# BIOLOGICAL ASSESSMENT OF POTENTIAL IMPACTS OF THE EDGEMOOR CONTAINER PORT PROJECT TO SPECIES LISTED UNDER THE ENDANGERED SPECIES ACT

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## 1.0 INTRODUCTION

Diamond State Port Corporation (DSPC) proposes to construct a new shipping container port facility on a site formerly occupied by the Chemours (DuPont) Edge Moor Plant along the Delaware River in Edgemoor, New Castle County, Delaware. The project will require dredging of a new approach channel and berth area, and construction of a wharf to support large container cranes. DSPC will be applying to the U.S. Army Corps of Engineers (USACE), Philadelphia District, for permits pursuant to Section 404 of the Clean Water Act (CWA) and Section 10 of the Rivers and Harbors Act of 1899 to construct the facility. The applicant is also exploring with the USACE the federal interest in assuming the responsibility for maintaining the approach channel to the port under Section 204(f) of the Water Resources Development Act (WRDA) of 1986.

Section 7(a) (2) of the federal Endangered Species Act (ESA) requires that each federal agency, in consultation with the U.S. Fish & Wildlife Service (USFWS) and/or National Marine Fisheries Service (NMFS), ensure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of an endangered or threatened species, or result in the destruction or adverse modification of critical habitat. Since the Edgemoor Container Port project must obtain Section 404 and Section 10 permits from the USACE, and the USACE may become responsible for maintenance dredging of the approach channel, the project is subject to consultation under Section 7 of the ESA.

In response to a National Environmental Policy Act (NEPA) scoping request from the USACE, NMFS (2019a) requested that the potential impacts of the project be addressed for the following species listed as threatened or endangered under the ESA, as well as critical habitat for the New York Bight Distinct Population Segment (DPS) of Atlantic sturgeon:

| Common Name | Scientific Name | Federal Conservation Status |
|---|---|---|
| Shortnose sturgeon | *Acipenser brevirostrum* | endangered |
| Atlantic sturgeon | *Acipenser oxyrinchus oxyrinchus* | endangered (New York Bight DPS) |
| Kemp's ridley sea turtle | *Lepidochelys kempi* | endangered |
| Leatherback sea turtle | *Dermochelys coriacea* | endangered |
| Loggerhead sea turtle | *Caretta caretta* | threatened (Northwest Atlantic Ocean DPS) |
| Green sea turtle | *Chelonia mydas* | threatened (North Atlantic DPS) |
| Right whale | *Eubalaena glacialis* | endangered |
| Fin whale | *Balaenoptera physalus* | endangered |

This document is a Biological Assessment (BA) of the potential effects of construction and operation of the Edgemoor Container Port on ESA-listed species and critical habitat. For the purposes of this BA, shortnose sturgeon and Atlantic sturgeon are considered species of primary concern because they occur in the immediate vicinity of the project. The listed sea turtles and whales are considered species of secondary concern because they occur only within the larger "Action Area," which includes the federal navigation channel of the Delaware River and Bay downriver of the project (see Section 2.1).

## 2.0 SITE DESCRIPTION

### *2.1 Action Area*

The Action Area is defined in 50 CFR § 402.02 as "all areas to be affected directly by the Federal action and not merely the immediate area involved in the action." The Action Area must also include areas to be affected by interrelated and interdependent activities, such as an increase in vessel traffic due solely to the project. The Action Area for this consultation includes the area affected by construction of the wharf ("Construction Area") (5.5 acres) and dredging activities ("Dredging Area") (86.9 acres) as well as the Delaware River federal navigation channel from river mile (rm) 0-73.2 (river kilometer (rkm) 0-117.8) (approximately 8,000 acres) (rm/rkm designations based on DRBC, 1969), which will be transited by vessels associated with construction and dredging, and by cargo vessels calling on the Edgemoor facility when the port is operating. The Action Area for the project is shown in Figure 2-1. The Dredging Area is shown on Sheet 2 of 17 and the Conceptual Site Plan for the port illustrating the Construction Area is shown on Sheet 5 of 17 of the permit drawings, provided in Appendix 1.

#### 2.1.1 Physical Characteristics of the Action Area

***Construction Area***

The Construction Area (5.5 acres) consists of the nearshore waterfront portion of the project where the proposed wharf will be constructed (Fig. 2-2). Aquatic habitat in the Construction Area is estuarine subtidal and intertidal, with existing water depths ranging from approximately 0-5 ft (0-1.5 m) (Fig. 2-3). Bottom substrate consists primarily of sand and gravel, with some concrete rubble. The shoreline in the Construction Area experiences high energy from wind, tide, and shipping traffic, and is armored in many areas with rip-rap, gabion baskets, and pilings (Miller, 2020). There are no vegetated wetlands (Duffield Associates, Inc., 2018) or submerged aquatic vegetation (SAV) (Miller, 2020) within the Construction Area.

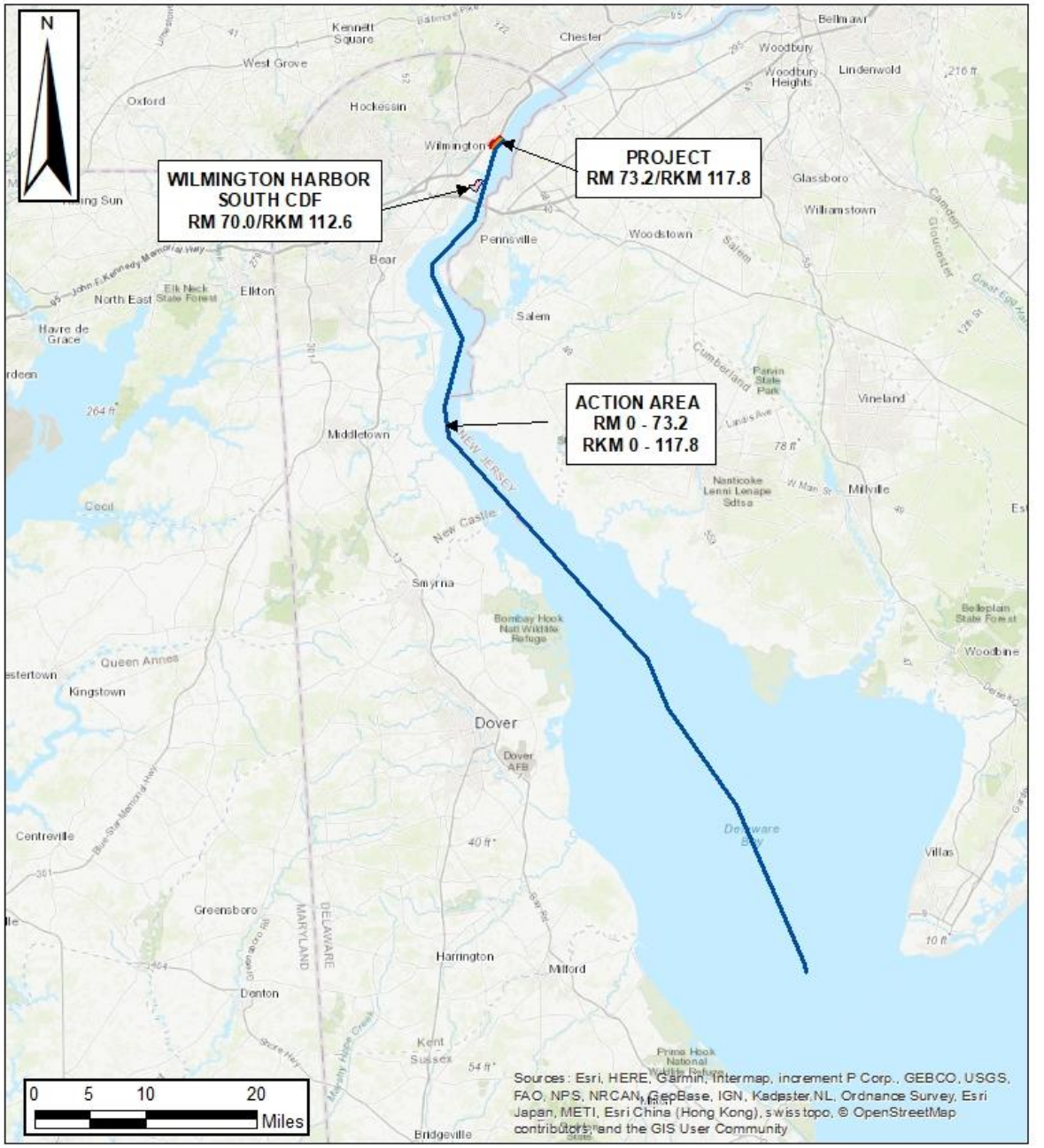
***Dredging Area***

The Dredging Area (Sheet 2 of 17, Appendix 1) consists of 86.9 acres (including side slopes) of estuarine subtidal and intertidal habitat, with existing water depths ranging from approximately 0-45 ft (0-13.7 m) as illustrated on Sheet 4 of 17 of the permit drawings provided in Appendix 1. Bottom substrate within the Dredging Area consists of fine-grained sediments (silt/clay/sand), based on acoustic surveys conducted by Sommerfield and Madsen (2003) and the DNREC Delaware Bay Benthic Mapping Program (described by Wilson and Carter, 2008) (see Figs. 2-2 and 2-3), and field observations (Duffield Associates, Inc., "Geotechnical Report, Port of Wilmington, Edgemoor Expansion, Edgemoor, New Castle County, Delaware," dated October 2019", Miller, 2020). There are no vegetated wetlands (Duffield Associates, Inc., 2018) or SAV (Miller, 2020) within the Dredging Area. Salinity in this portion of the Delaware River ranges from freshwater in the spring to oligohaline during drier periods (typically in late summer-early fall). Mean tidal range in the Delaware

River at Marcus Hook, PA, located approximately 10 km upriver of the Edgemoor site, is 5.59 ft (1.70 m) (NOAA, 2019).

***Federal Navigation Channel***

The federal navigation channel adjacent to and downriver of the Edgemoor site is maintained at a controlling depth of -45 ft (-13.7 m) MLLW. Substrate types within the channel vary widely from silty clay to gravel (Sommerfield and Madsen, 2003). Salinity within the channel ranges from tidal freshwater/oligohaline in the upper reaches to that of seawater near the mouth of Delaware Bay (Cronin et al., 1962; Polis and Kupferman, 1973).




| | | | |
|---|---|---|---|
| Date: 06/2019 | **ACTION AREA FOR THE EDGEMOOR CONTAINER PORT PROJECT** | DESIGNED BY: JLF | DUFFIELD ASSOCIATES |
| SCALE: AS SHOWN | | DRAWN BY: JLF | 5400 LIMESTONE ROAD WILMINGTON, DE 19808-1232 TEL. (302)239-6634 FAX (302)239-8485 |
| PROJECT NO. 11139.LH | | CHECKED BY: RLH | OFFICES IN PENNSYLVANIA, SOUTHERN DELAWARE, MARYLAND AND NEW JERSEY |
| SHEET: | WILMINGTON~NEW CASTLE COUNTY~DELAWARE | FILE: 11139LH.0619.ACTIONAREA.MAP | EMAIL: DUFFIELD@DUFFNET.COM |

Figure 2-1. Action Area for the proposed Edgemoor Container Port project.

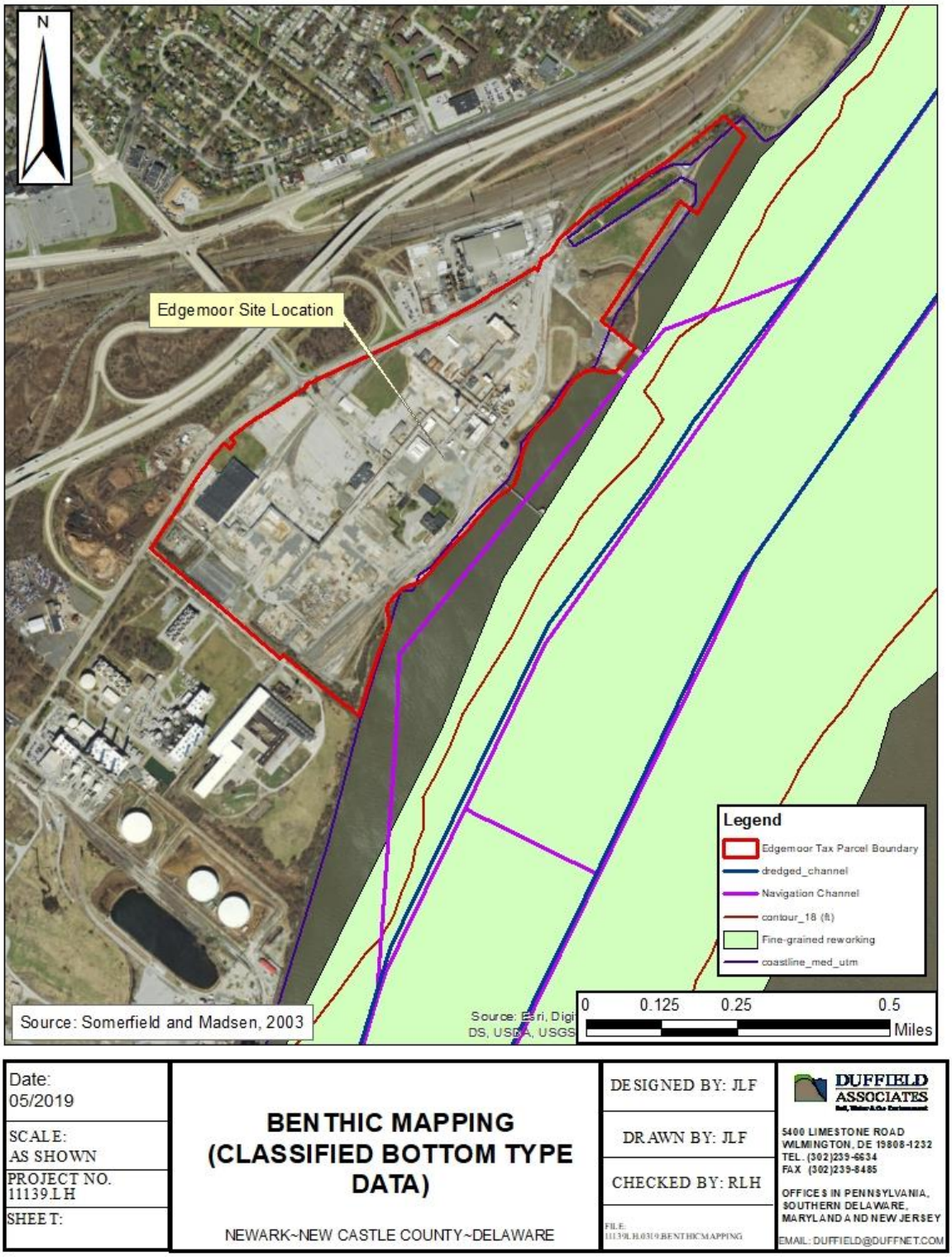



Figure 2-2. Classified bottom type at and adjacent to the proposed Edgemoor Container Port site based on acoustic data collected by Sommerfield and Madsen, 2003.

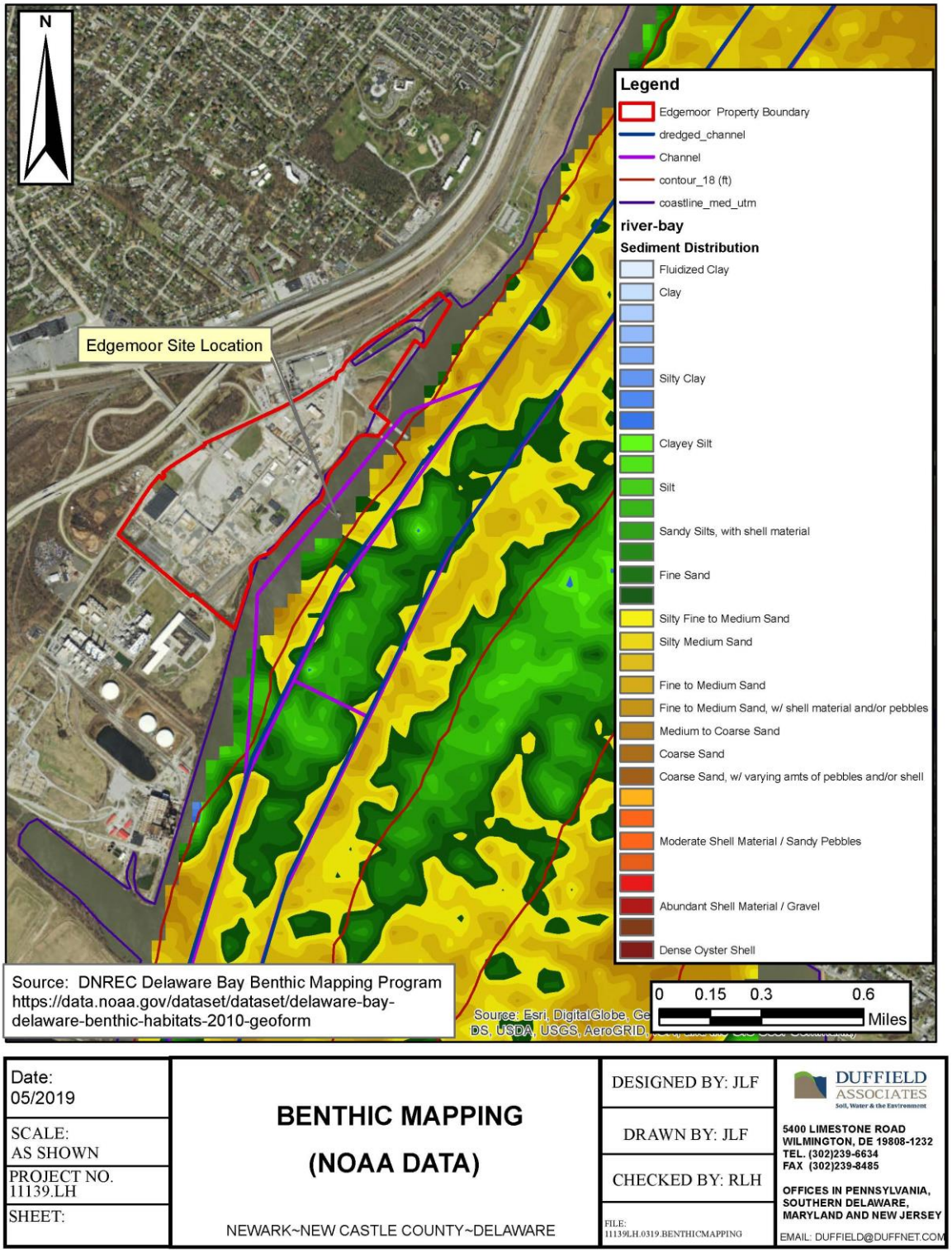



Figure 2-3. Benthic habitats at and adjacent to the proposed Edgemoor Container Port site based on acoustic data collected by the DNREC Delaware Bay Benthic Mapping Program.

## 3.0 PROJECT DESCRIPTION

### 3.1 *Project Background*

#### 3.1.1 Port of Wilmington – Operational History

DSPC is a corporate entity of the State of Delaware and was established in 1995 by an act of the Delaware General Assembly to manage and operate the Port of Wilmington after the port was purchased from the City of Wilmington by the State of Delaware (7 Del.C. Chapter 87). The Port of Wilmington, operated by the DSPC, is a deep-water port located at the confluence of the Christina River and the Delaware River in Wilmington, Delaware.

The port has been ranked as a top North American port for imports of fresh fruits and juice concentrates, dry bulk cargo and automobiles. The Port of Wilmington operates in a competitive environment that includes other facilities along the Delaware River and along the east coast of the United States of America. Access to the Port is available directly from the Delaware River federal navigation channel and from the federal channel in the Christina River. The majority of the Port's berths are located on the Christina River, which has a controlling depth of 38 ft at mean lower low water (MLLW) between the Delaware River and the upper end of the Port's turning basin, roughly adjacent to Berth 5. Additional berths (Berths 6 and 7) upriver of the turning basin are maintained at 35 ft MLLW. The Port's waterborne commerce grew in the 1990s, most notably with auto imports. Since 2000, the DSPC has continued to improve and expand its assets to serve growing market demands. A 90,000 square-foot (sf) dry cargo warehouse was constructed in 2000, the construction and commissioning of the Autoberth structure on the Delaware River was completed in 2002, and a 92,000 sf cold storage warehouse was constructed in 2006 (AECOM et al., 2016).

Cargoes handled at the Port of Wilmington are varied. During 2015, over 6.8 million tons of cargo were handled at the port mainly comprised of containerized goods (33%), dry/break bulk (32%), and liquid bulk (32%). Based on the Diamond State Port Corporation Strategic Master Plan, dated July 29, 2016, in 2015 the Port of Wilmington accounted for approximately five percent of East Coast ports' international waterborne trade. For inbound trade, 89 percent of imported commodities include: petroleum products (35%), bananas (26%), industrial salt (20%), various minerals (4%), and pineapples (4%).

The existing Port, which opened in 1923, has experienced significant changes over the last 90 years. DSPC prepared a Strategic Master Plan (AECOM et al., 2016) to evaluate future development to meet its objectives to retain and grow port business within the ever-changing dynamics of the maritime industry. The Master Plan evaluated alternatives for optimizing the existing port facility at the confluence of the Christina and Delaware Rivers while attempting to sustain and grow the existing cargo. The Master Plan also evaluated alternative off-port properties on the Delaware River that would capture additional market for development of a new terminal.

### 3.1.2 Forecasted Cargo Volume Increase

Following the completion of Panama Canal Lock Expansion Project in 2017, New Panamax ships, or vessels that were too large to traverse the Panama Canal prior to expansion, are able to more efficiently reach East and Gulf Coast Ports. Capacities of New Panamax ships can be as large as 12,000 twenty-foot container equivalent units (TEU) and standard draft requirements are 49 ft. With increases in capacity capability through the Panama Canal, there is an expectation that cargo volume will increase at East and Gulf Coast ports from the Asia/U.S. trade. According to the DSPC Strategic Master Plan, conservative assumptions forecast that the share of the Asian trade arriving at East Coast ports will expand between 27 to 32 percent above the average volumes experienced over the past five years.

In response to the increasing size of modern shipping vessels, and to remain competitive with other ports along the eastern seaboard, USACE embarked on the Delaware Main Channel Deeping Project in 2010. The deepening provides for more efficient transportation of cargo to the Delaware River ports. To capitalize on the economic benefits of the deepening project, existing Delaware River ports will also need to deepen their harbors and new harbors would be expected to match the depth of the navigation channel.

### 3.1.3 Expansion of Port of Wilmington Operations

In addition to the relatively shallow navigation channel in the Christina River, the land-based configuration of the Port of Wilmington constrains capacity. In an effort to expand port operations and acquire a portion of the projected increases in future market demand, DSPC purchased the Edgemoor Site in 2016, as recommended in the DSPC Strategic Master Plan.

The Edgemoor Site was purchased with the intent of re-developing the property into a multi-user containerized cargo port capable of accepting New Panamax cargo ships. The Edgemoor Site formerly was developed as a titanium dioxide and ferric chloride manufacturing facility, which reportedly initiated operations in the early 1930s. Production at the manufacturing facility ceased in 2015 followed by decommissioning and demolition of the process equipment by the former owner. DSPC has since demolished and removed most of the buildings that remained after decommissioning in preparation for redevelopment. The property is zoned industrial and is enclosed in its entirety by security fencing.

The acquisition of the Edgemoor site was followed by the issuance of a request for proposals by DSPC to seek potential partners that would assume operations at the Port of Wilmington through a Concession Agreement, make investments for upgrades at the existing port facility and construct a new containerized cargo facility at Edgemoor. As a result of that process, a recommendation to enter into a 50-year Concession Agreement with GT USA for the operation of the Port that included estimated total capital expenditures by GT USA of $500 million. The agreement also included a commitment to construct and operate a containerized cargo facility at Edgemoor, which was approved by the DSPC Board of Directors and the Delaware General Assembly in 2017.

### 3.1.4 Navigation

The authorized 45 ft maintained depth of the Delaware River Main Navigation Channel traverses the Delaware River Estuary from Philadelphia, Pennsylvania to the mouth of Delaware Bay. The channel extends 102.5 river miles and borders 10 counties in the Commonwealth of Pennsylvania, and the States of New Jersey and Delaware. The upstream portion of the project area includes the cities of Philadelphia, Pennsylvania and Camden, New Jersey, which together form the fifth largest metropolitan area in the United States. In conjunction with the Port of Wilmington, Delaware, this area supports the largest freshwater port in the world. The area maintains a high concentration of heavy industry, including the nation's second largest complex of oil refineries and petrochemical plants.

The USACE, Philadelphia District is responsible for maintaining the authorized Delaware River navigation channel. The Delaware River Main Stem and Channel Deepening project was authorized by Public Law 102-580, Section 101(6) of the Water Resources Development Act of 1992 to deepen the channel from 40 ft to 45 ft MLLW and currently is nearing completion. The channel width is 400 ft in Philadelphia Harbor (length of 2.5 miles); 800 ft from the former Philadelphia Navy Yard to Bombay Hook (length of 55.7 miles); and 1,000 ft from Bombay Hook to the mouth of Delaware Bay (length of 44.3 miles).

The USACE also maintains the navigation channel in the Christina River. The existing Christina River project was adopted as HD 54-66 in 1896 and 1899, and subsequently modified several times (1922, 1930, 1935, 1940 and 1960) pursuant to the authority of Section 107 of the River and Harbor Act of 1960 (PL 86-645). The project currently provides for a channel with depths of 38, 35, 21, 10, and 7 ft from the Delaware River to Newport, Delaware, a turning basin 2,050 ft long, 640 ft wide and 38 ft deep opposite the Wilmington Marine Terminal (Port of Wilmington), and jetties at the mouths of Christina and Brandywine Rivers.

The federal government has the responsibility for providing the necessary dredged material disposal areas for placement of material dredged for Delaware River and Christina River project maintenance. For the Delaware River channel, there are currently seven upland sites, and one open-water site located in Delaware Bay, that are used for dredge material disposal purposes. The seven confined upland sites are National Park, Oldmans, Pedricktown North, Pedricktown South, Penns Neck, Killcohook and Artificial Island. The open water site in Delaware Bay is located in the vicinity of Buoy 10 near the mouth of the estuary. This site is only approved for placement of sand. Historically, two confined upland facilities have been used for maintaining the Christina River channel – Wilmington Harbor North and Wilmington Harbor South. Two additional upland storage areas, identified as Reedy Point North and Reedy Point South are located along either side of the Chesapeake and Delaware Canal (C&D Canal) at the eastern terminus of the canal at the Delaware River. Those storage areas primarily serve maintenance needs in the C&D Canal.

### 3.1.5 Physical Setting

The main stem of the Delaware River extends approximately 330 miles flowing south from the State of New York to the Delaware Bay. The river is fed by approximately 216

tributaries and drains approximately 14,000 square miles of land (www.delawareestuary.org). The proposed project is located at river mile (RM) 73.2 in the southern portion of Reach B of the Delaware River, where the Bellevue and Cherry Island navigation ranges intersect. This area is within a transition zone of the river generally characterized as a low salinity, high turbidity region. The transition zone, also known as the Estuary Turbidity Maximum (ETM), lies between the bay and riverine regions of the Delaware estuary. At the project site, water depths range between the height of tide and 45 ft below MLLW, while the width of the estuary at the site is approximately 1.5 miles. Jurisdictional boundaries, including mean high water (MHW), mean low water (MLW) and high tide line (HTL) are shown on Sheet 2 of 17 – Jurisdictional Boundary Plan in Appendix 1.

The federal navigation channel adjacent to and downriver of the proposed project is maintained at a controlling depth of -45 ft MLLW. Substrate types within the channel vary widely from silty clay to gravel (Sommerfield and Madsen, 2003). Salinity within the channel ranges from tidal freshwater/oligohaline in the upper reaches to that of seawater near the mouth of Delaware Bay (Cronin et al., 1962).

## 3.2 ***Proposed Action – Preferred Alternative***

The proposed project is offshore of the Applicant's Edgemoor Site and is bounded by the federal navigation channel in the Delaware River. The channel, which extends from Cape May and Cape Henlopen at the mouth of the Delaware Bay (RM0) to Trenton, New Jersey (RM134), recently has been deepened to a maintained depth of 45 ft MLLW between Philadelphia and the Atlantic Ocean. The Applicant proposes to deepen portions of the Delaware River adjacent to the federal navigation channel to create a primary access channel that will serve the proposed berth construction at the Edgemoor Site. Please refer to the permit drawings provided in Appendix 1 for illustrations of existing and proposed conditions.

The primary harbor access channel will provide vessel passage to an approximately 2,600-foot long wharf structure (see Appendix 1 – Sheets 5, 9 and 10). The berth and access channel will be excavated to the 45-foot MLLW project depth. At the riverward edge of the wharf, the future river bottom will be shaped to slope upward to a sheet pile wall along the landside of the wharf. The sheet pile wall will support the elevation transition from the river bottom to the grade of land within the new port. The 45-ft MLLW project depth matches the maintained depth of the federal navigation channel.

