

**PRELIMINARY COMPENSATORY MITIGATION PLAN**

**WILMINGTON HARBOR - EDGEMOOR EXPANSION  
EDGEMOOR, NEW CASTLE COUNTY, DELAWARE**

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## 1. Introduction

The Diamond State Port Corporation, a body corporate and politic established under Chapter 87, Title 29 of the Delaware Code within the Delaware Department of State (the “DSPC” or the “Applicant”), has applied to the United States Army Corps of Engineers (USACE) for a Clean Water Act Section 404 permit, and a Rivers and Harbors Act Section 10 permit (Application CENAP-OR-R-2019-278) for construction and dredging related to the construction of a primary harbor access channel and ship berth development (the “Project”) at the applicant’s Edgemoor property (the “Edgemoor Site”). The Project supports the redevelopment of the Edgemoor Site into a multi-user containerized cargo port.

For the benefit of the regional economy, the Purpose of this project is to maintain and strengthen the State of Delaware’s international waterborne trade capabilities by meeting the rising and evolving demand for modern containerized ports, while electrifying ports operations in accordance with the State of Delaware Coastal Management Program Policy and Procedures. 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 regional, state and local 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.

The need for this Project is driven by the increase in vessel size and draft depth. With the completion of the Panama Canal Lock Expansion, Asia/U.S. trade shipping to the eastern seaboard 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 are known as New Panamax ships, several of which are now already in service. As these New Panamax ships increasingly seek to enter east coast ports, they will inevitably displace the smaller vessels that currently dominate the fleet. Currently, there is not an existing port in the State of Delaware capable of accepting New Panamax vessels. The current Port of Wilmington berths capable of handling containerized cargos are maintained to a depth of 38 ft MLLW. Therefore, container vessels such as New Panamax ships bound for the Port of Wilmington in the State of Delaware would need to be light-loaded (loaded at a reduced capacity) or lightened prior to arrival at the Port. Both options decrease the efficiency and efficacy of operations, putting the Port of Wilmington at a competitive disadvantage.

If Delaware is to meet the increasing demands of international waterborne trade and to continue DSPC’s mission to contribute to the economic vitality of Delaware and the region, Delaware needs to modernize its ports facilities and the ship berths need additional depth to accommodate the larger ships in the fleet.

The Project is located adjacent to and north of the Federal navigation channel, in the southern portion of Reach B of the Delaware River, at the intersection of the Cherry Island and Bellevue Ranges and is offshore of the applicant’s property located along Hay Road, in Edgemoor, Delaware as shown in Figure 1. The Applicant proposes to deepen portions

of the Delaware River adjacent to the Federal Navigation Channel to create primary harbor access that will serve the proposed berth construction at the Edgemoor Site.

The primary harbor access channel will provide access to an approximately 2,600 foot long wharf structure. Proposed construction of the berth and access channel calls for excavation to a 45-foot mean lower low water (MLLW) project depth. The 45-foot MLLW Project depth matches the maintained depth of the Federal navigation channel of the Delaware River. The area to be dredged is approximately 4000 feet in length and a width extending from the boundary of the federal navigation channel to approximately 300 feet offshore of the site at MLLW. The harbor layout and berth grading are shown in project permit drawings titled "Port of Wilmington – Edgemoor Expansion, Permit Plans" prepared by Duffield Associates, LLC (Duffield) dated October, 2019, Revised June 2021. The permit applications include a report titled, Wilmington Harbor, Edgemoor Expansion, and Environmental Assessment Technical Document (EATD)." The EATD included a series of site assessments which document the conditions at the site and evaluate the impacts of the project.

On April 20, 2021, the Applicant received a letter from the USACE stating that based on the review of the Project and supporting documents, comments received during the public comment period, as well as consultation with the resource agencies, a compensatory mitigation is required for the direct loss of approximately 5.5 acres of water associated with the proposed bulkhead filling and 7.5 acres associated with the shading resulting from the wharf construction at a ratio of 1:1 for functions lost to functions compensated. In response thereto, this Preliminary Compensatory Mitigation Plan has been prepared in accordance with 33 CFR 332 and the posted USACE Philadelphia District Regulatory Programs "Mitigation and Monitoring Guidelines", as well as additional input from a number of compensatory mitigation discussions with USACE and the resource agencies. Therefore, this Preliminary Compensatory Mitigation Plan includes three main components:

- A discussion on Design Element to minimize the habitat loss;
- A discussion on Mitigation Project Selection; and
- A discussion on the proposed compensatory mitigation.

In summary, the Applicant proposes a compensatory mitigation with elements that provide for (1) the preservation of existing estuarine habitat near the project site; (2) the restoration of habitat that is currently inaccessible to anadromous fish; and (3) the support of population and restoration studies to be performed by resource agencies in the watershed near the project site.

## **2. Project Impact Avoidance and Minimization**

### **2.1 Adverse Impacts Avoided Through Initial Project Planning**

The initial phase of this Project included the development of a strategic master plan for the Port of Wilmington. This planning evaluated the condition of the current facilities, the economic projections and solicited input from a variety of stakeholders, including port operators, environmental non-governmental organizations, state and local government agencies, community groups and the general public. Several alternatives to modernize the facilities were assessed for the value they offered for expansion and for the environmental impacts that might result from the selection of those alternatives. The document that was prepared as part of this initial phase is included as Appendix 2 of the referenced EATD, and the discussion of alternatives for port expansion in Chapter 5 of that appendix. The alternative sites included:

- Improvements to Existing Port of Wilmington (Alternative 1 and 1A);
- Expansion of the Port along the Delaware River adjacent to the current the existing Autoberth (Alternatives 2B and 2C);
- Development of a new containerized cargo port downstream of the Delaware Memorial Bridge at Riveredge Industrial Park (Alternative 3), in New Castle; and
- Development of a new containerized cargo port at the former Chemours Edge Moor Plant, located in Edgemoor, Delaware (Alternative 4).

In-water work to support Alternative 1 required repair of the existing seven Christina River fixed wharves, demolition of existing buildings interfering with crane movements along the wharves, extending crane rails to berths 6 and 7, reconfiguring areas within the Port to enhance cargo and movements. Some of these improvements have been implemented but are not expected to support the predicted expansion of cargo shipping as they cannot facilitate berthing of the expected new Panamax ships because the available draft of the Christina River (35 to 38 feet at MLLW) remains unchanged and the technical constraints of the Wilmington Harbor limit the viability of channel deepening without significant environmental impacts.

Alternative 1A was illustrated as Figure 5-3 in the EATD Appendix 2 and was used to assess an expansion of the usable inland areas of the Port to accommodate the throughput of additional cargo. For this alternative to work, approximately 51 acres of former Pigeon Point Landfill would have had to be acquired and utilized to store roll-on/roll-off cargo to make room within the existing port for an expanded container yard. The repurposing of Pigeon Point landfill would have necessitated regrading of the top of the landfill and construction of a road around Wilmington Harbor South Confined Dredge Facility (WHS CDF), which would have triggered extensive impacts to the tidal and non-tidal wetlands that extend between Pigeon Point landfill and WHS CDF. These impacts would have far exceeded those contemplated by the Project.

Alternatives 2B and 2C were illustrated as Figures 5-4 and 5-5 in the EATD Appendix 2. Both Alternatives 2B and 2C would have necessitated ceasing the use of WHS CDF for dredge material storage, which in turn would have required construction of another CDF at some other location. Alternative 2B assessed expansion of berthing capacity along the Delaware River with new berths developed in deep water in line with the existing Autoberth. The environmental impacts associated with this alternative would have included decking over or filling most of the shallow subtidal area, and intertidal area located between the Delaware River navigation channel and the existing WHS CDF. The intertidal area along Wilmington Harbor South, approximately 6 acres, was developed as an intertidal wetlands mitigation project by USACE to compensate for the destruction of similar wetlands during the construction of Wilmington Harbor South. The area of shading impact by a pile supported deck would have been approximately 61 acres, far exceeding the impacts contemplated by the Project.

Alternative 2C assessed construction of a marginal wharf along the current shoreline of WHS CDF. Alternative 2C would have required structural modifications to the dike support system of WHS CDF, likely a deep foundation bulkhead along the low tide line to replace the support currently provided by geotextiles that extend beneath the dikes and well out under the Delaware River. The area between the bulkhead and the top of the WHS CDF would be filled. That area would have included approximately 6 acres of the USACE intertidal wetland constructed as mitigation for the construction of WHS CDF. If the bulkhead was moved further inland, the same wetland area would have been removed by dredging. In either case, dredging would have removed the shallow, subtidal and intertidal river bottom to provide ship access to the wharf from the navigation channel. The impacts related to this Alternative 2C far exceed those contemplated by the Project and were likely otherwise not implementable given USACE's already existing mitigation obligations.

The Riveredge Industrial Park site, Alternative 3, was illustrated as Figure 5-6 in the EATD Appendix 2. Alternative 3 would have required excavation (dredging of an access channel, berth area and turning basin) to allow ships to move across the approximately 4,100 feet of shallow water between the navigation channel and the margin wharves along the Delaware River shoreline. The initial estimated area of dredging for the project ranged from 110 to 130 acres, with corresponding volume estimates of 7.5 to 8 million cubic yards. Estimates of annual maintenance dredging ranged from 1 to 2 million cubic yards. Construction of the marginal wharf and container yard along the Delaware River shoreline would have resulted in shading approximately 38 acres of shallow subtidal and intertidal habitats, plus shading or filling approximately 23 acres of tidal wetlands. Construction of truck and railroad access to the wharf would have required the filling or bridging of tidal wetlands. Impacts to tidal wetlands was estimated to be approximately 23 acres. Those wetlands are believed to help support the heronry located on Pea Patch Island, near Delaware City, Delaware. The impacts related to Alternative 3 far exceed those contemplated by the Project.

The Edgemoor Site, Alternative 4, was illustrated as Figure 5-7 in the EATD Appendix 2. Alternative 4 required excavation (dredging of an access channel, berth area and turning basin) to allow ships to move across the approximately 800 feet of water between the navigation channel and the wharves along the Delaware River shoreline. The current estimated area of dredging for the project is on the order of 86 acres, with corresponding volume estimates of 3.3 million cubic yards. Estimates of annual maintenance dredging ranged from 0.2 to 0.3 million cubic yards. Construction of a high deck wharf and bulkhead and container yard along the Delaware River shoreline will result in shading approximately 7.5 acres of shallow subtidal and intertidal habitats, plus filling approximately 5.5 tidal lands. Through the strategic planning process, Alternative 4 was identified as the Project.

## 2.2 Selected Project - Edgemoor Development

### 2.2.1 Adverse Impacts Avoided Through Project Design

The selection of the Edgemoor Site for the Project avoided tidal wetland impacts. The site shoreline currently has been modified with bulkheads, retaining walls and rip-rap armor that fix the extent of high tide penetration of the property. An unvegetated, high energy, intertidal beach is present in most areas between the high tide and low tide lines. The shallow subtidal areas are also void of vegetation likely due to a combination of the highly turbid water which limits light penetration and the exposed, high energy conditions that exist at this location.

The Applicant understood the resource value of Cherry Island Flats as a spawning location for striped bass and selected a design that avoided construction impacts to that area. The Project requires that ships be able to turn (reverse direction) within the project area. As conceived, the radius describing the outer arc of the ship would pass through during a turn was set to coincide with the outer boundary of the navigation channel so that there would be no dredging of Cherry Island Flats.

Optimization of the channel design shifted the wharf structure up river to reduce the impacts to the substrate on the down river end (where the project is further from the channel) and reduced the model sedimentation rates. The channel design also considered alternatives which shifted the bulkhead toward the river; however these alternatives would have required widening of the navigation channel to accommodate the turning basin, and would have resulted in impacts to the Cherry Island Flats. Alternatives which shifted the bulkhead further inland (reducing the shading of the existing river) were also considered, but would have resulted in additional impacts to the legacy environmental impacts that have been remediated on the site (as discussed further in Section 2.2.2) and were not selected.

