infilling the trough with dredged material could reduce hypoxic conditions in the proposed expansion site.

8.3 GEOLOGY AND SEDIMENTS

Quality and texture of sediments dredged from the York Spit Channel is expected to be similar to the existing sediments in WTAPSNE. Therefore, no changes in geology in the proposed expansion site are expected.

8.4 AIR QUALITY

Minor, short-term, localized direct impacts to air quality would occur as a result of dredging activities that generate exhaust emissions every 4 years. Emissions will cease once construction stops. No long-term impacts to air quality would occur. Emissions would not pose a significant risk to the environment or the health of workers or the public because they will be minor in quantity and short-term in nature. Because the proposed expansion site is in attainment, in compliance with the approved air quality Implementation Plan in Virginia, and no new stationary emissions sources will be created as part of the proposed action, no air quality conformity analysis is required.

8.5 FISH AND WILDLIFE

8.5.1 Threatened and Endangered Species

Federally-listed species

Effects from the No-Action Alternative (continued placement in the WTAPS) on NMFS-trust threatened and endangered species was assessed in the 2018 NMFS Biological Opinion (BO) (F/NER/2018/14816) (NOAA, 2018b). Activities covered under this BO included the construction and maintenance of the Baltimore Harbor and Channels Project Virginia Approach Channels and use of the associated dredged material placement sites. In the BO, NMFS concluded that that these activities may adversely affect, but are not likely to jeopardize the continued existence of any DPS of Atlantic sturgeon, Kemp’s ridley or green sea turtles or the Northwest Atlantic DPS of loggerhead sea turtles and is not likely to adversely affect leatherback sea turtles, hawksbill sea turtles, shortnose sturgeon, fin whales, sei whales, blue whale, sperm whales, and North Atlantic right whales. The BO allowed for a certain number of incidental take of listed species, primarily from dredging and not from placement, over the life of the project (50 years). The BO also included reasonable and prudent measures designed to minimize and monitor the impact of incidental take that might otherwise result from the activities including a time-of-year (TOY) restriction for dredging.

There are two peak windows for turtle activity in the lower Chesapeake Bay; in the spring (March to May) and in the fall (September to November). Restrictions on dredging during both windows was deemed by Baltimore District to be too restrictive to dredging. Additionally, at least 6 contiguous months is required for dredging contracts. Therefore, in consultation with NMFS, USACE makes every effort to avoid dredging during the fall window (from September 1 through November 14) because more turtles have historically been taken during hopper dredge activities in the fall than during the spring. For example, the 2015 hopper dredging contract was impacted by post-Hurricane Sandy work and resulted in dredging occurring from May-Aug 2015. This resulted in 6 turtles takes.

The USACE, in coordination the NMFS, determined that the effects on listed species from the proposed action are similar to the effects considered in the 2018 NMFS Biological Opinion (F/NER/2018/14816) (NOAA, 2018b) for the lower Bay channels and placement areas. In an email dated May 6, 2019, NMFS concurred with the USACE determination that re-initiation is not warranted. Please refer to Appendix B: Endangered Species Act Coordination, for a detailed analysis on the effects of the proposed action on listed species and the rationale for the "no re-initiation" determination.

The USACE determined that there will be no effect to listed species under the purview of USFWS. An effects analysis for the northern long-eared bat can be found in the USFWS Project Review Package located in Appendix B: Endangered Species Act Coordination. Through the online project review process, USFWS concurred with USACE's "no effect" determination in a letter dated February 14, 2019.

State-listed species

The Kemp's ridley, leatherback and loggerhead sea turtles and the Atlantic sturgeon are also federally-listed. An effects analysis for each of these species is included in the Request for Concurrence from NMFS of a No Re-Initiation Determination for WTAPSNE that is located in Appendix B: Endangered Species Act Coordination.

The hawksbill sea turtle is listed as endangered by the Commonwealth of Virginia (VADGIF, 2019). Hawksbill sea turtles are extremely rare in the Chesapeake Bay; only two have been reported since 1979. These turtles prefer tropical and subtropical waters (VIMS, 2019). Since it would be extremely rare for a hawksbill sea turtle to occur in the Chesapeake Bay, the proposed action will have no effect on the hawksbill sea turtle.

The West Indian manatee is listed as endangered by the Commonwealth of Virginia (VADGIF, 2019). The West Indian manatee is rarely seen in the Chesapeake Bay; its northernmost range is the Georgia coast. The West Indian manatee is found along the coast of Florida and in the Caribbean (USFWS, 2008). The last local live sighting was in November 2017 at the VIMS boat basin (Daily Press, 2017). Since it would be extremely rare for a West Indian manatee to occur in the Chesapeake Bay, the proposed action will have no effect on the West Indian manatee.

8.5.2 Finfish

Available literature regarding specific effects to fish behavior from dredged material placement activities is generally confined to turbidity, with little information available on effects from other aspects of dredging and placement.

It is anticipated that some slow-moving benthic individuals (bottom feeder finfish including windowpane, summer and winter flounder, scup, hogchoker, northern sea robin, northern stargazer (CBP, 2019a)), as well as larvae and eggs suspended in the water column, would be buried by 2 inches to 2 ft thick of sediment as a result of placement activities. Benthic individuals would be particularly vulnerable during months of coldest bottom water when fish could be lethargic.

It is expected that individuals would be permanently lost; however, impacts to the bottom feeder finfish population are expected to be negligible. Turbidity may cause temporary disorientation for some finfish. Because of their high mobility, most finfish are expected to be able to avoid being directly impacted by placement activities and would be temporarily displaced during placement operation. The existing community is also probably exposed to episodic oxygen stress and hypoxia, at least during some summers. Therefore, it is highly unlikely that finfish will suffer significant impacts as a result of placement activities.