The initial dredging for the berth and primary harbor access is anticipated to require removal of an approximate volume of 3.3 million cubic yards (cy) of river sediments and the underlying soils. Project planning anticipates that this material will be placed in existing USACE Confined Disposal Facilities (CDFs) along the Delaware River proximate to the Edgemoor Site and a portion (up to a few hundred thousand cubic yards) of dredged sediments may be placed on site for reuse as fill. The Applicant anticipates that the utilized volume of storage will be compensated through a Section 217 capacity permit that mitigates adverse impacts to USACE regarding their mission to maintain navigation in the Delaware and Christina Rivers.

Proposed project activities producing direct impacts result from the proposed deepening of an area of the Delaware River approximately 4,000 feet in length and having a width extending from the boundary of the federal navigation channel to the landward side of the proposed wharf. This area encompasses approximately 1.5 million square feet (approximately 87 acres). The direct impacts are also derived from construction of the approximately 2,600-foot wharf structure that will accommodate ships and other incidental structures located water-ward of MHW as well as anticipated future maintenance dredging (see Appendix 1 – Permit Drawings).

The development of infrastructure needed to support the operation of a container port and constructed on the upland portion of the Applicant's property, site of the former Chemours Edge Moor Plant, are considered incidental to the project. The Edgemoor Site previously was developed for industrial use, including chemical processing with car, truck, and rail access for moving people, raw materials, wastes, and finished products. Based on the presence of docking structure at the site and an apparent docked vessel observed in a 1992 aerial photograph, the site also included vessel access.

### 3.2.1 Project Purpose

The purpose of this project is to modernize the State of Delaware's international waterborne trade capabilities, allow for the State of Delaware port to remain competitive within the Delaware River international trade market, meet the rising demand for modern containerized cargo ports, and to continue, and strengthen, waterborne trade's importance to the State of Delaware and regional economy. International waterborne trade is considered an essential part of the State of Delaware's economy. According to the DSPC Strategic Master Plan, the Port of Wilmington supports over 4,000 jobs annually, generates nearly $340 million in business revenue, over $300 million in personal revenue, and $31 million in state and regional taxes. The State of Delaware's position along the Delaware River places it within a competitive international trade market with the Port of Philadelphia, just 25 miles upriver of the Port of Wilmington.

### 3.2.2 Project Need

The need for this project is driven by the following considerations:

- **Vessel Capacity Constraints.** With the completion of the Panama Canal Lock Expansion, Asia/U.S. trade shipping to the eastern seaboard of the United States of America is forecasted to increase. The increase is expected to come through the use of new ships that are larger than those currently in service, due to the inherent efficiency of shipping goods in the largest vessel possible. These larger vessels will be known as New Panamax ships, several of which are now in service. To accommodate the increase in modern, New Panamax ships entering east coast ports, the Applicant anticipates that there will be demand for expansion of East Coast port operations. Ports capable of accepting vessels with 45-ft or greater drafts are positioned to most readily accept New Panamax vessels. Currently, no ports in the State of Delaware are capable of accepting New Panamax vessels. The Port of Wilmington berths capable of handling containerized

cargos currently are maintained to a depth of 38 ft MLLW. Therefore, container vessels that are bound for Ports in the State of Delaware would need to be light-loaded (loaded at a reduced capacity) or lightened prior to arrival at the port. Either option decreases the efficiency of operations and increases the potential for environmental impacts due to air emissions from a larger number of ships calling at the port to handle the same forecast increase in cargo than would occur with the newer, larger ships. As such, containerized cargo operations would move from the existing Port of Wilmington to the proposed Edgemoor Expansion Site.

- **Cargo Handling Constraints.** To meet the increasing demand of international waterborne trade, and to continue DSPC's mission to contribute to the State of Delaware's economic vitality, the volume of cargo entering and exiting Delaware's ports should expand. According to the DSPC Masterplan, there are constraints to expanding port operations at the Port of Wilmington, but arguably the most constrictive limitation is the lack of backland storage capacity. Any capital improvement project to increase berth capacity likely would require the development of additional backland storage. Expansion needed to create such backland storage is constrained by the degree of private, industrial, and commercial development along the Port of Wilmington's inland boundaries and by the USACE Wilmington Harbor South CDF located along the Delaware River. Increases in backland use for containerized cargo would come at the loss of dry and break-bulk cargo capacity, which would work against the purpose of increasing the current economic benefits associated with the Port of Wilmington. Dry and break-bulk cargo currently accounts for 32% of the Port's annual cargo throughput. As such, containerized cargo operations would move to the Edgemoor Expansion Site to take advantage of the backland available at that site.

## *3.3 Project Details*

This section provides additional information and discussions of the details of the preferred alternative. Information related to the sizing of the basin, wharf structures, dredging and construction activities are also included.

### 3.3.1 Hydraulic Dredging Process

Based on volumes of dredging proposed for the Preferred Alternative, hydraulic dredging is proposed for the initial construction. The yearly maintenance dredging of the harbor access of the project is also proposed to be performed by hydraulic dredging. Hydraulic dredging is considered one of the most common methods for larger scale dredging operations. It typically consists of a shallow draft ship (barge-like hull) that utilizes hydraulic pumps to suction a mix of sediments and water from the river bottom and pump the effluent through a discharge pipe up to several miles away. Figure 3.3-1 illustrates a dredge ship cutting sediments from a river bottom.

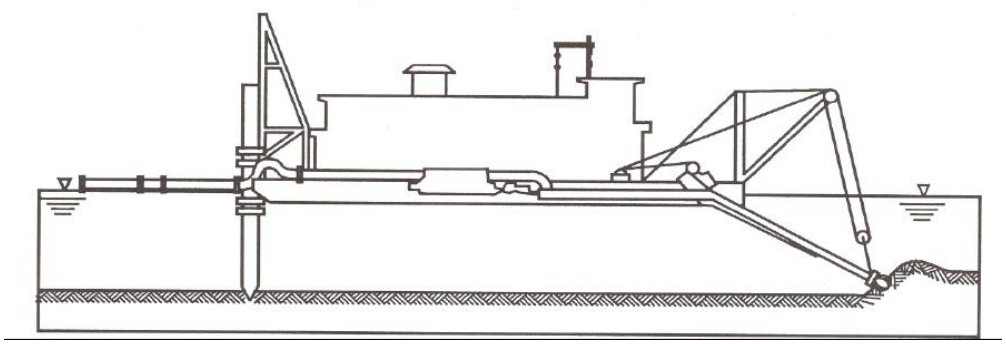


Figure 3.3-1: Hydraulic Dredging (USACE EM 1110-2-5025, 2015)

The suction intake contains a cutter head that rotates to disturb, or dig, the soil and sediment to be removed and mixes the cuttings with the suction water. The soil-water slurry then travels though the pump and piping until it discharges to the storage location. The ship sweeps though the proposed dredge area, cutting away 2 to 3 foot sections of material per pass. The slurry material generally contains 25 to 30% sediment and 70 to 75% water based on USACE Engineering Manuals.

Typically, dredging occurs over a 15 to 18-hour cycle per day, and the production rate is dependent upon parameters such as the type of dredge, pipeline length, dredging depth, and sedimentology of the material. The dredge discharge pipe is typically oriented to discharge into a CDF. CDFs can be constructed in water, along shore, or in "upland" areas along the river banks. There are a number of active CDFs along both shores of the Delaware River in the vicinity of the project site. Once inside the CDF, the dredged slurry begins to settle in a general succession according to grain size and/or flocculate (formed by aggregation of suspended solids) size, so that the finest sediment typically remains in suspension over the longest distance.

On the opposite end of the basin, a sluice box with a series of weirs is installed and is set at an elevation that controls the ponding depth within which flocculation of the fine-grained solids from the supernatant water occurs. As the settled solids accumulate on the bottom of the CDF, the ponding depth is adjusted so that the water depth can be maintained (typically at least 2 feet of water depth is maintained for effective flocculation). This control of water

depth is commonly achieved through the insertion of additional weir boards at the sluice boxes on an as-needed basis. The downstream side of the sluice box contains a discharge pipe, which discharges the suitable effluent back to the river. This process is depicted in the following Figure 3.3-2.

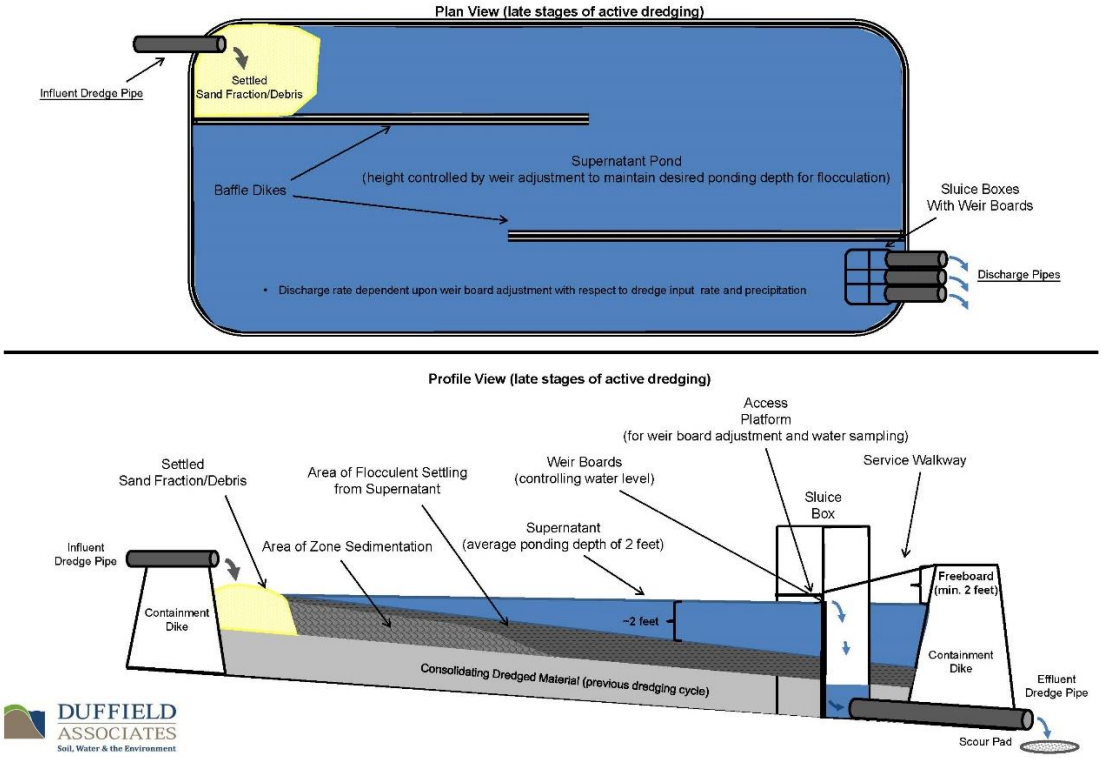



Figure 3.3-2: Schematic of CDF during Dredge Event

Interior baffle dikes are used to create a longer flow path to provide additional retention time and increased efficiency for sedimentation to occur. Following dredging, the decanting of clean water from the surface of the CDF continues through the removal of weir boards until the free water is substantially removed, and the sediment remains as depicted in Figure 3.3-3.

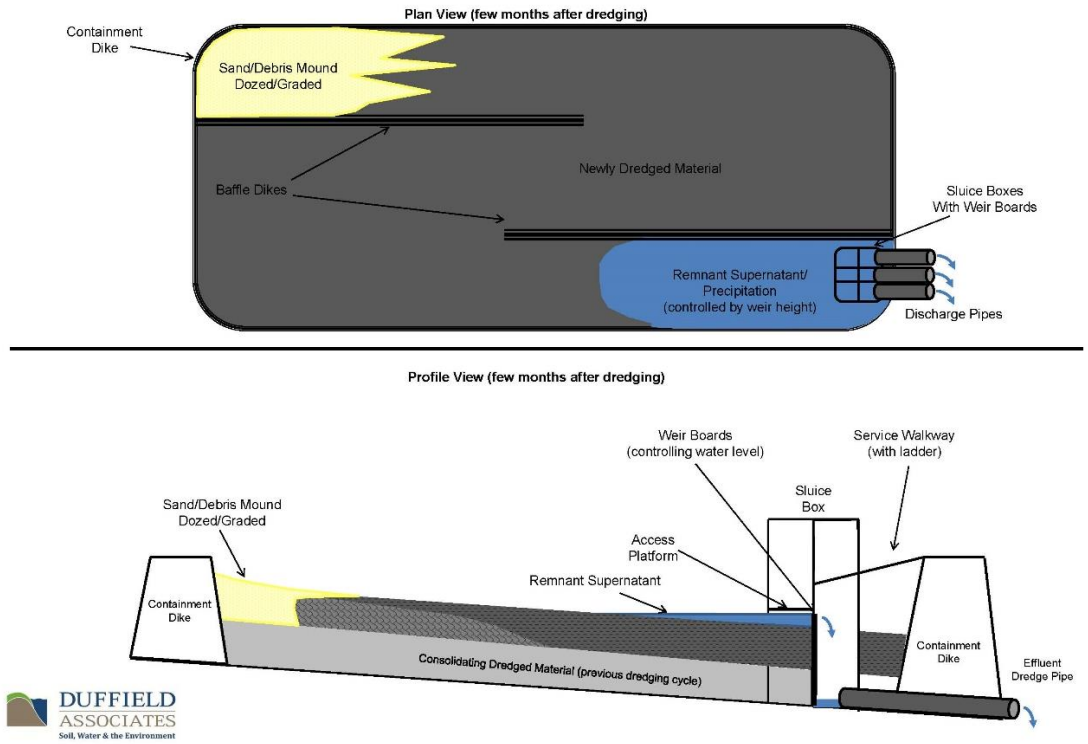



Figure 3.3-3: Schematic of CDF following Dredge Event

Between dredge events, maintenance ditches excavated through the soft surface of the CDF promotes dewatering of the soil allowing for consolidation of the layers of sediment as well as removal of precipitation from the CDF as shown in Figure 3.3-4.

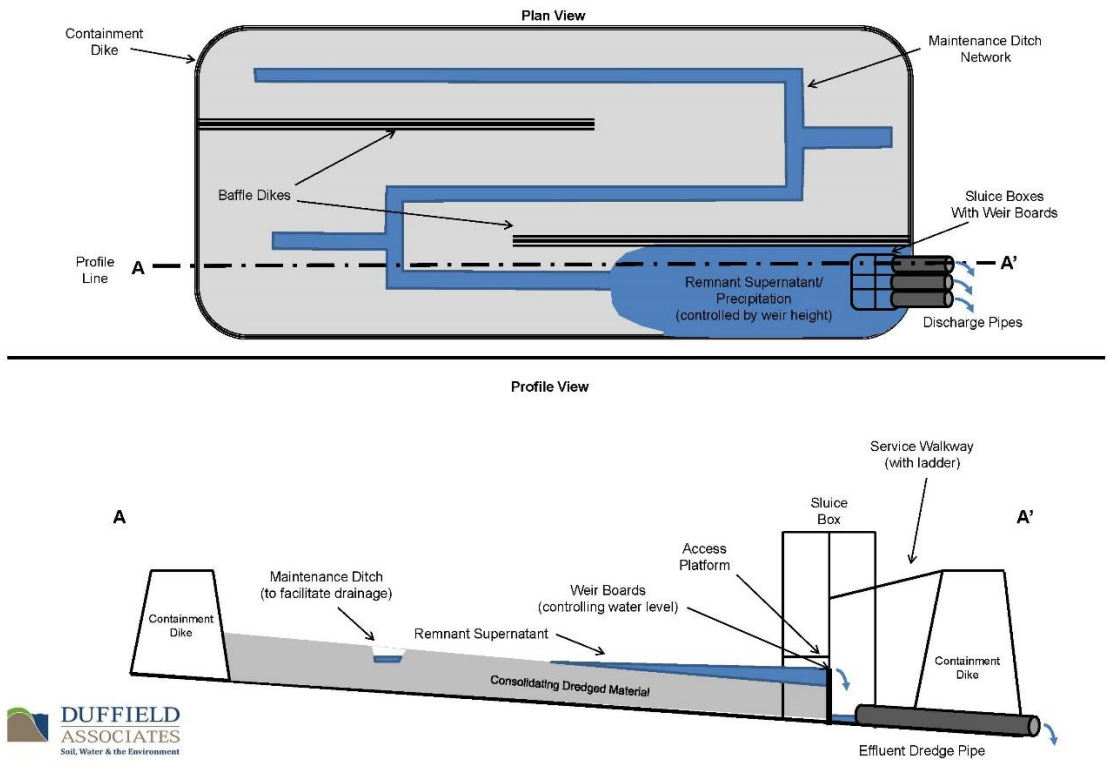



Figure 3.3-4: Schematic of CDF between Dredge Events

By design, CDFs provide for a residence time that allows for a desired flocculation of the soil water slurry to maintain effluent concentrations that are set in accordance with regulatory limits. Generally, discharge from the CDF is limited by a minimum of 80% removal of total suspended solids (TSS) from the slurry; however the actual limits are set based on the local regulation and are site specific. The effluent suspended solids concentration is typically monitored throughout the dredging process and can be used to guide ponding depth adjustments at the weir (e.g., if suspended solids concentrations are too high, add weir boards at the sluice box to provide additional ponding depth to enhance flocculation from the supernatant. If concentrations are low and storage volume is limited, remove weir boards to reduce ponding depth). It should be noted that it is the standard of practices that operating procedures require at least 2 feet of dike freeboard beyond the anticipated bulked storage in the facility, so that the vertical limit of disposal of new material is predicated by the maximum dike height allowable for stability, the height of bulked storage from previous dredging cycles, and the minimum ponding depth (2 feet).

Near the peak of the dredging operation, effluent flow rate through the weir could approximate the influent flow rate from the dredge pipeline. However, it may remain below the influent rate depending on the sedimentation/flocculation rates of the slurry. After a period of time (generally one to two months) the effluent volume released from the site gradually lessens, and is dependent upon such factors as rainfall and compression settling of the dredged deposit. Active maintenance activities, such as ditching, can be used to enhance dewatering and the rate of compaction to prepare the site for the next dredge cycle or dike raising.

### 3.3.2 Harbor Dredging and Dredged Material Disposal Plan

The Preferred Alternative includes dredging of the river bottom along the Delaware River main channel and the construction of harbor access and berthing areas along the port facility. The harbor access is proposed to include the construction of a 1,700-foot diameter turning basin on the downstream portion of the project sufficient for the largest design ship expected to use the facility, a 12,000 TEU container ship. The turning basin is inclusive of the Delaware River main shipping channel, with the harbor extending approximately 1,000 feet from the edge of the shipping channel at its widest. The proposed harbor layout is shown in the permit drawings, included as Appendix 1.

The harbor of the Preferred Alternative is to be constructed with a flat bottom corresponding to a maintained depth of -45 feet MLW consistent with the maintained depths of the main shipping channel and is proposed to cover an area of 64.5 acres. The transitions into the harbor from the up river and down river subaqueous slopes are to be dredged to a 6 horizontal to 1 vertical slope, and a 3 horizontal to 1 vertical slope is proposed along the shore from the base of the sheet pile wall to the front of the wharf for a total area of 86.9 acres of dredged footprint. This grading profile results in a total dredge (excavation) volume of approximately 3.3 million cy of material.

The Edgemoor expansion initial construction dredging is planned to occur over at least three dredge cycles, with the slurry going into existing CDFs located along the Delaware River or constructed on the Applicant's property. The primary disposal area proposed is Wilmington Harbor South CDF, but other existing CDFs might also be used, such as Wilmington Harbor North and Reedy Point North. The applicant performed a study to evaluate the feasibility of utilizing Wilmington Harbor South CDF for the disposal of the initial dredged material.

The study establishes that Wilmington Harbor South CDF would have sufficient "air capacity" to store the construction dredged material over multiple dredge events with a minimum dike height of 11 feet at the start of construction. However, the disposal area would be utilized to its short term (e.g. diked) capacity during the first two events, with dewatering activities between to establish additional capacity. The study also indicates that it may be appropriate for a contingent disposal area to be available, based on the volume of the proposed dredging events. Additional CDFs along the Delaware River shoreline include Reedy Point North, Reedy Point South, and Wilmington Harbor North as shown in Figure 3.3-5.

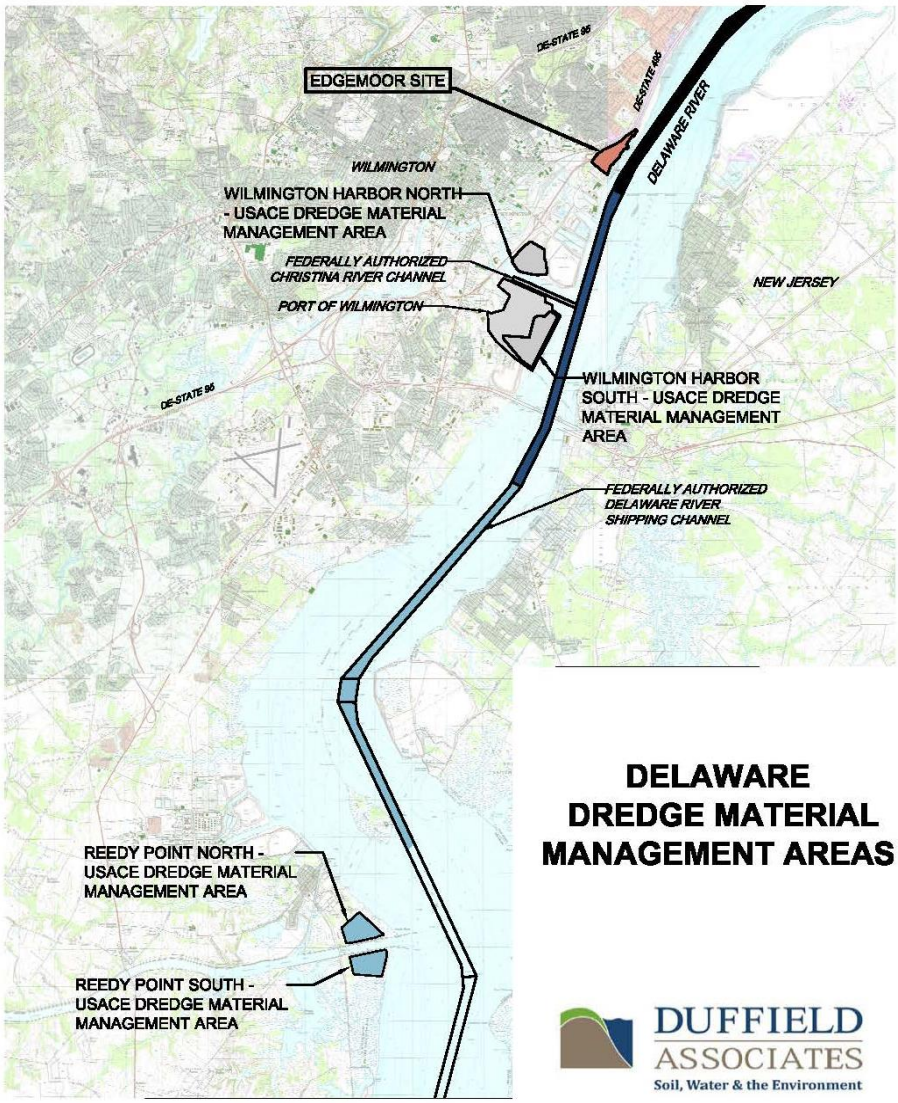



Figure 3.3-5: Delaware Dredged Material Management Areas

The study demonstrates that portions of the dredged material, which consist of a combination of soft mud soil, dense sand soils, and dense clay soils could be dredged to these areas. The cost associated with the additional pumping equipment and disposal area preparation necessary to utilize these CDFs for all of the dredge may be deleterious to the project, but the CDFs are suitable contingency options for the project. The study also establishes that there is sufficient capacity in these existing confined disposal facilities located in the State of Delaware to accommodate the yearly maintenance dredging. It is noted that if the Applicant's submission for Assumption of Maintenance (AOM) of the harbor channel under Section 204(f) of the Water Resources Development Act (WRDA) 1986 is approved, the CDFs utilized for the maintenance dredging would be the responsibility of the Operations Section of the Philadelphia District of the USACE and may be modified.

### 3.3.3 Associated Construction Activities-

The Preferred Alternative also includes the portion of the landside development that transitions to the harbor dredging. These activities include the associated construction of the wharf structure integrated with a site retention system along the wharf, the extension and termination of the site retention system at each end of the site, and the filling of the space between the retention system and MHW. The structures have been considered in the permitting process and are defined further herein and depicted in the project permit drawings, included as Appendix 1. Further, all in-water construction activities (e.g., dredging, pile driving, and demolition) will occur between July 15 and March 15, minimizing and/or avoiding impacts to sturgeon and other ESA-listed species. Demolition and pile driving will be conducted over an approximately 2.5 year period, with the schedules for these activities sequenced with that for dredging.

*3.3.3.1 Wharf Construction*

The initial phase of construction of the Edgemoor Container Port wharf will involve the removal of two existing wooden dock structures and remnant timber piles within the Construction and Dredging areas. Piles within the Dredging Area will be removed using vibratory methods. Piles outside of the Dredging Area will be cut off at the mudline. Some of the timber piles along the shore may be left in place.

The wharf structure is proposed to extend along the Delaware River and provide 2,600 feet of berth footage along the riverside face. The structure is to consist of a pile-support, reinforced concrete high-deck with fendering along the river side. The dock structure is proposed to be approximately 112 feet wide for a total wharf square footage of 296,100 square feet including the fender system. The wharf will be supported by a pile system consisting of approximately 4,500, 20-inch diameter, concrete-filled steel pipe piles. Plumb vertical piles will be spaced roughly on 10-foot centers and batter (angled) piles in one row on 5-foot centers for the wharf support. Two rows of piles intended to support gantry crane rails will be placed on 5-foot centers beneath the wharf. Batter piles will be installed along the riverfront side of the wharf to support the 13 proposed shoaling fans (see Section 3.3.3.4). The total number of piles also accounts for possible termination piles at the ends of the wharf. The piles will be coated with an epoxy coating for corrosion protection.

The deck will include two crane rails for support of a series of electric mobile gantry cranes for ship loading and unloading. The crane rails will be structurally integrated with the deck structure along the full length of the dock face. No isolated mooring structures or floating dock structures are proposed.

*3.3.3.2 Pile Installation*

The piles will be installed from a barge using a combination of vibration and cushioned impact driving. A vibratory hammer will be used to drive the piles to refusal and then a cushioned impact hammer will be used to drive the piles to their final design depth. Cushion blocks will consist of multiple layers of plywood approximately 12 inches (30.5 cm) thick. Piles will be driven in water 10 to 40 ft (3.0-12.2 m) deep (post-dredging depths). A reduced

energy "soft-start" procedure, where the equipment will be operated at half-power for the first 15 minutes, will be used for both types of pile driving.

*3.3.3.3 Sheet Pile Retaining Wall Installation*

A sheet pile retaining wall, consisting of PZ steel sheets, will be constructed along the landward edge of the wharf (Appendix 1 – Permit Plan Drawings). The sheets will be installed by vibration in 10 to 15 ft (3.0-4.6 m) of water (post-dredging depths).

The deck will transition to land at the landward side of the wharf structure behind the sheet pile retaining wall/bulkhead. The sheet pile wall, which will also be coated for corrosion protection similar to the piles, will span an exposed height on the order of 25 feet. The retaining wall may include dead man anchorages constructed in the landside fill or may be supported on the riverside by steel pipe piles, depending on the outcome of design analyses. The retaining wall will be integral with the wharf along the 2,600 foot deck.

On the upriver side, the retaining wall returns transition out of the subaqueous lands and terminates on the site. On the down river end of the site, the sheet pile wall extends out of the subaqueous lands and continues to the property line to facilitate the site grading requirements.

An approximately 5.3-acre area of subtidal and intertidal waters between the sheet pile wall and the high tide line will be filled with suitable sediment or soil. The fill area will be separated hydraulically from the river by the sheet pile wall prior to the placement of fill to preclude impact to water quality or aquatic resources outside of the fill area.

*3.3.3.4 Anti-Sedimentation Devices (Shoaling Fans)*

In order to reduce the volume of maintenance dredging associated with this project and to maintain functionality of the berths, the Applicant is proposing to install a sedimentation reduction system, SedCon® Turbo System, along the face of the wharf consisting of a series of sediment fans. The sediment fans are to be installed at approximate 200-foot spacing along the wharf face. The units are secured to the dock structure on a batter pile extending beneath the dock structure, as depicted in the permit plans in Appendix 1.