### 2.2.2 Minimization of Unavoidable Adverse Environmental Impacts

The shoreward location of the proposed bulkhead and landward side of the proposed wharf were constrained by existing environmental conditions within the upland portion of the property. The property is regulated under the Resource Conservation and Recovery Act (RCRA). There are four closed and capped waste lagoons located within the upriver portion of the site. The dikes and caps for two of those former lagoons extend to locations close to the high tide line on the property. In the downriver portion of the site, a closed solid waste disposal area is present behind the existing and failing bulkhead. To avoid disturbing and exposing the wastes stored in the former lagoons and landfill while also minimizing impacts to the aquatic environment, the Project bulkhead location is set at the low tide line near the closed facility. The bulkhead is designed to be linear in order to reduce the abnormal flow and sedimentation that could result from variable flow conditions in a bulkhead, which matches the existing shoreline that result from proposed grade differential of approximately 30 feet. This location minimized the amount of fill that would be placed in the aquatic environment to the unvegetated intertidal beach. The fill improves the long-term safety of the site by providing structural support of the dikes and caps, provides additional buffer between the wastes and the Delaware River, as well as providing resilience against the inevitable sea level rise that is occurring.

The wharf structure is pile-supported to maintain water circulation beneath it. The size of the wharf is minimized to support berthing of two post-Panamax (also called new Panamax) container ships and operation of six cargo gantry cranes that will be used to offload and load the ships. The deck of the wharf was set at an elevation (18 feet North American Vertical Datum) that not only places it above the forecast height of the 100-year flood, it exceeds the height of the storm waves expected during such a storm and the expected rise of sea level during the life of the wharf. This height results in approximately 10 feet of separation between the lower surface of the wharf and the surface of the water at high tide (approximately 15 feet of separation at low tide). This feature, along with the minimization of the size of the wharf, serve to minimize the impact of the shading generated by construction of the wharf.

A portion of the stratum B (sandy) sediments that will be dredged are planned for reuse for the fill to be placed behind the proposed bulkhead. The environmental quality of those sediments is suitable for use within the proposed port. This reuse minimizes the amount of dredged material that requires long-term storage in a dredged material disposal area, which in turn, prolongs the useful life of the dredged material disposal area. It helps to avoid or minimize environmental impacts associated with the construction of a replacement disposal areas.

### 2.2.3 Summary of the Affected Environment

The proposed project is planned to include a discharge of dredged materials to approximately a 5.5-acre area of intertidal environment located along the right descending bank of the Delaware River. The fill will be placed behind a bulkhead installed as part of the Project. The proposed bulkhead will be installed roughly along the existing mean low water location. The jurisdictional fill will extend from the bulkhead landward to the mean high water line. Figure 2 includes photographs providing views of the intertidal area of the site where filling in waters of the United States of America (U.S.) will occur. The fill placed into waters of the U.S. will be granular soil material obtained from an upland source. Project planning anticipates that in-water work, such as pile driving and dredging, will not occur during the anadromous fish spawning migration, including the extended period associated with Atlantic sturgeon spawning.

Per 40 CFR 230 Subpart E-*Potential Impacts on Special Aquatic Sites*, the Edgemoor Site for the Project is not a designated sanctuary or refuge. Further, the area to be filled does not meet the definition of a special aquatic site. No wetlands are present in the area that will be filled, based on a wetlands report prepared in October 2019 and provided as Appendix 9 of the EATD. The area to be filled is not a mudflat. The intertidal beach is composed of sand, gravel, cobbles and detritus. The area to be filled is not vegetated, is not a coral reef, and is not a riffle and pool complex.

The intertidal area waterward of the shoreline retaining structures is a high energy environment typified by an exposed beach that consists of sandy and gravelly materials. No living vegetation has been observed in the intertidal area (or subtidal area) proposed for filling. The beach is subject routinely to wake from passing ships and storm waves. Storm winds in the project vicinity commonly blow from a northerly direction. The fetches to the northeast of the project site extend 2 to 3 miles. No significant historical or cultural resources were identified at the Project site.

The construction will include filling of existing intertidal and subtidal areas, excavation of areas to create subtidal areas as well as the construction of high deck shading and the removal of several areas of shading from historic dock structures that are to be removed. Figure 3 includes detail related to the modifications of site conditions and Table 1 summarizes the project impacts.



Table 1: Summary of Project Impacts

	As Constructed	Area Filled/ Covered	Area Excavated/ Unshaded	Net Change
Intertidal Area	0 acres	5.15 acres	0 Acres	-5.15 Acres
Subtidal Area	86.9 Acres	0.35 Acres	0.1 Acres	-0.25 Acres
Shaded Area	7.5 Acres	7.13 Acres	0.43 Acres	- 6.7 Acres
Net Impact				-12.1 Acres

### 3. Mitigation Site Selection

The Applicant conducted an evaluation of potential mitigation project using a combination of aerial photography and knowledge of restoration initiatives and concepts involving other agencies and organizations. In addition, a mitigation team was assembled to provide guidance and feedback on mitigation concepts. Led by USACE, the mitigation team also included representatives from the National Oceanic and Atmospheric Administration (“NOAA”), the National Marine Fisheries Services (“NMFS”) the U.S. Fish and Wildlife Service, the Delaware River and Basin Commission (“DRBC”), the U.S. Environmental Protection Agency (“EPA”), the National Park Service (“NPS”) and the Delaware Department of Natural Resources and Environmental Control (“DNREC”).

In evaluating potential mitigation projects, the applicant considered on-site and off-site mitigation, the use of mitigation banking credits, whether projects were in-kind or out-of-kind, their feasibility and likelihood of success and feedback from representatives of the state and federal agencies on the mitigation team. As per 33 CFR Section 322, the following factors were taken into consideration by the Applicant while reviewing potential mitigation projects:

- Hydrologic conditions;
- Habitat connectivity;
- Adjacent land uses; and
- Likelihood of success.

Five potential alternatives were initially identified and discussed with the Applicant and then presented to state and federal agencies. Four additional potential projects were then identified during discussions with the resource agencies; shallow water habitat preservation, West Bay Pier Removal, Mussel Restoration in New Castle County Delaware and Brandywine Creek Dam 2 Fish Passage. The sites and projects are discussed briefly below and are indicated in Figure 4.



### 3.1 Onsite Mitigation

Opportunities for on-site mitigation at the Edgemoor Site are precluded for practical considerations. Much of the shoreline will be occupied by infrastructure supporting the proposed port. The Edgemoor Site has historically been utilized for industrial activity for more than 100 years. Areas of shoreline that will not be developed as supporting infrastructure are located near solid waste operable units that were closed under corrective action and are not suitable for on-site mitigation.

### 3.2 Offsite In-Kind Mitigation

#### 3.2.1 Pigeon Point Living Shoreline and Habitat Restoration

This project was identified as its location is immediately adjacent to the Delaware River in proximity to the Edgemoor site. The location downriver of the WHS CDF and has been identified as a depositional area where habitat loss has occurred following shoreline modifications. This project would include the removal of recent sediments to restore the former shoreline with hydrology and ecological design element of a living shoreline. A staggered breakwater near the limit of the shallow water habitat would provide protection to the constructed intertidal and shallow water habitat. The potential area of construction was identified as 15 acres.

Evaluation of this alternative identified risk factors, including the portion of the project with established habitat that would be impacted as well as a multiple land ownership of the target area including federal, state, city and private interests. The Applicant concluded the various ownership issues with the parcels involved would present significant challenges to securing the required approvals to conduct timely on-site construction and significantly hinder the likelihood of success.

#### 3.2.2 Bay West (New Castle) Pier Removal

Three piers owned by Riverview Industrial Park located on the Delaware River, south of the City of New Castle, were identified as possible mitigation projects if one or more of the piers could be removed. Two of the three piers are constructed on fill with one built on wooden piles. The mitigation project would include removal of the pier structures and re-establishment of the natural physical characteristics of the site. The future site protection would include a restrictive covenant preventing future reconstruction of the piers. DSPC estimated the areas of the piers and found the acreage occupied by the piers was approximately  $\frac{3}{4}$  acre.

As part of the assessment, DSPC's representatives contacted Paul Cirillo, a principal/owner of the Riverview Industrial Park, to discuss the possibility of DSPC acquiring and removing one or more of the piers. Mr. Cirillo indicated that all three piers are currently functional, permitted and regularly used by

his business and clients. Mr. Cirillo also indicated he was planning improvements to at least one of the structures and was hesitant to consider any proposal that would result in his business losing access to any of the three piers given the lack of any commercially accessible piers in this area of Delaware.

Considerations -- Estimated areas of the piers showed that the acreage occupied by the piers was .059, .327 and .378 acres, respectively. Given that USACE has indicated that a mitigation ratio of 1:1 will be required to compensate for the impacts from fill and shading totaling more than 12 acres and the owner of the piers in question expressly indicated he was not interested in such a transaction, DSPC concluded that the potential mitigation credit based on acreage of the three piers was too small to warrant actively pursuing the project that has a low likelihood of success.

### 3.2.3 Preservation of Christina River Subaqueous Lands

The preservation of in-kind habitat (intertidal and shallow water habitat) in the vicinity of the project site was identified as a potential mitigation through discussions with the resource agencies. The Delaware shoreline of the Delaware and Christina Rivers in the vicinity of the project site have experienced similar industrial development generally consisting of an intertidal area along a constructed shoreline dating to the mid-20<sup>th</sup> century, when the dredge disposal at the Cherry Island facility commenced, as described in the project Cultural Resources Survey included as Appendix 21 of the EATD. The Applicant identified a potential preservation area along the northern bank of the Christina River.

The Christina River flows into the Delaware River southeast of the City of Wilmington with the mouth of the river bounded by the Port of Wilmington to the South and the Cherry Island facility to the north. Tributaries of the Christina River include the White Clay, Red Clay and Brandywine Creek. Anadromous fish that utilize the tributaries for foraging, spawning and nursery areas must pass through the Christina River and the Port of Wilmington to and from the Delaware River.

The Applicant has identified subaqueous lands on the northern bank of the Christina that contain intertidal and shallow subtidal habitation that could be subject to permanent protection through the establishment of a conservation easement or restrictive covenant to be placed on the property.

Considerations -- Legal title to the subaqueous lands is controlled by the Applicant. The Applicant is not aware of any third-party easement right on the land in questions but will conduct a full title search prior to the Submission of a Final Compensatory Mitigation Plan.

The preservation mitigation project would protect similar migration and foraging habitat of anadromous fish and sturgeon identified by the resource

agencies as the project impacts. Additionally, the preservation mitigation project would prevent the additional placement of permanent fill, or the placement of structures which may reduce the function of the habitat in the future. The preservation mitigation project on the Christina River preserves one bank of the Christina River to fish migration unimpeded by the dock structures and shading which exist currently on the southern bank of the river as well as the associated intermittent shipping traffic in the navigation channel.

#### 3.2.4 Fox Point State Park Wetland Enhancement and Habitat Creation

This proposed mitigation project was identified through discussion with the State of Delaware as a potential mitigation to support DNREC subaqueous permitting. The Fox Point State Park is contiguous to the project site, upriver from the project site. The Park was created through filling activities performed along the Delaware River shoreline<sup>1</sup>. Historical aerial photos for the Site dating back to 1954 document the filling activities as well as the condition of the site prior to filling. This generally consisted of aquatic river habitat, and the placed fill material acted in the creation of the upland area that is the park today. The fill reportedly includes a variety of materials, principally dredged material from the Delaware River underlain by steel-making slag, bricks, timber, waste ingots, and ash furnace dust, in addition to miscellaneous trash and debris<sup>1</sup>.

Along the upriver end of the park, a low-lying area that is separated from the Delaware River by a constructed revetment has been overgrown with phragmites. The area has been identified as a potential for fill removal to restore the historic use of the site as intertidal land with habitat.

Considerations – The shoreline along Fox Point State Park is substantially similar to the substrate impacted by the project and would provide the opportunity to restore habitat proximate to the project site similar to the Edgemoor project, with the additional benefit of providing wetland plantings to enhance the potential nursery and forage habitat.

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<sup>1</sup> Integral Consulting, Inc. (2019). “Remedial Investigation Report for Fox Point State Park Phase II Operable Unit (DE-1011)”.