8.5.3 Essential Fish Habitat

Please see Appendix C: Essential Fish Habitat Assessment for a comprehensive effects analysis for each species with EFH in the proposed expansion site. NMFS conservation recommendations and the USACE response to the recommendations and are included in Appendix C. In summary, potential adverse effects to EFH of the 14 species described in this assessment would be periodic and concurrent with maintenance dredging of the York Spit Channel roughly every 4 years. Potential adverse effects due to turbidity and sedimentation would be temporary. The proposed dredged material placement would potentially disturb motile life stages of managed fish species, at least temporarily, which may cause them to seek alternative habitats elsewhere. This avoidance would occur only when dredged material placement activities are underway. The proposed placement sites comprise a small proportion of the suitable area within the lower Bay. There would be plentiful habitat available throughout the Bay, to include adjacent waters, from which fishes can forage during project activities. In-water work would occur over several months, and once completed, the local habitats would again be available to all managed fish species and their prey.

8.5.4 Benthic Community

This community is characterized by opportunistic and equilibrium species that are adapted to and tolerant of bottom-disturbing events such as major storms and flows. The existing community is also probably exposed to episodic oxygen stress and hypoxia, at least during some summers.

Bottom-dump placement of dredged material typically produces mounded deposits on the bay bottom, and the thickness of such mounds and the force of impacting sediment will be lethal to benthic organisms within the footprint of the deposit.

Impacts of dredged material placement on benthic habitats are varied and difficult to predict. Although many projects have been monitored and substantial literature exists on the subject, few generalizations can be made about typical recovery[11] rates because biological responses are influenced by numerous factors, including site-specific bathymetry, hydrodynamics, thickness of sediments, spatial scale of the disturbance, sediment type and the timing and frequency of disturbance. In general, recovery of the benthic community in deep, stable habitats is measured in years (Wilber and Clarke, 2007).

A 2 year study by VIMS showed that benthic communities in WTAPS recovered fairly quickly, particularly when the depth of sediment deposited at the disposal site was relatively shallow. Sites buried by 6 inches or less of dredged material were minimally affected, with many of the organisms able to burrow back up to the surface. These organisms likely evolved this ability in response to frequent burial by tides and storms in the lower Chesapeake Bay. With deeper burial, beneath more than 6 inches of sediment, it took 1.5 years or less for the study sites to converge with reference sites in terms of species richness, abundance, biomass, and community composition. Recolonization via immigration from nearby areas was apparently more important for re-establishing benthic communities than upward migration of animals through the new sediment layers (Schaffner, 2010).

It is expected that the dredged material placement locations would return to pre-placement conditions following the project activities, with an approximation that the benthic community would become recolonized within 1.5 years. Placement activities would occur in accordance with the anticipated York Spit Channel maintenance schedule, or as necessary as a result of shoaling from storm events and other environmental factors. The benthic community would have an opportunity to fully recover following each dredged material placement event and prior to the subsequent such event.

8.5.5 Blue Crab

The effects of dredged material placement upon blue crab survival was studied by Norfolk District and Engineer Research and Development Center (ERDC), using a controlled mesocosm study. Burial of mature female blue crab at depths of 5 and 10 cm increased mortality, whereas few crab survived burial depths of 30 cm. There did not appear to be an effect of burial duration, i.e., mortality rates did not increase over time. Although water temperatures reached lows of -2°C, the high survival rates of control crab suggest low temperatures alone did not cause mortality. In addition, because survivors were recovered at the sediment surface, it appears that an inability to ascend through the sediment overburden was the cause of death, with a burial depth of 30 cm most associated with having very few crab recovered at the sediment surface (USACE, 2017b).

[11] Recovery is defined as a return of benthic resources to a baseline (pre-impact) condition.

Blue crab populations in the Bay show substantial variation from year to year as a function of multiple natural and anthropogenic factors. Many factors influence fluctuations in blue crab abundances, including larval success, prey availability, predator abundance, habitat degradation, and disease. Overwintering mortality is another important factor affecting the variability in population size. Overwintering studies have found that smaller blue crab are more likely to survive intense cold winters and mature females are more susceptible to mortality. Overwintering blue crab survival is highest in warmer, saline waters (USACE, 2017b).

Short-term project effects to blue crab would consist primarily of direct mortality, by burial or asphyxiation, of overwintering female crab, when these crab are present within the dredged material placement area. Turbidity would result in suspended particulates within the water column and may temporarily degrade ambient water quality for nutrients, dissolved oxygen content, and other constituents. Turbidity may also clog the gills of fishes and invertebrates within the turbidity plume. Anoxic dredged materials may also contain chemically-reduced sediments which, at least in some circumstances, produce significant chemical oxygen demand (COD) within ambient waters at the site of disposal. In practice, however, this effect is generally mitigated by the entrainment of oxygen-rich surficial waters during overboard placement and by tidal mixing. Cold temperatures reduce the crabs' locomotor ability, and would make overwintering females susceptible to mortality by burial, especially in overburden thicknesses greater than 10cm.