An illustration of a sediment fan unit is provided as Figure 3.3-6. In operation, water is drawn into the top of a 48-inch diameter ("J-shaped" tube), passes through a hydraulically powered, four bladed, pump impellor, and is discharged as a jet along the bottom of an area being protected. The hydraulic power is provided from a landside engine and pump and carried to the fans by hydraulic hoses, which provides the hydraulic pressure to the fully submerged unit. The hydraulic fluid consists of a biodegradable vegetable oil suitable for water applications. The fans within the units are configured to rotate at speeds on the order 275 revolutions per minute. The units are provided with a screen at the larger intake end and provide an open space of 1½ feet between blades.

Figure 3.3-6: Individual Sediment Fan Unit

Each of the fan units starts an operating cycle with the jet aimed perpendicular to the current and then turns 90º in the direction of the current (ebb or flood) over a period of approximately 45 minutes. A computer operates the units within a group sequentially, in coordination with the tides. Total run time for a group of four fans units would be 3 hours (4 x 45 minutes per unit). The group of three fan units would operate within the time period of the group of 4 units, but for 45 minutes less overall time (i.e., 2.25 hours). The project currently anticipates installation of 13 fans units, which would likely result in three operational groups with three fans in each group and one operational group having four fans. The groups would run simultaneously during each tide cycle, with one fan running in each of the groups at the same time.

## 4.0 ESA-LISTED SPECIES AND CRITICAL HABITAT OF PRIMARY CONCERN

This section of the BA discusses the distribution, life history, and habitat preferences of the shortnose sturgeon and the Atlantic sturgeon, with emphasis on their occurrence and biology in the Delaware River and estuary. In addition, information is provided on designated critical habitat for the New York Bight DPS of Atlantic sturgeon in the Delaware River.

## *4.1 Shortnose Sturgeon*

### 4.1.1 Geographic Distribution and Stocks

The shortnose sturgeon is a relatively small (<1.2 m total length (TL)) sturgeon that inhabits large Atlantic coastal rivers and estuaries from the St. John River, New Brunswick, Canada, to the St. Johns River, FL (Vladykov and Greeley, 1963). The shortnose sturgeon was placed on the Endangered Species List in 1967 and was subsequently listed as endangered under the federal Endangered Species Act (ESA) of 1973, as amended.

Nineteen distinct populations, ranging in size from less than 100 adults in the Merrimack River, MA (Kynard, 1997) to greater than 60,000 adults in the Hudson River, NY (Bain et al., 2007) have been documented (SSSRT, 2010). Genetic studies indicate that these 19 populations can be aggregated into five genetically similar groups: 1) Gulf of Maine; 2) Connecticut and Housatonic Rivers; 3) Hudson River; 4) Delaware River and Chesapeake Bay; and 5) Southeast. The Delaware River/Chesapeake Bay and Southeast groups function as metapopulations, while the other groups function as independent populations. Although shortnose sturgeon may migrate within metapopulations and occasionally between populations, gene flow between populations appears to be very limited, suggesting that few individuals spawn outside of their natal rivers (Walsh et al., 2001; King et al., 2014; Wirgin et al., 2005, 2009). Distinct Population Segments (DPSs) have not been designated for shortnose sturgeon.

The Delaware River estuary supports the third largest population of shortnose sturgeon range wide, the Hudson River and the St. John River having larger estimated populations. ERC (2006b) estimated the population of adult shortnose sturgeon in the Delaware River to be 12,047 (95% CI 10,757-13,589) using the Schnabel population estimator with mark-recapture data collected during 1999-2003. ERC's estimate was very similar to an earlier Schnabel estimate of the Delaware River adult shortnose sturgeon population of 12,796 (95% CI 10,228-16,367) based on mark-recapture data from 1981-1984 (Hastings et al., 1987). The similarity of the estimates suggests that the population of adult shortnose sturgeon in the Delaware River is stable, but not increasing.

### 4.1.2 Distribution in the Delaware River

Shortnose sturgeon occur throughout the Delaware River estuary (Brundage and Meadows 1982a). Adults are abundant in the upper tidal Delaware River from Trenton, NJ to Philadelphia, PA year-round (Hastings et al., 1987; ERC, 2006a), and common in the lower tidal river from approximately Chester, PA to Wilmington, DE, particularly during late fall and winter (ERC, 2006a, 2016, 2017, 2018a, 2019).

Shortnose sturgeon in the Delaware River overwinter in dense aggregations in the upper tidal river between Roebling and Bordentown, NJ, and also in the lower tidal river in the vicinity of Marcus Hook and Chester, PA. It was earlier thought that shortnose sturgeon overwintering in the lower tidal river were not likely to spawn that year (ERC, 2006a), but more recent acoustic telemetry studies have shown that sturgeon from the downriver

overwintering aggregation are as likely to participate in spawning as those from the upriver aggregations (ERC, 2014a, 2016, 2017, 2018a, 2019).

Spawning occurs primarily in the lower non-tidal Delaware River from Trenton to Lambertville, NJ from late March or early April into early May (Brundage, 1986; ERC, 2008, 2015, 2018b). After spawning, adult shortnose sturgeon move back to the tidal river and spend the summer and fall foraging throughout the tidal river, with fish occasionally moving into Delaware Bay (O'Herron et al., 1993; ERC, 2006a).

Delaware River shortnose sturgeon generally remain in the estuary throughout their lives, although there are a few records of their occurrence in the ocean near the mouth of Delaware Bay (Brundage and Meadows, 1982a).

Juvenile shortnose sturgeon in the Delaware River co-occur with adults, but being sensitive to salinity (Jarvis et al., 2001), generally remain upriver of the freshwater/saltwater interface (O'Herron et al. 1993; Brundage and O'Herron, 2009). The distribution of juveniles in the lower tidal river may be limited in summer by higher salinities below Wilmington and lower dissolved oxygen concentrations in the Philadelphia area (Brundage and O'Herron, 2009). Juvenile shortnose sturgeon appear to overwinter in a dispersed fashion rather than in the aggregations typical of adults (Brundage and O'Herron, 2009).

Adult and juvenile shortnose sturgeon in the Delaware River prefer channel habitats and are typically found in the deepest water available (Hastings et al., 1987; O'Herron et al., 1995; ERC, 2014b), although use of shoal areas has been reported for Connecticut and Merrimack River shortnose sturgeon (Kynard et al., 2000).

### 4.1.3 Adults

Shortnose sturgeon reach maturity at lengths of 45-55 cm FL (fork length) throughout their range, but growth rate, maximum age, and maximum size vary with latitude. Shortnose sturgeon in southern populations grow more rapidly and mature at a younger age, but attain smaller maximum sizes than those in the north. Males mature at 2-3 years in Georgia, 3-5 years in South Carolina, and 10-11 years in the St. John River. Females mature at 4-5 years in Georgia, 7-10 years in the Hudson River, and 12-18 years in the St. John River. Shortnose sturgeon live 30-67 years in the north, while those in the south live 10-25 years (Dadswell, 1984; Kynard, 1997).

Shortnose sturgeon appear to be strictly benthic feeders. Adults in the Saint John River prefer mollusks and vary their dominant prey in different salinity regions; *Mya* in saline waters, *Macoma* in brackish water, *Amnicola* and *Valvata* in fresh water with high chloride content (100-1,000 ppm), and *Pisidium* and *Elliptio* in permanent freshwater areas (Dadswell, 1979). Benthic insects and crustaceans are more important components of the diet in the upper Connecticut River and the Hudson River (Dadswell et al., 1984). Recent unpublished data indicate that the invasive zebra mussel (*Dreissena polymorpha*) is now a major forage item of adult shortnose sturgeon in the Hudson River (Kynard et al., 2016).

Adult shortnose sturgeon in Montsweag Bay, ME (salinity 18-24 ppt) fed on *Mya*, *Crangon*, and small flounder (McCleave et al., 1977).

No formal studies of the food habits of shortnose sturgeon in the Delaware River have been conducted. However, incidental observations suggest that the invasive Asian clam (*Corbicula fluminea*) is an important component of the diet of adult shortnose sturgeon in the Delaware River. Asian clams have also been reported in the diet of adult shortnose sturgeon in the Merrimack River (Kynard et al., 2016) and the freshwater portion of the Winyah Bay estuary, SC (Dadswell et al., 1984).

### 4.1.4 Spawning

Shortnose sturgeon may not spawn every year and spawning periodicity appears to vary among populations. Dadswell (1979) reported that male shortnose sturgeon in the St. John River spawned at 2-year intervals and females every 3-5 years. Kieffer and Kynard (2012) reported that the spawning interval in the upper Connecticut River ranged from 1-5 years (mean 1.4 years) for males and 2-10 years (mean 4.5 years) for females. In the Delaware River, some acoustically-tagged shortnose sturgeon of both sexes were detected on the spawning grounds in consecutive years (ERC, 2008, 2015). Annual spawning by some males and females has also been reported for Savannah River shortnose sturgeon (Collins and Smith, 1993).

Shortnose sturgeon spawn once in spring, typically as far upriver as the population ranges (Bain, 1997). Water temperature appears to be the major environmental factor determining the timing of spawning (ERC, 2015), although photoperiod and river flow are also important (Kynard et al., 2016). Shortnose sturgeon spawn primarily over clean, well oxygenated gravel/cobble/boulder substrate in areas with at least moderate current velocity (Dadswell et al. 1984).

In the Delaware River, shortnose sturgeon spawn primarily in the lower non-tidal river between Trenton and Lambertville, some 96-120 km upriver of the Edgemoor Container Port site. Spawning adults first enter the lower non-tidal river in mid-late March or early April, depending on water temperature, and may remain on the spawning grounds through early May, over a temperature range of 6.3-17.6°C, with peak abundance between 11.5-14.2°C (ERC, 2008, 2015, 2018b). Acoustically-tagged adults have been detected in the lower non-tidal river for periods ranging from 1-31 days (ERC, 2008, 2015, 2018b), with males tending to remain on the spawning grounds somewhat longer than females (ERC, 2008, 2015). Spawning adults concentrate in areas of rapid, turbulent flow, such as the Trenton rapids, and below the Scudder Falls and Lambertville wing dams, although conditions suitable for spawning occur throughout much of the reach from Trenton to Lambertville (ERC, 2008, 2015).

### 4.1.5 Eggs and Larvae

Fertilized shortnose sturgeon eggs (3.0-3.2 mm in diameter) are demersal and adhesive, dark brown to black in color (Dadswell et al., 1984). At 8-12°C, eggs hatch after about 13 days or

136-143 degree days (Kynard et al., 2016). Length at hatching is 7.3-11.3 mm (Buckley and Kynard, 1981).

Dadswell et al. (1984) provided the following description of larval development:

> At hatching, the larvae are tadpole-like and dark gray, with a large yolk sac, the head is closely attached to the yolk sac, the mouth is unopened, and pectoral and pelvic fins are undeveloped. At 14 mm TL, approximately 10 days after hatching, the barbels are formed, the mouth is large and distinctly *brevirostrum*-like but has teeth (9-12 upper, 8-11 in lower jaw), pectoral but not pelvic fins are present, eye size averages 0.7 mm, the anlage of the dorsal fin is present, and the yoke is gone (Taubert and Dadswell, 1980). By 16.3 mm pelvic fins are present and by 20 mm scutes, nose shape, and dorsal and anal fins are characteristic of the species (Pekovitch, 1979).

Shortnose sturgeon larvae transition from yolk-sac larvae (YSL) to post-yolk-sac larvae (PYSL) at about 14-15 mm TL. PYSL have well-developed eyes, open electrosensory organs, a mouth with teeth, and fins that allow normal swimming. Active feeding also begins at this transition (Kynard, 1997).

Shortnose sturgeon larvae are initially photonegative and hide under available cover. Older larvae, typically after they become PYSL, evidence "swim-up" behavior by which they enter the river drift and disperse downriver to rearing habitats (Richmond and Kynard, 1995; Kynard and Horgan, 2002). The duration and distance that the larvae drift varies between river systems (Parker and Kynard, 2014).

Shortnose sturgeon transition from the PYSL to the juvenile life stage when the adult complement of fin rays has formed. Bain (1997) reported that shortnose sturgeon in the Hudson River have fully developed external characteristics at 20 mm TL. However, Snyder (1988) reported that the full complement of caudal fin rays is not attained until a length of at least 57 mm SL, greater than 30 days after hatching.

Shortnose sturgeon eggs and larvae have been collected in the non-tidal Delaware River from immediately upriver of the Trenton rapids to the Lambertville rapids (ERC, 2008, 2015). There are only two records of shortnose sturgeon larvae being collected in the upper tidal Delaware River, between rkm 204-212, during approximately the same time period. The SSSRT (2010) speculated that these may have been anomalous occurrences caused by a high river flow event that flushed the larvae out of the non-tidal river.

### 4.1.6 Juveniles

Shortnose sturgeon grow rapidly during their first year and the may reach 300 mm TL by the end of the first growing season, depending on latitude (Bain, 1997). Based on analysis of length-frequency distributions, Delaware River shortnose sturgeon may attain a length of ≤275 mm FL by the end of their first year (ERC, 2018a).

Juvenile shortnose sturgeon feed on available benthic crustaceans and insect larvae, such as *Gammarus*, *Ascellus*, *Hexagenia*, *Chaoborus*, *Chironomous*, and *Cyathura* (Dadswell et al., 1984; Kynard et al., 2016).

Juvenile shortnose sturgeon disperse downriver either as young-of-year or yearlings (Kynard et al., 2016), but in all populations, dispersal ends upriver of salt water because of the sensitivity of young shortnose sturgeon to salinity (Jarvis et al., 2001). In the Delaware River, at least some shortnose sturgeon disperse downriver during their first year, arriving in the lower tidal river by late fall or winter. The precise timing and rates of dispersal of shortnose sturgeon from the spawning/upriver nursery area to the lower tidal Delaware River are not known. Older juvenile shortnose sturgeon in the Delaware River occur throughout the tidal freshwater and seasonally brackish zones of the river (Brundage and O'Herron, 2009), and appear to use the same habitats as adults (ERC, 2006a), consistent with studies in the St. John (Dadswell, 1979), Connecticut (Kynard, 1997), and Hudson (Bain, 1997) rivers.

Juvenile shortnose sturgeon in the Delaware River prefer deep channel habitats (Brundage and O'Herron, 2009; ERC, 2006c, 2007), consistent with other river systems (Pottle and Dadswell, 1979; Haley et al., 1996; Bain, 1997; Kynard, 1997).

Shortnose surgeon life history characteristics, behavior/habitat use, and occurrence in the Edgemoor Container Port Action Area are summarized in Table 4-1.

### 4.1.7 Critical Habitat

Critical habitat has not been formally designated for shortnose sturgeon.

Table 4-1. Summary of shortnose sturgeon life history and occurrence in the Edgemoor Container Port Action Area

| Life Stage (size mm) | Duration | Behaviors/Habitat Use | Occurrence in Action Area |
|---|---|---|---|
| Egg (3.0-3.3) | ~13 days post spawn | Stationary in interstices of cobble and rock in fresh, fast-flowing water | Do not occur |
| Yolk-sac larvae (~7-15) | ~8-12 days post hatch | Photonegative, hide under rocks at and near spawning site | Do not occur |
| Post-yolk sac larvae (~16-57) | ~12-40 days post hatch | Become photopositive, evidence swim-up behavior, enter river drift, disperse to rearing sites | Do not occur |
| Young-of-year (~58-275) | ~40 days post hatch to one year | Disperse downriver, occupy deep, soft-sediment areas upriver of salt wedge | Fall and winter (exact timing of arrival in lower non-tidal river unknown) |
| Juvenile (~276-450) | 1 year to maturation | Forage in freshwater and seasonally brackish regions of river; salinity tolerance increases with age, prefer deep channel habitats | Year-round |
| Adults (~451-1100; max ~1400) | Post-maturation | Freshwater to estuary, some occurrence in nearshore coastal waters, prefer deep channel habitats | Year-round |

## *4.2 Atlantic Sturgeon*

### 4.2.1 Geographic Distribution and Stocks

The Atlantic sturgeon is a large (historically reaching lengths ≤ 4.6 m) sturgeon that inhabits large rivers and coastal environments along the Atlantic coast from Labrador, Canada to Cape Canaveral, Florida (Hilton et al., 2016). Atlantic sturgeon are anadromous. Spawning and rearing of eggs, larvae, and early juveniles occurs in fresh water. Juveniles develop a tolerance to salinity as they age and most migrate to the sea for the first time when they are 2-3 years old. Older juveniles, referred to as subadults, and adults spend a significant portion of their lives in marine waters, and may undertake extensive migrations along the Atlantic coast. Adults return to tidal fresh water to spawn and older juveniles/subadults may return to tidal rivers seasonally to forage (Bain, 1997; Hilton et al, 2016).

The National Marine Fisheries Service (NMFS) delineated United States populations of Atlantic sturgeon into five DPS based on genetic studies: Gulf of Maine, New York Bight, Chesapeake Bay, South Atlantic, and Carolina (77 FR 5880 and 77 FR 5914, February 6, 2012). Gulf of Maine Atlantic sturgeon were listed as threatened and the other DPSs were listed as endangered under the ESA in 2012. Individuals from the various DPS mix extensively along the Atlantic coast and within coastal rivers (Hilton et al., 2016). It is believed that Atlantic sturgeon eggs, larvae, and non-migratory juveniles in the Delaware

River are exclusively from the New York Bight DPS. Because of their extensive migrations and mixing, adult and subadult Atlantic sturgeon in the Delaware River may not be from the New York Bight DPS. Based on mixed-stock analysis (Damon-Randall et al., 2013), NMFS has determined that adult and subadult Atlantic sturgeon in the Delaware River may originate from the five DPSs at the following frequencies: Gulf of Maine, 7%; New York Bight, 58%; Chesapeake Bay, 18%; South Atlantic, 17%; and Carolina, 0.5%.

In the late 19th century the Delaware River supported the largest and most profitable fishery for Atlantic sturgeon on the East Coast, but the fishery had virtually collapsed by 1905 because of overfishing and habitat degradation (Brundage and Meadows, 1982b). The Delaware River was estimated to have less than 300 adult Atlantic sturgeon by ASSRT (2007), although this is generally believed to be an underestimate (Hilton, et al., 2016).

There is evidence that the Delaware River population of Atlantic sturgeon is recovering, with evidence of successful spawning most years since 2009 and of a particularly successful year class apparently being produced in 2017 (Brundage and O'Herron, 2009, 2010, 2011, and 2014b; Brundage et al., 2014; and ERC, 2014, 2016, 2017, 2018a, 2019). The population of early juvenile (ages 0 and 1) Atlantic sturgeon in the Delaware River was recently estimated to be 3,656 individuals (95% CI = 1,935–33,041) using a Schumacher-Eschmeyer estimator with mark-recapture data collected in 2014 (Hale et al., 2016).

### 4.2.2 Distribution in the Delaware River

Adult Atlantic sturgeon acoustically tagged by Breece et al. (2013) and Fox et al. (2015) entered the Delaware River on presumed spawning runs as early as mid-April and typically departed by the end of July, although several individuals reported on by Fox et al. (2015) remained in the tidal river into the fall. Adult Atlantic sturgeon primarily occupied the river reach from New Castle, DE (rkm 99) to Tinicum Island, PA (rkm 137), although a few traveled as far upriver as Roebling, NJ (rkm 201). Although the current spawning location(s) of Atlantic sturgeon in the Delaware River have not been definitely identified, acoustic tracking data indicate that Atlantic sturgeon spawn above the salt front, primarily in areas of cobble and bedrock substrate, from Claymont, DE to Tinicum Island, PA (rkm 125-137) during May through early June. An Atlantic sturgeon spawning site in the upper tidal Delaware River near Burlington, NJ (approximately rkm 187) has also been suggested (Simpson, 2008; D. Fox, Delaware State University, pers. comm., March 7, 2018), although evidence for this is not as strong as for the downriver spawning areas.

Young-of-year Atlantic sturgeon occur throughout the freshwater portion of the tidal Delaware River, from approximately New Castle, DE (rkm 99) to Roebling, NJ, with their distribution centered on the Marcus Hook-Chester reach of the river (rkm 123-129) (Brundage et al., 2014, Hale et al., 2016). Early juvenile Atlantic sturgeon in the Delaware River shift their center of distribution progressively down-estuary as they age, until they migrate to the higher salinity waters of Delaware Bay and eventually the nearshore Atlantic Ocean during their second or third years. After their first outmigration, juvenile Atlantic sturgeon typically return to the lower tidal Delaware River in spring where they remain through fall, at which time they move back to the lower bay/ocean (Brundage et al., 2014).

### 4.2.3 Adults

Male Atlantic sturgeon mature at 150-210 cm TL and females at >200 cm TL (Bain, 1997). Age at maturity varies with latitude and gender, with southern populations maturing earlier than northern populations and males maturing at a younger age than females. In southern populations males mature as early as 5 years and females as early as 10 years (Smith et al., 1982). In the James River, VA, a tributary to Chesapeake Bay, males mature at approximately 10 years and females at 15 years (Balazik et al. 2012a). In the Hudson River, males mature at 12-19 years and females at 16-20 years (Van Eenennaam et al., 1996). At the northern limit of their range, male Atlantic sturgeon mature at 16-24 years and females at 17-28 years (Bradford et al., 2016). Atlantic sturgeon are long-lived, with maximum ages of approximately 43 years reported for a female in the Hudson River, 35 years for an individual of unknown gender collected off the coast of New Jersey, and 60-64 years old for Atlantic sturgeon in Canada (Hilton et al., 2016).

Atlantic sturgeon are benthic feeders and use their barbels to locate prey. Polychaetes are a dominant prey item of adult and subadult Atlantic sturgeon. Other common food items include decapods, amphipods, isopods, bivalves, and small fish such as sand lance and juvenile tomcod (Guilbard et al., 2007; Hilton et al., 2016).

### 4.2.4 Spawning

Atlantic sturgeon may not spawn every year and spawning interval appears to vary with latitude. Spawning intervals of 2-5 years, 2-3 years, and 3-5 years have been reported for female Atlantic sturgeon in southern rivers (Smith, 1985), in the James River (Hilton et al., 2016), and the Hudson River (Bain, 1997), respectively. Male Atlantic sturgeon spawn every 1-5 years (Smith, 1985), although recent work on the James River found that some males spawned every year for five consecutive years (Balazik, 2015).

Adult Atlantic sturgeon migrate into fresh waters in advance of the spawning season, the males preceding the females (Gilbert, 1989). This migration may begin as early as mid to late February in Florida (Gilbert, 1989) to as late as early July in tributaries to the Gulf of Maine and in the St. John River, New Brunswick (Scott and Crossman, 1973; Vladykov and Greely, 1963; Bradford et al., 2016). Water temperature appears to be the major factor initiating spawning migrations, with males beginning their migration at approximately 6°C and females at 12-13°C (Smith et al., 1982; Dovel and Berggren, 1983; Smith, 1985).

Pre-spawning male Atlantic sturgeon enter the Hudson River in April, while females enter during May (Bain, 1997). The spawning period is protracted in the Hudson River, ranging from May through July or possibly August (Dovel and Berggren, 1983; Van Eenennaam et al., 1996). Individual females return to marine waters shortly after spawning, while at least some post-spawning males remain in the Hudson River as late as November (Dovel and Berggren, 1983).

Atlantic sturgeon spawn above the salt front because of the intolerance of Atlantic sturgeon eggs and larvae to salinity (Dovel and Berggren, 1983; Van Eenennaam et al., 1996).

Atlantic sturgeon spawning areas are typically characterized by moderate to fast current velocities and hard substrates (rocks, rubble, shale, and hard sand) (Smith and Clugston, 1997; Hilton et al., 2016), although spawning over soft sand and silt substrates has been reported (Van den Avyle, 1984).

Atlantic sturgeon in northern rivers spawn once in late spring and/or early summer. A portion of the Atlantic sturgeon population in southern rivers may also spawn in the fall. Fall spawning has been reported for Atlantic sturgeon in some rivers in Virginia (Balazik et al., 2012b), North Carolina (Smith et al., 2015), South Carolina (Collins et al. 2000), and Georgia (Hilton et al., 2016).

As discussed in Section 3.2.2, the current spawning location(s) of Atlantic sturgeon in the Delaware River have not been definitely identified (nor have Atlantic sturgeon eggs or larvae been collected in the Delaware River). However, acoustic tracking data strongly point to Atlantic sturgeon spawning in areas of cobble and bedrock substrate from Claymont, DE (rkm 125) to Tinicum Island, PA (rkm 137) during May through early June (Breece et al., 2013). These putative spawning areas are 7-19 km upriver of the Edgemoor Container Port site. An Atlantic sturgeon spawning site in the upper tidal river, near Burlington. NJ (rkm 187), some 69 km above the Edgemoor site, is also a possibility.

### 4.2.5 Eggs and Larvae

Fertilized Atlantic sturgeon eggs (3-4 mm) are demersal and highly adhesive (Jones et al., 1978). Hatching time is inversely related to water temperature, ranging from about 94 hours at 20°C to 140 hours at 18°C (Smith et al., 1980). Atlantic sturgeon embryos are approximately 7 mm TL at hatching and, under hatchery conditions, grow to about 20 mm TL in 20 days (Smith et al., 1980). Yolk absorption in complete 10-14 days after hatching, depending on water temperature, when the larvae are 13-14 mm SL (Hilton et al., 2016)

Bath et al. (1981) described the development of larval Atlantic sturgeon ranging from 8.4-31.5 mm TL, collected in ichthyoplankton samples in the Hudson River. Yolk-sac Atlantic sturgeon larvae were robust, opaque, and dull brown, with scattered melanophores that increased in number as the yolk was absorbed and size increased. The mouth was visible in an 8.4 mm specimen, and barbels first appeared as buds in a 9.7 mm specimen. The eye was fully formed by about 11.0 mm. By approximately 14 mm, the yolk sac was nearly absorbed, and the presence of barbels, the morphology of the mouth, and head shape made the larvae easily identifiable as sturgeons. Incipient dorsal scutes began to appear at 19 mm and incipient lateral scutes were apparent on larvae longer than 29 mm. Bath et al. (1981) and Bain (1997) reported that transformation from PYSL to the juvenile stage was essentially complete at ≥30 mm TL, although Snyder (1988) reported that the full complement of caudal fin rays is not attained until a length of >116 mm SL.

Hudson River Atlantic sturgeon YSL in an artificial stream were highly photonegative and sought cover, while PYSL left cover, were photopositive, and initiated exogenous feeding (Kynard and Horgan, 2002). PYSL initiated downstream movement in the simulated river drift that lasted for 6-12 days, which, in the Hudson River, would be sufficient to transport

the larvae from spawning to rearing areas without entering salt water (Kynard and Horgan, 2002). It appears likely that Atlantic sturgeon larvae in the Delaware River drift for only a short period of time, since long duration drift from the presumed spawning areas would transport the larvae into waters of higher salinity, where they would not survive. As with the larvae of other sturgeon species, Atlantic sturgeon have likely evolved river/population-specific patterns of dispersal that result in their movement downriver from spawning areas to optimal rearing areas upriver of the salt front (Hilton et al., 2016). It is interesting to note that the presumed Atlantic sturgeon spawning reach in the lower tidal Delaware River (rkm 125-137) overlaps with the area of greatest abundance of young-of-year Atlantic sturgeon (rkm 123-129), suggesting that PYSL dispersal is minimal. Atlantic sturgeon PYSL typically occupy deep channel habitats (Bath, 1981; Bain, 1997).

### 4.2.6 Juveniles

Atlantic sturgeon grow rapidly during their first years. Based on length-frequency distributions, Atlantic sturgeon in the Delaware River may attain a length of 450 mm FL by the end of their first year and 700 mm FL by the end of their second year (ERC, 2017, 2018a).

Juvenile Atlantic sturgeon feed on amphipods, aquatic insects, insect larvae, and other invertebrates (Guilbard et al., 2007).

Recent passive acoustic tracking has shown that young-of-year (i.e., age 0) Atlantic sturgeon utilize a large portion of the tidal freshwater Delaware River, from approximately New Castle, DE (rkm 99) to Roebling, NJ (rkm 201), with the Marcus Hook-Chester reach (rkm 123-129) being the area of greatest utilization (Brundage et al., 2014; Hale et al., 2016). Young Atlantic sturgeon shift their center of distribution progressively down-estuary as they age, until they migrate to the higher salinity waters of Delaware Bay and the nearshore Atlantic Ocean during their second or third years (Brundage et al., 2014). After their first outmigration, juvenile Atlantic sturgeon typically return to the lower tidal Delaware River in spring where they remain through fall, at which time they move back to the lower bay/ocean. Older juveniles/subadults, however, are less likely to return to the tidal river than younger fish, with some older subadults remaining exclusively in marine waters until they mature (Brundage et al., 2014).

Fisher (2011a), using manual tracking techniques, found acoustically-tagged age 0 Atlantic sturgeon in the deepest portions of Delaware River, over mud, sand, gravel, cobble, and bedrock substrates.