### 3.3 Offsite Out-of-Kind Mitigation

#### 3.3.1 Fox Point State Park Shoreline Stabilization

This proposed mitigation project was identified to provide stabilization of the shoreline near Fox Point State Park north of the Edgemoor Site where impacts would be occurring. The stabilization would require measures to sustain strong currents and high energy environments that could stabilize slopes and sustain minor damage without affecting structural integrity of the project elements.

Considerations -- Federal agencies raised concerns about this site as it would likely require disturbance of existing intertidal habitat and filling of subaqueous lands, which is not a preferred approach for compensatory mitigation projects. Delaware DNREC expressed an interest in potential enhancements to the Fox Point State Park, which is very much utilized and valued by the local community near the Edgemoor Site. As a result, Delaware DNREC is considering a mitigation plan that includes for wetland and upland enhancements to the Fox Point State Park to fulfill the state mitigation requirements. The upland and recreational improvements proposed in this plan are not being submitted as part of the Preliminary Compensatory Mitigation Plan. Elements related to wetland improvements have been summarized in Section 3.2.4.

#### 3.3.2 Christina River Wetlands Restoration

This proposed mitigation project was identified due to its location within the Delaware River watershed and the previous restoration and mitigation projects associated with DNREC's Northern Delaware Wetlands Rehabilitation Initiative that included the Old Wilmington Marsh known today as the Peterson Wildlife Refuge. The area is located at the southern portion of the Riverfront area of Wilmington near the DuPont Nature Center. The evaluation identified a 15 acre parcel within the bank where restoration could potentially occur.

Considerations -- Discussions with the resource agencies indicated that while this project would be considered for the benefits provided to water quality, the construction of wetland would provide limited offset to the intertidal and shallow water habitat impacts to anadromous fish. In addition, discussions with DNREC indicated that restoration of many of the sites had already occurred and there was additional funding dedicated to future restoration at the Wilmington site, limiting the need for further restoration efforts.

#### 3.3.3 Pea Patch Island Shoreline Stabilization and Habitat Restoration

Pea Patch Island is located in the Delaware River near Delaware City and is home to Fort Delaware State Park and a rookery for numerous species of wading birds. A seawall constructed by USACE on the easterly side of the island has provided significant protections from the wake created by shipping

traffic utilizing the nearby navigation channel. However, erosion still threatens intertidal shoreline and tidal wetlands along the southern shore of the island near the dock area that serves the ferry for park visitors and supplies. This potential mitigation project identified the need for shoreline stabilization and creation for shallow water habitat.

Considerations -- Concerns for this proposed mitigation project were identified by the resource agencies because it would likely require filling of subaqueous lands, which is not a preferred approach for compensatory mitigation projects.

#### 3.3.4 White Clay Creek Dam #3 Removal

The removal of White Clay Creek Dam 3 was identified as a proposed mitigation project due to the positive impact that could result for anadromous species such as American shad, hickory shad and river herring, which are species of concern for the federal agencies. Removal of the dam would allow access for migratory fish to spawning and nursery habitat on the White Clay Creek, above Dam 2. Dam 1 was removed in December 2014 along the White Clay Creek, which has been designated as a Wild and Scenic River under the National Park Service.

Considerations -- Previous fishery surveys indicated a significant population of shad below Dam 1 prior to its removal. Limited, subsequent sampling has not consistently confirmed the presence of significant numbers of shad above Dam 1 raising questions about the shad populations in the Creek and efficacy of fish passage of the Dam 1 location due to shallow depths and sediment, especially during low tides. Additionally, the timing associated with the proposed Dam No. 2 and Dam No. 4 removal projects, which are currently in design, was identified as a risk factor. Therefore, the mitigation project has not been identified as a project that would have strong likelihood of success.

#### 3.3.5 Mussel Restoration Delaware River Watershed

The Partnership for the Delaware Estuary (PDE) was contacted to assist in identifying any potential mitigation projects that could be suitable for mitigation. PDE has partnered with numerous organizations to implement shoreline and habitat restoration and enhancement projects within the Delaware watershed. Dr. Danielle Kreeger, Science Director for PDE, provided a summary proposal titled for The Mussels for Clean Water Initiative – Concept Proposal for New Castle County, Delaware. The proposal, which could be scalable based on the number of sites, animals, species of mussels and monitoring, focused on restoration of mussels in Red Clay Creek, White Clay Creek and/or the Christina River. These systems are currently devoid of mussel populations, although pilot studies have indicated that conditions are suitable to sustain mussel populations if reintroduced but only in areas protected from storm water. The project would involve growing mussels in

hatchery for 1-2 years, restocking in years 2-3 and multi-species augmentation in years 3-4. Project performance measures are based on water quality enhancements due to the mussels' filtering of water and removal of total suspended solids, nitrogen and phosphorous.

Considerations -- This project appears better developed for mitigation for water quality impacts than loss of habitat. In addition, the uncertainty survivability of the mussels and time frame associated with full implementation suggests that the project would not be suitable as compensatory mitigation.

### 3.3.6 Brandywine Creek Dam 2 Fish Passage

Brandywine Creek Dam 2 was identified as a potential mitigation project through discussions with the resource agencies as it currently prohibits fish passage for both resident and migratory species including American shad, hickory shad and river herring. Dam 1 was removed by the City of Wilmington in 2019. A non-profit agency (Brandywine Shad 2020) commissioned a feasibility report<sup>2</sup> to support passage or removal of a series of dams on the Brandywine Creek. The Applicant also discussed the operational requirements for Dam No. 2 with the City of Wilmington. Based on these discussions it is understood that removal of Dam 2 is not practical at this time as it provides the mechanism for the City of Wilmington to obtain supply for its potable water needs. However, fish passage can be created through the construction of a rock weir nature-like fishway on the face of the dam. The resource agencies expressed significant interest in this proposed mitigation project and the Applicant conducted a Feasibility Assessment.

Three Alternatives were identified to provide fish passage at Dam No. 2 in the Feasibility Assessment. They included a denil technical fishway, natural bypass channel and a full-width rock weir nature-like fishway. The nature-like fishway is considered to have a higher effectiveness to fish passage and is considered the best available technology for this impendent at this time. Design alternatives which do not include a full -width downstream entrance are considered to have reduced effectiveness due to attraction limitations.<sup>1</sup>

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<sup>1</sup> Brandywine River Dams 2-6, Engineering Feasibility Assessment and Fish Passage Alternatives Analysis, Kleinschmidt, March 31, 2021

Considerations -- Brandywine Shad 2020 is a non-profit and consortia of organizations, including the University of Delaware Water Resources Center, whose goal is to restore fish passage to the Brandywine Creek. It has obtained funding from the National Fish and Wildlife Foundation and other sources to support its goal and, among other activities, has submitted applications to the USACE and DNREC seeking approvals for removal of Dam 4. Dam 3 is partially breached and a 2020 feasibility study concludes that the breach is sufficient to allow fish passage. Young of the year shad were found below Dam 2 in 2020 sampling. The creation of the rock ramp represents an off-site, out of kind project that would restore access to habitat that is suitable for compensatory mitigation.

It should be further noted that the City of Wilmington residents who utilize the park and depend on the water infrastructure also constitute the citizens that would be impacted by the Edgemoor Expansion. The community will also provide the work force that will benefit from the economic impact of the project. A letter from the Mayor of the City of Wilmington that supports this project for consideration as mitigation for the Edgemoor project and verifies the commitment of the City of Wilmington to partner with the Applicant to implement and maintain this project has been enclosed as Appendix A.

#### 3.3.6 Establishment of a State of Delaware Environmental DNA Program

The Applicant is proposing to fund monitoring and research activities to be performed by Delaware DNREC in the immediate and regional areas through the use of eDNA sampling and analysis. Monitoring activities will help evaluate and understand potential impacts of the dredging project on resident and transient fish species that use this portion of the Delaware River. It is well documented that the DSPC expansion project area is considered essential habitat for recreationally and commercially valuable species. As such, the Applicant will provide the funding for the purchase of the necessary sampling and analytical equipment to allow for an expansion of the DNREC Environmental Laboratory Section's (ELS) existing eDNA monitoring capabilities. In addition, the Applicant proposes to fund expanded eDNA sampling activities in the Delaware River to monitor state and federal public trust species. The sampling activities will be conducted by DNREC's Division of Fish and Wildlife (DFW) Fisheries Section and/or by DNREC's Division of Water (DW) Environmental Laboratory Section (ELS) for the three years (cycles) of dredging that are anticipated for the Port of Wilmington Expansion Project. In addition, sampling activities will be conducted in other areas of the state, not related to Port construction, to assist in ongoing research activities and to assist in the identification of potential future habitat restoration and enhancement projects. The Applicant will fund up to \$750,000 towards the activities described above.

Considerations – This mitigation project has the benefit of expanding the knowledge of the regulatory and technical communities on the condition of the

Delaware River fisheries with technologies that have not currently been widely utilized in the State. Additionally, the project provides capital investments in equipment to support continued monitoring by the State of Delaware at a reduced funding level. This project also informs these communities on the cumulative impacts of the Delaware River development as well as provides data on the endangered species which are present in the vicinity of the project site but may not utilize the potential intertidal habitat or other mitigation projects.

### 3.4 Fee-In Lieu or Mitigation Bank

The Applicant is not aware of an approved mitigation bank or an approved in-lieu fee program within service area of the proposed project. A review of the Regulatory In lieu fee and Bank Information Tracking System (RIBITS) for the USACE Philadelphia District did not yield any suitable potential projects. The Applicant is not proposing to establish either an in lieu fee program or mitigation bank.

## 4. Selection of Mitigation Project

The Applicant considered the type and location of the appropriate compensatory mitigation under 33 CFR Part 332.3 (b) and reviewed the potential projects with the resource agencies as described in Sections 3.1 – 3.4, and evaluated the risk associated with the implementation and the likelihood of successes. This review includes input from USACE and the resource agencies through the evaluation phase. The selected projects represent a permittee-responsible mitigation both in-kind mitigation and out-of-kind with a watershed approach under the American Shad Habitat Plan for the Delaware River, as well as support of resource agencies efforts to monitor the fisheries on the Brandywine Creek.

The American Shad Habitat Plan for the Delaware River was approved May 5, 2021 in response to the Atlantic States Marine Fisheries Commission's (ASMFC) Amendment 3 to the American Shad and River Herring Fishery Management Plan. The Plan was prepared by the Nature Conservancy for the Delaware River Basin Fish and Wildlife Management Cooperative comprised of the Delaware Division of Fish and Wildlife, New Jersey Division of Fish and Wildlife, Pennsylvania Boat Commission, New York State Division of Fish, Wildlife and Marine Resources, US Fish and Wildlife Service and National Marine Fisheries Service. In addition to the plan, ASMFC has also published Life History and Habitat Needs documents for American Shad, Hickory Shad and Atlantic Sturgeon, which were identified as species of concern though the consultation with USACE and the resource agencies along with River Herring and Striped Bass.

### 4.1 Fox Point State Park Wetland Enhancement and Habitat Creation

Fox Point State Park is located adjacent to the proposed project location along the Delaware River and provides an opportunity to develop environmental improvements in the immediate area where impacts will occur from construction of the Port of Wilmington expansion. The design will create intertidal habitat and wetland area



including features to provide productive foraging habitat for native fish species as well as habitat for other aquatic species.

The design calls for the removal and treatment of the invasive plant phragmites from a one-acre site that will be excavated down to appropriate elevations to provide intertidal interaction and hydrology creating a range of habitat communities from deep to shallow and emergent intertidal wetlands. Portions of an existing revetment will be removed to facilitate intertidal flow to the wetland area and provide access to the wetland habitat for aquatic species. The location of the project is in an area of the Delaware identified as essential fish habitat for recreationally and commercially valuable species and critical habitat for endangered species.

The creation of an intertidal wetland serves as an in-kind, offsite mitigation project to compensate for the filling of intertidal area as part of the construction of the proposed container port at Edgemoor. The project is also being proposed to satisfy State of Delaware mitigation requirements.