Placement of dredged material into either WTAPS or WTASPNE while female crab are not overwintering (generally from early April to mid-November) presents a higher risk of adverse impacts to sea turtles. The increased risk is not related to the placement site, but to the use of hopper dredges during times of year when the water is warmer. Sea turtles are not present in the Chesapeake Bay during the coldest winter months (NOAA, 2018a). A hopper dredge is the preferred dredge method because it is more cost efficient and generally performs better than other dredge types in rough sea conditions. A hopper dredge removes material from the bottom of the channel in thin layers with hydraulic pressure. Sea turtles are generally present in the lower Chesapeake Bay from April through November. Sea turtles are vulnerable to entrainment in the draghead of the hopper dredge when they are likely to be feeding or resting on the bay bottom. Measures can be taken to minimize adverse impacts to sea turtles including the use of a mechanical dredge instead of a hopper dredge. Mechanical dredging entails removing material by scooping it from the channel bottom using an open bucket or clamshell and then placing it on a barge. It is unlikely that sea turtles would be captured in the mechanical dredge, presumably because they are able to avoid the dredge bucket. However, it is more cost effective to use a hopper dredge than a mechanical dredge. Therefore, because a hopper dredge is more cost effective and to minimize adverse impacts to sea turtles that may be entrained in a hopper dredge, dredging and placement is conducted in the winter months.

When assessing the significance of this effect, however, it must be remembered that the WTAPSNE site supports fewer overwintering female crab than the currently-used WTAPS site. As previously discussed, a deep muddy channel runs through the center of WTAPSNE. According to the Dredge Disposal Effects on Blue Crab Report provided by VIMS (Appendix F), crab density will almost always be low in muddy habitats. It is likely that within the deeper, muddy channel, crab density will almost always be low due to the muddy habitat, which is usually avoided as an overwintering habitat by blue crab (Lipcius and Knick, 2016). USACE plans to utilize this the deeper channel for placement as practicable. In addition, the expected blue crab take resulting from project implementation is not significant compared to the overall blue crab population of the Bay and typical fishery take.

If, due to placement of dredged material at WTAPSNE, crab habitat becomes more suitable in the area, USACE will reevaluate the use of individual WTAPSNE cells (Figure 4). If habitat alteration occurs, it may take multiple maintenance dredging cycles to alter habitat suitability over the entire WTAPSNE site. In FY 2020, Baltimore District plans to begin a comprehensive evaluation of alternative placement sites and methods through a DMMP for the portion of the Baltimore Harbor and Channels Project located in Virginia.

8.6 CULTURAL RESOURCES

As stated in Section 7.6 above, the Phase I archaeological survey report was finalized in October 2019. The survey report identified ten targets (four are located within the northern expansion site placement cells) that could represent potential historic properties. One of the targets (adjacent to Cell NE-5) was identified as the *Polynia*, a steam yacht later converted to a barge which sank in 1917. To avoid any potential adverse effects to historic properties, USACE is planning to place dredged material only in Cell NE-6, which does not contain any potential historic properties. USACE has developed a PA in consultation with the VDHR that outlines procedures for evaluating the project's effects to historic properties in future placement cycles outside of Cell NE-6. The final PA was executed on December 11, 2019, and is located in Appendix E.

8.7 NOISE

Noise impacts from project equipment are expected to increase in the vicinity during placement operations as a result of engine noise and noise emitted from other job-related equipment. While there is little that can be done to reduce noise during operations, these impacts would be short-term and restricted to the immediate vicinity of the activity. The west boundary of the proposed expansion site is located approximately 3 nm from the nearest shoreline and any noise from the area is dissipated by wind, waves, and distance before it reaches land. No long-term increase in noise would occur within the proposed expansion site. Noise is not expected to be a significant impact.

Many fish and marine mammal species in the Bay use noise to communicate, navigate, breed, and locate sources of food. Sensitivity to noise varies among species, location, and season. Underwater noise influences fish and other marine animal behavior resulting in changes in their hearing sensitivity and behavioral patterns. Sound is crucial to marine animals when they are hunting for prey, avoiding predators, or engaging in social interaction.

It is anticipated that noise produced during placement activities would not cause any mortality to marine life. However, underwater noise from the hopper dredge may alter the behavior of fish in the vicinity of the area during placement activities. Fish may alter swim speed and direction and fish communication could be affected. Overall noise impacts to marine life are expected to be minor and temporary.

8.8 NAVIGATION

The proposed action will not encroach into and impede navigation in a marked navigation channel. However, recreational and fishing vessels, and tow and tug vessels transit through the area. To minimize the risk of collision, USACE would utilize measures such as posting a Notice to Mariners, maintaining communication with passing vessels, and conducting operations in accordance with general regulations of the Department of the Army and the USCG governing lights and day signals. Utilizing these measures, impacts to navigation are anticipated to be negligible to minor.

8.9 RECREATION

Recreational vessels would not be able to access the waters of the proposed expansion site during placement activities. Fish may temporarily leave the area during placement activities. However, impacts to recreation will be minor and temporary and the public would be able to access the area shortly after placement activities occur.

8.10 FISHERIES

Fishermen would avoid the area during placement activities. Fishing would be shifted elsewhere. In light of the vast area of the Chesapeake Bay available in the vicinity of the proposed expansion site of equivalent value as fishing grounds, the proposed action would be expected to have a negligible or minor impact on fisheries. Placement activities would generate turbidity, but turbid conditions would be temporary with no anticipated impact on commercial fishing. Fisheries impacts would be comparable to those from the use of WTAPS, just shifted further north. However, because placement would be shifted north away from higher density blue crab wintering areas, there would be a reduction in adverse impacts to the blue crab population and thus to the blue crab fishery.

9.0 CUMULATIVE EFFECTS

The principal cumulative effects concerns are to bay bottom. Historical use of open water placement sites within the lower Chesapeake Bay has been necessary to accommodate large volumes of dredged material from the Baltimore Harbor and Channels Project. The project vicinity has historically been used for the placement of dredged material since the early 1960s. The proposed action would impact a new area of bay bottom that has not been previously impacted by material placement. The volumes, frequency, and acreage impacted by placement activities during any given dredging cycle of the York Spit Channel would not change, relative to the No Action Alternative. At potential greatest extent, over multiple dredging cycles, the area of bay bottom impacted would be cumulative greater. However, benthic recovery to pre-project conditions is anticipated within 2 years, more quickly than the 4 year dredging cycle, and therefore the total area used would have minimal bearing on benthic health and no adverse cumulative impacts.