Acoustic tracking studies during 2009-2011 (Brundage and O'Herron, 2010, 2011, 2014; Brundage et al., 2014; Fisher, 2011a, b) suggest only minimal utilization of the upper tidal Delaware River by early juvenile Atlantic sturgeon. In contrast, Lazzari et al. (1986) commonly collected juvenile Atlantic sturgeon, including 1 and 2 year old individuals, in the upper tidal river between Roebling and Trenton, NJ during July 1981 through December 1984. Moreover, of the five occurrences of age 0 Atlantic sturgeon in the Delaware River (all from the 1970s) reported by Brundage and Meadows (1982b), four were from the upper tidal river between Burlington Island (rkm 190) and Newbold Island (rkm 196). These older

records suggest that the upper tidal Delaware River may have been more important as a nursery area for Atlantic sturgeon in the 1970s and 1980s then it is now. Fisher (2011b) offered that the primary nursery area for early juvenile Atlantic sturgeon may have shifted from the upper to the lower tidal river because of improvements in dissolved oxygen concentration in the lower river since the 1980s.

Atlantic surgeon life history characteristics, behavior/habitat use, and occurrence in the Edgemoor Container Port Action Area are summarized in Table 4-2.

Table 4-2. Summary of Atlantic sturgeon life history and occurrence in the Edgemoor Container Port Action Area

| Life Stage (size mm) | Duration | Behaviors/Habitat Use | Occurrence in Action Area |
|---|---|---|---|
| Egg (~3.0-4.0) | ~94-140 hrs post spawn | Stationary in interstices of hard bottom substrates above the salt wedge | Unlikely to occur. Spawning occurs upriver of Action Area |
| Yolk-sac larvae (~7-14) | 10-14 days post hatch | Photonegative and seek cover, do not enter river drift, remain near spawning site | Unlikely to occur |
| Post-yolk sac larvae (~15-116) | 2 weeks to approx. 3 months post hatch | Leave cover, become photopositive, initiate exogenous feeding; may enter river drift, but remain in fresh water | Occurrence possible May through September |
| Young-of-year (~117-450) | ~3 months post hatch to one year | Forage in tidal freshwater, prefer deeper waters with soft sediments | Year-round |
| Non-migratory juveniles (~451-760) | Through end of second or third years | Forage in tidal and brackish regions of river, increased salinity tolerance with age, prefer deep channel habitats | Year-round |
| Migratory juveniles/subadults (~761-1500) | End of second or third year through maturation | Make seasonal migrations between lower tidal river and lower estuary/ocean | Occur in lower portion of Action Area (Delaware Bay) year round. May occur in upper Action Area April-November. |
| Adults (~1,501-2,100) | Post-maturation | Migration/staging for spawning/foraging | Occur in lower portion of Action Area (Delaware Bay) year round. May occur in upper Action Area April-November (principally May-July) |

### 4.2.7 Critical Habitat

NMFS has designated the entire tidal Delaware River, from "the crossing of the Trenton-Morrisville Route 1 Toll Bridge [rkm 214.6] downstream to where the main stem river discharges at its mouth into Delaware Bay [rkm 77.7]" as critical habitat for the New York Bight DPS of Atlantic sturgeon (81 FR 39160, August 17, 2017; NMFS, 2017a). The critical habitat rule identified four habitat units (referred to as physical or biological features (PBFs)) that are essential to the conservation of the species and that may require special management considerations or protection:

PBF 1: Hard bottom substrate (e.g., rock, cobble, gravel, limestone, boulder, etc.) in low salinity waters (i.e., 0.0–0.5 ppt range) (upriver of rkm 107.8) for settlement of fertilized eggs, refuge, growth, and development of early life stages (ELS),

PBF 2: Aquatic habitat with a gradual downstream salinity gradient of 0.5 up to 30 ppt and soft substrate (e.g., sand, mud) between the river mouth and spawning sites for juvenile foraging and physiological development,

PBF 3: Water of appropriate depth and absent physical barriers to passage (e.g., locks, dams, thermal plumes, turbidity, sound, reservoirs, gear, etc.) between the river mouth and spawning sites necessary to support:

I. Unimpeded movement of adults to and from spawning sites;

II. Seasonal and physiologically dependent movement of juvenile Atlantic sturgeon to appropriate salinity zones within the river and estuary;

III. Staging, resting, or holding of subadults or spawning condition adults. Water depths in main river channels must be deep enough (e.g., at least 1.2 m) to ensure continuous flow in the main channel when any sturgeon life stage would be in the river;

PBF 4: Water, between the river mouth and spawning sites, especially in the bottom meter of the water column, with the temperature, salinity, and oxygen values that, combined, support:

I. Spawning;

II. Annual and inter-annual adult, larval, and juvenile survival; and

III. Larval, juvenile, and subadult growth, development, and recruitment (e.g., 13-26°C for spawning habitat and no more than 30°C for juvenile rearing habitat, and 6 mg/l dissolved oxygen (DO) or greater for juvenile rearing habitat) (NMFS, 2019a).

The Edgemoor Container Port Action Area contains some of the elements of PBF 2 (soft substrate for juvenile foraging and may seasonally have salinities within the specified range), PBF 3 (contains no physical impediments to the in-migration of spawning adults, or the movement and maintenance of any life stage), and PBF 4: (water temperature, salinity, and

dissolved oxygen concentrations that can support successful recruitment). The Action Area does not contain the hard substrates of PBF 1 required for settlement of fertilized eggs, refuge, growth, and development of early life stages (see Section 2.1).

## 5.0 ESA-LISTED SPECIES OF SECONDARY CONCERN

This section of the BA presents information on the distribution and life history of ESA-listed sea turtles and whales that were identified by NMFS (2019a) as potentially occurring in the Action Area.

### *5.1 Sea Turtles*

Four sea turtle species may occur within the Action Area: loggerhead (federally-threatened Northwest Atlantic DPS), Kemp's ridley (endangered), leatherback (endangered), and green (threatened North Atlantic DPS) (NMFS, 2019a).

#### 5.1.1 Species Description and Life History

In U. S. Atlantic waters, sea turtles commonly occur throughout the inner continental shelf from Florida to Cape Cod, MA. The recognized life stages for sea turtles are egg, hatchling, juvenile/subadult, and adult (Hirth, 1971). All sea turtle species are migratory to some degree in that they return to nest at the same beach in subsequent years (Hopkins and Richardson, 1984).

Along the Atlantic coast of the United States, leatherback, green, and loggerhead sea turtle nesting beaches occur from Virginia south through Florida. A few green and loggerhead sea turtle failed nesting attempts have occurred on Delaware and New Jersey beaches but these are believed to be anomalies. Beaches in the two states do not support regular nesting of either species. Kemp's ridley nesting occurs primarily as a synchronized mass nesting event along the Gulf of Mexico in the state of Tamaulipas, Mexico, where nearly 95% of worldwide Kemp's ridley nesting occurs. Some Kemp's ridley nesting may also occur in U.S. Gulf of Mexico waters, especially along the coast of Texas (NMFS, 2018a).

Sea turtle nesting generally begins in the middle of April and continues into September. Mating and copulation occur just off the nesting beach. Females nest in sandy substrates above the high tide line (Carr, 1952; Hopkins and Richardson, 1984; Nelson, 1988). Incubation periods for loggerhead and green sea turtles average 55 days, but range from 45-65 days depending on local conditions (Nelson, 1988). Hatchlings emerge from the nest at night and find their way to the ocean by orienting to light reflecting off the breaking surf (Hopkins and Richardson, 1984). Once in the surf, hatchlings exhibit behavior known as "swim frenzy," during which they swim in a straight line towards the open sea for many hours (Carr, 1986). Little is known about sea turtles during their first or second years, but the young turtles may become associated with floating sargassum rafts offshore (Carr, 1986). Juveniles reenter coastal waters once they have grown in size.

In U.S. waters, adult and juvenile sea turtles overwinter along the southern Atlantic coast. Sea turtles move northward as water temperatures warm in the spring, arriving in Virginia waters as early as April/May and in their more northern foraging grounds in New England by June. This trend is reversed in the fall as water temperatures cool, with most sea turtles leaving New England by fall. Juveniles and, to a lesser extent, adult sea turtles may be found foraging in New Jersey and Delaware coastal waters, including Delaware Bay, during those times.

The feeding ecology of sea turtles in marine and estuarine waters is varied. The loggerhead is primarily carnivorous and has jaws well-adapted to crushing mollusks and crustaceans, and grazing on encrusted organisms attached to reefs, pilings, and wrecks. The Kemp's ridley is omnivorous and feeds on swimming crabs and other crustaceans. Juvenile green sea turtles are primarily carnivorous feeding on cnidarians, mollusks, crustaceans, sponges, and jellyfish, along with vascular sea grasses. Adult green sea turtles are herbivorous and graze on marine grasses and algae. The leatherback feeds primarily on jellyfish (Hopkins and Richardson, 1984).

Additional background on life history and population status can be found in the recovery plans for these turtles: loggerhead (NMFS and USFWS, 2008), Kemp's ridley (NMFS et al. 2011), green (NMFS and USFWS, 1991), and leatherback (NMFS and USFWS, 1992).

### 5.1.2 Occurrence in the Action Area

The Action Area is outside the range of sea turtle nesting; therefore, no eggs or hatchlings will be present. Adult and juvenile sea turtles may occur in Delaware Bay and the lower tidal Delaware River during May through early November (Stetzar, 2002, as cited in NMFS, 2018a). Artificial Island (rkm 87) is generally considered to be the upper range for sea turtles within the Delaware River estuary because of low salinity above this point, although sea turtles have occasionally been recorded as far up-river as the mouth of the Chesapeake & Delaware Canal (C&D Canal) (rkm 94.3) (NMFS, 2018a). Sea turtle presence in the Action Area is limited to the federal navigation channel. Sea turtles arrive in the mid-Atlantic from southern overwintering areas in May and typically begin migrating southward by mid-November. Sea turtles would not be expected to occur in the vicinity of the Edgemoor project. Sea turtles could be exposed to in- and outbound container vessels operating primarily below Artificial Island during May through November.

## *5.2 Whales*

Two endangered whale species, the fin whale and the right whale, may potentially occur within the very lowest portion of the Action Area near the mouth of Delaware Bay (NMFS, 2019a).

### 5.2.1 Species Description and Life History

Fin whales are found in deep, offshore waters of all major oceans, primarily in temperate to polar latitudes, and less commonly in the tropics. They occur year-round in a wide range of latitudes and longitudes, but the density of individuals in any one area changes seasonally. Fin whales have a maximum length of approximately 23 m in the northern hemisphere and 26 m in the southern hemisphere. Fin whales show slight sexual dimorphism, with females measuring 5-10% longer than males. Adults can weigh between approximately 36-73 metric tons. Fin whales live in social groups of two to seven whales and, in the North Atlantic, they are often seen feeding in groups that include humpback whales, minke whales, and Atlantic white-sided dolphins. During the summer, fin whales feed on krill, small schooling fish (e.g., herring, capelin, and sand lance), and squid by lunging into schools of prey with their mouth open. Fin whales fast in the winter while they migrate to warmer waters (NMFS, 2010; Jefferson et al. 2015).

The best abundance estimate available for the western North Atlantic fin whale stock is 1,618 individuals (Hayes et al., 2018). This estimate was derived from 2011 NOAA shipboard surveys and is the most current available, though the survey did not include all of the stock's range.

North Atlantic right whales are large baleen whales. Females are larger than males. Right whales generally feed from spring to fall, though they may also feed in winter in some areas. Their primary food sources are zooplankton, including copepods, euphausiids, and cyprids. Right whales feed at or just below the water surface and at depth. They primarily occur in coastal or shelf waters, although movements over deep waters are known. Right whales migrate to higher latitudes during spring and summer (NMFS, 2005).

North Atlantic right whales experienced substantial decline during the whaling period and their population may have been reduced to fewer than 100 individuals by 1935 when international protection for right whales came into effect (Hayes et al., 2018). By 1990, the population was estimated to be 270 individuals and estimated abundance continued to climb to 483 individuals by 2010. The population has since declined to an estimated 458 individuals in 2015 (Pace et al., 2017).

Adult and juvenile right whales occur throughout the continental shelf and slope waters of the mid-Atlantic. NMFS established Seasonal Management Areas ("SMAs") in 2008 to reduce the likelihood of death and serious injuries to right whales resulting from ship collisions (73 FR 60173). A mid-Atlantic SMA is located at the mouth of Delaware Bay and is active from November 1 through April 30. Vessels 20 m (65 ft) or longer are required to operate at speeds of 10 knots or less when traveling through the SMA and to steer away from a right whale at a slow safe speed if a whale is observed within 460 m (1,500 ft) of the vessel.

### 5.2.2 Occurrence in the Action Area

Fin and right whales occur throughout the continental shelf and slopes of the mid-Atlantic. In addition, right whales have been observed at the mouth of Delaware Bay and in a few rare

occasions within the bay itself. Right whales are most likely to occur in New Jersey-Delaware coastal waters and, therefore the Action Area, between November 1 and April 30 as they migrate between northern foraging and southern calving grounds. Adult and juvenile fin whales have never been observed within the Delaware River estuary, although theoretically they could occur, most likely near the mouth of Delaware Bay. Fin whales and right whales do not occur in the vicinity of the Edgemoor project.

## 6.0 EFFECTS OF THE ACTION ON SPECIES AND CRITICAL HABITAT OF PRIMARY CONCERN

### *6.1 Dredging*

Construction of the Edgemoor Container Port will require dredging of an estimated 3.3 million cy of bottom sediment to achieve a controlling depth of 45 ft below MLLW. Advanced maintenance dredging ranging from 1 to 3 ft is being considered to increase the time interval between construction and the first maintenance dredging, which would increase the volume of dredged material up to 200,000 cy. The footprint of the Dredging Area, including side slopes, is approximately 86.9 acres (Appendix 1 – Permit Drawings). All dredging will by cutterhead dredge, with the dredge material hydraulically pumped preferentially to the USACE's Wilmington Harbor South CDF, located immediately south of the Port of Wilmington (rkm 112.6). Alternative existing CDFs that might also be used include Wilmington Harbor North located along Christina River, Reedy Point North and Reedy Point South, located at the eastern terminus of the C&D Canal at the Delaware River, at locations illustrated in Figure 3.3-5. A portion of the dredged sediments may be pumped to a CDF built on the Applicant's property to facilitate reuse of the sediment as fill.

The amount of material that can be dredged at any one time is limited by the capacity of the CDF and the time required for the material to consolidate and dewater. Three dredge events are presently planned (Table 6-1).

Table 6-1. Proposed construction dredging schedule for the Edgemoor Container Port Project.

| Date Range | Estimated Volume (million cy) |
|---|---|
| December 1, 2020-March 15, 2021 | 1.3 to 1.6 |
| July 15-August 31, 2021 | 0.7 to 1.0 |
| February 1-March 15, 2022 | 0.4 to 0.8 |

DSPC anticipates that the responsibility for maintenance dredging of the approach channel to the port will be assumed by the USACE under Section 204(f) of the Water Resources Development Act (WRDA) of 1986. The port owner/operator will be responsible for maintenance dredging of the berth area.

Sedimentation modeling indicates that deposition in the Edgemoor berth area may be significant and that annual maintenance dredging of up to 500,000 cy of sediment may be

required. To reduce the frequency, upland storage requirements, and cost of maintenance dredging, the use of anti-sedimentation devices known as shoaling fans is being considered. Shoaling fans draw water through an intake located approximately mid-depth in the water column and discharge it horizontally at the mudline to keep sediments from settling in the berth area. Water flow through the unit is created by a four-bladed impeller, with a blade spacing of approximately 1.5 ft (0.46 m), operating at relatively low speed (275 to 500 rpm depending on the installation). The impeller is driven by a shore-mounted hydraulic pump that uses vegetable oil as its hydraulic fluid (see SedCon Technologies, Inc. web site: http://www.sedcontech.com).

The intake of each fan unit will have a surface area of approximately 60 $ft^2$ (5.6 $m^2$) and will be screened with bars spaced approximately 4 inches (10.2 cm) apart. Intake velocity will be approximately 2.5 ft/sec (76.2 cm/sec) at the screen and 0.5 ft/sec (15.2 cm/sec) at a distance of 4 ft (1.2 m) (Bryant and Moseley, 2007).

A conceptual design for the Edgemoor project indicates that thirteen fans would be placed along the length of the berth, grouped in three sets of three individual units and one group of four individual units. Each fan within a group would be operated sequentially, in coordination with the tide, stirring the water column while rotating 90 degrees in the direction of the tidal current. Specifically, the individual units within a group will each operate for 45 minutes. All four groups would have one unit operating simultaneously. A group of three units would operate for 2.25 hours per tide (3 units x 0.75 hours/unit = 2.25 hours) or 9 hours per day (2.25 hours/tide x 4 tides/day = 9 hours/day). The group of four units would operate for 3 hours of each tide for a total operating time of group 12 hours/day (4 units x 0.75 hours/unit x 4 tides).

### 6.1.1 Risk of Entrainment of Sturgeon During Dredging

***Juveniles and Adults***

All dredging for the Edgemoor Container Port project will be performed using a cutterhead (hydraulic) dredge. A cutterhead dredge operates with the dredge head buried in the sediment, although a flow field extending into the water column is produced by the suction of the operating dredge. The amount of suction produced and the resulting size of the flow field, increase with linear flow rate inside the pipe and the pipe diameter. Velocity within the flow field decreases exponentially with distance from the dredge head (Boysen and Hoover, 2009).

The vulnerability of sturgeon to dredges is thought to be inversely related to the length of the fish, with longer fish being capable of higher swim speeds and better able to avoid the intake flow of the dredge (Reine and Clarke, 1998; Boysen and Hoover, 2009). Two studies evaluated the risk of entrainment of juvenile sturgeon by a cutterhead dredge in relation to swim speed and behavior.

Boysen and Hoover (2009) developed a model of entrainment risk based on the swim speed, degree of rheotaxis, and station holding behavior of juvenile white sturgeon (*Acipenser*

*transmontanus*) (8 to 10 cm TL), as determined in the laboratory, in relation to calculated intake velocities within the flow field of an operating cutterhead dredge. They concluded that the sturgeon were at risk of entrainment only when intake velocities exceeded 45 cm/sec, which occurred at distances of 1.5 to 2.0 m from the dredge head, depending on the diameter of the dredge pipe.

In a similar study with juvenile lake sturgeon (*Acipenser fulvescens*) (12.0-17.3 cm FL) and pallid sturgeon (*Scaphirhynchus albus*) (12.2 to 16.8 cm FL), Hoover et al. (2011) concluded that substantial entrainment risk occurred only within a 1.25 m radius of the dredge intake. Since swim speed increases with length, larger juveniles and adult sturgeon would be even less vulnerable to a cutterhead dredge because of their higher swim speeds.

Boysen and Hoover (2009) and Hoover et al (2011) opined that the noise and turbidity associated with an operating dredge may elicit an avoidance response that would further reduce the vulnerability of the juvenile sturgeon to entrainment.

The swim speeds of juvenile shortnose and Atlantic sturgeon are within the ranges of those for juvenile white, lake, and pallid, sturgeon determined by Boysen and Hoover (2009) and Hoover et al. (2011) (Table 6-2), indicating that their conclusions would apply to shortnose and Atlantic sturgeon as well.

Table 6-2. Sustained swim speeds of juvenile white, lake, pallid, shortnose, and Atlantic sturgeon.

| Species | Length | Sustained Swim Speed (cm/sec) |
|---|---|---|
| White sturgeon[a] | 8.0-10.0 cm TL | <30-50 |
| Lake sturgeon[b] | 12.0-17.3 cm FL | 45 maximum |
| Pallid sturgeon[b] | 12.2-16.8 cm FL | 10-70 |
| Shortnose sturgeon[c, d, e, f, g, h, i] | 7.1-22.1 cm TL | 22-48 |
| Atlantic sturgeon[i, j] | 12.8-22.6 cm FL | 21-42 |

Sources: [a]Boysen and Hoover, 2009; [b]Hoover et al., 2011; [c]Deslauriers and Kieffer, 2012a; [d]Deslauriers and Kieffer, 2012b; [e]Downie and Kieffer, 2017; [f]Kieffer et al., 2009; [g]May and Kieffer, 2017; [h]Pottle and Dadswell, 1979; [i]Washburn and Gillis Associates, 1981; [j]Wilkens et al., 2015

Operating experience generally has supported the conclusion of low vulnerability of sturgeon to cutterhead dredges. Because of the direct pumping of the material dredged by a cutterhead dredge, monitoring for entrained sturgeon is conducted at the disposal area. Inspections are performed using standard protocols, and the disposal sites are equipped and operated in a manner that provide the inspectors with a reasonable opportunity for detecting sturgeon. No sturgeon or parts thereof were observed in disposal areas during cutterhead dredging for the Delaware River Main Channel Deepening (DRMCD) project, where approximately 5,894,963 cy of material was dredged from the lower tidal river during 2010-2013 (NMFS, 2018a).

The only records of sturgeon being entrained by a cutterhead dredge were five adult shortnose sturgeon (two in mid-March 1996 and three in January 1998) found in disposal areas during maintenance dredging of the navigation channel in the upper tidal Delaware River (approximately 1,022,869 cy of material was removed during these events) (NMFS, 2018a). This dredging took place in a known overwintering area where large numbers of

shortnose sturgeon concentrate, and the high density of sturgeon was likely a significant factor in their entrainment. NMFS (2018a) concluded that entrainment of juvenile and adult sturgeon by cutterhead dredges is rare, although possible in areas of high density.

The literature on the behavioral responses of sturgeon to operating dredges is limited. ERC (2012, 2013) studied the course-scale movements of acoustically-tagged juvenile Atlantic sturgeon, and juvenile and adult shortnose sturgeon in relation to dredging in Reach B (cutterhead) and Reach A (cutterhead and hopper) of the Delaware River. Most of the sturgeon tracked in these studies showed no apparent response to the dredging operations, although several individuals of both species demonstrated behaviors that could be interpreted as avoidance. ERC opined that these sturgeon may have been avoiding the substantial noise generated by the dredges, but cautioned that the observed movement patterns could also have been coincidental. In a similar study, Reine et al. (2014) studied the movements of five acoustically-tagged subadult Atlantic sturgeon in the James River, VA and concluded that the sturgeon neither avoided nor were attracted to the operating cutterhead dredge.

Juvenile and adult shortnose sturgeon, and juvenile Atlantic sturgeon occur in the general vicinity of the Edgemoor project year-round. Adult Atlantic sturgeon may be present in the area during the second proposed construction dredging event (July 15 to August 31, 2021), but would not be present during the first and third events, which will be in late fall-winter. Neither sturgeon species is known to form dense aggregations in the vicinity of the project. Considering the low intake velocity and small flow field of the cutterhead dredge, it is unlikely that juvenile or adult sturgeon would be entrained during dredging operations for the Edgemoor project. It is also unlikely that operation of the dredge would affect the movement or other behaviors of juvenile or adult sturgeon in the adjacent river.

***Eggs and Larvae***

Shortnose sturgeon in the Delaware River spawn primarily in the non-tidal river, some 96-100 km upriver of the Edgemoor Container Port site. Eggs are demersal and adhesive, and typically do not drift long distances before settling onto rocky substrates. Yolk sack larvae (YSL) are photonegative, hide under rocks at the spawning site, and typically do not enter the river drift. Post yolk sack larvae (PYSL) become photopositive, enter the river drift, and disperse to downriver rearing sites. The duration of downriver dispersion of PYSL varies by river system and appears to be limited in the Delaware River (ERC, 2018c). There are only two records of shortnose sturgeon larvae being collected in the tidal Delaware River, despite frequent ichthyoplankton sampling over a number of years. Both occurrences were associated with a rapid increase in river flow and the consensus is that the larvae were displaced further downriver than usual (ERC, 2018c). The furthest downriver shortnose sturgeon larvae have been collected in the tidal Delaware River is rkm 204, which is 86 km upriver of the Edgemoor site. Thus, shortnose sturgeon early life stages will not occur in the vicinity of the Edgemoor project.

Although the current spawning locations of Atlantic sturgeon in the Delaware River are not definitively known (eggs and larvae have never been collected), the weight of evidence, based on analysis of acoustic tracking data of adults, indicates that spawning occurs above

the salt front, primarily in areas of cobble and bedrock substrate from Claymont, DE to Tinicum Island, PA (rkm 125-137) (ERC, 2018c). These locations are 7-19 km upriver of the Edgemoor Container Port site. An Atlantic sturgeon spawning site in the upper tidal Delaware River near Burlington, NJ (rkm 187), some 69 km above the Edgemoor site, is also a possibility (ERC, 2018c). Atlantic sturgeon eggs are demersal and adhesive, and rapidly settle onto rocky substrates. YSL are photonegative, seek cover, and typically do not enter the river drift. PYSL become photopositive and may disperse downriver, but remain in fresh water. Atlantic sturgeon eggs and YSL are not likely to occur in the vicinity of the Edgemoor Container Port site because of their lack of movement and specific association with rocky substrates, which do not occur at or near the Edgemoor site. However, PYSL larvae may disperse from the spawning area and thus could potentially occur in the project vicinity from approximately May through September, with the exact dates depending on when spawning occurs in a given year. However, as discussed in Section 4.2.5, the extent to which PYSL disperse in the Delaware River is likely minimal and, since Atlantic sturgeon early life stages have never been collected in the Delaware River, occurrence of PYSL in the vicinity of the project is conjectural.

No in-river work will be conducted during March 15 to July 15, which encompasses approximately the first half of the period when Atlantic sturgeon PYSL may be present. The first and third construction dredging events for the Edgemoor project will be conducted during fall and winter months, when PSYL would not be present. The second construction dredging event (July 15 to August 31, 2021) will occur during the second half of the period when PYSL are potentially present. Even if Atlantic sturgeon PYSL occur in the general vicinity of the project, the likelihood of them being present in the Dredging Area is low. The majority of the Dredging Area does not contain the deep channel habitat preferred by Atlantic sturgeon PYSL (see bathymetric information on permit drawings in Appendix 1. Moreover, the zone of influence of the cutterhead dredge head within which PYSL are at risk of entrainment is small, although larger than the zone of influence for juveniles and adults because of the slower swim speeds of PYSL.

There are no swim speed data for Atlantic sturgeon PYSL, but Wilkens et al. (2015) determined sustained swim speeds for small juvenile Atlantic sturgeon that can be used to approximate the swim speed of late-stage Atlantic sturgeon larvae. Wilkens et al. (2015) calculated an average swim speed of 1.90 body lengths (BL)/sec for four groups of juvenile Atlantic sturgeon that ranged in length from 12.8 to 14.3 cm FL. Applying this swim speed to a late-stage PYSL, say 10 cm FL, yields a swim speed of 19 cm/sec. Clarke (2011) reported that a cutterhead dredge has an intake velocity of approximately 95 cm/sec at a distance of 1 m from the dredge head, 24.9 cm/sec at a distance of 2 m, and less than 9.9 cm/sec at a distance of 3 m. Comparing these intake velocities to the estimated swim speed of a 10 cm PYSL Atlantic sturgeon suggests a zone of influence of greater than 2 m but less than 3 m from the dredge head. The low probability of occurrence of Atlantic sturgeon PYSL in the Dredge Area combined with the small zone of influence of the cutterhead dredge suggests only a slight, likely discountable, risk of entrainment of PYSL.

### 6.1.2 Interaction with Suspended Sediments During Dredging

Dredging causes sediment to become suspended in the water column. The extent of sediment suspension varies with a number of factors including the type and size of dredge used, the particle size and composition of the dredged material, and hydrologic conditions in the dredging area (e.g., currents, water temperature).

Sediment suspension during cutterhead dredging is caused primarily by the lateral swinging of the dredge head as the dredge moves forward. Sediment plumes resulting from cutterhead dredging are relatively small because most of the sediment is pulled into the dredge head by pump suction. Modeling conducted by the USACE (1983) indicates that total suspended sediment (TSS) concentrations above background typically occur within approximately the bottom 1.8 m (6 ft) of the water column for a distance of approximately 305 m (1,000 ft) from the dredge head. TSS concentrations within cutterhead dredge sediment plumes typically range from 11.5 to 282.0 mg/l, with the highest levels near the dredge head and concentrations decreasing with distance from the dredge (Nightingale and Simenstad, 2001). These concentrations are less than those shown to have a negative effect on fish (580 mg/l for the most sensitive species) or to impact benthic organisms (390 mg/l) (USEPA, 1986).

There is relatively little literature on the effects of suspended sediments on sturgeon. Garakouei et al. (2009) reported median lethal concentrations ($LC_{50}$) of 46,294 and 60,802 mg/l TSS after 24 hour exposure, and 8,539 and 15,367 mg/l TSS after 96 hour exposure, respectively, for *Acipenser stellatus* and *A. percicus* fingerlings in static bioassays.