#### 4.2 Brandywine Creek Dam 2 Fish Passage

The ASMFC identifies dams and other obstructions as a threat to the habitat of the species of concern identified by the resource agencies. The American Shad Plan for the Delaware River specifically defines Brandywine Creek Dam No. 2 as a relevant barrier. While practical constraints (the City of Wilmington Water Intake) prevent the removal of the dam at this time; a rock weir, nature- like stream constructed downstream of the dam would restore access to the upstream habitat to anadromous fish. This action is suitable as an off-site, out-of-kind mitigation and has increased consideration through the watershed approach. A figure indicating the habitat area has been included as Figure 8.

The project is appropriate mitigation as it is located within the Delaware River watershed. It suitably replaces the lost functions and services caused by the impact of the loss of habitat due to the filling of the intertidal and subtidal land along the Delaware River to backfill the proposed bulkhead and for shading of habitat from the high deck. The mitigation project impacts habitat that is used as a nursery and foraging area for a variety of species, several which are in decline due to habitat loss; specifically river herring, striped bass, and American shad. The mitigation project will restore fish passage and access to approximately 12 acres of shallow and

deeper water spawning and nursery habitats on the Brandywine Creek that have been inaccessible to anadromous fish for nearly 200 years. These points are further explored in Section 5.

The American Shad Habitat Plan states the Brandywine Creek historically supported very large shad runs. Young of year shad were found below Broom Street Dam (No. 2) in 2020 sampling. It notes that dam removals and fishways are planned for remaining 10 dams. Finally, the American Shad Habitat Plan acknowledges the assessment and planning work of Brandywine Shad 2020.<sup>3</sup>

#### 4.3 Brandywine Creek Fisheries Sampling Support

The Applicant is proposing to supplement fish population survey data through support of DNREC Fisheries Section and the University of Delaware for sampling beyond monitoring associated with performance measures to assess effectiveness of fish passage. Supplemental sampling is expected to be conducted for up to 10 years in order to collect data on both anadromous and resident species. Data collected will inform future updates to and implementation of the American Shad Habitat Plan.

Sampling beyond the monitoring associated with the verification of fish passage at Dam 2 may include:

- Utilization of recreational anglers to collect adult shad located below Dam 2 and above Dam 4 (once removed) for tagging with Passive Integrated Transponders;
- Electrofishing up to two days/week to supplement recreational angler success to provide sufficient tagged fish for an effective data set;
- The construction of additional monitoring points down river of Dam No. 2 and upriver of Dam No. 4 to monitor migration patterns; and
- Juvenile sampling conducted by haul sein at various locations on the river to monitor effectiveness of regional efforts.

With this mitigation proposal, the Applicant will provide funding support to DNREC, the University of Delaware or identified Non-Profit groups for labor and equipment. DNREC and the agencies will perform data analysis and publicly report annually independent of the monitoring reports prepared for agency submission.

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<sup>3</sup> The American Shad Habitat Plan Approved May 5, 2021

#### 4.4 Establishment of the State of Delaware eDNA Monitoring and Research Program

The applicant is proposing to provide financial support for an environmental DNA monitoring and research program that will be implemented by DNREC. Monitoring activities will help evaluate and understand potential impacts of the proposed project on resident and transient species that utilize the area around Edgemoor. The support will also fill a number of immediate needs identified by DNREC associated with challenges of collecting fisheries data from around the state using traditional sampling techniques and equipment.

The data collected during this three-year project will be vital for state and federal fisheries managers to mitigate impacts from dredging, water withdrawals, shoreline stabilization projects, development of breakwater structures and other possible future perturbations within the Delaware River. The results of this study will also be used to guide the DNREC-DFW time-of year restrictions that reduce anthropogenic impacts on sturgeons (and other species). The eDNA monitoring for river-resident juvenile Atlantic Sturgeon and migratory adult Atlantic Sturgeon in the Delaware River will provide a better understanding of habitat use within the Delaware River Estuary and provide guidance for traditional sampling efforts to evaluate changes in the location of nursery habitat.

### 5. Determination of Credits

The Applicant proposes to fill approximately 5.5 acres of an intertidal area at the Edgemoor Site for the purposes of backfilling a proposed bulkhead as part of the Project. As a result, USACE is requiring compensatory mitigation to offset a loss of 5 acres of shallow water habitat. In addition, USACE is requiring compensatory mitigation for construction and shading from the proposed wharf for impacts to approximately 7.5 acres of shallow habitat used as nursery and foraging area for a variety of species, several of which are in decline due to habitat loss; specifically river herring, striped bass and American shad. USACE has determined that mitigation is being required on a 1:1 basis.

Project construction will include the removal of several existing historic dock structures that have caused areas of shading. The area that will be uncovered as a result of removal of these structures is approximately .43 acres. Applying this .43 acres to the required 7.5 acres to be offset results in a net area of 7.13 acres. The total net area to be mitigated is 12.1 acres.

#### 5.1 Credits for Fox Point State Park Wetland Enhancement

The Fox Point State Park intertidal habitat creation and wetland restoration is proposed to create 1.1 acres of intertidal land. A mitigation ratio of 1:1 was used to compute credit for the creation of intertidal lands, wetlands, and mudflats. Intertidal habitat will be planted to sustain a mixture of vegetated wetland and mudflat. Summing the components of intertidal acreages, the proposed mitigation credit for the Fox Point habitat project is 1.1 acres.

## 5.2 Credits for Dam 2 Fish Passage

The proposed mitigation includes the construction of a full width rock ramp to facilitate fish passage of Dam 2 on Brandywine Creek. Dam 3 is located approximately .5 miles above Dam 2. Dam 3 has been partially breached and surveys have indicated that fish passage could occur under current conditions. Dam 4 is located approximately .3 miles above Dam 3.

USACE Regulatory Guidance Letter (RGL) No. 18-01: Determination of Compensatory Mitigation Credits for the Removal of Obsolete Dams and Other Structures from Rivers and Streams addresses the applicability of projects “to restore river and stream structure, functions and dynamics.” The construction of a rock weir fishway provides fish passage functionality and restores the functional use of the stream habitat in the area between the existing Dam 2 and the next impediment, Dam 4.

The restoration of fish passage also supports federal and state goals for the recovery of diadromous fish. Given the close proximity of the habitat area between Dam 2 to Dam 4, the likely spawning and nursery habitat and the presence of American shad below Dam 2 since removal of Dam 1, full value on an acre for acre basis should be applied to the restored function of the stream habitat.

The habitat area of the creek between Dam 2 and Dam 4 is approximately 12.55 acres and includes a combination of pool/run area habitat and riffle area habitat, which are available as spawning and nursery areas. The area of quiescent pool and run water is estimated at 9.38 acres and the area of turbulent flow/riffle water is estimated at 2.49 acres. There is also a stagnant water area upstream of Dam 3 with 0.68 acres of pool water with minimal flushing at normal flow. Additionally, the rock pools with all of the protected pore spaces created as part of the rock weir fishway should provide enhanced benthic habitat compared to the boulder and bedrock habitat currently found at the area immediately below Dam 2.

Using USACE’s 1:1 ratio for mitigation, the restoration of fish passage at Dam 2 with the associated access to both pool/run and riffle habitat areas on Brandywine Creek located between Dams 2 and Dam 4, the Applicant should receive full credit on a per acre basis for the 12.57 acres of habitat.

## 5.3 Credits for Support of Fish Studies

The applicant proposes to provide funding for DNREC fishery monitoring and research programs through support of an environmental DNA and conventional fishery management data collection along the Brandywine Creek and in the area proposed for construction of the Port expansion project. Funding for the eDNA program will include both sampling and the purchase of sampling and analytical equipment to help sustain the program. Data collected will help inform future resource management decisions. The cumulative expected positive benefits of enhanced monitoring and data collection does not provide an ecological function enhancement but deserves

consideration as an indirect benefit to the aquatic resources associated with the Delaware River and its tributaries.

#### 5.4 Calculating Credits

The intertidal habitat created at the Fox Point State Park will offset 1.1 of the 5.0 acres that will be lost to fill of an intertidal area.

The remaining 3.9 acres required for offsetting the fill of an intertidal area result from the access to 12.57 acres of habitat created from the establishment of fish passage through the rock ramp fishway.

Mitigation for the 7.13 acres of impacted area resulting from construction and shading comes from the 8.67 acres of habitat remaining from applying 3.9 acres to offsetting impacts from fill. The application of credits in this manner results in an excess of 1.55 acres that is also considered part of the proposed mitigation, with the additional consideration of the cumulative benefits provided by the support of the regional fisheries efforts noted in Section 5. 3.

Table 2: Mitigation Credit Summary

Net Impacts for Mitigation	Mitigation Credits
5.0 acres for fill impacts	1.1 acres intertidal wetland habitat
	2.49 acres accessible riffle stream habitat
7.13 acres for shading/construction	9.38 acres accessible pool and run stream habitat
	0.68 acres of pool habitat (stagnant)
12.1 acres total	13.65 acres total

#### 5.5 Conclusion

Impacts from the loss and reduced function of 12 acres of intertidal area of the Delaware River at Edgemoor are more than compensated for through:

- The establishment of a rock ramp fishway on the Brandywine Creek that provides fish passage for American shad and river herring as well as resident species and access to more than 12 acres of spawning, nursery and foraging habitat; and
- The establishment of an approximately 1.1 acre intertidal habitat with wetland sat Fox Point State Park along the Delaware River; and
- Funding support for a DNREC environmental DNA monitoring and research program for areas around the proposed Edgemoor expansion site; and
- Support for fishery monitoring efforts on the Brandywine Creek, beyond the monitoring efforts related to the rock ramp fishway.

The Applicant understands that the benefit of both eDNA and traditional fishery monitoring programs cannot be evaluated by applying a value in acreage as may be appropriate for determining credits assignable to the restoration of habitat. However, the Applicant believes that the sum of the direct and indirect benefits of this Preliminary Compensatory Mitigation Plan offset the impacts from the effects of filling and shading intertidal areas at the proposed project site.

## **6. Site Protection Instrument**

### **6.1 Fox Point State Park Wetland Enhancement**

The site is owned and managed by the State of Delaware through DNREC's Division of Parks and Recreation whose charge according to Delaware law is to "plan, develop and maintain all areas entrusted to its administration as to preserve in every reasonable degree the scenic, historic, scientific, prehistoric and wildlife values of such areas." Public activities and access are limited through regulations administered by DNREC. Once the wetland is created it will be subject to protection under state and federal law.

The Site is currently under an environmental covenant that restricts most earth disturbing activities onsite without the written approval of Delaware DNREC.

### **6.2 Brandywine Creek Dam No. 2 Site**

The Site is owned by the City of Wilmington and includes Dam 2 and the associated water supply and wastewater infrastructure located at the site. Adjoining lands on both the north and south banks of Brandywine Creek are owned by the City of Wilmington. Brandywine Park, owned by the City of Wilmington and managed by the Delaware DNREC, is located on the north side of the Creek.

The Applicant has included as Attachment A a letter from Wilmington Mayor Michael Purzycki expressing his support for the Port of Wilmington expansion at Edgemoor and his commitment to work with DSPC to include development of the appropriate agreements for implementation, maintenance and protection of the nature like fishway project while assuring that the City water supply infrastructure associated with Dam 2 is maintained.

## **7. Baseline Information**

### **7.1 Fox Point State Park Wetland Enhancement**

The use of the site as an area for placement of industrial fill, the environmental assessment and associated remediation activities through its use as a County Park and cleanup and conversion to what is now Fox Point State Park are well documented, largely through the remedial action plan<sup>1</sup> records. Those records will be relied on to determine the extent of any further site assessment in the area identified for wetland creation and will be more fully detailed in the final plan. The intertidal creation area and wetland has been documented by the U.S. Fish and Wildlife Service (USFWS)

wetland mapper as consisting of Palustrine, Emergent, Phragmites australis, Seasonally Flooded (PEM5R) as indicted in Chart 1: US Fish and Wildlife Mapping Chart. This is consistent with the visual indications of overgrown phragmites. The State of Delaware does not map the area as regulated wetlands.