The allowable placement area would be expanded, enabling dredged material to be placed in the northern extension area, and thereby mitigating adverse impacts on overwintering female blue crab that currently occurs under the No-Action Alternative. Therefore, no adverse cumulative impacts to blue crab are anticipated as a result of the proposed action.

Improvements to the Port of Baltimore, including improvements to berthing facilities at the Seagirt Marine Terminal and development of a new terminal at Tradepoint Atlantic (Sparrows Point) will support increased vessel traffic and increased vessel size utilizing York Spit Channel. These activities will not affect the maintenance dredging cycle and therefore will not affect lower Chesapeake Bay bottom habitat.

Other activities planned or ongoing in the Lower Chesapeake Bay affecting bay bottom and the water column include ongoing maintenance and deepening of navigation channels serving The Port of Virginia. Additionally, Virginia Port growth is anticipated to increase throughout the next 50 years, and a new port facility is planned. Additional development, including construction of the Third Crossing (I-64 Hampton Roads Crossing) and expansion of the Chesapeake Bay Bridge Tunnel (parallel Thimble Shoal tunnels), is planned in the future. The implementation of the Preferred Alternative is not predicted to substantially cumulatively impact bay bottom with the aforementioned actions (USACE, 2018b).

Dissolved oxygen levels in deeper waters in the middle Bay is a major concern. There are efforts underway by many entities to improve water quality in the Chesapeake Bay through a Total Maximum Daily Load (TMDL). Positive trends in Bay water quality would not be impacted by placement activities, because nutrient releases into the water column will remain the same as the No-Action Alternative over the dredging cycle.

Placement of dredged material at the northern expansion site would result in adverse cumulative effects to the USACE hopper dredge fleet. The travel distance to the northern expansion site versus the travel distance to WTAPS (average distance of 14.3 nm vs. 8.5 nm, respectively) would add approximately 50 days to the duration of the project. There is a high demand for hopper dredges for USACE dredging projects, and adding 50 days to the duration of the project puts stress on the USACE hopper dredge fleet with the potential for the loss of work. Cumulative environmental impacts of moving the hopper dredging fleet around are uncertain.

10.0 MITIGATION

Available data indicate that WTAPS, particularly the southern portion, provides habitat for a high density of overwintering female blue crab. By proceeding with the proposed action, adverse effects to these overwintering female crab would be greatly reduced, relative to the No-Action alternative. Although blue crab is not managed under the Magnuson-Stevens Act, minimizing impacts to blue crab mitigates EFH impacts for those managed fish species evaluated in this document for which blue crab is an important prey item.

To avoid/minimize adverse effects to ESA-listed sea turtles, USACE makes every effort to avoid dredging of the York Spit Channel from September 1 through November 14, of any year. The

2015 hopper dredging contract was impacted by post-Hurricane Sandy work and resulted in dredging occurring from May through Aug 2015. This resulted in 6 turtles takes. Therefore, if dredging does not occur during this period, dredged material placement would not occur at the proposed expansion site during this period. Furthermore, USACE generally seeks to perform this work in the winter and early spring, subject to availability of dredging contractors. This TOY would also help to avoid and minimize effects to sandbar shark HAPC used for pupping and nursery activities (occurring from May 1 to October 30).

Bottom-dump placement of dredged material typically produces mounded deposits on the bay bottom, and the thickness of such mounds and the force of impacting sediment will be lethal to benthic organisms within the footprint of the deposit. The dredging contractors open the hopper of hopper dredges while they are moving to assist in spreading the material. The hopper operators attempt to slowly release material, but the process is difficult to control and may take 5 to 10 minutes to completely empty, with about 75 percent or more of the material discharged within the first minute. If significant mounds are formed during placement, or if placement accumulates above the allowable depth, the contractor is required to drag the area to make the bottom more uniform. The USACE considered requiring the contractor to smooth all deposits to a roughly uniform thickness, but reworking the sediments in this way would be extremely costly, time consuming and likely ineffective. It would extend the duration of project disturbance, increase vessel traffic and emissions, and exacerbate turbidity. Moreover, distributing the sediments after placement would merely spread adverse effects over a much larger area. While it might result in somewhat-reduced mortality within the deposit footprint, it would greatly increase mortality and sublethal stress on benthic communities over a much larger area, and would result in delayed post-disturbance recovery and greater temporal loss of functions. If deposited “mounds” are left in place, natural currents will gradually redistribute sediments, but this process would occur at a rate similar to that of natural sediment movements within the area, to which native benthic communities can acclimate with minimal risk of harm. For these reasons, USACE believes that spreading deposited material is not a viable measure to reduce project impacts, and would likely increase adverse effects to the benthic community.

11.0 COMPLIANCE OF THE PROPOSED ACTION WITH ENVIRONMENTAL PROTECTION STATUTES AND OTHER ENVIRONMENTAL REQUIREMENTS

Coastal Zone Management Act of 1972. Baltimore District certifies that the proposed action is consistent to the maximum extent practicable with the enforceable policies of the approved CZM plan for the Commonwealth of Virginia. On September 17, 2019, VADEQ conditionally concurred that the proposed action is consistent with Virginia’s CZM program.

Clean Water Act of 1972. On October 30, 2013, the Commonwealth of Virginia issued a Virginia Water Protection Permit (13-0593) and a Section 401 Water Quality Certification for maintenance dredging of the York Spit Channel and for placement of dredged material into WTAPS. The permit and WQC expires on October 29, 2028. In a letter dated 17 September 2019, the Commonwealth of Virginia stated that the section 401 WQC requirements were met through the CZM conditional consistency determination provided by VADEQ on 17 September 2019.