Wilkens et al. (2015) investigated survival and swimming performance of small (12.8-14.3 cm FL) juvenile Atlantic sturgeon exposed to TSS concentrations of 0, 100, 250, and 500 mg/l in flow-through aquaria for a 3-day period. Of the 90 fish exposed, 86 (96%) survived the test (mortality was reported for one fish exposed to 250 mg/l and three exposed to 500 mg/l). No significant differences in swim speed, which the authors used as a measure of sub-lethal stress, were observed among treatments. Wilkens et al. (2015) concluded that the "absence of substantial or significant immediate effects on survival and swimming performance suggest that impacts of sediment plumes in nature, where fish have freedom of movement and the power to rapidly escape, are minimal".

Shortnose sturgeon eggs, YSL, and PYSL do not occur in the vicinity of the Edgemoor Container Port project, and Atlantic sturgeon eggs and YSL are unlikely to occur. Late-stage Atlantic sturgeon PYSL may potentially occur in the project area, but would likely have similar responses to TSS as the small juveniles tested by Wilkens at al. (2015). It is thus unlikely that suspended sediment resulting from dredging for the Edgemoor project would have a significant effect on any life stage of shortnose or Atlantic sturgeon.

### 6.1.3 Mobilization of Contaminants During Dredging

Contaminants bound to sediments can be mobilized into the water column during dredging. Duffield Associates, Inc. (2019) (Duffield) performed an assessment of sediment quality in the Dredging Area for the Edgemoor port based on samples collected in October 2016 and

July 2019. Grab and composite samples were collected from three distinct sediment strata and analyzed for the standard suites of organic and inorganic contaminants, as well as total organic carbon (TOC) and acid volatile sulfides/simultaneously extracted metals (AVS/SEM).

The existing river bottom in the project area generally consists of very soft silty sediment deposits of varying thickness designated by Duffield (2019) as "stratum A". This silt covers a layer of primarily sandy sediments, designated as "stratum B", with interlayered silty sediments in some areas. These apparently fluvial sediments are underlain by undisturbed clays and clayey sands of the Potomac Formation, designated as "stratum C". Strata A and B will be removed during dredging along with a portion of stratum C. In situ stratum C represents what will be the exposed bottom after dredging.

Duffield (2019) reported that a number of substances in the strata A and B samples, including various polynuclear aromatic hydrocarbons (PAHs), total polychlorinated biphenyls (PCBs), and metals, exceeded DNREC ecological screening values for freshwater sediments. These substances will be removed by dredging and sequestered in an upland CDF, resulting in a significant net benefit to the river ecosystem. Chromium, iron, manganese, and selenium were the only substances detected in stratum C sediments at concentrations exceeding DNREC ecological screening values. The metals detected in stratum C are naturally occurring and characteristic of Potomac Formation soils (Duffield, 2019).

Duffield (2019) modeled the concentration of each substance potentially released into the water column within the state-defined mixing zone (nominally a maximum of 200 ft down-current of the dredge) during dredging. The calculations indicated that dissolved concentrations of all substances would remain below acute Delaware River Basin Commission (DRBC) Stream Quality Objectives (SQOs) for aquatic life in fresh water during dredging of all strata, but would exceed chronic DRBC SOQs for 4,4'-DDE (a chlorinated pesticide), total PCBs, and copper during dredging of stratum A and 4,4'-DDE during dredging of stratum B. Dredging of stratum C sediments is not expected to result in concentrations of any substances above DRBC SQOs (Table 6-3).

Total PCBs and copper were also detected in river water samples collected during the sediment sampling program, with the ambient dissolved copper concentration only 0.5 µg/l lower than the DRBC chronic SQO (Table 6-3) in the water column.

Table 6-3. Dissolved concentrations of substances exceeding DRBC chronic SQOs in the dredge plume mixing zone (complied from Duffield, 2019).

| Substance | Concentration Within Mixing Zone, µg/l | | | Mean River Water Concentration, µg/l | DRBC SQOs - Fresh Water Aquatic Life, µg/l | |
|---|---|---|---|---|---|---|
| | Stratum A | Stratum B | Stratum C | | Acute | Chronic |
| 4,4'-DDE | 0.00563 | 0.0073 | ND | ND | 1.1 | 0.001 |
| Total PCBs | 0.209 | 0.000471 | 0.00000482 | 0.0055 | 1.0 | 0.014 |
| Copper | 6.7 | 4.7 | 3.03 | 6 | 9.6 | 6.5 |

exceeds DRBC chronic SOQ

ND = not detected

The DRBC chronic SQOs are based on continuous exposure of an organism to the substance over a 4-day time period. The location and shape of the mixing zone associated with the dredge plume will shift with changing tidal currents and the location of the dredge head. Given the small size and shifting location of the mixing zone, it is highly unlikely that a sturgeon would hold position in the plume long enough to meet the duration criterion for chronic exposure. Moreover, it is anticipated that sturgeon will avoid at least the highest turbidity portion of the dredge plume further reducing the probability of exposure. Therefore, it is concluded that the potential effects of mobilization of contaminants during dredging on sturgeon are discountable.

### 6.1.4 Effects of Dredging on Benthic Prey Communities

Juvenile and adult shortnose surgeon and Atlantic sturgeon feed on a variety of benthic invertebrates, including amphipods, polychaete worms, and isopods. Adult shortnose sturgeon also eat mollusks, and the Asian clam *Corbicula* appears to be an important food item in the Delaware River. Adult and subadult Atlantic sturgeon may also eat small fish.

Dredging for the Edgemoor Container Port project will result in a temporary reduction in the availability of prey species and/or an alteration in prey composition within the Dredging Area. Turbidity and suspended sediment from dredging may also impact benthic invertebrate communities outside of the Dredging Area, although any effects are likely to be minor and temporary because of the rapid dispersion of the dredge plume. TSS concentrations resulting from cutterhead dredging are expected to be below those likely to have an adverse effect on benthic organisms (390 mg/l).

Changes in benthic community composition and availability associated with dredging will not have a significant or meaningful impact on sturgeon feeding opportunities. The Dredging Area is not unique in its benthic community composition (see data in Kreeger et al., 2010) and extensive alternative foraging areas for sturgeon occur throughout the adjacent river. Moreover, changes in the benthic community within the Dredging Area will likely be temporary, with recovery taking a few months to a few years (Hirsch et al., 1978; LaSalle et al., 1991), although propeller wash from vessels operating within the port area may have some long term negative effects (see Section 6.4.3). In a study focusing specifically on a shortnose sturgeon food item, O'Herron and Hastings (1985) found that *Corbicula* recolonized maintenance dredging areas in the upper tidal Delaware River during the subsequent growing season, although it took two growing seasons for the *Corbicula* to attain a size similar to before dredging.

### 6.1.5 Effects of Dredged Material Disposal/Dewatering

All material dredged during construction of the Edgemoor Container Port will be pumped to an existing USACE upland CDF, preferentially the Wilmington Harbor South CDF, located immediately downriver of the Port of Wilmington (see Fig. 2-1), with a few hundred thousand cubic yards of sediment potentially being pumped to a CDF constructed on the Applicant's property to facilitate reuse of the sediment as fill. Once the dredged material is

placed into the CDF, the material will settle and the slurry water will be separated from the sediments and discharged back to the Delaware River.

Duffield (2019) modeled the concentration of each substance potentially released to the mixing zone in the Delaware River during dewatering of the dredged material. Modeling was performed for each of the three planned dredge cycles. Aluminum was the only substance that exceeded DRBC SQOs. Calculated final aluminum concentrations in the river mixing zone ranged from 890-892 µg/l. The DRBC SQO for aluminum is 750 µg/l for acute exposure and 87 µg/l for chronic exposure. Aluminum is believed to be naturally occurring in the Delaware River and occurs at high ambient concentrations (Duffield, 2019). The mean aluminum concentration in the Delaware River water samples collected by Duffield (2019) was 885 µg/l, exceeding the DRBC SQOs. Thus, the high aluminum concentrations modeled for the CDF mixing zone represent a background condition and are not likely to impose significant additional risk to sturgeon.

### 6.1.6 Effects of Shoaling Fans

Shoaling fans are being considered to reduce sedimentation in the berth area and, based on experience at other ports, will significantly reduce the frequency of maintenance dredging (SedCon Technologies, Inc., 2019). It is unlikely that operation of the shoaling fans would affect sturgeon. Shortnose sturgeon eggs, YSL, and PYSL do not occur in the vicinity of the Edgemoor project, and Atlantic sturgeon eggs and YSL are unlikely to occur. Late-stage Atlantic sturgeon PYSL potentially may occur in the project area, but would be unlikely to encounter the mid-water column intake of the shoaling fan because of their benthic orientation. Small juvenile shortnose and Atlantic sturgeon may occur in the vicinity of the Edgemoor project, but would not likely be effected because of their largely benthic orientation and the small zone of influence of the fan intake, which, compared with the swim speeds of juvenile sturgeon, would have an effective radius of <4 ft (1.2 m). Larger juvenile and adult shortnose and Atlantic sturgeon would easily be able to avoid the intake flow of the shoaling fan, should they encounter it.

Field studies have shown that shoaling fans do not increase turbidity, but simply keep sediment suspended in the water column (SedCon Technologies, Inc., 2019). Therefore, water quality will not be altered or negatively affected by operation of the fans.

## *6.2* ***<u>Construction of the Wharf</u>***

### 6.2.1 Effects of Pile Driving on Sturgeon

Pile driving produces underwater sound pressure waves that can affect aquatic species, including sturgeon (NMFS, 2017b). Effects on fish can range from temporary avoidance of an area to death resulting from injury to the swim bladder or other internal organs. Factors that contribute to the likelihood of an adverse effect include type and size of pile, installation method (i.e., vibratory vs. impact hammer), size and species of organism (smaller individuals are more susceptible to effects), and distance from the sound source. Generally, the larger

the pile and the closer an individual is to the pile, the greater the likelihood of adverse effects (NMFS, 2017b).

The potential impact of pile driving for the Edgemoor project on sturgeon was assessed using the NMFS GARFO Acoustics Tool (NMFS, 2018b) (version updated 7/9/2018). This spreadsheet uses the results of sound measurements at proxy pile driving projects to estimate sound levels and distances to species injury and behavioral effects thresholds. In this analysis, a pile diameter of 20 inches, which is the steel pipe pile diameter being proposed for the project, was used. The model was run for both vibratory and cushioned impact hammer methods, since both will be used, and for vibratory installation of the sheet pile. Results of the Acoustics Tool analysis are presented in Tables 6-4 through 6-6.

Table 6-4. Proxy projects for estimating underwater sound.

| Project Location | Water Depth (m) | Pile Size (inches) | Pile Type | Hammer Type | Attenuation rate (dB/10m) |
|---|---|---|---|---|---|
| Stockton, CA - San Joaquin River | 3 to 4 | 20" | Steel Pipe | Vibratory | 3 |
| Stockton, CA - San Joaquin River | 3 to 4 | 20" | Steel Pipe | Cushioned Impact | 3 |
| Not Available | 15 | 24" | AZ Steel Sheet | Vibratory | 5 |

Table 6-5. Proxy-based estimates of underwater sound.

| Type of Pile | Hammer Type | Estimated Peak Noise Level ($dB_{Peak}$) | Estimated Pressure Level ($dB_{RMS}$) | Estimated Single Strike Sound Exposure Level ($dB_{sSEL}$) |
|---|---|---|---|---|
| 20" Steel Pipe | Vibratory | 198 | 177 | 166 |
| 20" Steel Pipe | Cushioned Impact | 197 | 176 | 165 |
| 24" AZ Steel Sheet | Vibratory | 175 | 160 | 160 |

Table 6-6. Estimated distances to sturgeon injury and behavioral sound thresholds.

| Type of Pile | Hammer Type | Distance (m) to 206$dB_{Peak}$ (injury) | Distance (m) to sSEL of 150 dB (surrogate for 187 dBcSEL injury) | Distance (m) to Behavioral Disturbance Threshold (150 $dB_{RMS}$) |
|---|---|---|---|---|
| 20" Steel Pipe | Vibratory | NA | 63.3 | 100.0 |
| 20" Steel Pipe | Cushioned Impact | NA | 60.0 | 96.7 |
| 24" AZ Steel Sheet | Vibratory | NA | 30.0 | 30.0 |

### *Physical Effects*

NMFS has determined that sturgeon may be injured if exposed to underwater sound levels of 206 $dB_{Peak}$[a], the instantaneous energy received from a single pile strike, or 187 $dB_{cSEL}$

(cumulative sound exposure level), the accumulated energy from multiple strikes over the time required to install the pile (NMFS, 2018b). When it is not possible to accurately calculate the distance to the 187 $dB_{cSEL}$ isopleth, the Acoustics Tool calculates the distance to the 150 $dB_{sSEL}$ (single strike sound exposure level) isopleth as a surrogate. The greater the distance between the fish and the pile being driven, the greater number of strikes it must be exposed to for injury to occur. A fish beyond the 150 $dB_{sSEL}$ isopleth would not accumulate enough energy to be injured regardless of the number of pile strikes it was exposed to (Stadler and Woodbury, 2009).

> [a]Peak sound pressure level: the largest absolute value of the instantaneous sound pressure expressed in decibels referenced to 1 micro Pascal (dB re: 1 µPa) in water (NMFS, 2018b).

For the Edgemoor project, the single strike criterion for injury to sturgeon (206 $dB_{Peak}$) will not occur with any of the pile driving methods (Table 6-5), so there is no potential for instantaneous injury. The only potential for injury would be if a sturgeon remained closer than the distance to the 150 $dB_{sSEL}$ isopleth for the duration of pile driving. For the Edgemoor project, this distance ranges from 30.0 m for vibratory installation of sheet pile to 63.3 m for vibratory installation of the steel pipe pile (Table 6-6). However, it is unlikely that sturgeon would remain within the zone where sound levels are >150 $dB_{sSEL}$ long enough to be injured.

Sturgeon are expected to avoid or move out of areas where sound levels exceed 150 $dB_{RMS}$[b], the behavioral disturbance threshold. For the Edgemoor project, the 150 $dB_{RMS}$ isopleth is calculated to be at a distance equal to or further than (depending on pile driving method) the 150 $dB_{sSEL}$ isopleth (Table 6-6). Therefore, sturgeon are not expected to enter or remain within the area where they could accumulate enough sound energy to be injured.

> [b]Root Mean Square (RMS): the square root of the average squared pressures over the duration of a pulse; most pile-driving impulses occur over a 50 to 100 millisecond (msec) period with most of the energy contained in the first 30 to 50 msec of the operation. Therefore, RMS pressure levels are generally "produced" within seconds and represent the effective pressure and intensity (in dB re: 1 µPa) produced by a sound source (NMFS, 2018b).

### *Behavioral Effects*

As stated above, sturgeon are expected to avoid the ensonified field associated with pile driving, as defined by the 150 $dB_{RMS}$ isopleth. For the Edgemoor project, this field would extend 30.0 to 100.0 m from the pile, depending on pile driving method. The soft start procedure will allow sturgeon that may be within the ensonified field time to react to the sound and leave the area. The deep water of the navigation channel is more than 150 m from the riverfront edge of the wharf at the closest location. It is extremely unlikely that avoidance of the ensonified area would affect essential sturgeon behaviors, such as foraging, resting, or migration, because of the small size of the ensonified area and the short duration of avoidance (only while the pile is being driven). The Delaware River is sufficiently wide in the project vicinity to allow sturgeon to easily avoid the ensonified field while continuing foraging, migrating, and other behaviors. Thus, the expected effects of pile driving sounds on sturgeon are expected to be insignificant.

### 6.2.2 Effects of Fill on Sturgeon Habitat

Construction of the wharf for the Edgemoor Container Port will require the filling of an approximately 5.5-acre area of subtidal and intertidal habitat between the sheet pile wall along the landward edge of the wharf and the high tide line. It is unlikely that this shallow water habitat would be used by shortnose or Atlantic sturgeon to any extent. The literature is consistent that PYSL, juveniles, and adults of both species are associated primarily with deep water habitats (McCleave et al., 1977; Bath et al., 1981; Fisher and Jacobini, 2007; Brundage and O'Herron, 2009; Fisher, 2011a; Hilton et al., 2016; Kynard et al., 2016; ERC, 2018c).

The depth distribution of juvenile shortnose and Atlantic sturgeon in the lower tidal Delaware River was studied systematically by Brundage and O'Herron (2009) (see also ERC, 2006c, 2007). In this study, gillnets and trammel nets were set in three depth zones (shallow – <3 m, intermediate – 3.0-6.1 m, and deep – >6.1 m) at three stations between rkm 115 and 130. All 10 of the juvenile shortnose sturgeon and five of the six juvenile Atlantic sturgeon collected in this study were taken in the deep stratum, at depths ranging from 8.1 to 15.2 m. The single Atlantic sturgeon not taken in the deep stratum was collected in the intermediate stratum at a depth of 4.6 m. These findings are consistent with Fisher and Jacobini (2007), who recorded Atlantic sturgeon with depth-sensing acoustic transmitters in depths of 6.1 to 15.5 m ($\bar{x}$=9.0 m) during manual tracking in the Delaware River.

Based on the preference of shortnose and Atlantic sturgeon for deep water, it can be concluded that the filling of shallow water habitat for the Edgemoor project is not likely to have a significant impact on habitat used by either sturgeon species.

## *6.3 <u>Effects of Vessel Strike</u>*

Vessel strikes pose a risk to sturgeon, particularly Atlantic sturgeon, and may result from entrainment of sturgeon through the vessel's propeller or direct collision with the hull (Brown and Murphy, 2010). The vulnerability of sturgeon to vessel strike appears to vary with a number of factors, including size and speed of the vessel, navigational clearance (i.e., depth of water compared to the draft of vessel), physical characteristics of the river (e.g., narrow channels, restrictions, etc.), and time of year, as well as the size, density, and behavior (e.g., foraging, migrating, etc.) of the sturgeon (Brown and Murphy, 2010; Balazik et al., 2012c; NMFS, 2018a). Large vessels are thought to be responsible for most vessel strikes of sturgeon because of their deep draft and limited navigational clearance (Brown and Murphy, 2010). Large vessels also have larger propellers and draw more water through their propellers, which increases the probability of entraining sturgeon in their vicinity, particularly in confined channels. Although smaller vessels have a shallower draft and entrain less water, they also pose a risk to sturgeon, and sturgeon strikes by smaller vessels have been documented in the Delaware (Ian Park, DNREC, pers. com), Kennebec (ME), and Hudson (NY) rivers (NMFS, 2018a). Shortnose sturgeon appear to be less vulnerable to vessel strike than Atlantic sturgeon, perhaps because of their smaller size (NMFS, 2018a) or because there is less ship traffic in areas of the estuary where shortnose sturgeon tend to be most abundant.

### 6.3.1 Baseline Vessel Traffic in the Delaware River Estuary

The Delaware River is geographically and operationally one of the most important waterways on the East Coast of the United States for port operations. Incoming ships bring in some 20% of the nation's crude oil imports to refineries along the Delaware River, while the Ports of Philadelphia, South Jersey, and Wilmington together comprise one of the largest cargo complexes in the nation, handling general, bulk, and container cargo types (Altiok et al., 2012). Commercial vessel traffic in the Delaware River is predicted to increase regardless of the construction of new ports (Altiok et al., 2012).

The USACE publishes estimates of vessel traffic involving the transport of goods on navigable waters of the United States on its Institute of Water Resources website: http://cwbi-ndc-nav.s3-website-us-east-1.amazonaws.com/files/wcsc/webpub/#/report-landing/year/2017/region/1/location/5250. In 2017, the most recent year for which data is available, there were an estimated 45,826 vessel trips between Philadelphia and the sea and 3,086 vessel trips between Philadelphia and Trenton, NJ (48,912 total vessel trips) (Table 6-7). These data include small and large commercial vessels of varying draft, but exclude recreational vessels, ferries, and military (i.e., U.S. Navy, U.S. Coast Guard) vessels and, therefore, underestimate total vessel traffic in the estuary.

### 6.3.2 Vessel Traffic Associated with the Project

**During Construction**

Dredging and wharf construction for the Edgemoor Container Port Project is expected to take approximately 2.5 years to complete, with no in-water work during the March 15 through July 15 time period. Dredging will be performed with one cutterhead dredge supported by two tugs, a crew boat, and a hydrographic survey vessel. Pile driving will be performed from two, possibly three, barges, each supported by one tug and one crew boat. It is anticipated that the crew boats, survey vessel, and some of the tugs will operate out of the existing Port of Wilmington, located approximately 4 km (2.5 miles) downriver of the Edgemoor site.

**During Port Operation**

The Edgemoor Container Port will be owned by DSPC, which also owns the existing Port of Wilmington. DSPC anticipates that all of the current container cargo operations at the Port of Wilmington will be shifted to the Edgemoor facility. It is estimated that the Edgemoor Container Port will annually receive 244 container ship calls (combined inbound and outbound), of which 157 will be existing traffic that would have called at the Port of Wilmington and 87 will be new container traffic (M. Richard Beringer, Duffield Associates, Inc., pers. comm., April 30, 2019). The estimated additional container traffic associated with the Edgemoor Container Port represents a 0.18% increase in the total Delaware River estuary commercial vessel traffic over the reported 2017 traffic.

### 6.3.3 Estimates of Sturgeon Mortality in the Delaware River Estuary Caused by Vessel Strike

DNREC has maintained a database of sturgeon mortalities reported in the Delaware River estuary and nearby coastal areas since 2005. This database includes information on surgeon carcasses found along the shoreline and in the water, as well as mortalities due to permitted activities such as dredging and impingement at power plant intakes. The database contains information such as location where the carcass was found or the mortality occurred, the species and life stage of the sturgeon, a description of the injuries sustained, and, if determinable, the likely cause of death. Many of the records, however, do not include complete information and, in many cases, cause of death was not determinable because of the state of decomposition of the carcass.

The most recent sturgeon mortality database was obtained from DNREC (Ian Park, DNREC, pers. comm., May 16, 2019), and the data were sorted to remove records after 2017 (the last year for which vessel traffic estimates are available), records that were outside of the Delaware River and Bay, and records for which the cause of death was known to be something other than vessel strike (e.g., dredging, impingement, or trawling mortalities).

For Atlantic sturgeon, the sorted database contained records for 166 mortalities, of which cause of death was listed as “vessel or boat strike” for 98 and “unknown” for 68 carcasses. Life stage was listed as “adult” for 86 of the Atlantic sturgeon, “juvenile” for 35, and “unknown” for 45.

For shortnose sturgeon, the sorted database contained records for 11 mortalities, of which cause of death was listed as “vessel or boat strike” for eight and “unknown” for three carcasses. Life stage was listed as “adult” for two of the shortnose sturgeon, “juvenile” for three, and “unknown” for six.

The number of each sturgeon species killed per vessel trip was estimated by dividing the number of recorded mortalities during the 2005 to 2017 period by the total number of vessel trips in the Delaware River estuary during the period between 2005 and 2017, as estimated by the USACE (Table 6-7). It was conservatively assumed that all “unknown” mortalities were caused by vessel strike. This calculation yielded an estimate of 0.000230 Atlantic sturgeon mortalities per vessel trip and 0.000015 shortnose sturgeon mortalities per vessel trip.

This calculation underestimates the number of sturgeon killed per vessel trip since not all sturgeon mortalities were observed or reported. A study on the reporting rate for Atlantic sturgeon carcasses released in the Delaware River estuary is currently being conducted by Delaware State University (Dewayne Fox, Delaware State University, pers. comm., April 18, 2019), but results were not available at the time this BA was prepared. Based on a similar study, Balazik et al. (2012c) estimated that less than one-third of Atlantic sturgeon carcasses in the James River, VA, were reported. Although the comparability of carcass reporting rates in the James River and the Delaware River is not known, Balazik et al. (2012c) provides a basis for scaling (3x) the estimates of sturgeon mortality per vessel trip calculated here.

Table 6-7. Estimated annual commercial vessel trips in the Delaware River estuary, 2005-2017.

| Year | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | Total Vessels |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Philadelphia to Sea | 111,911 | 57,192 | 57,422 | 43,137 | 39,341 | 32,448 | 40,085 | 37,961 | 34,993 | 42,399 | 51,574 | 48,040 | 45,826 | 642,329 |
| Philadelphia to Trenton | 7,240 | 9,572 | 8,478 | 8,673 | 5,897 | 6,039 | 5,339 | 5,003 | 5,282 | 5,384 | 4,100 | 4,209 | 3,086 | 78,302 |
| Total Delaware River Vessels | 119,151 | 66,764 | 65,900 | 51,810 | 45,238 | 38,487 | 45,424 | 42,964 | 40,275 | 47,783 | 55,674 | 52,249 | 48,912 | 720,631 |

Source: U.S. Army Corps of Engineers Water Resources website (http://cwbi-ndc-nav.s3-website-us-east-1.amazonaws.com/files/wcsc/webpub/#/report-landing/year/2017/region/1/location/5250).

Multiplying the estimates of mortality per vessel trip calculated above by three yields 0.000691 Atlantic sturgeon mortalities per vessel trip and 0.000045 shortnose sturgeon mortalities per vessel trip in the Delaware River estuary.

### 6.3.4 Estimates of Project-Related Sturgeon Mortality Caused by Vessel Strike

As stated above, operation of the Edgemoor Container Port project is estimated to result in a net increase of 87 container vessel trips per year. Multiplying the scaled estuary-wide estimates of sturgeon mortality per vessel trip by 87 additional container vessel trips gives an estimated additional mortality of 0.060117 Atlantic sturgeon/year and 0.003915 shortnose sturgeon/year.

The above estimates do not include the potential impact of support vessels (tugs) assisting in docking and undocking the container ships. If it is assumed that, on average, two tugs are required per container vessel trip, operation of the Edgemoor port will result in an additional 174 tug trips per year, or a total of 261 additional vessel trips per year (87 container ship trips + 174 tug trips). Multiplying the scaled estuary-wide estimates of sturgeon mortality per vessel trip by 261 additional vessel trips gives an estimated additional mortality of 0.180351 Atlantic sturgeon/year and 0.011745 shortnose sturgeon/year. These estimates are conservative in that they assume the sturgeon strike rate for tugs, which will be operating locally over small distances, is the same as that for container vessels traversing the entire distance of the federal channel from the mouth of Delaware Bay to the Edgemoor port (approximately 73.2 miles (117.8 km)).

Estimates of estuary-wide sturgeon vessel strike rates and additional ship strikes due to the Edgemoor project are summarized in Table 6-8.

Table 6-8. Estimates of estuary-wide sturgeon vessel strike rates and additional vessel strikes due to the Edgemoor Container Port Project.

| | Estuary-Wide Vessel Strike Rate 2005-2017 (mortalities/vessel trip) | Estuary-Wide Vessel Strike Rate 2005-2017 Scaled for Under-Reporting (mortalities/vessel trip) | Additional Vessel Strikes Due to Project – Container Ships Only (mortalities/year) | Additional Vessel Strikes Due to Project – Container Ships and Tugs (mortalities/year) |
|---|---|---|---|---|
| Atlantic sturgeon | 0.000230 | 0.000691 | 0.060117 | 0.180351 |
| Shortnose sturgeon | 0.000015 | 0.000045 | 0.003915 | 0.011745 |

There is no data on the DPS composition of the Atlantic sturgeon carcasses in the DNREC database. In the absence of this data, it can be assumed that the DPS origin of any ship-struck Atlantic sturgeon would approximate the frequencies determined by Damon-Randall et al. (2013): Gulf of Maine, 7%; New York Bight, 58%: Chesapeake Bay, 18%; South Atlantic, 17% percent; and Carolina, 0.5%.

Assuming that the risk of vessel strike is proportional to the area of exposure, the expectation is that the vast majority of sturgeon strikes likely would occur in the federal navigation channel portion of the Action Area, not within the dredged area of the port. The federal channel is 800 feet (244 m) wide from the project site to Bombay Hook (28.9 miles (46.5 km)) and 1,000 ft (305 m) wide from Bombay Hook to the mouth of Delaware Bay (44.3 miles (71.3 km)) (NMFS, 2018a), which equates to an area of approximately 8,000 acres. Therefore, the Dredging Area at the Edgemoor port (86.9 acres including side slopes) represents only 1% of the area where a vessel strike may occur. The risk of vessel strike within the port itself may also be reduced by the lower operating speed of vessels within the port compared with those in the federal channel, although the effect of vessel speed on sturgeon vulnerability to vessel strike is not well understood. The owner/operator of the Edgemoor port will not own or operate any of vessels calling at the port, and will have no authority to regulate or control these vessels when they are operating in the federal channel, where vessel strikes are most likely to occur.

In summary, container vessels calling at the Edgemoor Container Port and the tugs that assist them may impose a slight increase in the risk of vessel strike to sturgeon. Based on the estimates of vessel strike rate presented above, operation of the Edgemoor port may result in one additional Atlantic sturgeon mortality every 5.5 years and one additional shortnose sturgeon mortality every 85 years.