*Chart 1: USFWS Wetland Mapping*

A preliminary wetland delineation of the project site was performed on October 13, 2021, and is indicated in the existing conditions plans included in Appendix B. Additionally photographs of the existing conditions are also included in Figure 5. Based on the visual review of the area, the northern end of the site appears to receive tidal flow at extreme high tides, which is consistent with the survey information. The bulk of the area contains shallow areas of stagnant water (as seen in the site photographs in Figure 5. Based on the relative elevations in the survey, this stagnant water appears to be primarily supported by runoff from the surrounding

uplands with site grading that currently prevents effective drainage. The applicant evaluated the existing conditions of the area surrounding the wetland enhancement areas and established a preliminary score of 15 in accordance with the State of Delaware Rapid Assessment Procedure (DERAP)<sup>4</sup> resulting in a value category of limited.

As part of the site assessment, the Applicant worked with the State of Delaware DNREC team to identify and evaluate an appropriate reference site for the enhancement work. An appropriate reference site for the proposed mitigation would consist of a naturally occurring intertidal wetland located on the Delaware River. Reference sites should be of higher quality wetlands which have good diversity and limited invasive species cover. Our team identified the below criteria that is desired for the appropriate reference site:

- Intertidal wetland
- Experiences riverine conditions (high turbidity)
- Low invasive species cover (<10%)
- DERAP score of greater than 30
- Within the Delaware River Terraces and Uplands Level III Ecoregion

It is noted that the shoreline in the immediate vicinity of the enhancement site is highly industrialized and has been entirely modified from its natural condition. Accordingly, an appropriate reference site on the Delaware River within 1 mile of the project site was not identified. Additionally, there are numerous healthy wetland areas that have been restored or protected from the tidal energy of Delaware River that, while not appropriate reference sites, are an indication that appropriately designed intertidal wetlands can be constructed in this section of the Delaware River.

To identify an appropriate reference site, the evaluation process identified numerous natural shallow intertidal wetlands along the coastline, many of which were dominated by invasive species such as phragmites, making them less desirable as reference sites. However, through an extensive review process, a reference wetland site meeting the desired reference criteria was located. The selected reference site for this project is a natural wetland area located in New Castle, Delaware,

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<sup>4</sup> Duffield Department of Natural Resources and Environmental Control “Guidance for Rating Wetland Values in Delaware Version 1.1, September 2014.



approximately 11 miles south of the enhancement area. The reference site is indicated in Figure 6 and depicts a wetland area which is protected from the river energy with a beach and has a tidal access point with established flow channels to permit tidal exchange. The site experiences river conditions (e.g. tidal range within the turbidity maximum of the river). The site was observed to consist primarily of wild rice; with limited areas of phragmites around the perimeter as indicated in Figure 7.

## 7.2 Brandywine Creek Dam No. 2 Site

The man-made impediments on the Brandywine Creek restrict the natural migration of anadromous fish. The goal of restoration of access to the Brandywine Creek habitat has been well documented. The current efforts to restore the Brandywine Creek date to a 2005 feasibility study<sup>5</sup> performed by the Brandywine Conservancy, which expanded efforts to restore fish passage in the 1980s. These efforts were then reinitiated in 2016 by a group led by the University of Delaware and the Nature Conservancy<sup>6</sup> which now includes Brandywine Shad 2020, a collaboration of educational organizations, non-profits, governmental agencies, and private citizens with the primary objective of restoring American Shad and other migratory fish to the Brandywine Creek.

The Brandywine Creek flows from southeast Pennsylvania into the Christina River in Wilmington Delaware. Due to the fall of the creek and the proximity of the creek to the industrial center of Wilmington, more than 100 mills and dams were constructed along the Creek to support manufacturing in early America. Currently, 11 dams remain on the creek which restrict fish migration. Historically, technical fishways have been constructed at several of the Brandywine dams, including Dam 2; however these fishways have been damaged beyond repair and their effectiveness was not fully documented. Dam 1 was removed in 2019 and Dam 2 is currently the downstream impediment.

The removal of Dam 1 included the lowering of a sanitary sewer force main within the dam that provided the restoration of 11.5 acres of creek habitat to anadromous fish. Young of the year studies performed by Delaware Sea Grant in 2020<sup>7</sup> demonstrated that in the year following the dam removal, spawning occurred in the

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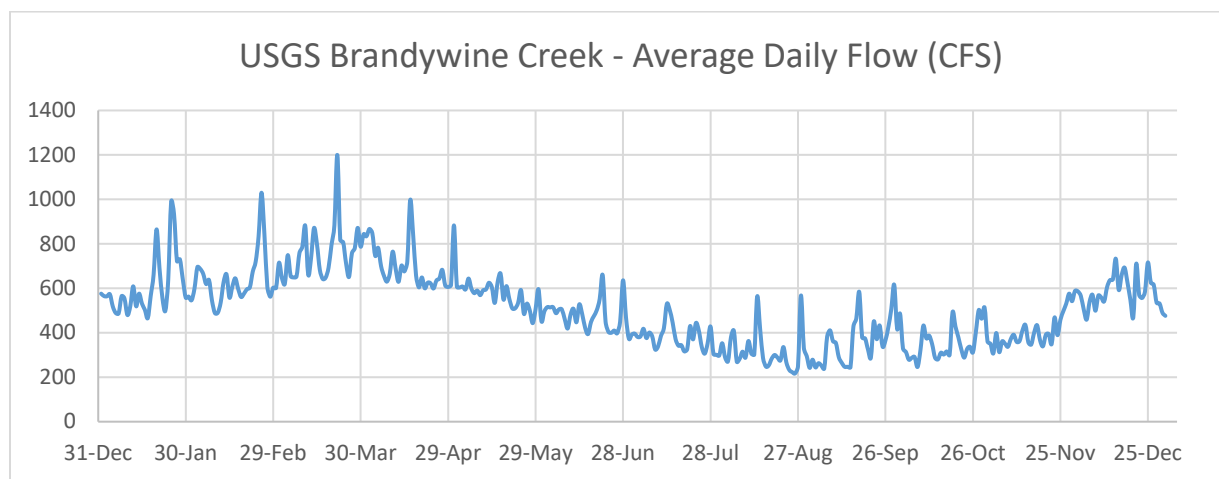
<sup>5</sup> The Restoration of American Shad to the Brandywine River, Brandywine Conservancy 2005

<sup>6</sup> Brandywine Creek Shad Restoration Project, April 2016

<sup>7</sup> Annual Report Examining the Recovery of Diadromous Fishes in the Brandywine Creek DE, 2020

pool area at the base of Dam 2. The sampling program identified a series of resident species up river of Dam 2, but did not observe the presence of the primary target species during the seven sampling events.

The reach of the creek where Dam 2 is located is characterized by the USGS Tide Gauge at Rising Sun Bridge (approximately 9200 feet upstream of the dam). The flow of the creek has been in place since 1946 and provides established flow characteristics as indicated in Chart 2.



*Chart 2: Brandywine Creek Tide Gauge 1946-2020*

The average daily flows demonstrate that through the migration season, typical flows in excess of 500 cubic feet per second (cfs) are anticipated. Typical weirs in fish passage systems are constructed to pass 20 to 30 cfs depending on the design depth and width. Based on these anticipated flows, a system with four weirs can be detailed to maintain flow during the migration period.

The Dam 2 impoundment provides water supply for the City of Wilmington residents through a raceway built into a dam and a pump station upriver of the dam at the western end of the pond area. The sediments accumulated behind the dam have been tested by DNREC Watershed Approach to Toxics Assessment and Restoration (WATAR) Team, and the cultural resources team and the University of Delaware Center for Historic Architecture & Design are performing a survey of the dam structure. The Applicant will perform additional studies and consultation as outlined in Section 8.

## **8. Work Plan**

### **8.1 Fox Point State Park Wetland Enhancement**

The primary goal of the project is to create an intertidal habitat with hydraulic connection to the Delaware River with functional wetland habitat to provide foraging and nursery habitat to the species impacted by the Project.

The preliminary intertidal wetland mitigation plan consists of the removal of fill that has been placed by others to restore the area to tidal flow and construct intertidal wetland habitat within the footprint of the existing 1-acre phragmites stand. The invasive phragmites (and any other invasive species) will be removed and treated within the Site, and the 1-acre area will be excavated down to appropriate elevations to provide intertidal interaction and hydrology. High tide water depths are proposed to vary between 2.0 and 3.5 to provide a range of habitat communities going from deep to shallow and emergent intertidal wetlands.

The tidal flow will be provided by excavating through portions of the existing revetment along the northern portion of the park which had been constructed, by others, to contain the fill that is to be removed during the wetland construction. The excavation and grading within the wetland area and revetment removal will restore intertidal flow to the wetland area and provide connection to the river and access to the wetland habitat to the marine species of the river. The connection is proposed to be located in the portion of the existing revetment where the limited tidal connection currently exists.

Following invasive species removal and associated excavation, the wetland area will be stabilized with coir matting and will be planted with native emergent wetland plants. Plant species and locations will be selected based on anticipated water and tidal depths in the wetland as appropriate, and are anticipated to include:

- Wild Rice (*Zizania aquatica*)
- Small Saltmarsh Spikerush (*Eleocharis parvula*)
- Chairmakers Bulrush (*Schoenoplectus pungens*)
- Pickerelweed (*Pontederia cordata*)
- Rice Cutgrass (*Leersia oryzoides*)
- Flatsedge (*Cyperus* spp.)
- Switch Grass (*Panicum virgatum*)
- Sharp-fruited Rush (*Juncus acuminatus*)
- Rose Mallow (*Hibiscus moscheutos*)

These species are consistent with the reference site which is primarily Wild Rice. The preliminary design included as Appendix B will be further developed to incorporate any relevant findings from the existing design investigation and supplemental site studies and feedback from the project stakeholders. The design will restore intertidal wetland habitat and include features to provide productive foraging habitat for native fish species as well as habitat for many other aquatic species which have been impacted by the proposed Edgemoor project.

This design will incorporate our team's knowledge of viable Delaware River shoreline and intertidal marsh wetland management practices, and principles of wetland functional design to create a restored site with diverse habitat and minimal invasive species. This restoration project will be designed to be resilient to fluctuating water levels and storm surge events and will incorporate recommendations and guidance

provided by project stakeholders. The restoration plan will feature native plant communities historically present in the area and have an overall landscape aesthetic suitable for this prominent location along the Delaware River.

The intertidal wetland design development addresses the following:

- Potential to improve fish and wildlife habitat,
- Fluctuating water levels associated with the tidal influence on the Delaware River,
- Projected impacts from climate change.

Conceptual Design plans will, at a minimum, include:

- Identification of targeted plant community structures, species compositions, and habitat enhancement features based on the reference site;
- Summary of existing conditions and details of relevant information gathered during the site evaluation activities;
- Site grading and earthwork activities (e.g., site preparation, excavation, grading, etc.) based on the reference site;
- Proposed site improvements and final end-use plan depicting contours, dimensions, locations, and materials for each improvement feature;
- General erosion and sediment control plan;
- Revegetation plan and planting schedule;
- Performance Criteria and definition of success measurements;
- Monitoring Criteria and methods;
- O&M Plan; and,
- Construction specification descriptions.

The intention of the conceptual design plans and documents is to show a level of detail necessary to enable the issuance of all appropriate authorizations to construct and develop a design based on the reference site which represents a reasonable expectation of a successful outcome.

To conclude the Conceptual Design stage, the Applicant will provide the design plans incorporating the input from the project stake holders and is to be completed by the submission of the Final Compensatory Mitigation Plan

Based on input received from the federal and state project stakeholders during Preliminary Design Review Meeting, the applicant will update the design plans and will prepare the Final Design plans to be used to direct construction. During the development of the Final Design plans, the Applicant consultant will prepare final plans to support construction that will include:

- All construction documents, plans, notes and specifications required for construction;
- Access agreements and environmental covenants;
- O&M Plan; and

- Updated Monitoring and Performance Criteria.

The intention of the Final Design Plans is to be prepared to be used for project implementation and construction by the Applicant with oversight by DNREC, as the land owner.