Coastal Barrier Resources Act (CBRA) of 1982. No coastal zones covered under CBRA will be impacted by the proposed action. The Coastal Barrier Resources System mapper, created by USFWS, was referenced to verify there are no CBRA areas within the proposed expansion site.

Rivers and Harbors Act of 1899. The proposed action would not obstruct navigable waters of the United States.

Executive Order 13045, Protection of Children. The proposed action complies with EO 13045, "Protection of Children from Environmental Health Risks and Safety Risks", and does not represent disproportionally high and adverse environmental health or safety risks to children in the United States. The proposed expansion site is located in open water of the Chesapeake Bay and uninhabited; thus, no changes in demographics, housing, or public services would occur as a result of the proposed action. With respect to the protection of children, the likelihood of disproportionate risk to children is not significant. The proposed action does not involve activities that would pose any disproportionate environmental health risk or safety risk to children.

Executive Order 12898, Environmental Justice. The proposed action complies with EO 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations", and does not represent disproportionally high and adverse human health or environmental effects on minority populations and low-income populations in the United States. The proposed action is not designed to create a benefit for any group or individual. A review and evaluation of the proposed modification has not disclosed the existence of identifiable minority or low-income communities that would be adversely impacted.

Table 8. Compliance of the proposed action with environmental protection statutes and other environmental requirements.

Federal Statutes	Level of Compliance[1]
Anadromous Fish Conservation Act	N/A
Archeological and Historic Preservation Act	Full
Clean Air Act	Full
Clean Water Act	Full
Coastal Barrier Resources Act	N/A
Coastal Zone Management Act	Full
Comprehensive Environmental Response, Compensation and Liability Act	N/A
Endangered Species Act	Full
Estuary Protection Act	Full
Farmland Protection Policy Act	N/A
Federal Water Project Recreation Act	N/A
Fish and Wildlife Coordination Act	Full
Land and Water Conservation Fund Act	N/A
Magnuson-Stevens Act	Full
Marine Mammal Protection Act	N/A
Marine Protection, Research and Sanctuaries Act	N/A
National Environmental Policy Act	Full
National Historic Preservation Act	Full
Noise Control Act	Full
Resource Conservation and Recovery Act	N/A
Rivers and Harbors Act	Full
Safe Drinking Water Act	N/A
Solid Waste Disposal Act	N/A
Toxic Substances Control Act	N/A
Water Resources Planning Act	N/A
Watershed Protection and Flood Prevention Act	N/A
Wetlands Conservation Act	N/A
Wild and Scenic Rivers Act	N/A
Executive Orders (E.O.)	
Migratory Bird (E.O. 13186)	Full
Protection and Enhancement of Environmental Quality (E.O. 11514)	Full
Protection and Enhancement of Cultural Environment (E.O. 11593)	Full
Floodplain Management (E.O. 11988)	N/A
Protection of Wetlands (E.O. 11990)	N/A
Environmental Justice in Minority and Low-Income Populations (E.O. 12898)	Full
Protection of Children from Health Risks and Safety Risks (E.O. 13045)	Full
Chesapeake Bay Protection and Restoration (E.O. 13508)	Full
Invasive Species (E.O. 13112)	N/A
Indian Sacred Sites (E.O. 13007)	N/A
Stewardship of the Oceans, Our Coasts and the Great Lakes (E.O. 13547)	Full
Streamlining Service Delivery and Improving Customer Service (E.O. 13571)	Full
Facilitation of Cooperative Conservation (E.O. 13352)	Full

[1]Level of Compliance:
Full Compliance (Full): Having met all requirements of the federal statute, executive order (E.O.), or other environmental requirements.
Partial Compliance (Partial): Having partially met all requirements of the federal statute, E.O., or other environmental requirements. See Section 5.0, Environmental Consequences, for an explanation of each partial level of compliance listed in the table.
Not Applicable (N/A): No requirements for the federal statute, E.O., or other environmental requirements.

12.0 CONCLUSION

The USACE, Baltimore District has determined that no significant impacts on the quality of the human environment are projected to occur upon implementation of the proposed action. The District made this determination based on the following:

a. The WTAPSNE would be an extension of the existing authorized WTAPS. Effects on the human environment from placement of dredged material in WTAPS were evaluated in the 1987 Supplement #2 to the 1981 General Design Memorandum and EIS, and in the 2005 Baltimore Harbor and Channels (Maryland and Virginia) DMMP and Final Tiered EIS.
b. The proposed action would not create new or additional impacts, relative to the No-Action Alternative. The volumes, frequency and acreage impacted by placement activities during any given dredging cycle of the York Spit Channel would not change. It would merely expand the allowable placement area, to enable dredged material to be placed in the northern extension area, and thereby mitigate adverse impacts on overwintering female blue crab that currently occurs under the No-Action Alternative.
c. Aside from mitigating impacts to Chesapeake Bay blue crab population associated with the No-Action Alternative, the proposed action is not anticipated to have any other significantly different effects on the human environment.
d. The project vicinity has historically been used for the placement of dredged material since the early 1960s. The proposed action would shift impacts to a different location, but would not create new or additional impacts. Therefore, no adverse cumulative impacts are anticipated as a result of the proposed action.

13.0 REFERENCES

Blanton, D. B. and D. W. Linebaugh. 1994. *An Assessment of Virginia's Underwater Cultural Resources.* For the Virginia Department of Historic Resources, Survey and Planning Report Series No. 3. William and Mary Center for Archaeological Research.