## *6.4 Effects of Vessel Operations at the Port*

### 6.4.1 Effects of Intake of Ballast Water on Sturgeon Early Life Stages

All commercial vessels take on and discharge ballast water to control stability, trim, and heel while at sea, and while loading and unloading cargo. The amount of ballast water carried and pumping rates vary widely with type of vessel, being greatest for dry bulk carriers, oil tankers, and liquefied gas carriers, and least for passenger and fishing vessels. Ballast requirements for container ships, the type of vessel that will call at Edgemoor, fall in the middle of the range (see Table 2-1 in NRC, 1996). The discharge or intake of ballast water

when in port is not continuous, but is controlled as necessary to maintain stability during the loading or unloading process (NRC, 1996).

Fish eggs and larvae have the potential to be entrained during the intake of ballast water. Shortnose sturgeon eggs, YSL, and PYSL do not occur in the vicinity of the Edgemoor project, and Atlantic sturgeon eggs and YSL are unlikely to occur. Late stage Atlantic sturgeon PYSL may potentially occur, although, based on the distribution of age 0 juveniles, the dispersal of PYSL in the Delaware River appears to be minimal. Atlantic sturgeon larvae have never been collected in the Delaware River so the occurrence of PYSL at Edgemoor is conjectural (see Section 6.1.1).

Prakash et al. (2014) developed a 3-dimensional hydrodynamic model of the withdrawal of ballast water by a liquefied natural gas (LNG) carrier for the proposed (now de-authorized) Crown Landing project on the Delaware River. They calculated a zone of influence with a vertical dimension of 5 to 6 m and a horizontal dimension of approximately 50 m, based on a ballast pumping rate of 2,500 $m^3$/hr. Velocity was calculated to be 50 cm/sec at the intake opening and decreased exponentially with distance from the intake. Assuming that the area of the intake opening was similar, the zone of influence of a ballast water intake on a container ship would be smaller because of a lower pumping rate, which NRC (1996) indicates would be in the range of 1,000 to 2,000 $m^3$/hr.

Applying the average sustained swim speed of 1.90 BL/sec determined by Wilkens et al. (2015) for small juvenile Atlantic sturgeon to a late-stage PYSL, say 10 cm FL, yields a swim speed of 19 cm/sec. Burst swim speed would be substantially greater. Based on Figure 8 in Prakash et al. (2014), intake velocities of 20 cm/sec or higher extend only about 1 m from the intake opening of the LNG carrier. Assuming a similar intake open area, velocities of this magnitude would extend a lesser distance for a container ship pumping ballast water at 1,000 to 2,000 $m^3$/hr.

Ballast water intakes are not located at the bottom of the vessel's hull, but are located further up the side, often amidships between the water line and the keel, to reduce the possibility of withdrawing sediment into a ballast tank (e.g., the intake in Prakash's LNG carrier model was 3.7 m above the keel). The probability of an Atlantic sturgeon PYSL encountering the ballast water intake is, thus, further reduced by the benthic orientation of the larvae relative to the depth of the ballast water intake.

The small zone of influence and elevation in the water column of the ballast water intakes, combined with the uncertain occurrence of Atlantic sturgeon PYSL in the project area, suggests that the risk of entrainment of PYSL in ballast water at the Edgemoor port is insignificant.

### 6.4.2 Effects of Vessel Maneuvering on Sturgeon Early Life Stages

Laboratory studies have indicated that the turbulence and shear stress associated with the passage of a large vessel's hull through the water and particularly passage through a ship's propeller can result in mortality of fish eggs and larvae (Morgan et al., 1976; Killgore et al.,

1987, 2001). Smaller larvae suffer higher mortality then larger larvae (Killgore et al., 2001). Field studies have shown that vessel passage can affect the distribution of ichthyoplankton (Holland, 1986), but attempts to measure vessel-associated mortality in the field have been inclusive (Holland, 1986; Odom et al., 1992).

As discussed previously, Atlantic sturgeon PYSL are the only sturgeon early life stage that may occur in the Edgemoor project area. Vessels maneuvering within the port area at Edgemoor may result in mortality of Atlantic sturgeon PYSL, if they occur there. The magnitude of such mortality can be put in perspective by comparing the area of the Dredged Area at the Edgemoor Port with the area of the Delaware River potentially available to Atlantic sturgeon PYSL. A similar approach was used by NMFS (2019b) to assess the potential impact of maintenance dredging of the Delaware River navigation channel on Atlantic sturgeon PYSL. In this analysis, NMFS (2019b) assumed that Atlantic sturgeon PYSL were evenly distributed between the upriver limit of the potential Atlantic sturgeon spawning grounds, which NMFS (2019b) assumed to rkm 212, and the salt front at rkm 107.8. NMFS (2019b) calculated that the bank-to-bank area between rkm 107.8 and 212 of the Delaware River was 28,436 acres. The 86.9-acre Dredged Area at Edgemoor comprises 0.3 percent of the area calculated by NMFS (2019b) as potentially being occupied by Atlantic PYSL. Thus, vessels operating at Edgemoor could theoretically result in an additional 0.3% mortality of Atlantic sturgeon PYSL, assuming that the abundance of PYSL is proportional to area occupied and that vessel movement kills all PYSL in the port area. It is unlikely that the effect of an increase in mortality this small would be measurable or observable, and it can be concluded that potential effect of vessel maneuvering on Atlantic sturgeon PYSL is insignificant.

### 6.4.3 Effects of Vessel Maneuvering on Substrate and Benthos

Vessels maneuvering with the Edgemoor port area may scour and resuspend bottom sediment because of shear produced by rotating propellers and wave action (Karaki and Van Hoften, 1975; Hong et al., 2016). Repeated disturbance of the river bottom, and resuspension and settling of sediment may negatively affect the composition and density of benthic macroinvertebrates within the port area (Gabel, 2002). It should be noted that the Edgemoor site is located within the Estuary Turbidity Maximum (ETM) zone of the Delaware River (Sommerfield, 2007) and that the bedload is mobile within this part of the river (Sommerfield and Madsen, 2003), so presumably benthic organism in the site vicinity are adapted to high turbidity and a shifting bedload.

Nonetheless, repeated disturbance of the substrate by propeller wash may result in the loss of benthic invertebrates and degradation of foraging habitat for sturgeon of both species within the Edgemoor port area. However, such loss would be insignificant given the extensive alternative foraging areas in the adjacent Delaware River.

## *6.5 <u>Effects of Activities in Adjacent Uplands</u>*

Construction of the Edgemoor Container Port project will require extensive activities in uplands, including demolition of existing infrastructure, grading, construction of roads,

railroads, terminal facilities, and paving for the storage of shipping containers. The only pathway by which these activities could affect shortnose and Atlantic sturgeon is through the transport of sediment and, possibly, chemicals to the Delaware River through the discharge of stormwater. Similarly, it is possible that sediment, oil and grease, and other materials could be discharged to the Delaware River with stormwater during operation of the facility.

Erosion and sedimentation (E&S) control during construction of the port will be regulated by New Castle County. An E&S control plan will be prepared for approval by the County, and all requirements of the plan (e.g., silt fencing, berms, de-silting basins) will be implemented and monitored during construction. A stormwater management (SWM) plan will be prepared as part of the design of the facility, and submitted to New Castle County and the State of Delaware for approval. Stormwater discharge during operation of the port will be regulated by an industrial NPDES (National Pollutant Discharge Elimination System) permit issued by the State of Delaware. Stormwater discharges from the site will be monitored as required by the NPDES permit.

The future pathways for potential effects of upland activities on water quality in the Delaware River will be controlled through the implementation of the approved E&S and SWM plans. Therefore, upland activities during construction and operation of the port are unlikely to affect shortnose or Atlantic sturgeon.

### *6.6 Effects of the Action on Critical Habitat Designated for the New York Bight DPS of Atlantic Sturgeon*

The upper portion of Action Area, between rkm 77.7 and 117.8, includes the area designated by NMFS (2017a) as critical habitat for the New York Bight DPS of Atlantic sturgeon. NMFS (2017a) identified four PBFs (physical or biological features) that are essential to the conservation of the species and may require special management considerations or protection (see Section 3.2.7).

PBF 1 consists of hard bottom substrate (e.g., rock, cobble, gravel, limestone, boulder, etc.) in low salinity waters (i.e., 0.0 to 0.5 ppt range) (upriver of rkm 107.8) that may be used for settlement of fertilized eggs, refuge, growth, and development of early life stages. There is no habitat meeting the criteria of PBF 1 in the Action Area. The nearest hard bottom substrate that may be used by Atlantic sturgeon for spawning is located 7 km upriver of the Edgemoor Container Port site. Therefore, the project will not impact PBF 1 habitat.

PBF 2 is aquatic habitat with a gradual downstream salinity gradient of 0.5 up to 30 ppt and soft substrate (e.g., sand, mud) between the river mouth and spawning sites used by juvenile Atlantic sturgeon for foraging and physiological development. The Construction and Dredging Areas at the Edgemoor site contain the soft substrates required for PBF 2, although salinity is often less than 0.5 ppt during wetter times of the year. Most of the federal navigation channel within the Action Area meets the substrate and salinity criteria for PBF 2.

Dredging for the Edgemoor project will result in removal of soft substrate that may seasonally meet the salinity criterion for PBF 2 and impact benthic organisms that may be

used as forage by sturgeon. Project-related vessels operating at the port or in the federal channel may result in some ongoing degradation of PBF 2 foraging habitat by disturbance of substrate and the associated benthic community by propeller wash (see Section 6.4.3).

The bank-to-bank area of PBF 2 habitat in the Delaware River between the project site (rm 73.2; rkm 117.8) and the downriver limit of designated Atlantic sturgeon critical habitat (rm 48.3; rkm 77.7) is 34,240 acres, of which 2,230 acres consists of federal navigation channel (Jessica Fedetz, Duffield Associates, Inc., pers. comm., February 14, 2020). If it is assumed that benthic communities in the federal channel have already been degraded to some degree by propeller wash and maintenance dredging, a baseline condition, the area of effective PBF 2 habitat is reduced to 32,010 acres. The combined Construction and Dredging Areas at the Edgemoor project comprise 94.4 acres, which represents less than 0.3% of the available PBF 2 habitat. The loss or degradation of PBF 2 habitat of this magnitude would have an insignificant effect on Atlantic sturgeon.

PBF 3 relates to impediment of movement of adult or juvenile Atlantic sturgeon during various times of year or phases of their life history. Development of the Edgemoor project will not involve construction of structures or other features that could impede the movement of adults to and from spawning sites, the movement of juveniles to appropriate salinity zones within the estuary, or the staging, resting, or holding of subadults or spawning adults. Therefore, construction and operation of the Edgemoor project will not impact PBF 3 habitat.

PBF 4 relates to water, especially in the bottom meter of the water column, with the temperature, salinity, and oxygen values necessary for spawning, survival, growth, and recruitment of Atlantic sturgeon. Conversion of the mostly shallow project area to deep water (-45 ft (-13.7 m) at MLLW) could potentially change temperature and/or salinity distributions from those at present if there were significant differences in these parameters between surface and bottom waters. However, the waters of the lower tidal Delaware River are well mixed with regard to temperature and salinity year round, with no biologically relevant differences between surface and bottom (see Cronin et al., 1962; Polis and Kupferman, 1973; and water quality data in the appendices of ERC, 2006c, 2007). Moreover, Ross et al. (2015) detected no significant change in salinity trends at the USGS Chester gage (located approximately 16 km upriver of the Edgemoor site) after deepening of the main navigation channel to 45 ft. Therefore, construction and operation of the Edgemoor project is not likely to effect the temperature or salinity component of PBF4

Disturbance of sediment during dredging may result in a temporary reduction in dissolved oxygen concentrations by resuspension of oxygen-demanding material in the sediment, although any reduction will be minimal in extent and duration because of the strong tidal currents in the project area. Therefore, significant impact to PFB 4 habitat by the project is not anticipated.

## 7.0 EFFECTS OF THE ACTION ON SPECIES OF SECONDARY CONCERN

### *7.1 Sea Turtles*

Sea turtles occur seasonally (May through early November) within the lower Delaware estuary, but are unlikely to occur upriver of Artificial Island (rkm 87), located some 31 rkm below the Edgemoor Container Port site. Therefore, the only potential effect of the project on sea turtles would be vessel strike from container ships inbound to, or outbound from, the port operating in the federal channel below Artificial Island.

Vessel strike has been identified as a significant source to anthropogenic mortality to sea turtles (NRC, 1990). Vessel strike of sea turtles appears to be related to vessel speed and most strikes are believed to be caused by recreational vessels operating at higher speeds (Hazel et al., 2007; Work et al., 2010). Sea turtles are generally thought to be able to avoid slower moving cargo vessels or to be pushed out of the impact zone by propeller wash or bow wake (NMFS, 2013).

Stetzer (2002, as cited in NMFS, 2018a) reported that 33 of 109 sea turtles stranded along the Delaware River estuary from 1994 to 1999 had evidence of boat interactions (hull or propeller strike), although it is not known how many of these strikes occurred after the turtle had died. This data suggests a vessel strike rate in the Delaware River estuary of 5-6 sea turtles per year if it is assumed that all 33 turtles had been struck prior to death (NMFS, 2018a), although the reporting rate for sea turtle carcasses is not known.

As discussed in Section 5.3.2, the Edgemoor project is expected to result in 87 additional container ship trips in the Delaware River estuary per year, a 0.18% increase in the total commercial traffic estimated for 2017, the latest year for which estimates were available. Assuming that this additional traffic is distributed evenly through the year, only about half of these vessels would occur during the approximately 6-month period that sea turtles are present in the estuary. Given this small increase in vessel traffic relative to baseline vessel activity and the baseline rarity of strike, the increased risk of sea turtle strike by vessels bound to or from the project is too small to be meaningfully measured or detected and, therefore, project effects to sea turtles are insignificant.

### *7.2 Whales*

Right whales occur in the coastal waters of Delaware and New Jersey primarily during November through April and, on rare occasions, have been observed within the lower Delaware Bay. Fin whales have never been documented in Delaware Bay, but could theoretically occur, most likely at or near the mouth of the bay.

Vessel strike is a significant source of anthropogenic mortality to large whales and one of the primary threats to recovery of right whales (Laist et al., 2001; Conn and Silber, 2013; Van Der Hop et al., 2013). Vessel speed and size have been identified as significant factors that increase the probability of whale vessel strikes and contribute to the severity of injury (Laist et al., 2001; Vanderlaan and Taggert, 2007). Based on an analysis by Laist et al. (2007), the most lethal or severe injuries to whales are caused by vessels greater than 80 m (262 ft) in length traveling at speeds greater than 14 knots.

NMFS established Seasonal Management Areas ("SMAs") in 2008 to reduce the likelihood of death and serious injuries to right whales resulting from ship collisions. A mid-Atlantic SMA is located at the mouth of Delaware Bay and is active from November 1 through April 30. Vessels 20 m (65 ft) or longer are required to operate at speeds of 10 knots or less when traveling through the SMA and to steer away from a right whale at a slow safe speed if a whale is observed within 460 m (1,500 ft) of the vessel.

The risk to fin and right whales from vessels bound to or from the Edgemoor project is insignificant considering the extreme rarity of the whales in the Action Area, the small increase in vessel traffic relative to baseline vessel activity, and the protection afforded by the mid-Atlantic SMA.

## 8.0 SUMMARY AND CONCLUSIONS

This BA evaluates the effects of the proposed Edgemoor Container Port project on ESA-listed species and designated critical habitat for the New York Bight DPS of Atlantic sturgeon. In this BA, shortnose sturgeon and Atlantic sturgeon are considered species of primary concern because they occur in the immediate vicinity of the project. Sea turtles and whales are considered species of secondary concern because they do not occur in the vicinity of the project, but may occur within the larger Action Area, i.e., the federal navigation channel of the Delaware River and Bay downriver of the project.

This BA considered the potential for entrainment of sturgeon by cutterhead dredge, the effects of dredging on sturgeon movement/migration, the effects of dredging on water quality and benthic communities that serve as forage for sturgeon, the effects of dredged material disposal, the effects of shoaling fan anti-sedimentation devices, the effects of the ballast water withdrawal and vessel maneuvering in the port area, the physical and behavioral effects of pile driving, the effects of placement of fill on sturgeon habitat, the effects of vessel traffic during construction and operation of the port, and the effects of adjacent upland activities. As summarized in Table 8-1, these potential effects are insignificant or discountable, the only exception being the effect of operating vessels striking Atlantic sturgeon.

Operation of the Edgemoor port will result in a small increase in vessel traffic above baseline, which increases the risk of vessel strike to sturgeon. Based on the estimates of vessel strike rate presented in Section 6.3.4, operation of the Edgemoor port may result in the mortality of one additional Atlantic sturgeon every 5.5 years. While the loss of any individual of an endangered species is of concern, it is unlikely that a loss of this magnitude would jeopardize the continued existence of Atlantic sturgeon in the Delaware River.

The vessel strike analysis estimated that the increased vessel traffic resulting from the Edgemoor Container Port may result in one additional shortnose sturgeon mortality every 85 years, an increase so small that it is discountable.

In regard to designated critical habitat, dredging and vessel operations within the port area will disturb some soft bottom foraging habitat that seasonally meets the salinity criterion for PBF 2 and may have a minimal effect on dissolved oxygen concentrations relating to PFB 4,

but these disturbances are localized and not likely to have a significant effect on designated Atlantic sturgeon critical habitat.

The only potential effect of the Edgemoor project on sea turtles is vessel strike in the federal navigation channel below Artificial Island. The risk to sea turtles from vessels bound to or from the Edgemoor project is insignificant given the baseline rarity of sea turtle strike and the small increase in vessel traffic that will occur as a result of the project.

The only potential effect of the Edgemoor project on right whales and fin whales is vessel strike in the very lowest portion of the Action Area, near the mouth of Delaware Bay. The risk to fin and right whales from vessels bound to or from the Edgemoor project is insignificant considering the extreme rarity of the whales in the Action Area, the small increase in vessel traffic relative to baseline vessel activity, and the protection afforded by the speed reduction within the mid-Atlantic SMA, located at the mouth of Delaware Bay.

Table 8-1. Summary of the potential effects of the Edgemoor Container Port Project on ESA-listed species.

| Common Name | Atlantic Sturgeon | Shortnose Sturgeon | Sea Turtles | Whales |
|---|---|---|---|---|
| Federal Status | Varies with DPS | Endangered | Varies by Species | Endangered |
| Dredging – Entrainment | Insignificant | Insignificant | No effect | No effect |
| Dredging – Effects on movement/migration | Insignificant | Insignificant | No effect | No effect |
| Dredging – Effects on Water Quality | Insignificant | Insignificant | No effect | No effect |
| Dredging – Effects on Prey Communities | Insignificant | Insignificant | No effect | No effect |
| Dredged Material Dewatering | Insignificant | Insignificant | No effect | No effect |
| Operation of Shoaling Fans | Insignificant | Insignificant | No effect | No effect |
| Pile Driving | Insignificant | Insignificant | No effect | No effect |
| Placement of Fill | Insignificant | Insignificant | No effect | No effect |
| Vessel Traffic from Construction | Insignificant | Insignificant | No effect | No effect |
| Vessel Strike | may adversely affect, but not jeopardize the continued existence | Discountable | Insignificant | Insignificant |
| Intake of Ballast Water in Port – Effect on ELS | Insignificant | No effect | No effect | No effect |
| Vessel Maneuvering in Port – Effect on ELS | Insignificant | No effect | No effect | No effect |
| Vessel Maneuvering in Port – Effects on Substrate and Benthos | Insignificant | Insignificant | No effect | No effect |
| Effects of Upland Activities | Insignificant | Insignificant | No effect | No effect |

### *8.1 Cumulative Effects Including State and Private Activities*

The Delaware River is a highly urbanized and industrialized water body and, as such, shortnose and Atlantic sturgeon in the river are exposed to a number of man-created stressors. These stressors include maintenance dredging of the federal navigation channel; water quality effects from runoff, wastewater discharge, and legacy contaminants; impingement at power plant cooling water intakes; existing vessel traffic; and incidental catch in various fisheries (see NMFS, 2018a for a detailed discussion of baseline stressors to sturgeon in the Delaware River). Based on the analyses and discussion presented in this BA, construction and operation of the Edgemoor Container Port is not likely to impose significant or measurable additional stress on sturgeon or other ESA-listed species in the Delaware estuary.

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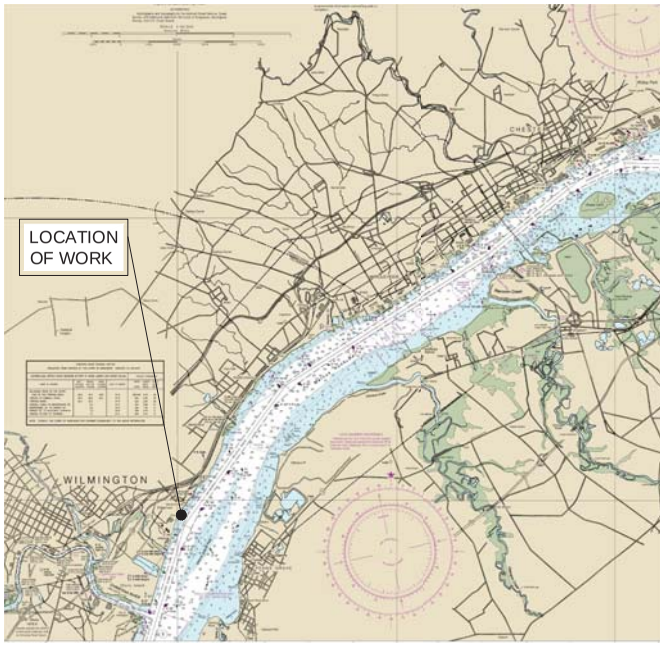
# APPENDIX 1

PROJECT PERMIT PLAN DRAWINGS

# PORT OF WILMINGTON EDGEMOOR EXPANSION
# PERMIT PLANS

## BRANDYWINE HUNDRED, NEW CASTLE COUNTY, DELAWARE




LOCATION MAP

SCALE: 1" = 8,000'

8,000' 0 8,000' 16,000'

SCALE IN FEET 1" = 8,000'

**PURPOSE:**

THE PURPOSE OF THESE PLANS IS TO PROVIDE PLANS AND DETAILS FOR THE PERMITTING OF A NEW HARBOR AND DOCK STRUCTURE AT THE PORT OF WILMINGTON EDGEMOOR FACILITY IN NEW CASTLE COUNTY, DELAWARE. THESE DRAWINGS ARE FOR PERMITTING PURPOSES ONLY AND ARE NOT FOR BIDDING.

**SITE DATA:**

| | | |
|---|---|---|
| 1. | TAX PARCEL NO.: | 06-153.00-006 |
| 2. | SITE ADDRESS: | 4600 HAY ROAD<br>WILMINGTON, DE 19809 |
| 3. | OWNER: | DIAMOND STATE PORT CORPORATION<br>1 HAUSEL ROAD<br>WILMINGTON, DE 19801 |
| 4. | SOURCE OF TITLE: | IN20170227-0010347 |
| 5. | ZONING: | HI - HEAVY INDUSTRIAL |
| 6. | PARCEL SITE ACREAGE: | 113.29 ± AC |
| 7. | DATUM: | HORIZONTAL: NAD 83 DE STATE PLANE GRID<br>VERTICAL: NAVD 1988 |
| 8. | SURVEY: | THE TOPOGRAPHIC SURVEY DEPICTED ON THIS PLAN WAS TAKEN FROM AN AERIAL SURVEY PREPARED BY COOPER AERIAL SURVEYS CO. DATED DECEMBER 23, 2018.<br><br>BATHYMETRIC SOUNDING PERFORMED BY GAHAGAN & BRYANT ASSOCIATES IN JULY, 2018 WITH SINGLE BEAM AND MULTIBEAM SURVEY IN GENERAL ACCORDANCE WITH EM 1110-2-1003.<br><br>THE GROUND CONTROL POINTS UTILIZED BY COOPER AERIAL SURVEYS CO. FOR THE AERIAL SURVEY WERE SET IN THE FIELD BY VANDEMARK & LYNCH, INC. DATED DECEMBER 12-14, 2018. |

**INDEX OF SHEETS:**


| | |
|---|---|
| SHEET 1 | COVER SHEET |
| SHEET 2 | JURISDICTIONAL BOUNDARY PLAN |
| SHEET 3 | EXISTING CONDITIONS PLAN |
| SHEET 4 | EXISTING TOPOGRAPHY |
| SHEET 5 | CONCEPTUAL SITE PLAN |
| SHEET 6 | BERTH GRADING PLAN |
| SHEET 7 | SECTIONS |
| SHEET 8 | SECTIONS |
| SHEET 9 | WHARF STRUCTURAL DETAILS |
| SHEET 10 | WHARF STRUCTURAL DETAILS |
| SHEET 11 | SEDIMENT FAN DETAILS |
| SHEET 12 | ANALYTICAL SAMPLE LOCATION SKETCH |
| SHEET 13 | GEOTECHNICAL BORINGS LOCATION SKETCH |
| SHEET 14 | ESSENTIAL FISH HABITAT |
| SHEET 15 | BATHYMETRIC SURVEY |
| SHEET 16 | MAGNETOMETER CONTOUR MAPPING |
| SHEET 17 | SITE SCAN SONAR |


**QUANTITY NOTES:**

| | | |
|---|---|---|
| 1. | AREA OF DREDGE: | 86.9 ACRES |
| 2. | AREA OF DREDGE TO 48': | 64.5 ACRES |
| 3. | AREA OF SUBAQUEOUS FILL: | 5.5 ACRES |
| 4. | VOLUME OF DREDGE: | 3,325,000 CUBIC YARDS |
| 5. | VOLUME OF SUBAQUEOUS FILL: | 20,107 CUBIC YARDS |
| 6. | VOLUME OF FLOODPLAIN FILL: | 145,893 CUBIC YARDS |
| 7. | AREA OF WETLAND IMPACT: | 0.0 ACRES |
| 8. | AREA OF SHALLOW WATER IMPACT: | 35.3 ACRES |
| 9. | APPROXIMATE NUMBER OF PILES: | 4,500 (PLUMB AND BATTER ) |
| 10. | VOLUME OF PILE FILL: | 2,160 CUBIC YARDS |
| 11. | "SHADED" FOOTPRINT AREA COVERED BY WHARF / FENDERS: | 32,900 SQUARE YARDS |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DRAWN BY: AR
CHECKED BY: BJD
FILE: PRMT-Index-11139LH.dwg

PERMIT PLAN
COVER SHEET
PORT OF WILMINGTON EDGEMOOR EXPANSION
BRANDYWINE HUNDRED ~ NEW CASTLE COUNTY ~ DELAWARE

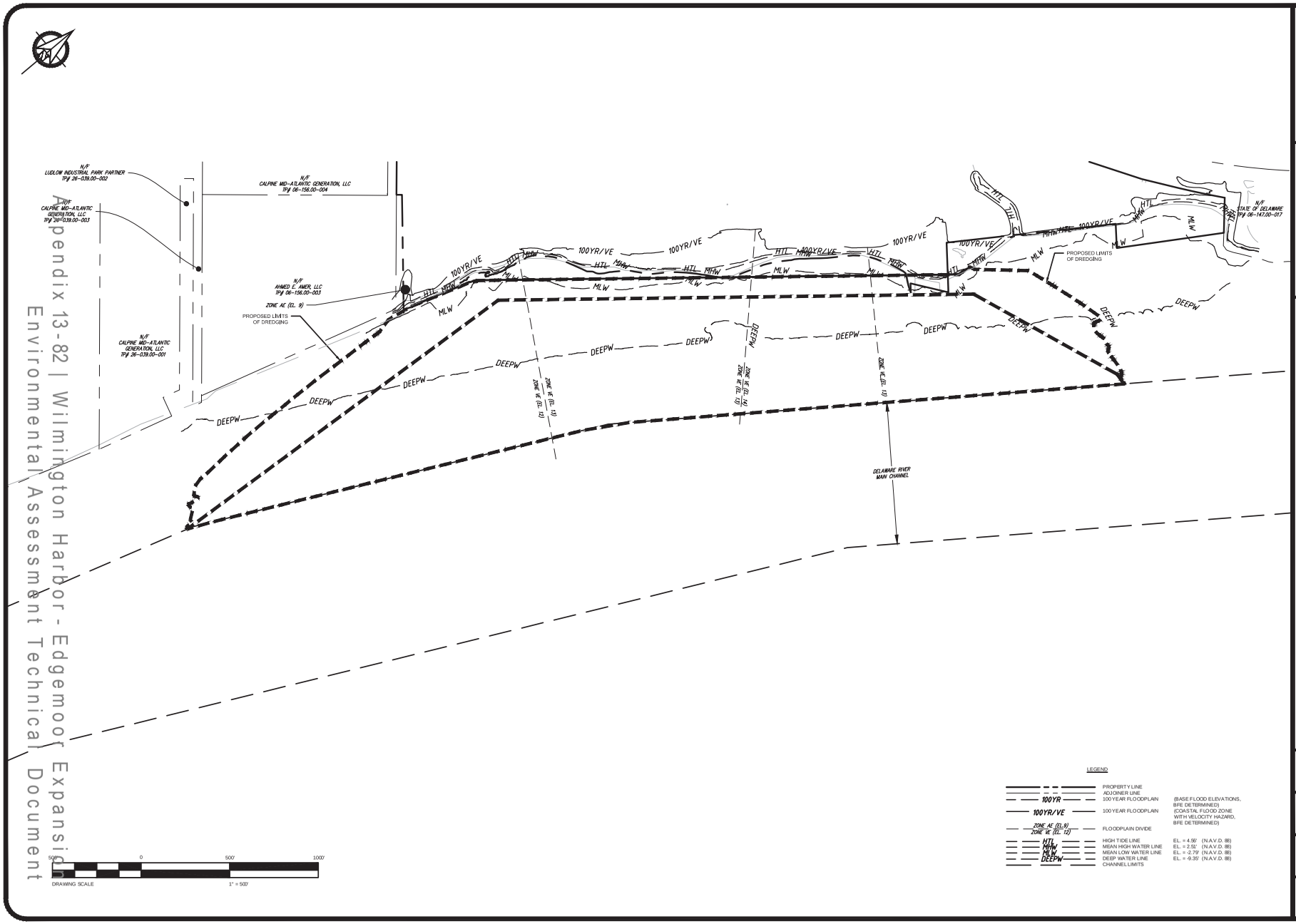
DATE: OCTOBER 2019

SCALE: 1" = 8,000'