To conclude the Final Design stage, the Applicant consultant will provide the Final Design plans to the project stake holders for review and comment. Following the meeting, the Applicant will incorporate and update the Final Design plans with stakeholder comments and submit the completed Final Design plans to be used for construction. Construction will not commence without the approval of the Final Design plans by DNREC and USACE.

## 8.2 Brandywine Dam No 2 Site

The primary goal of the project is to restore access of upstream habitat to anadromous fish by constructing a rock weir, nature-like fishway constructed at Dam 2, the current downstream impendent to fish passage. The majority of the project work will consist of modifications to the dam and raceway structures to accommodate the improvements, reconstruction of the stream bed on the downstream side of the dam and the construction of the rock weirs. The preliminary drawings have been enclosed in Appendix C. The project elements include:

- *Utility Condition Assessment and Relocation Planning.* There are two existing 42-inch sanitary sewers that extend below Brandywine Creek in the target area of the rock weirs. Additionally, there are also existing sanitary sewers extending along each bank of the creek and a combined sewer overflow outfall in the project area. The project has the potential to impact each of these structures, but at a minimum is expected to impact the crossing sewer. The conditions of these utilities will be assessed and a plan to relocate or reinforce the utilities as appropriate will be developed and implemented.
- *Endangered/Threatened Species Review.* A Project review request will be submitted to the US Fish and Wildlife Service on -line Information for Planning and Consultation (IPaC) system to determine if the northern long-eared bat and bog turtle are present in the mitigation project area. A Determination Key will be completed to determine if the mitigation project may cause incidental take of the northern long-eared bat. DSPPC will coordinate with DNREC to determine if bog turtles may be present in the mitigation area and whether a survey for habitat or turtles is appropriate.
- *Cultural Resource Assessments and Consultation.* The dam structure is part of a historic district and portions of the dam structure may be historic. A nonprofit working on the creek (Brandywine Shad 2020) has commissioned a survey of the structure. Consultation with the State Historic and Preservation office will be performed during the design process.
- *Environmental Site Assessments.* Limited environmental assessments are anticipated to be performed as part of the project. It is understood that the nonprofit agency

working on the creek has coordinated wetland delineations as well as environmental assessments of sediments impounded behind the dam. If these studies are not sufficient, additional evaluations in the project area may be appropriate.

- *Hydraulic Modeling and Fishway Design.* Hydraulic Modeling will be performed to assess flows through the fishway and evaluate the effects of the fishway on the creek. The modeling will be based on the historic flow conditions in the creek at the USGS Tide Gage at Rising Sun Bridge (approximately 9200 feet upstream of the dam) with consideration for each water withdraw structure that is present between the gage and the creek. At a minimum, the 5% exceedance and 95% exceeded flows during the migration season and throughout the year will be considered. The modeling results will be utilized to adjust the fishway to achieve the maximum flows and drops in accordance with the USFWS Design Manual for the primary target species of American Shad, river herring and alewife, with consideration for the secondary species of hickory shad, if appropriate. Based on discussions with the resource agencies, passage of striped bass or sturgeon are not proposed to be considered.
- *Regulatory Permitting and Design Submissions.* The construction of the nature-like fishway will include several levels of regulatory permitting. It is currently anticipated that an individual permit from USACE and State of Delaware subaqueous permit will be required. The City of Wilmington regulatory approval will also be required, which is anticipated to include a review by the City of Wilmington Design Review and Preservation Commission and Floodplain permit. It is anticipated that the approval is likely to include an application with the Federal Emergency Management Agency associated with the hydraulic modeling results.
- *Stream Bed Construction.* In order to limit the height of the rock weirs, a portion of the bed of the river will be filled with stone to construct a maximum 2.5 percent base slope at the proposed pond depth of 4 feet. The stream bed will be constructed into the existing stream banks with consideration for existing infrastructure and the long-term stability of the constructed bank to support the increased hydraulic loading of the nature-like stream.
- *Rock Weir Construction.* The boulder rock weirs will be constructed with bearing into the constructed stream bed to the existing stream bed. Each rock weir will be placed to the design elevation with three or four integrated rock weirs. In order to promote fish passage of various species, each rock section will include two weir sizes based on the target species. Weir depths of 1 foot and 2.25 feet will be incorporated to develop passage for American Shad, River herring and Alewife.
- *Dam and Raceway Modification.* Modifications to the dam and raceway structure are anticipated to consist of two weirs cut into the dam, sized to meet the design hydraulic requirements. The dam weirs will be configured with a means to restore the current elevation of the dam during low flow conditions, which will be permitted during certain flow conditions and times of year when migration is not expected. The closure gates in the weirs are anticipated to be detailed to

operate in a similar manner as the existing city gates, and to require similar maintenance.

- *Operations and Maintenance.* The rock weir system is anticipated to require minimal maintenance as described in Section 11. The rock weirs are not proposed to be constructed with wearable parts that would require replacement. The applicant will develop an operations and maintenance plan that details the anticipated maintenance and operation requirements of this compensatory mitigation plan for the long-term stewardship of the system.

This work will be implemented following approval of the preliminary compensatory mitigation plan. It is anticipated that the utility relocation planning, and hydraulic modeling and design work will be performed with the target of commencing the regulatory approval process prior to the final compensatory mitigation plan submission. It is assumed that construction will commence following the approval of the Project Section 204(f), concurrent with the start of Project construction. Based on the anticipated timelines, construction of the mitigation project will be complete prior to the completion of the Project construction.

### 8.3 Establishment of the State of Delaware eDNA Monitoring and Research Program

This section provides a scope-of-work for an Environmental DNA (eDNA) Monitoring and Research Program that will be funded by the Applicant and implemented by the Delaware DNREC. Establishment of the program will allow for collection and analysis of routine and meaningful data that will support future resource management decisions.

#### *DNREC Environmental DNA Program Establishment and Port Construction Monitoring*

In conjunction with the dredging activities proposed to occur in the Delaware River associated with the Port of Wilmington – Edgemoor Expansion Project, the Applicant is proposing to fund monitoring and research activities performed by DNREC in the immediate and adjacent areas through the use of eDNA sampling and analysis. Monitoring activities will help evaluate and understand potential impacts of the dredging project on resident and transient fish species that use this portion of the Delaware River. It is well documented that the region of the Delaware River where the Edgemoor Expansion and the Fox Point State Park mitigation projects include essential habitat for recreationally/commercially valuable species and critical habitat for endangered species<sup>1</sup>. As such, the Applicant will provide the funding for the purchase of the necessary sampling and analytical equipment to allow for an expansion of the DNREC Environmental Laboratory Section's (ELS) existing eDNA monitoring capabilities. In addition, the Applicant proposes to fund expanded eDNA sampling activities in the Delaware River to monitor state and federal public trust species. The sampling activities will be conducted by DNREC's Division of Fish and Wildlife (DFW) Fisheries Section and/or by DNREC's Division of Water (DW) Environmental Laboratory Section (ELS) for the three years (cycles) coinciding to the construction period anticipated for the Port of Wilmington Expansion Project. In addition, sampling activities will be conducted in other areas of the state, not related

to Port construction, to assist in ongoing research activities and to assist in the identification of potential future habitat restoration and enhancement projects.

#### *eDNA Overview*

Environmental DNA (eDNA) are intra- and extra-cellular forms of DNA released by organisms into the water, soil, or air, and data is generally used as a supplement to traditional sampling means. The eDNA identified in a sample can be compared to existing databases to determine the presence of specific species. It has proven to be cost-effective, safe, and to perform well in comparing changes in fish communities over time. eDNA sampling has many advantages over traditional sampling of fish communities. First, it is non-invasive; in-water work is minimized as only a simple water sample is needed for detection of species presence/absence. Second, it is time and cost effective; the number of staff needed to conduct sampling is minimized as only water samples and the associated processing equipment are needed. Samples can be collected temporally to document runs of several anadromous species that are sequential during the spring. Finally, with proper storage, eDNA samples can be retained indefinitely for future analysis to determine additional species' presence without the need to re-collect samples. eDNA methods have proven to consistently detect species absent from traditional sampling such as rare<sup>8</sup>, invasive<sup>9</sup>, and endangered<sup>10</sup> species. eDNA allows for better estimates of biodiversity<sup>11</sup>, a key indicator of overall ecosystem health. As eDNA methods have continued to evolve it has also shown merit for use in estimating species abundance<sup>12</sup>.

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<sup>8</sup> Jerde, et al., D.M., 2011. "Sight-unseen" detection of rare aquatic species using environmental DNA: eDNA surveillance of rare aquatic species

<sup>9</sup> Hinlo et. al., 2018 Performance of eDNA assays to detect and qualify an elusive benthic fish in upland Streams

<sup>10</sup> Strickland, G. J., & Roberts, J. H. 2018. Utility of eDNA and occupancy models for monitoring an endangered fish across diverse riverine habitats

<sup>11</sup> Evans et.al. 2016. Quantification of mesocosm fish and amphibian species diversity via environmental DNA metabarcoding

<sup>12</sup> Lacoursiere-et. Al., L. 2016. Quantifying relative fish abundance with eDNA: A promising tool for fisheries management



### *DNREC Programmatic Need*

According to the DNREC-DFW, numerous immediate needs for eDNA data have recently come to light. For the last 4 years, the Fisheries Section has obtained presence/absence fisheries data at 118 sites throughout the State using traditional sampling techniques and gear. Their traditional data collection efforts were hampered at 30 additional sites, however, due to access issues such as variable water depth, unfavorable bottom type, obstructions (e.g. down trees, steep banks, and uneven ground), and private property limitations. The collection of eDNA from surface water, which doesn't necessarily require a boat and other cumbersome equipment, would allow for the evaluation of species' presence/absence at these critical but challenging sample locations.

The Applicant also understands from DNREC-DFW that the monitoring requirements of federally mandated fisheries management plans typically take priority for their staff during the months of March through June. This leaves less time for additional sampling related to other fisheries management priorities using traditional methods. Time efficiency associated with eDNA sampling will potentially allow DNREC to expand its data acquisition efforts on anadromous fish stocks, including the federally endangered Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*) and the Shortnose Sturgeon (*Acipenser brevirostrum*).

Just as eDNA data will supplement physical monitoring of the endangered Atlantic Sturgeon and Shortnose Sturgeon in the Delaware River as part of the proposed study, there are apparent and similar data needs in Delaware's tidal Chesapeake Bay watersheds (e.g., Nanticoke River and Broad Creek).

According to DNREC-DFW, invasive species monitoring is yet another ongoing charge that demands time and effort from staff. From Flathead Catfish (*Pylodictis olivaris*) in the C&D Canal to Blue Catfish (*Ictalurus furcatus*) in the Nanticoke River to Northern Snakehead (*Channa argus*) in Delaware's rivers and ponds, data derived from eDNA sampling would provide a more efficient supplemental means of documenting the distribution of these species.

Finally, species specific data derived from eDNA analysis will be used as a barometer of fish species concentration (per unit volume), which can be an indicator of good or poor adult spawning stock abundance during the spring runs. This type of information, if available, would be a major asset to fisheries managers and biologists for population trend analysis.

### *Scope of Work*

After consultation with DNREC-DFW, the Applicant proposes that eDNA monitoring be conducted regularly in the immediate vicinity of the port expansion project dredging area, and also in areas outside of the immediate dredging area and in adjacent rivers and creeks of the larger Christina River watershed (due to the transient nature of the species of greatest concern). These areas will be evaluated prior to dredging, during dredging, and after dredging (for each dredging cycle), to evaluate what impacts to fish populations are occurring.

Of special interest in the Delaware River are Atlantic Sturgeon and Shortnose Sturgeon. Sturgeon DNA monitoring associated with this Port of Wilmington Expansion Project State Mitigation Plan will address several DNREC management directives and provide much needed information for the conservation and recovery of these species. The data collected during this three-year project will be vital for state and federal fisheries managers to mitigate impacts from dredging, water withdrawals, shoreline stabilization projects, development of breakwater structures and other possible future perturbations within the Delaware River. The results of this study will also be used to guide the DNREC-DFW time-of year restrictions that reduce anthropogenic impacts on sturgeons (and other species). The eDNA monitoring for river-resident juvenile Atlantic Sturgeon and migratory adult Atlantic Sturgeon in the Delaware River will provide a better understanding of habitat use within the Delaware River Estuary and provide guidance for traditional sampling efforts to evaluate changes in the location of nursery habitat.