Boon, J.D., M.O. Green, and K.D. Suh. 1996. Bimodal wave spectra in lower Chesapeake Bay, sea bed energetics and sediment transport during winter storms. Continental Shelf Research, 16(15): 1965-1988.

Bruce, Phillip Alexander. 1935. *Economic History of Virginia in the Seventeenth Century: An Inquiry into the Material Condition of the People, Based Upon Original and Contemporaneous Records.* Vol. 1. Reprint of the 1938 edition, Peter Smith, New York.

Buchheister, A., C.F. Bonzek, J. Gartland, and R.J. Latour. 2013. Patterns and drivers of the demersal fish community of Chesapeake Bay. *Marine Ecology Progress Series*, 481:161-180, doi: 10.3354/meps10253.

Chesapeake Bay Bridge and Tunnel (CBBT) District. 2014. CBBT Timeline. Electronic document, http://www.cbbt.com/downloads/2014%20CBBT%20TIMELINE.pdf.

Chesapeake Bay Foundation (CBF). 2019a. Atlantic Menhaden. https://www.cbf.org/about-the-bay/more-than-just-the-bay/chesapeake-wildlife/menhaden/. Accessed May 2019.

CBF. 2019b. ASMFC Takes Action on Striped Bass. https://www.cbf.org/news-media/newsroom/2019/virginia/asmfc-takes-action-on-striped-bass.html. Accessed May 2019.

Chesapeake Bay Program (CBP). 2008. Scientific and Technical Advisory Committee. Climate Change and the Chesapeake Bay: State-of-the-Science Review and Recommendations. Annapolis, MD. 59 pp. STAC Publication #08-004.

CBP. 2015. Maps. https://www.chesapeakebay.net/what/maps/keyword/IBI. Accessed May 2019.

CBP. 2019a. Discover the Chesapeake, Ecosystem, Physical Characteristics. Available online at: http://www.chesapeakebay.net/discover/ecosystem/physical_characteristics. Accessed March 2019.

CBP. 2019b. Striped Bass. https://www.chesapeakebay.net/issues/striped_bass. Accessed May 2019.

Center for Conservation Biology. 2010. https://ccbbirds.org/2010/03/10/investigation-into-the-ecology-of-tidal-freshwater-marsh-birds/. Accessed May 2019.

Daily Press. November 2017. VIMS spots rare manatee in Chesapeake Bay. http://www.dailypress.com/news/science/dp-nws-manatee-vims-20171103-story.html. Accessed May 2019.

Data USA. https://datausa.io/. Accessed April 2019.

Evans, Cerinda W. 1957. *Some Notes on Shipbuilding and Shipping in colonial Virginia.* Virginia 350th Anniversary Celebration Corporation, Williamsburg, Virginia.

Gahagan, & Bryant Associates (GBA), Inc. 2003. James Island Habitat Restoration Project. Dredging and Site Engineering Reconnaissance Study. Prepared for the Maryland Port Administration.

George Mason University. 1995. Geology of the Chesapeake. Accessed April 2019. www.gmu.edu/bios/Bay/cbpo/intro.htm#geology

Interstate Commission on the Potomac River Basin (ICPRB). 2007. Total Maximum Daily Loads of Polychlorinated Biphenyls (PCBs) for Tidal Portions of the Potomac and Anacostia Rivers in the District of Columbia, Maryland, and Virginia. Submitted to US Environmental Protection Agency, Water Protection Division. 53 pages plus appendices. https://doee.dc.gov/sites/default/files/dc/sites/ddoe/publication/attachments/TidalPotomac_PCB_TMDL_Final01.pdf

King, Helen Haverty. 1993. *Historical Notes on Isle of Wight County.* Isle of Wight County Board of Supervisors, Isle of Wight, Virginia.

Labaree, Benjamin W., William M. Fowler, Jr., John B. Hattendorf, Jefferey J. Stafford, Edward W. Sloan, Andrew W. German. 1999. *America and the Sea: A Maritime History.* Mystic Seaport, Philadelphia

Lipcius, R.N. and K.E. Knick. 2016. Dredge Disposal Effects on Blue Crab. Virginia Institute of Marine Science.

Lowery, D. L. 2008. *Archaeological Survey of the Coastal Shorelines Associated with Mathews County, Virginia: An Erosion Threat Study.* For the Virginia Department of Historic Resources Survey and Planning Report Series. Chesapeake Watershed Archaeological Research Foundation, Inc.

Ludsin, S.A., X. Zhang, S.B. Brandt, M.R. Roman, W.C. Boicourt, D.M. Mason, and M. Costantini. 2009. Hypoxia-avoidance by planktivorous fish in Chesapeake Bay: Implications for food web interactions and fish recruitment. *Journal of Experimental Marine Biology and Ecology*, 381:S121–131.

Maryland BayStat. 2013. Participants: Office of the Governor, Department of Agriculture, Department of the Environment, Department of Natural Resources, Department of Planning, University of Maryland, UMD Center for Environmental Science. http://www.baystat.maryland.gov/. Accessed May 2019.

Maryland Port Administration (MPA). 1990. Port of Baltimore Dredged Material Management Master Plan.

Maryland Sea Grant. 2011. Ecosystem-Based Fisheries Management in Chesapeake Bay: A Summary Brief from the Blue Crab Species Team. A Maryland Sea Grant Publication, Publication Number UM-SG-TS-2011-04, College Park, Maryland.

Mathews County Visitor's Information Center. 2019. Marinas in Mathews County, VA. https://visitmathews.com/marinas-in-mathews-county-va/. Accessed May 2019.

McAvoy, J. M. and L. D. McAvoy. 1997. *Archaeological Investigations of Site 44SX202, Cactus Hill, Sussex County, Virginia.* Virginia Department of Historic Resources Research Report Series No. 8. Richmond, Virginia.