PROJECT NO. 11139.LH

SHEET: 1 OF 17


Appendix 13-81 | Wilmington Harbor - Edgemoor Expansion
Environmental Assessment Technical Document





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# PERMIT PLAN
# JURISDICTIONAL BOUNDARY PLAN
# PORT OF WILMINGTON EDGEMOOR EXPANSION

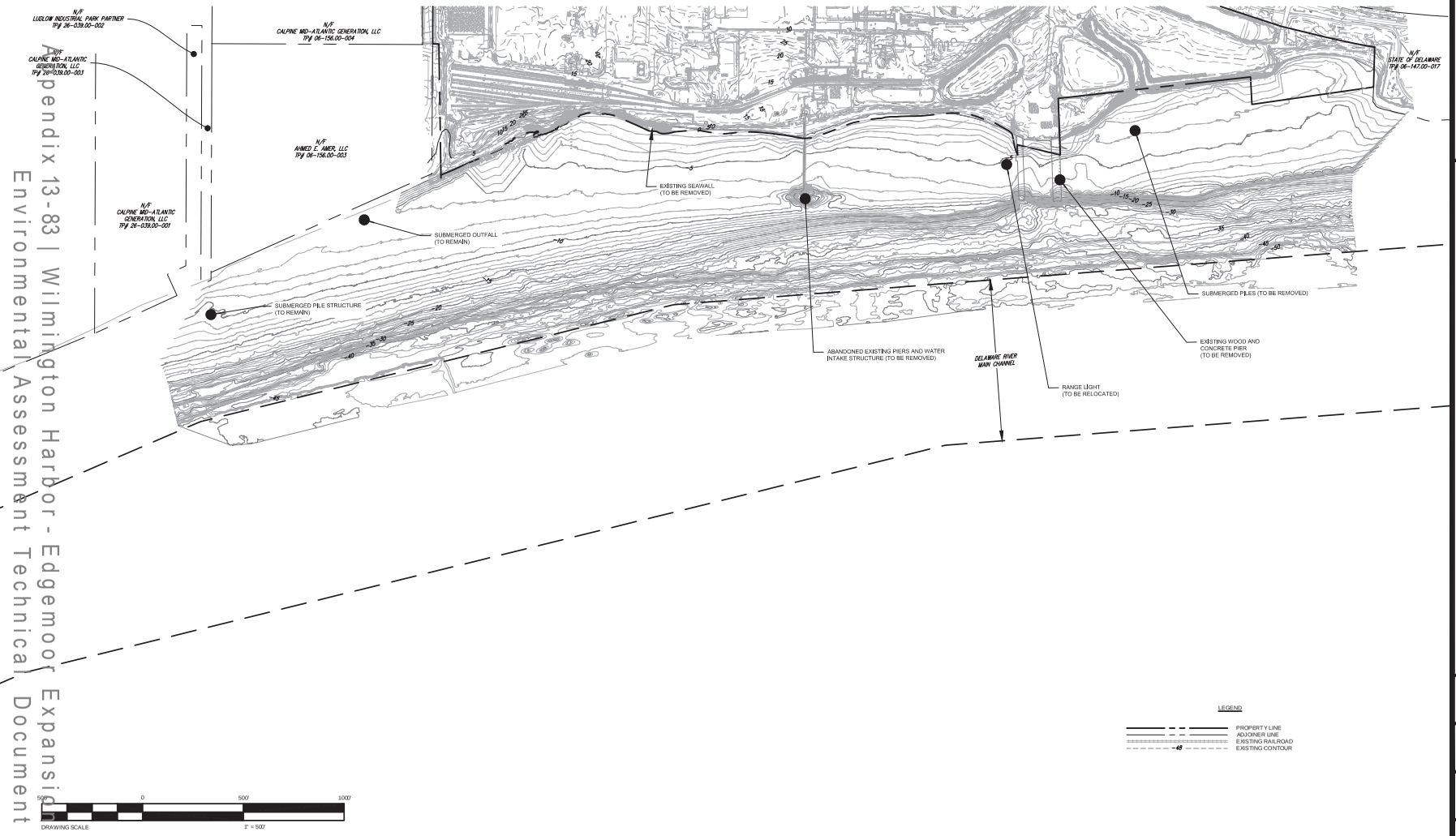
BRANDYWINE HUNDRED ~ NEW CASTLE COUNTY ~ DELAWARE

DATE: OCTOBER 2019

SCALE: 1" = 500'

PROJECT NO. 11139.LH

SHEET: 2 OF 17

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**PERMIT PLAN**
**EXISTING CONDITIONS PLAN**
**PORT OF WILMINGTON EDGEMOOR EXPANSION**

**BRANDYWINE HUNDRED ~ NEW CASTLE COUNTY ~ DELAWARE**

**DATE:** OCTOBER 2019

**SCALE:** 1" = 500'

**PROJECT NO.** 11139.LH

**SHEET:** 3 OF 17

LEGEND

PROPERTY LINE
ADJOINER LINE
EXISTING RAILROAD
EXISTING CONTOUR

500' 0 500' 1000'
DRAWING SCALE 1" = 500'

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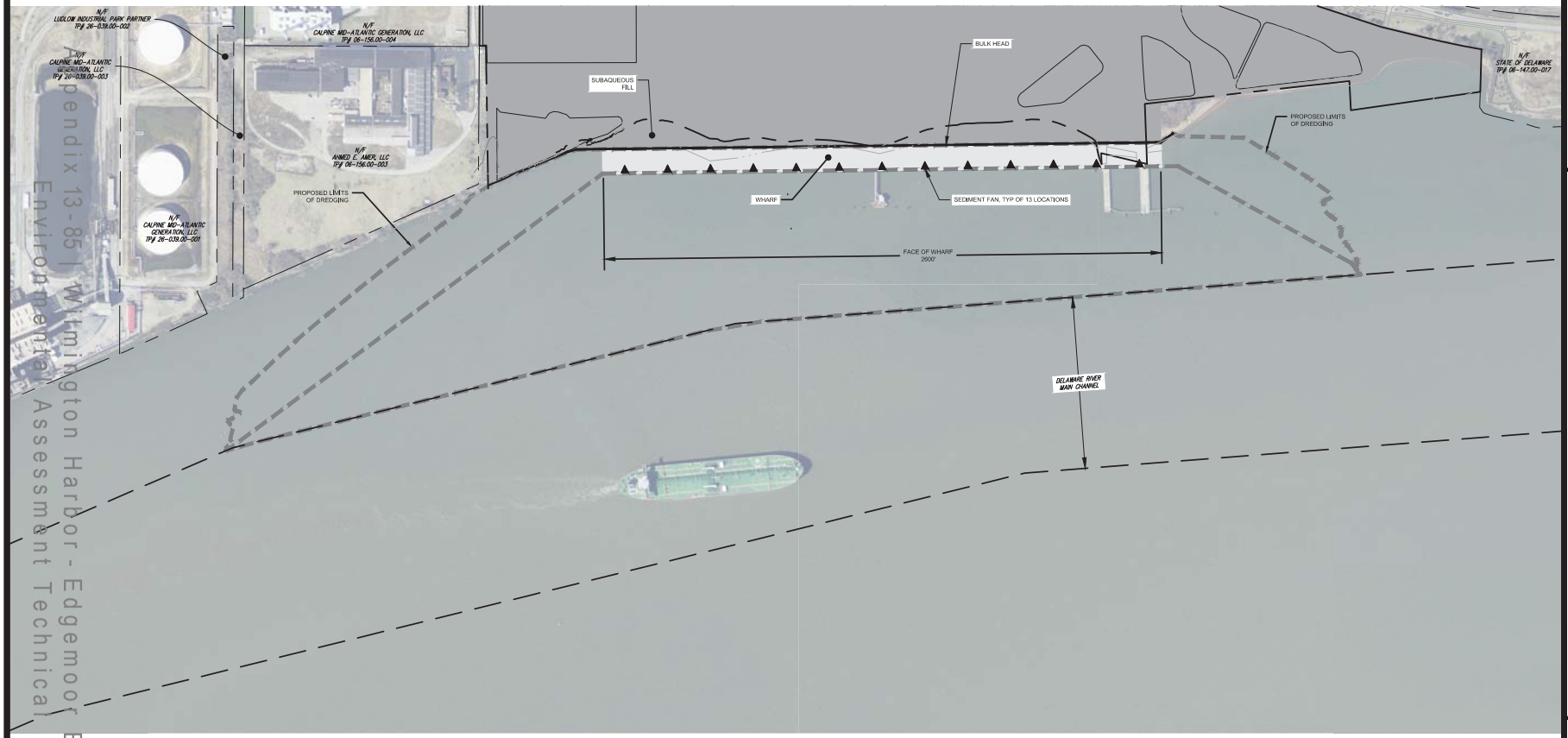
**PERMIT PLAN**
**EXISTING TOPOGRAPHY**
# PORT OF WILMINGTON EDGEMOOR EXPANSION
**BRANDYWINE HUNDRED ~ NEW CASTLE COUNTY ~ DELAWARE**

**DATE:** OCTOBER 2019

**SCALE:** 1" = 500'

**PROJECT NO.** 11139.LH

**SHEET:** 4 OF 17




LEGEND

- PROPERTY LINE
- ADJOINER LINE
- CHANNEL LIMITS
- LIMITS OF DREDGING
- PROPOSED ASPHALT
- PROPOSED WHARF

500' 0 500' 1000'

DRAWING SCALE 1" = 500'

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# PERMIT PLAN
## CONCEPTUAL SITE PLAN
# PORT OF WILMINGTON EDGEMOOR EXPANSION

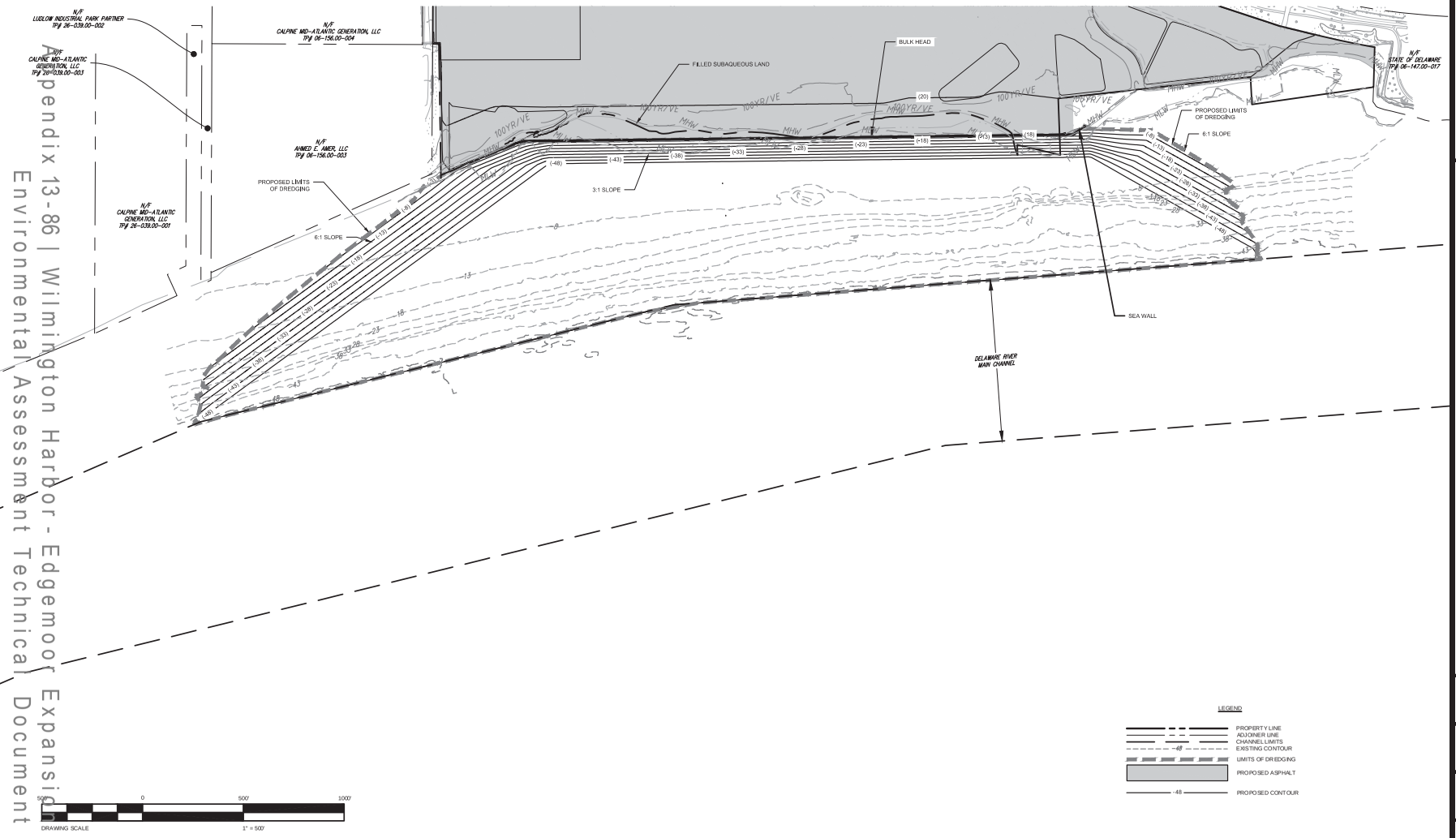
BRANDYWINE HUNDRED ~ NEW CASTLE COUNTY ~ DELAWARE

DATE: OCTOBER 2019

SCALE: 1" = 500'

PROJECT NO. 11139.LH

SHEET: 5 OF 17

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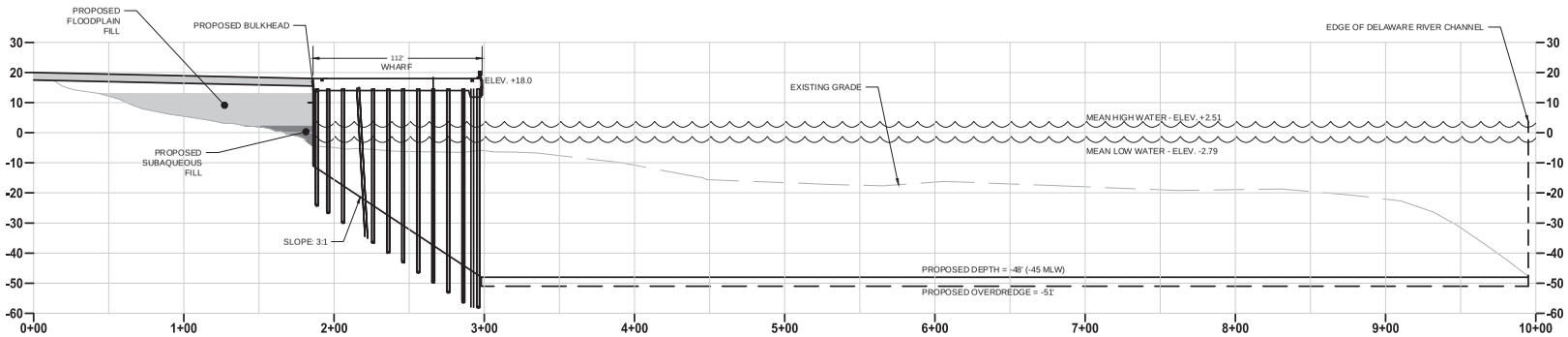
**PERMIT PLAN**
**BERTH GRADING PLAN**
# PORT OF WILMINGTON EDGEMOOR EXPANSION
**BRANDYWINE HUNDRED ~ NEW CASTLE COUNTY ~ DELAWARE**

**DATE:** OCTOBER 2019

**SCALE:** 1" = 500'

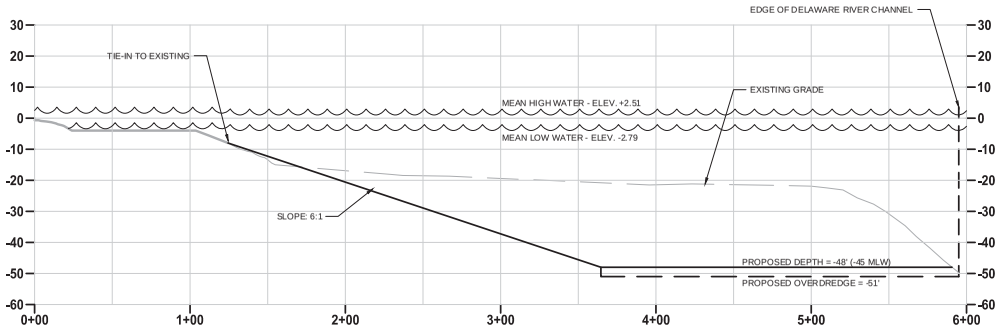
**PROJECT NO.** 11139.LH

**SHEET:** 6 OF 17




## SECTION WHARF

SCALE: HORIZONTAL: 1" = 80'
VERTICAL: 1" = 40'




## SECTION AT TIE-IN TO EXISTING SUBAQUEOUS SLOPE

SCALE: HORIZONTAL: 1" = 80'
VERTICAL: 1" = 40'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**PERMIT PLAN**
**SECTIONS**

# PORT OF WILMINGTON EDGEMOOR EXPANSION

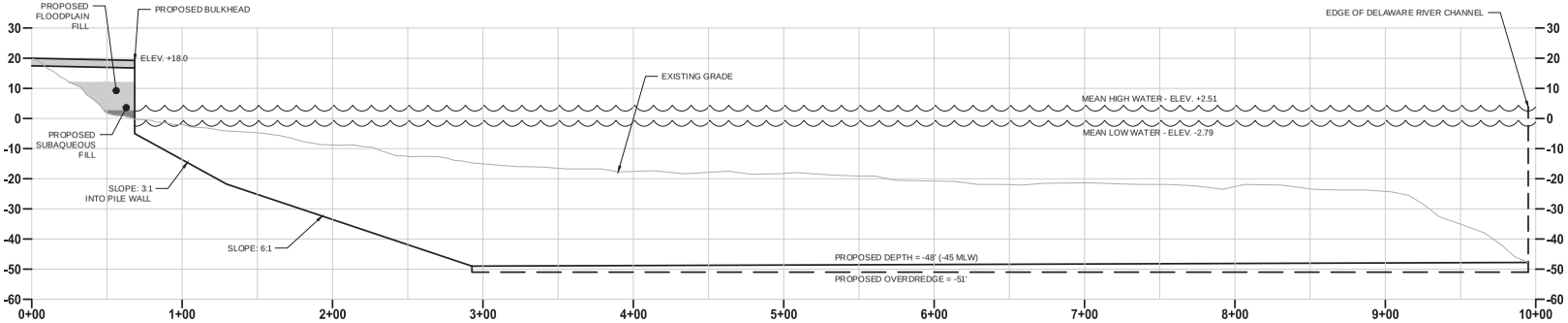
**BRANDYWINE HUNDRED ~ NEW CASTLE COUNTY ~ DELAWARE**

DATE: OCTOBER 2019

SCALE: AS SHOWN

PROJECT NO. 11139.LH

SHEET: 7 OF 17




**SECTION AT BULKHEAD**

SCALE: HORIZONTAL: 1" = 80'
VERTICAL: 1" = 40'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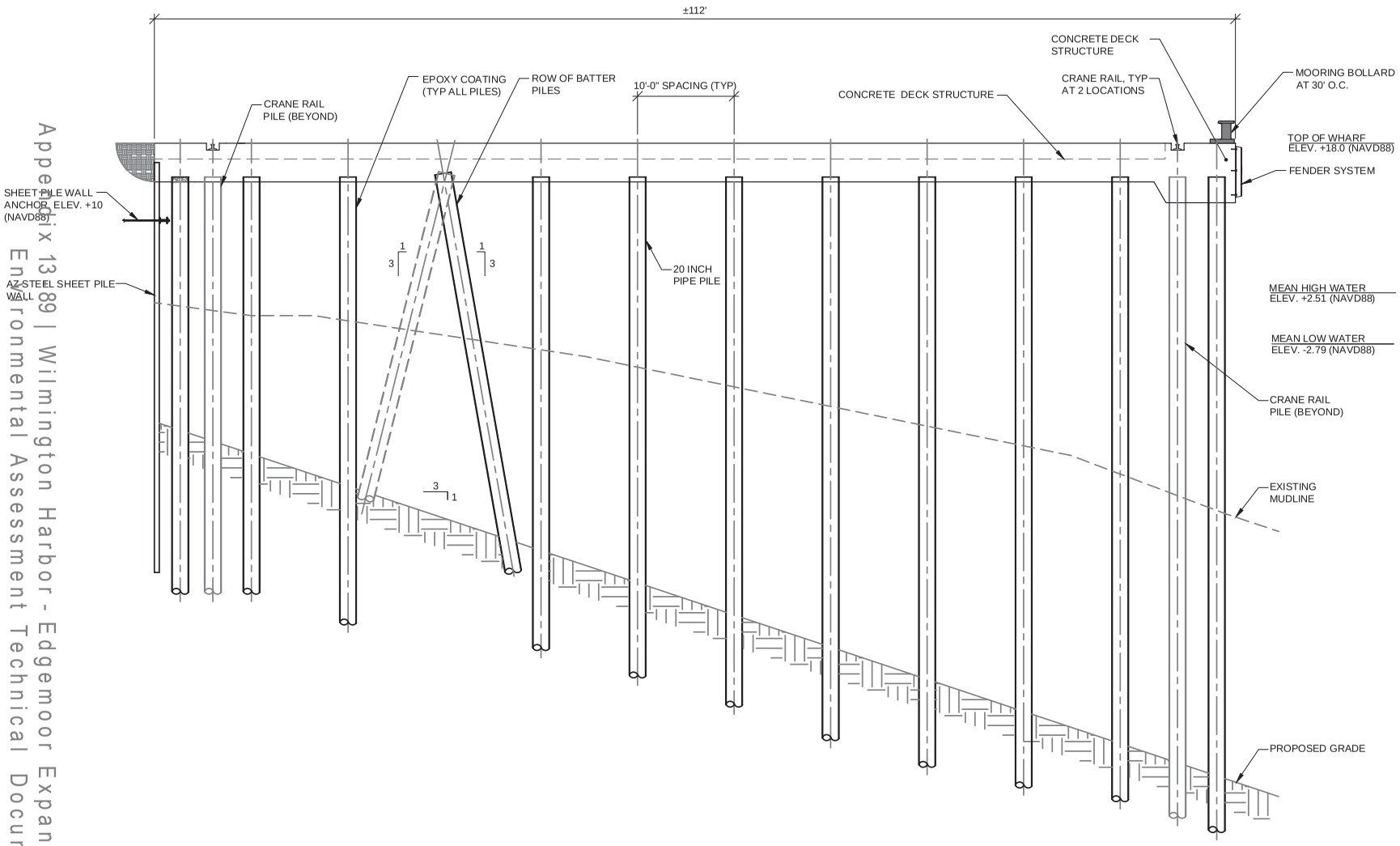
**PERMIT PLAN**
**SECTIONS**
**PORT OF WILMINGTON EDGEMOOR EXPANSION**
**BRANDYWINE HUNDRED ~ NEW CASTLE COUNTY ~ DELAWARE**

DATE: OCTOBER 2019
SCALE: AS SHOWN
PROJECT NO. 11139.LH
SHEET: 8 OF 17




WHARF CONSTRUCTION SECTION - SECTION VIEW
SCALE: NOT TO SCALE

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| CHECKED BY: | BJD |
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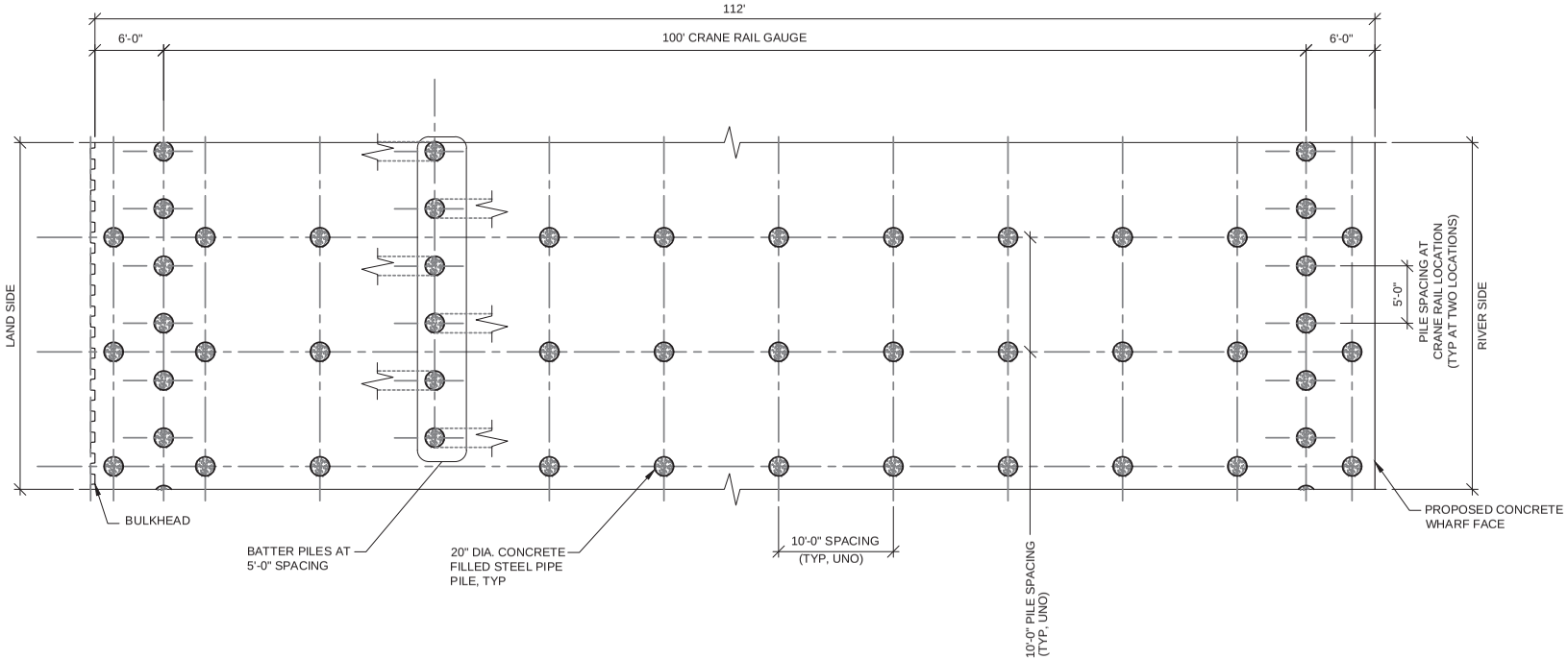
**PERMIT PLAN**
**WHARF STRUCTURAL DETAILS**
**PORT OF WILMINGTON EDGEMOOR EXPANSION**
**BRANDYWINE HUNDRED ~ NEW CASTLE COUNTY ~ DELAWARE**

DATE: OCTOBER 2019
SCALE: NTS
PROJECT NO. 11139.LH
SHEET: 9 OF 17




WHARF CONSTRUCTION SECTION - PLAN VIEW
SCALE: NOT TO SCALE

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**PERMIT PLAN**
**WHARF STRUCTURAL DETAILS**
**PORT OF WILMINGTON EDGEMOOR EXPANSION**