For the focus area (Delaware River), the DNREC-DFW recommends that sampling occur approximately once per river kilometer, monthly, from Liston Point to the State line (or slightly above). At a distance of approximately 50 kilometers, this would equate to 600 samples annually. As part of this monthly sampling DNREC-DFW will also include targeted sampling on Cherry Island Flats to monitor striped bass populations. The adjacent Christina River watershed includes the main stem of the river, as well as Brandywine Creek, Red Clay Creek, and White Clay Creek. DNREC-DFW staff recommend that sampling occur bi-weekly from March through October for the main stem Christina River at each river kilometer (10 km), for a total of 160 samples annually. Alosine spawning is well documented in the Brandywine Creek and therefore should have an increased sampling frequency. To supplement targeted sampling associated with the Dam #2 fish passage project, DNREC-DFW recommends eDNA sampling at each of the 10 bridges as well as above each of the 10 dams which currently exist on the creek. Sampling should be conducted bi-weekly in March, weekly in April and May (when anadromous species presence is believed to be at its highest), and bi-weekly again in the months of June through October. This increased frequency of sampling equates to approximately 400 samples annually. Finally, sampling in the Red Clay and White Clay creeks should occur at each bridge crossing (12 per creek) bi-weekly for the months of March through October for a combined total of 384 samples annually. This eDNA collection plan equates to 1,544 individual samples per calendar year in the Delaware River and the adjacent Christina River watershed.

All eDNA samples collected during the monitoring period will be collected by DNREC-DFW and/or DNREC-ELS, and all samples will be analyzed by the DNREC-ELS. In addition to Atlantic Sturgeon, species of interest may include, but not be limited to: Shortnose Sturgeon, Striped Bass (*Morone saxatilis*), American Shad (*Alosa pseudoharengus*), Blueback Herring (*Alosa aestivalis*) and Alewife (*Alosa sapidissima*; collectively, river herring), Hickory Shad (*Alosa mediocris*), and/or American Eel (*Anguilla rostrata*).

In addition to the sampling strategy summarized above for the Delaware River and greater Christina River watershed, it is proposed that DNREC-DFW extend their eDNA monitoring to other rivers, creeks, and ponds in the State over the same three-year period to meet their additional eDNA data needs and to supplement their existing data. Based upon information provided by DNREC-DFW, an additional 570 samples (190 samples annually) could be collected from the Nanticoke River and Broad Creek to evaluate interests related to Atlantic Sturgeon and Shortnose Sturgeon. An additional 2,700 samples (900 samples annually) could be collected from Delaware rivers, creeks and ponds for interests related to invasive species and other species of interest. Last, an additional 1050 samples (350 samples annually) could be collected in waters not already being sampled for other reasons described above.

### *Summary*

eDNA data can be used as an indicator of species presence/absence, and potentially species abundance as advances are made in this field. This type of information, in conjunction with traditional fisheries survey methods, can be used by DNREC to direct additional field sampling efforts, for fisheries and watershed management purposes, and to validate past fish collection data. In addition, eDNA data can be utilized to identify future potential mitigation areas in relation to critical habitat and with regard to dam removal/fish passage projects in the State. Finally, eDNA data can be used to identify and track invasive species in the State's water bodies without relying solely upon traditional field collection methods.

If funds remain after completion of the proposed three-year work plan described herein, additional eDNA sampling can be added at the discretion of the DNREC-DFW or can be utilized for additional juvenile sturgeon research in the Delaware River and/or Nanticoke River to meet Atlantic States Marine Fisheries Commission sampling confirmation protocols. In addition, the capital expenditure for analytical equipment will allow DNREC to continue its eDNA monitoring efforts into the future.

## **9. Ecological Performance Standards**

### **9.1 Fox Point State Park Wetland Enhancement**

The ecological performance standards would be determined by the final approved permit for the project, including the final compensatory mitigation plan. In general, performance standards for the habitat creation area and wetland enhancement will focus on verification that the in-kind habitat area is constructed, and that the sustaining native vegetation is established.

**Intertidal Habitat** – The constructed, functional intertidal zones that provide habitat that is equal to or greater than the unvegetated habitat that is impacted by the Edgemoor project. The elevations for the final design shall be similar to the range of elevations impacted, and the area of the intertidal and subtidal zones shall be consistent with the requirements of the mitigation plan.

Wetland Vegetation – The substrate of the shallow intertidal zone shall be modified such that the suitable soils for establishment of vegetation are provided. The selected vegetation shall be sufficiently sized to prevent damage from tidal flow (e.g., limited use of seeds). Further, the site should be designed with minimum water depth to reduce the prevalence of invasive species such as phragmites, and the maintenance plan should be sufficient to control the growth of invasive species during the establishment periods. The establishment period will be extended until such a time that the current phragmites stand is improved from a PEM5R classification in accordance with the NWI Code Definitions to a E2EM1N or greater classification.

Additionally, performance criteria for the wetlands will be based off the reference site as the relative target end-use condition for the wetlands. While the enhancement site may have limiting factors which prevent it from reaching the same quality of the reference, the reference serves as a guide for the potential condition. Limiting factors of the site will be considered and factored into the performance criteria.

## 9.2 Brandywine Dam No 2 Site

The ecological performance standards for the nature-like fishway have been developed to provide fish passage at Dam 2 for the primary species American Shad, Alewife and river herring by the Applicants fisheries consultant, Kleinschmidt Associates. The design of the fishway will provide for weirs with varied flow depths, widths and velocities to maximize the variety of anadromous and resident species which may utilize the fishway. The preliminary ecological performance standards have been enclosed as Appendix C.

The ecological performance standards are focused on providing effective fish passage to the existing impediment as well as demonstration of the use of the habitat to which access will be restored. The standards include:

- *Fishway that follows Design Criteria and Contemporary Guidance.* The nature-like fishway will be constructed to meet the target passage criteria for the primary species of concern including American Shad, Alewife and Blueback Herring with consideration for additional passage for secondary species including hickory shad.
- *Fishway meeting passage.* The nature-like fishway will operate with a minimum efficiency of 70 percent for the target species.
- *Fishway meeting mitigation delay.* The nature-life fishway will demonstrate a maximum migration delay of 4 days.
- *Demonstration of the Access to the Habitat.* The nature-like fishway will restore access of migrating adults of the target species throughout the available habitat to the base of Dam 4
- *Demonstration of the Use of the Habitat.* The migrating adults of the target species will utilize the habitat for spawning within the habitat where access is restored.

While the habitat will be utilized through the season, the migration of adults primarily occurs during the spring. The design of the fishway will be based on expected flows during the migration period. The operations plan will restrict closure of the system (e.g. closing the gates installed in the existing dam) to the summer period when migration does not occur, and to a low flow event which may put the City of Wilmington water supply at risk. The fishway will remain open through the year during normal flows.

## **10. Monitoring Plan**

### **10.1 Fox Point State Park Wetland Enhancement**

The performance standards for the intertidal habitat and wetland enhancement will be demonstrated through a monitoring plan which will be performed by the Applicant through the 5-year monitoring period. The monitoring plan shall be implemented to document compliance of the intertidal habitat with the performance standards primarily that the constructed habitat:

- Provides intertidal habitat
- Experiences tidal exchange of river flows
- The wetlands provide a stable habitat free of invasive species.

These standards will be monitored through a combination of quantitative and qualitative measurements. The monitoring of the constructed habitat will consist of an initial period of monthly visits to perform qualitative assessments of the constructed wetlands (overall site conditions, flow conditions, plant survival, cover, species composition). This monitoring would include photographic documentation of the site condition that would be distributed to the project stakeholders, including USACE and Delaware DNREC. Additional qualitative assessments will be performed whenever the Delaware River flows reach the 100 years flood flows, or elevation. The identification of damage to the system or the presence of invasive species (e.g. phragmites) will be reported to the maintenance team to be corrected.

Second, quantitative assessments should be conducted toward the end of each growing season (September) at quadrants established in each habitat type, including a reference area in adjacent emergent wetlands. Each vegetation community/habitat type will be monitored to assess performance of the mitigation areas and the need for institutional controls (e.g., management of invasive species), if necessary. These assessments shall also verify the stability of the intertidal habitat and verify that habitat loss has not been experienced through sedimentation or other means. The Quantitative assessment will verify that sufficient growth and survivability to meet the anticipated survivability rate of 60% of the plants, and direct sufficient supplemental plantings to achieve a stable wetland environment or engage other adaptive management measures. Quantitative assessments will occur annually for a period of 5 years unless it can be demonstrated that the mitigation goals have been met.

## 10.2 Brandywine Dam 2 Site

The design ecological performance standards will be demonstrated through a monitoring plan which will be performed by the Applicant through the 5-year target monitoring period. The draft monitoring plan has been prepared by the Applicant's fisheries consultant, Kleinschmidt Associates and has been enclosed in Appendix D and includes elements to demonstrate that the performance standards are focused on providing effective fish passage to the existing impediment as well as demonstration of the use of the habitat to which access will be restored. The standards include:

- *Fishway that Follows Design Criteria.* An as-built survey of the nature-like fishway will be performed following construction. The survey will demonstrate that the design weir dimensions, minimum pool depths and minimum pool areas have been constructed. The survey will include measuring hydraulics in the target weirs to ensure they are appropriate for target species.
- *Fishway meeting passage and migration delay.* The Applicant will perform a radio telemetry study to establish the efficiency of the system and monitor the migration delay. The survey will be performed annually for a minimum of three years (or until a minimum efficiency of 70 percent with maximum migration delay of 4 days has been demonstrated for three consecutive years). The target of the study will be an annual tagging of 30 American Shad and 30 river herring each year, tagged at the beginning of the migration season in mid-March.
- *Demonstration of the Access to the Habitat.* The Applicant will demonstrate that the primary target species migrating adult fish utilized the habitat that has been open through the nature-like fishway. This will be demonstrated by performing a PIT tagging study consisting of an additional 150 adult fish target species. To perform the monitoring, skilled anglers will be paired with a biological technician who will scan the collected fish at targeted locations in the pool area upriver of Dam 2, and in open areas between Dam 3 and Dam 4.
- *Demonstration of the Use of the Habitat.* The Applicant will demonstrate that the primary target species utilize the habitat for spawning by performing studies to document evidence of spawning. These studies are likely to include:
  - Haul seining in the fall to monitor for young of the year
  - Ichthyoplankton Sampling to verify the presence of egg deposition as a verification of spawning
  - Environmental DNA Sampling which permits detection of alosine fish in the target areas

These studies will be considered successful if the target species are observed in a minimum of two sample areas within the habitat for two sample events (years) and if evidence of spawning is verified through one of the methods during two sample events (years).

In order to further the research activities supporting the return of anadromous fish to the Brandywine Creek, the Applicant is proposing a variety of sampling methods through the monitoring period to further develop the baseline information for other restoration efforts. This monitoring, as well as other potential monitoring as outlined in Section 4.3, will be coordinated through DNREC and Brandywine Shad 2020.

## **11. Maintenance Plan**

### **11.1 Fox Point State Park Wetland Enhancement**

The Applicant shall be responsible for the maintenance of the constructed intertidal habitat area and wetland enhancement areas. The Applicant will be responsible to perform maintenance as identified by the monitoring reports, project stakeholders, or other appropriate parties. At a minimum, the applicant shall:

- Perform annual invasive species treatment and removal for five years as needed to maintain an invasive species abundance of 5% or less.
- Replace dead plants and/or perform supplemental planting as needed to achieve targeted plant densities within the wetland areas.
- Clear debris trapped within or blocking wetland inlet. Excess accumulation of sediment within inlet shall be removed if determined to be impeding wetland tidal interaction.