Mills, Eric. 1996. *Chesapeake Bay in the Civil War.* Tidewater Publishers, Centreville, Maryland.

Morris, John William III. 1991. *Site 44YO88, the Archaeological Assessment of the Hull Remains at Yorktown, Virginia.* Unpublished Master's Thesis. East Carolina University, Greenville, North Carolina.

National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS). 2015. Catch Data: Recreational Fisheries Statistics Queries. Available online at: http://www.st.nmfs.noaa.gov/recreational-fisheries/data-and-documentation/queries/index. Accessed Dec. 19, 2016.

Nilson, Karl J., Robert Diaz, Linda Schaffner, Donald Boesch, Rodney Bertelsen, and Michael Kravtiz, 1982. The Biogenic Structure of Lower Chesapeake Bay Sediments. Published by the USEPA. http://udspace.udel.edu/handle/19716/1550. Accessed May 2019.

NOAA. 2016. Alosines. https://chesapeakebay.noaa.gov/fish-facts/alosines. Accessed May 2019.

NOAA. 2017. Turbidity and Total Suspended Sediment Effects. https://www.greateratlantic.fisheries.noaa.gov/protected/section7/guidance/consultation/turbiditytablenew.html. Accessed May 2019.

NOAA. 2018a. Endangered Species Act Biological Opinion. Construction and Maintenance of Chesapeake Bay Entrance Channels and Use of Sand Borrow Areas for Beach Nourishment (F/NER/2018/14816).

NOAA. 2018b. Essential Fish Habitat (EFH) Source Documents: Life History and Habitat Characteristics. https://www.nefsc.noaa.gov/nefsc/habitat/efh/. Accessed May 2019.

NOAA. 2018c. Office of Coastal Survey: Find Nautical Charts Website. https://nauticalcharts.noaa.gov/. Accessed May 2019.

NOAA. 2019a. Estuarine Living Marine Resources Database. https://products.coastalscience.noaa.gov/elmr/. Accessed May 2019.

NOAA. 2019b. Essential Fish Habitat Mapper Tool. https://www.habitat.noaa.gov/protection/efh/efhmapper/. Accessed May 2019.

NOAA. 2019c. Office of Coastal Management: OceanReports Website. https://coast.noaa.gov/digitalcoast/tools/ort.html. Accessed May 2019.

Rouse, Parke Jr. 1972. *Roll Chesapeake, Roll: Chronicles of the Great Bay.* Norfolk Historical Society of Chesapeake, Norfolk.

Schaffner, L.C. 2010. Patterns and Rates of Recovery of Macrobenthic Communities in a Polyhaline Temperate Estuary Following Sediment Disturbance: Effects of Disturbance Severity and Potential Importance of Non-local Processes. Estuaries and Coasts. 33: 1300.

Stewart, R. M. 1992. Observations on the Middle Woodland Period of Virginia: A Middle Atlantic Region Perspective. *In Middle and Late Woodland Research in Virginia: A Synthesis,* edited by T. R. Reinhart and M. E. Hodges, pp. 1-38. Special Publication No. 29 of the Archaeological Society of Virginia, Dietz Press, Richmond, Virginia.

Still, William N. Jr. 1971. *Iron Afloat: The Story of the Confederate Armorclads.* Vanderbilt University Press, Nashville, Tennessee.

Tazewell, William L. 1982. *Norfolk's Waters: An Illustrated Maritime History of Hampton Roads.* Windsor Publications, Inc., Woodland Hills, California.

The Center for Conservation Biology. 2010. Chesapeake Bay Salinity Zones. Available online at: http://www.ccbbirds.org/2010/03/10/investigation-into-the-ecology-of-tidal-freshwater-marsh-birds/. Accessed March 2019.

Turner, E. R. 1992. *Middle and Late Woodland Research in Virginia: A Synthesis.* Edited by T. R. Reinhart and M. E. Hodges, pp. 65-96. Special Publication No. 29 of the Archaeological Society of Virginia, Dietz Press, Richmond, Virginia.

University of Maryland Center for Environmental Science (UMCES). 2013. Integration and Application Network. EcoCheck. http://ian.umces.edu/ecocheck/report-cards/chesapeake-bay/2013/indicators/benthic_index/. Accessed May 2019.

U.S. Army Corps of Engineers (USACE), Baltimore District. 1981. General Design Memorandum, Baltimore Harbor and Channels 50-Foot Project, Maryland and Virginia. https://www.nab.usace.army.mil/Missions/Civil-Works/Dredged-Material-Management-Plan-DMMP/

USACE, Baltimore District. 1987. Supplemental Information Report #2, Baltimore Harbor and Channels 50-Foot Project, Maryland and Virginia. https://www.nab.usace.army.mil/Missions/Civil-Works/Dredged-Material-Management-Plan-DMMP/

USACE, Baltimore District. 2005. Baltimore Harbor and Channels Dredged Material Management Plan and Final Tiered Environmental Impact Statement. https://www.nab.usace.army.mil/Missions/Civil-Works/Dredged-Material-Management-Plan-DMMP/

USACE. 2014. Prepared by the EA Engineering, Science, and Technology, Inc. FY 12 Evaluation of Dredged Material, Lower (Virginia) Chesapeake Bay Approach Channels to the Port of Baltimore, Chesapeake Bay, Virginia.

USACE, Baltimore District. 2016a. Prepared by GBA, Inc. Baltimore Harbor and Channels 50-Foot Project, Maryland and Virginia Draft Integrated Limited Reevaluation Report and Supplemental Environmental Impact Statement - Volume Calculations, Material Type Breakout, Hauling Distances, Equipment Packages and Dredging Surface Areas.