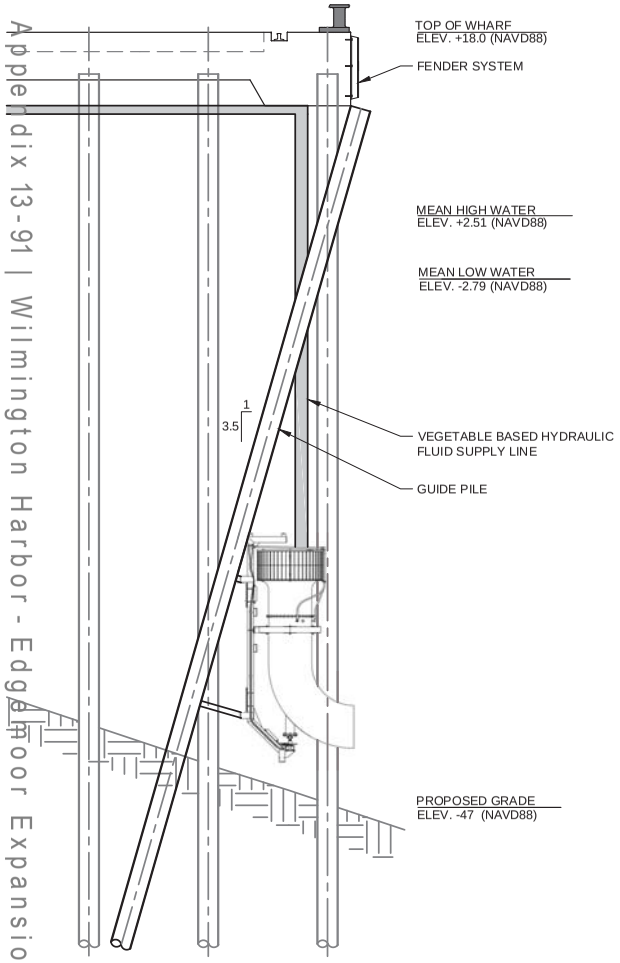
**BRANDYWINE HUNDRED ~ NEW CASTLE COUNTY ~ DELAWARE**

**DATE:** OCTOBER 2019

**SCALE:** NTS

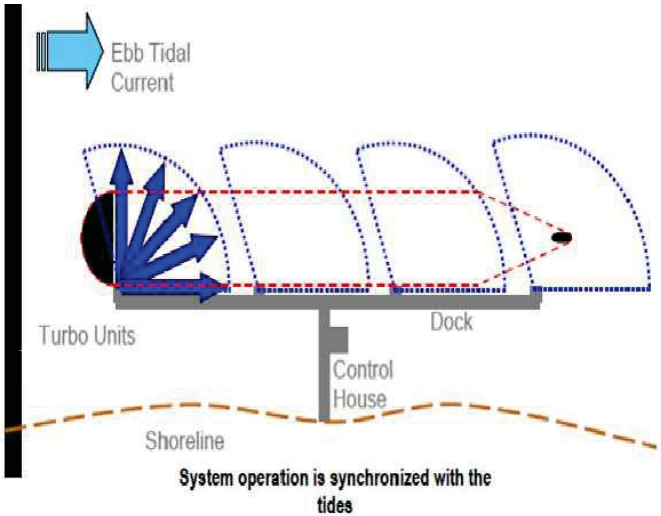
**PROJECT NO.** 11139.LH

**SHEET:** 10 OF 17




SEDCON SHOALING FAN CONFIGURATION - SECTION VIEW
SCALE: NOT TO SCALE

SEDCON SHOALING FAN - CONCEPTUAL IMAGE
SCALE: NOT TO SCALE




SEDCON SHOALING FAN - CONCEPTUAL IMAGE
SCALE: NOT TO SCALE

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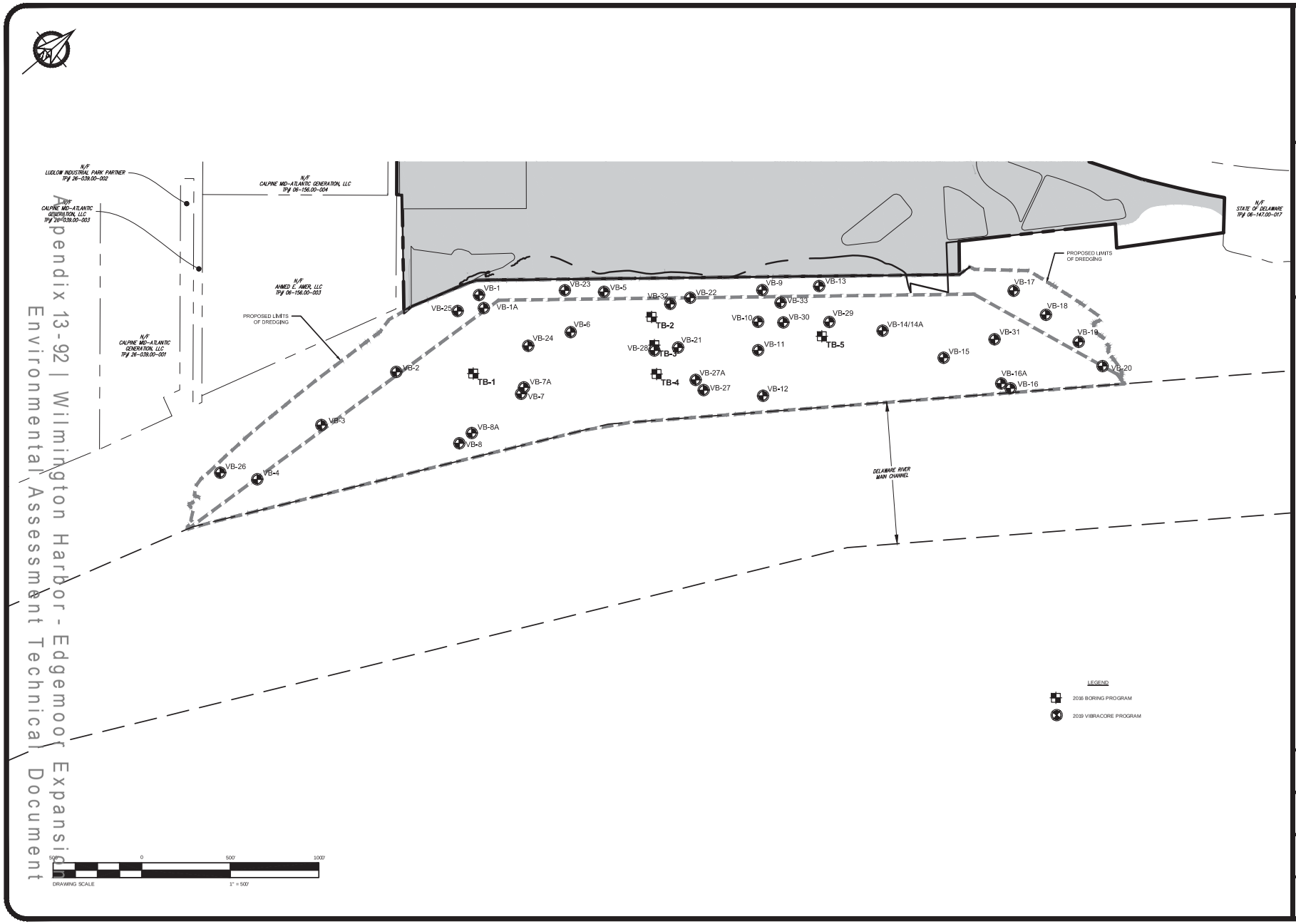
|---|---|
| DESIGNED BY: | MRB |
| DRAWN BY: | SFH |
| CHECKED BY: | BJD |
| FILE: | PRMT-Struct-11139.LH.dwg |

**PERMIT PLAN**
**SEDIMENT FAN DETAILS**
**PORT OF WILMINGTON EDGEMOOR EXPANSION**
**BRANDYWINE HUNDRED ~ NEW CASTLE COUNTY ~ DELAWARE**

DATE: OCTOBER 2019
SCALE: NTS
PROJECT NO. 11139.LH
SHEET: 11 OF 17

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| DRAWN BY: | KJT |
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| FILE: | PRMT-VIBRA-11139LH.dwg |

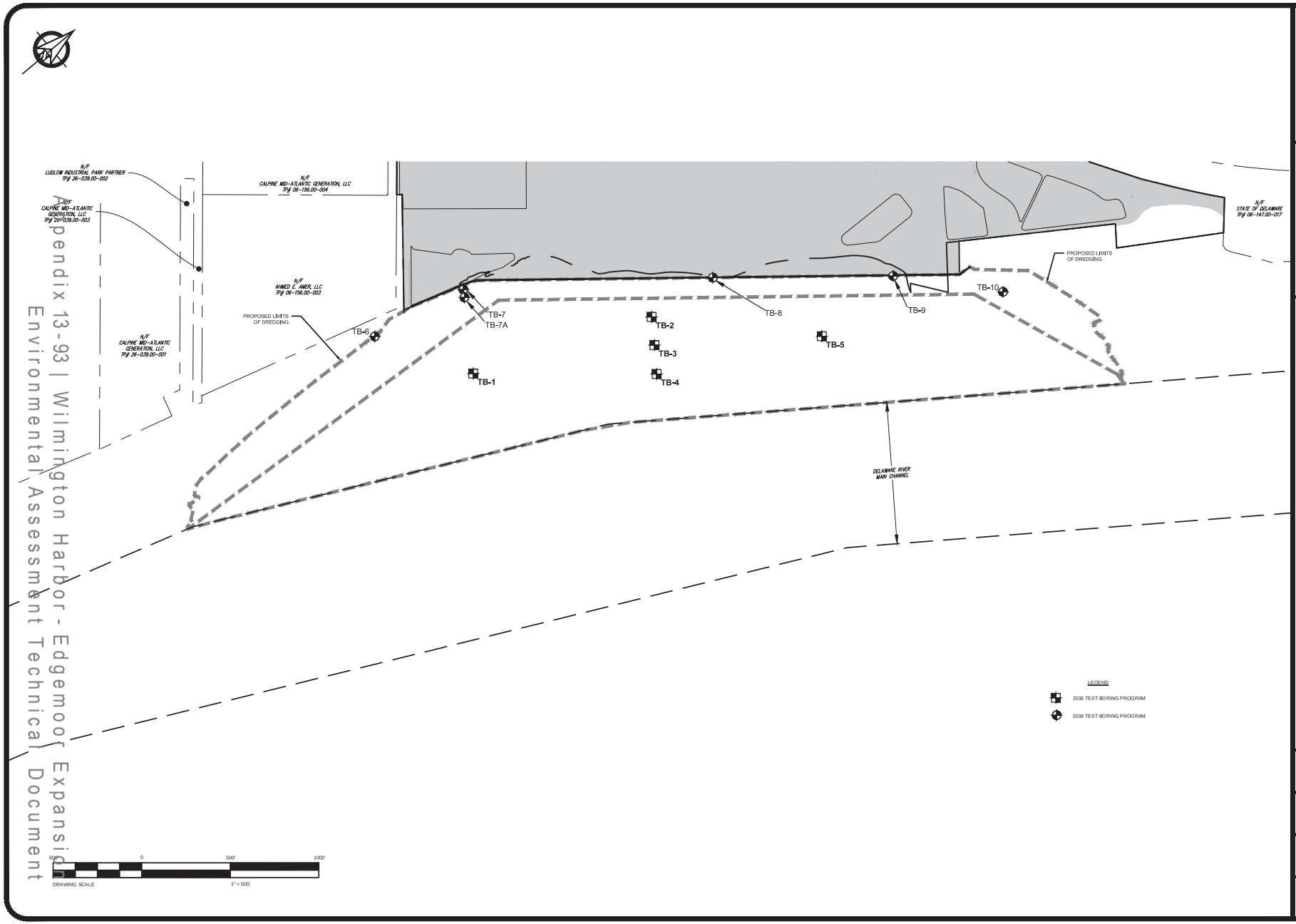
**PERMIT PLAN**
**ANALYTICAL SAMPLE LOCATION SKETCH**
# PORT OF WILMINGTON EDGEMOOR EXPANSION
**BRANDYWINE HUNDRED ~ NEW CASTLE COUNTY ~ DELAWARE**

**DATE:** OCTOBER 2019

**SCALE:** 1" = 500'

**PROJECT NO.** 11139.LH

**SHEET:** 12 OF 17

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| DESIGNED BY: | MRB |
| DRAWN BY: | KJT |
| CHECKED BY: | BJD |
| FILE: | PRMT-GEO-11139LH.dwg |

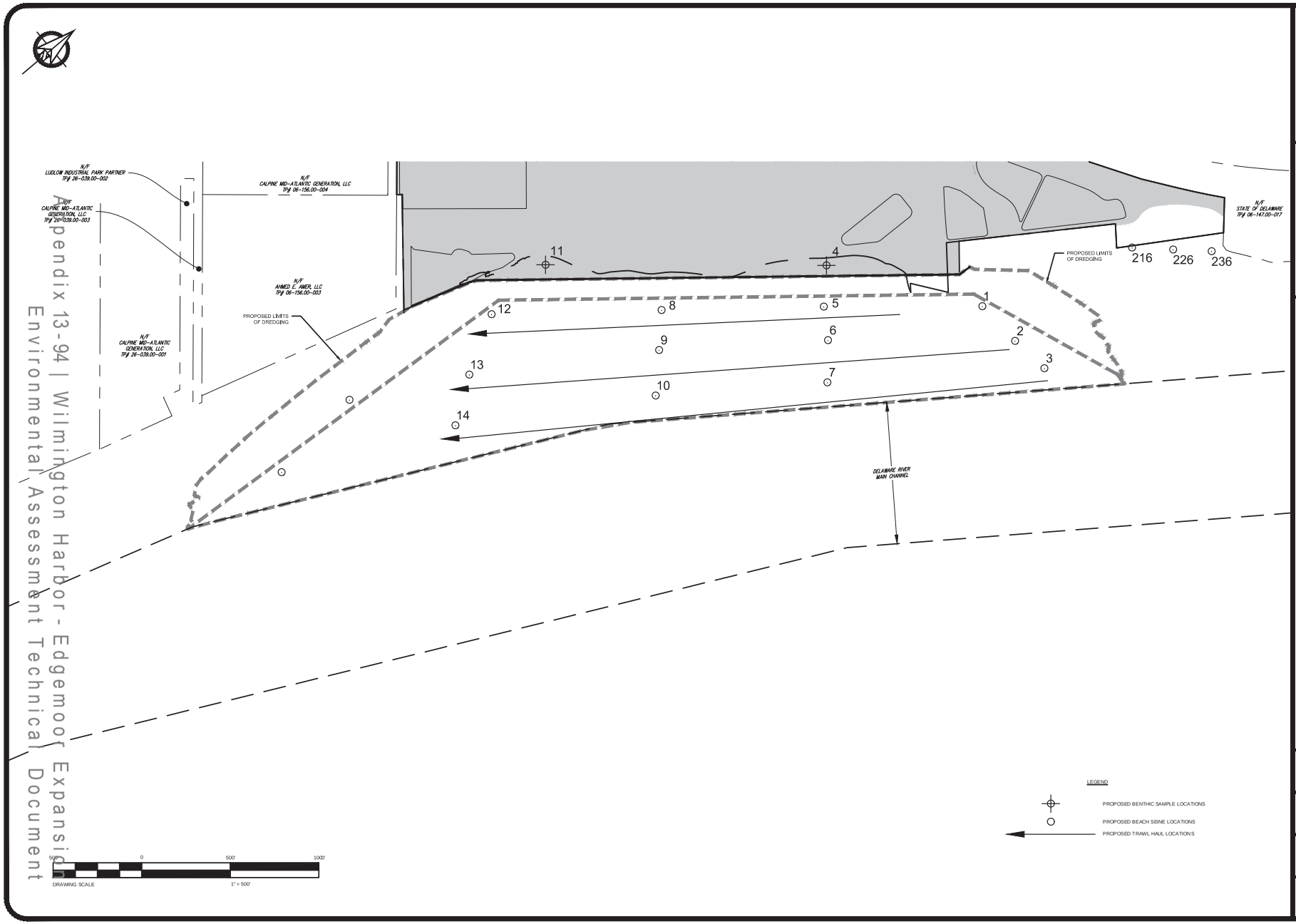
**PERMIT PLAN**
**GEOTECHNICAL BORING LOCATION SKETCH**
**PORT OF WILMINGTON EDGEMOOR EXPANSION**
**BRANDYWINE HUNDRED ~ NEW CASTLE COUNTY ~ DELAWARE**

**DATE:** OCTOBER 2019

**SCALE:** 1" = 500'

**PROJECT NO.** 11139.LH

**SHEET:** 13 OF 17

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| DESIGNED BY: | MRB |
| DRAWN BY: | AR/MH |
| CHECKED BY: | BJD |
| FILE: | PRMT-FISH-11139LH.dwg |

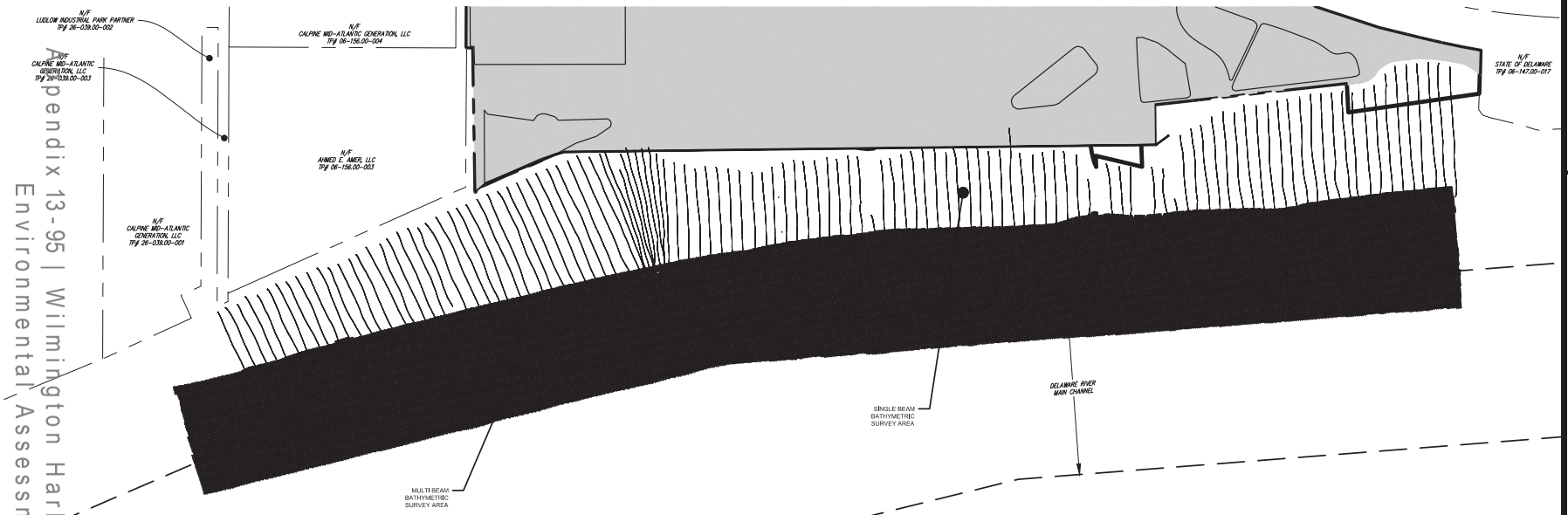
**PERMIT PLAN**
**ESSENTIAL FISH HABITAT SURVEY**
**PORT OF WILMINGTON EDGEMOOR EXPANSION**
**BRANDYWINE HUNDRED ~ NEW CASTLE COUNTY ~ DELAWARE**

**DATE:** OCTOBER 2019

**SCALE:** 1" = 500'

**PROJECT NO.** 11139.LH

**SHEET:** 14 OF 17




500' 0 500' 1000'

DRAWING SCALE 1" = 500'

NOTE
BATHYMETRIC SOUNDING PERFORMED BY GAHAGAN & BRYANT ASSOCIATES IN JULY, 2018 WITH SINGLE BEAM AND MULTIBEAM SURVEY IN GENERAL ACCORDANCE WITH EM 1110-2-1003.

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|---|---|
| DESIGNED BY: | MRB |
| DRAWN BY: | KJT |
| CHECKED BY: | BJD |
| FILE: | PRMT-Bath-11139LH.dwg |

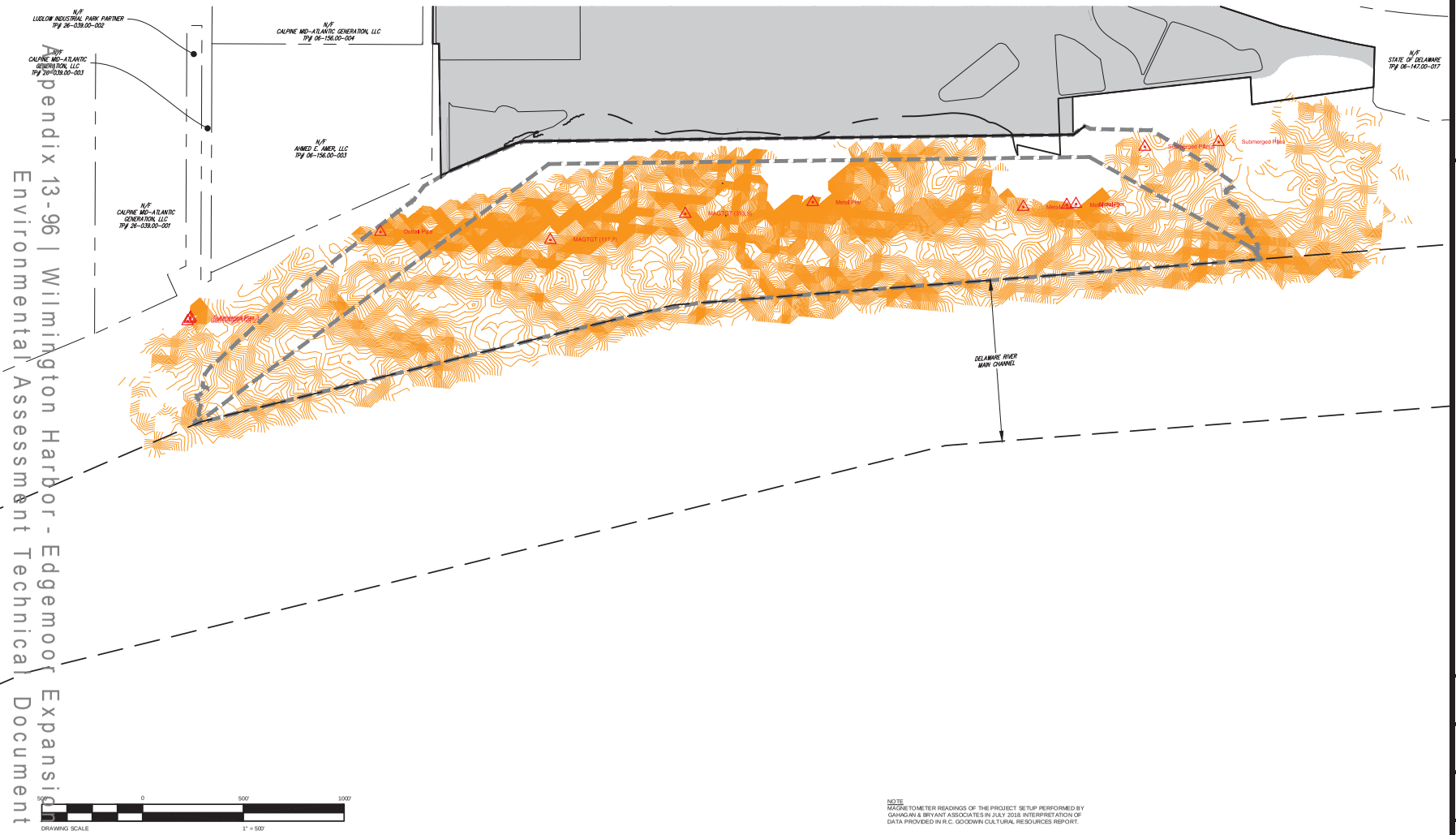
**PERMIT PLAN**
**BATHYMETRIC SURVEY**
# PORT OF WILMINGTON EDGEMOOR EXPANSION
**BRANDYWINE HUNDRED ~ NEW CASTLE COUNTY ~ DELAWARE**

**DATE:** OCTOBER 2019

**SCALE:** 1" = 500'

**PROJECT NO.** 11139.LH

**SHEET:** 15 OF 17




NOTE
MAGNETOMETER READINGS OF THE PROJECT SETUP PERFORMED BY GAHAGAN & BRYANT ASSOCIATES IN JULY 2018. INTERPRETATION OF DATA PROVIDED IN R.C. GOODWIN CULTURAL RESOURCES REPORT.

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| DESIGNED BY: | MRB |
| DRAWN BY: | MH |
| CHECKED BY: | BJD |
| FILE: | PRMT-MAG-11139LH.dwg |

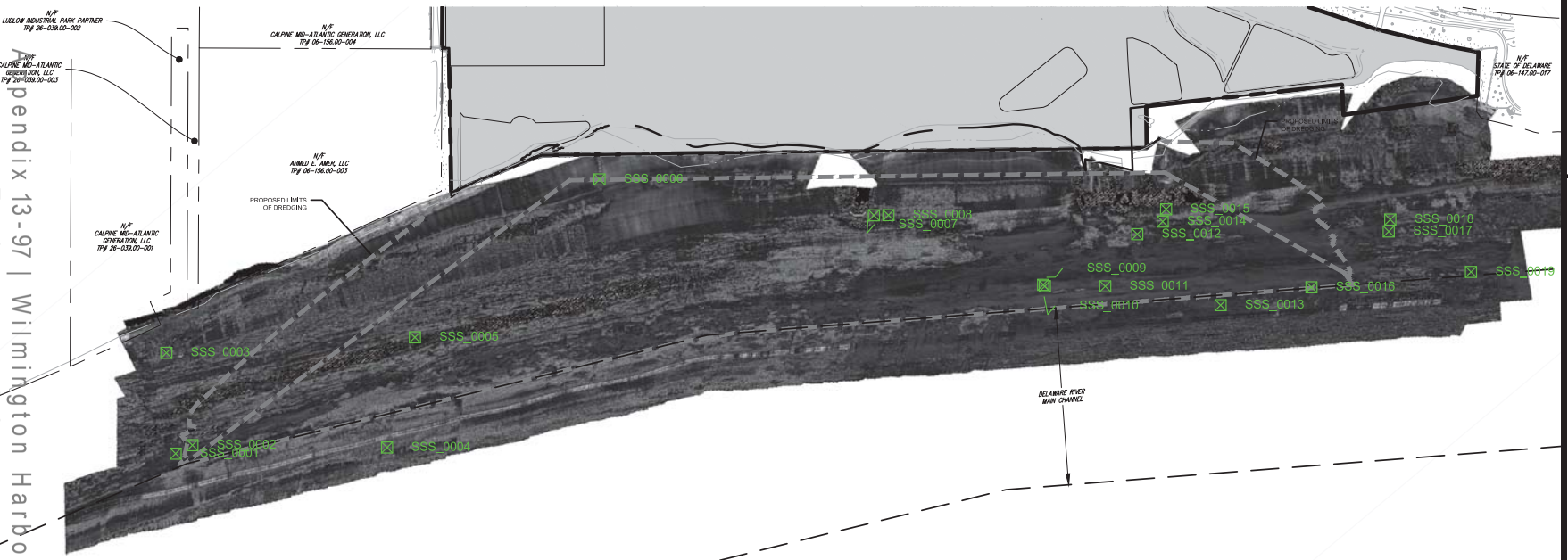
**PERMIT PLAN**
**MAGNETOMETER CONTOUR MAPPING**
# PORT OF WILMINGTON EDGEMOOR EXPANSION
**BRANDYWINE HUNDRED ~ NEW CASTLE COUNTY ~ DELAWARE**

**DATE:** OCTOBER 2019

**SCALE:** 1" = 500'

**PROJECT NO.** 11139.LH

**SHEET:** 16 OF 17




500' 0 500' 1000'

DRAWING SCALE 1" = 500'

NOTE
SIDE SCAN SONAR SOUNDING PERFORMED BY GAHAGAN & BRYANT ASSOCIATES IN JULY, 2018. INTERPRETATION OF DATA PROVIDED IN R.C. GOODWIN CULTURAL AND NATURAL RESOURCES REPORT.

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| DESIGNED BY: | MRB |
| DRAWN BY: | KJT |
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| FILE: | PRMT-SSS-11139LH.dwg |

**PERMIT PLAN**
**SIDE SCAN SONAR**
# PORT OF WILMINGTON EDGEMOOR EXPANSION
**BRANDYWINE HUNDRED ~ NEW CASTLE COUNTY ~ DELAWARE**

**DATE:** OCTOBER 2019

**SCALE:** 1" = 500'

**PROJECT NO.** 11139.LH

**SHEET:** 17 OF 17