USACE, Norfolk District. 2016b. Environmental Monitoring of the Wolf Trap Placement Site: A Characterization of Finfish, Blue Crabs and Benthic Invertebrates Before, During, and After Dredged Material Placement.

USACE, Baltimore District. 2017a. Baltimore Harbor and Channels: Dredged Material Management Plan Update. https://www.nab.usace.army.mil/Missions/Civil-Works/Dredged-Material-Management-Plan-DMMP/

USACE, Environmental Research Development Center (ERDC). 2017b. Effects of Dredged Material Burial on Blue Crab Survival, Final Report.

USACE, 2018a. Engineering and Construction Bulletin 2018-14. Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Works Studies, Designs, and Projects. https://www.wbdg.org/ffc/dod/engineering-and-construction-bulletins-ecb/usace-ecb-2018-14

USACE, Norfolk District. 2018b. Norfolk Harbor Navigation Improvements General Reevaluation Report and Environmental Assessment.

U.S. Census Bureau. https://www.census.gov/. Accesses April 2019.

U.S. Coast Guard (USCG). 2017. 2017 Recreation Boating Statistics Report. https://content.govdelivery.com/accounts/USDHSCG/bulletins/1f29c14. Accessed April 2019.

U.S. Department of Energy (USDOE), Environmental, Safety and Health, Office of NEPA Policy and Assistance, 2000, Clean Air Act General Conformity Requirements and the National Environmental Policy Act Process.

U.S. Environmental Protection Agency (USEPA) Region III. 1992. Final EIS for the Designation of an Ocean Dredged Material Disposal Site located offshore Norfolk, Virginia.

USEPA. 2019a. Site Management and Monitoring Plan for the Norfolk Ocean Dredged Material Disposal Site, Virginia. https://www.epa.gov/sites/production/files/2019-09/documents/2019_norfolk_odmds_smmp.pdf

USEPA. 2019b. Water Quality Assessment and TMDL Information. https://ofmpub.epa.gov/waters10/attains_index.home. Accessed May 2019.

USEPA. 2019c. Nonattainment Areas for Criteria Pollutants (Green Book). https://www.epa.gov/green-book. Accessed October 2019.

USEPA.2019d. Watershed Assessment, Tracking & Environmental Results System (WATERS). https://www.epa.gov/waterdata/waters-watershed-assessment-tracking-environmental-results-system. Accessed May 2019

U.S. Fish and Wildlife Service (USFWS). 2008. West Indian Manatee (*Trichechus manatus*). https://www.fws.gov/endangered/esa-library/pdf/manatee.pdf. Accessed May 2019.

USFWS. 2019. Environmental Conservation Online System Information for Planning and Consultation (ECOS-IPaC). https://ecos.fws.gov/ipac/. Accessed May 2019.

United States Geological Survey (USGS). 2003. A Summary Report of Sediment Processes in Chesapeake Bay and Watershed. U.S. Geological Survey Water-Resources Investigations Report 03-4123. New Cumberland, PA: U.S. Geological Survey.

Versar, Inc. 2017. Chesapeake Bay Benthic Monitoring Program website. http://www.baybenthos.versar.com. Accessed May 2019.

Virginia Cultural Resources Information System (V-CRIS). 2019 https://vcris.dhr.virginia.gov/vcris/Mapviewer/, accessed 4 February, 2019.

Virginia Department of Historic Resources (VDHR). 2017. *Guidelines for Conducting Historic Resource Surveys in Virginia.* Virginia Department of Historic Resources, Richmond, Virginia.

Virginia Department of Environmental Quality (VADEQ). 2019. VEGIS. http://www.deq.virginia.gov/mapper_ext/

Virginia Department of Game and Inland Fisheries (VADGIF). 2019. Fish and Wildlife Information Service. https://vafwis.dgif.virginia.gov/fwis/?Menu=Home. Accessed May 2019.

Virginia Marine Resources Commission (VMRC). Chesapeake Bay Map. Available online at: https://webapps.mrc.virginia.gov/public/maps/chesapeakebay_map.php. Accessed March 2019.

VMRC. Chapter 4 VAC 20-270-10 ET SEQ. Available online at: http://www.mrc.state.va.us/regulations/fr270.shtm. Accessed March 2019.

Virginia Institute of Marine Science (VIMS). 2019a. Coastal habitats. Center for Coastal Resources Management. Available online at: https://www.vims.edu/ccrm/research/ecology/coastal%20habitats/index.php. Accessed April 2019.

VIMS. 2019b. Virginia Estuarine and Coastal Observing System (VECOS) Interactive Map. Available online at: http://web2.vims.edu/vecos/ .Accessed March 2019.

VIMS. 2019c. Hawksbill Sea Turtles Webpage. https://www.vims.edu/research/units/legacy/sea_turtle/va_sea_turtles/hawskbill.php. Accessed May 2019.

Wennersten, John. 2007. *The Oyster Wars of Chesapeake Bay.* Eastern Branch Press, Washington.

Wilber, D.H. and Douglas Clarke. 2007. Defining and Assessing Benthic Recovery Following Dredging and Dredged Material Disposal.

Wright, L.D., D.B. Prior, C.H. Hobbs, R.J. Byrne, J.D. Boon, L.C. Schaffner, and M.O. Green. 1987. Spatial Variability of Bottom Types in the Lower Chesapeake Bay and Adjoining Estuaries and Inner Shelf. Estuarine, Coastal and Shelf Science (1987) 24, 765-784.

Xiong, Yi and Charlie Berger. 2010. Chesapeake Bay Tidal Characteristics. Journal of Water Resource and Protection, 2010, 2, 619-628.