The Fox Point State Park is maintained by Delaware DNREC. The Applicant anticipates that at the completion of the initial maintenance period in Year 6, the ongoing maintenance may be performed by the park personnel through an agreement with the Applicant. The applicant will maintain a maintenance fund to support maintenance and repairs (i.e., invasive removal and supplemental planting).

While the applicant anticipates that the maintenance may be performed by DNREC, it is understood that the responsibility to ensure the maintenance is performed remains with the Applicant. The formal maintenance plan will be prepared with the conceptual design and will depend on the final elements of the intertidal habitat and wetlands. This plan will be prepared and submitted to the project stakeholders for review prior to the submission of the final compensatory mitigation plan.

### **11.2 Brandywine Dam 2 Site**

The maintenance of the nature-like fishway consists of an initial maintenance period following construction and during the monitoring period, and visual inspections annually or following significant events. The draft maintenance plan prepared by Kleinschmidt Associates has been enclosed as Appendix E.

The initial maintenance will include annual structural assessments performed by the Applicant for a period of 5 years (coinciding with the monitoring period). The annual



assessments will include a visual review of the fishway elements and dam modifications to verify performance. The annual maintenance will include removal of debris accumulated within the fishway and may include minor modification to the fishway structure if movement or suboptimal flow conditions are observed as described in the enclosed plan. The initial maintenance period will conclude with the performance of a survey of the rock weirs during the low flow period of Year 5. The records of the initial maintenance periods will be included in the compensatory mitigation monitoring plan report.

At the completion of the initial maintenance period in Year 6, the ongoing maintenance will include visual inspections annually and following significant flow events. The annual reviews will be based on removal of accumulated debris and monitoring for significant damage to the structure. The ongoing maintenance will be performed by the long-term steward of the facility, the City of Wilmington, who will also maintain the records of the annual inspections. The applicant will maintain a maintenance fund to support up to 4 significant repairs (i.e., ramp modifications requiring regulatory notification).

## **12. Long Term Management Plan**

### **12.1 Fox Point State Park Wetland Enhancement**

The implementation of the intertidal habitat is intended to establish a functional, self-sustaining community with tidal connection to the Delaware River. The Applicant will perform monitoring and maintenance to ensure that a sustaining environment is constructed. Following the initial maintenance period, and when the performance standards have been achieved, the Applicant proposes to maintain the habitat with typical maintenance that is performed in the park to control invasive species that has been established as effective for a period of at least 10 years.

### **12.2 Brandywine Dam 2 Site**

The implementation of the rock weir nature-like stream has considered self-sustaining elements. The project is intended to establish functional self-maintaining elements that require minimal maintenance beyond removal of accumulated debris. The primary element of the project that will require long term replacement or regular mechanical maintenance is the gates within the dam structure which may be closed during low flow periods. The City of Wilmington water infrastructure currently includes two gates at the dam. The selection of a gate system that operates in a similar manner as the existing infrastructure will limit the impact of the new system.

When the performance standards have been achieved, the stewardship of the project is transitioned from the Applicant to the City of Wilmington, and possibly DNREC Parks, who manages the land adjacent to Dam 2 for the City of Wilmington. Each of these entities represent stable State of Delaware governmental agencies or Local governments which are capable of maintaining the system in accordance with guidance solicited from the resource agencies to comply with the federal and state



permit conditions for the nature-like fishway. While the Applicant intends to transition the performance of the long-term management, it is understood that the Applicant remains responsible to ensure that regular maintenance occurs and that repairs, when needed, are performed.

### **13. Adaptive Management Plan**

#### **13.1 Fox Point State Park Wetland Enhancement**

The Applicant will be responsible for implementing the proposed wetland enhancement and habitat creation at Fox Point State Park and ensuring that all as built and performance criteria are met during the monitoring period. In the event the Applicant determines that the site is not achieving the performance standards identified in the Performance Standards Section of the final Compensatory Mitigation Plan, a Notice of Deficiency shall be developed by the Applicant and submitted to USACE and DNREC. The Notice will define the deficiency and propose the adaptive management that is needed or required. The adaptive management will be approved by the USACE/DNREC in accordance with 33 CFR 332.4 (c) (12) and implemented by the Applicant.

#### **13.2 Brandywine Dam 2 Site**

The Applicant will be responsible for implementing this mitigation plan at Brandywine Dam 2 and ensuring that all as built and performance criteria are met during the monitoring period. In the event the Applicant determines that the site is not achieving the performance standards identified in the Performance Standards Section of the final Compensatory Mitigation Plan, a Notice of Deficiency shall be developed by the Applicant and submitted to USACE. The Notice will define the deficiency and propose the adaptive management that is needed or required. The adaptive management will be approved by the USACE in accordance with 33 CFR 332.4 (c) (12) and implemented by the Applicant.

The Applicant has identified several potential Adaptive Management activities that could be utilized at the project site:

- Engineering changes to optimize hydraulics or other modifications to weirs if monitoring of performance standards indicate fish passage is not being achieved.
- Stocking of Brandywine Creek upstream of Dam No. 2 with American shad if juvenile surveys at the project site and downstream, catch rates by anglers and eDNA concentrations indicate a decline in American shad populations over the 5-year monitoring period.
- Stream restoration at Dam No. 3 if monitoring indicates that performance standards for fish passage are not being achieved.

- Modifying the stagnant, backwater area near dam #3 to potentially connect it on upstream side to main stem of the Brandywine.

It is the Applicant's position that there are reasonable opportunities for adaptive management at the project site.

#### **14. Communications**

The Applicant expects to establish a routine and coordinated process for information sharing in order to facilitate decision-making on key project elements. Technical experts from USACE and appropriate federal and state agencies will be included, and participants may vary depending on issues under consideration. Initial emphasis will be placed on project design for the nature-like rock ramp and wetlands creation at Fox Point State Park.

#### **15. Financial Assurances**

The DSPC is a public corporation of the State of Delaware. The corporation receives funding from the operation of the port and has the ability to receive additional funding from the State of Delaware.

At the time of submission of this preliminary compensation the Delaware General Assembly has allocated \$3,000,000 on behalf of the DSPC to DNREC for the purpose of implementing the State of Delaware Compensatory Mitigation Plan that was included in the issuance of the State of Delaware Subaqueous Lands Permit for the project (Permit No. SP-101/20 dated September 30, 2021). A significant proportion of that funding is intended to support the wetland construction at Fox Point State Park and the Environmental DNA elements of this Preliminary Compensatory Mitigation Plan as well as the additional elements of the State of Delaware Compensatory Mitigation Plan not associated with this plan. The State is committed to funding the implementation of the approved, implementable compensatory mitigation plan and is in the process of obtaining the necessary funding, which would be based on the cost estimates developed after the mitigation plan is approved.

#### **16. Other Considerations.**

The benefits of the preliminary compensatory mitigation plan, including a rock ramp fishway on the Brandywine Creek and preservation of subaqueous lands on the Christina River, are presented within the context of a regulatory framework and generally considered through the applicable feasibility, monitoring and performance standards to assure effectiveness of the project. There are significant project attributes outside of that regulatory framework that are worthy of consideration.

Additive Resources – A mission critical element to restoration of access to the Brandywine Creek watershed for migratory and resident fish species rests with the creation of passage at Dam 2 as it presents the most significant financial and engineering challenges. This proposed mitigation enables the success of this important initiative through the allocation of resources to this project by DSPC, with other entities, notably Brandywine

Shad 2020 and its partners, to direct energy and resources to less challenging dams. While the goal of Brandywine Shad 2020 is to “restore anadromous and domestic fish passage to 17.6 miles and 250 acres of freshwater spawning habitat from tidewater to the Piedmont in Delaware and Pennsylvania.” the project also assists in implementation of the American Shad Habitat Restoration Plan for the Delaware River.

**Biodiversity and Recreation** – The reestablishment of fish passage at Dam 2 and beyond will also enhance the biodiversity of the Brandywine Creek as migratory and resident species will be able to expand their range, and potentially populations, as additional structures are removed. A greater abundance of fish will likely add recreational opportunities for anglers along this waterway which is located in a highly urbanized area.


**Public Awareness** – The location of Dam 2 within the City of Wilmington and its proximity to Brandywine Park and Brandywine Zoo, popular recreational amenities for the City and region, also provides opportunities to enhance public awareness of the importance of the Brandywine Creek as fisheries habitat. Placement of interpretive signage at the site could facilitate this awareness. Brandywine Shad 2020 hosted a shad festival in July 2021 with an estimated attendance of 500 people. Similar events throughout the mid-Atlantic have become annual eco-tourism events. One of Brandywine Shad 2020’s initiatives is to raise public awareness through public information materials, workshops and other events.

**Historical Preservation** – While these dams were a key component to the economic development of the Brandywine Valley through the 18th and 19th centuries, reliance on these structures for hydropower has dissipated. The Brandywine remains the primary source of water supply for the City of Wilmington and Dam 2 has also been designated as a historic structure as part of Wilmington’s Historic District. Preliminary discussions with SHPO indicate the construction of the project is possible while maintaining the historic integrity of the structure.

## FIGURES





Date: 12/2018	<p align="center"><b>FIGURE 1</b></p> <p align="center"><b>Site Location Sketch</b></p> <p align="center"><b>Port of Wilmington</b></p> <p align="center"><b>Edgemoor Expansion</b></p> <p align="center">EDGEMOOR - NEW CASTLE COUNTY - DELAWARE</p>	DESIGNED BY: JWF	 <p><b>DUFFIELD ASSOCIATES</b> Soil, Water &amp; the Environment</p> <p>5400 LIMESTONE ROAD WILMINGTON, DE 19808-1232 TEL. (302)239-6634 FAX (302)239-8485</p> <p>OFFICES IN PENNSYLVANIA, SOUTHERN DELAWARE, MARYLAND AND NEW JERSEY</p> <p>EMAIL: DUFFIELD@DUFFNET.COM</p>
SCALE: AS SHOWN		DRAWN BY: JWF	
PROJECT NO. 11139.LH		CHECKED BY: RLH	
SHEET: FIGURE 1		FILE: 11139.LD SiteLocationSketch	





**Port of Wilmington – Edgemoor Expansion**

PROJECT AREA  
EXISTING CONDITION OF SHORELINE

PAGE 1 OF 2



**DUFFIELD**  
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E-MAIL: duffield@duffinet.com

Project No. 11139.LH

Figure 2

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**Port of Wilmington – Edgemoor Expansion**

PROJECT AREA  
EXISTING CONDITION OF SHORELINE

PAGE 2 OF 2



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Project No. 11139.LH

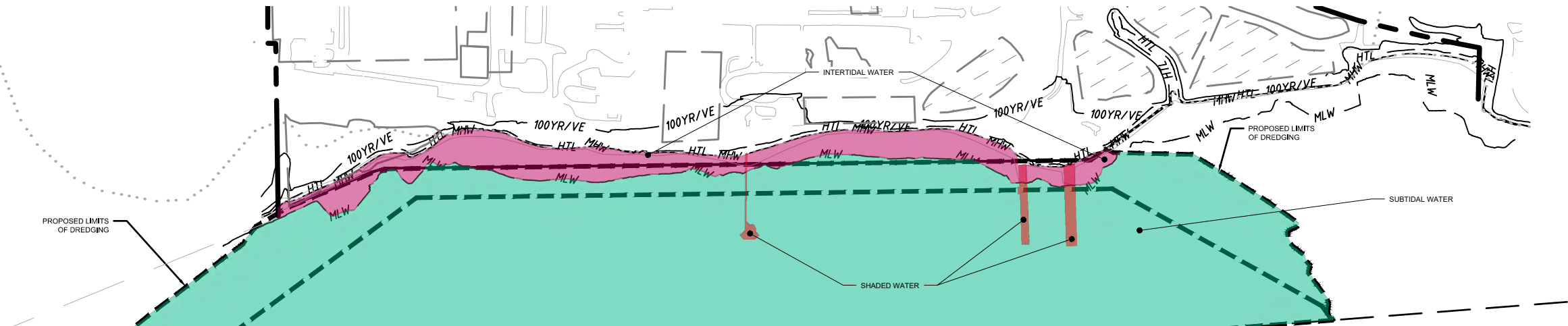
Figure 2



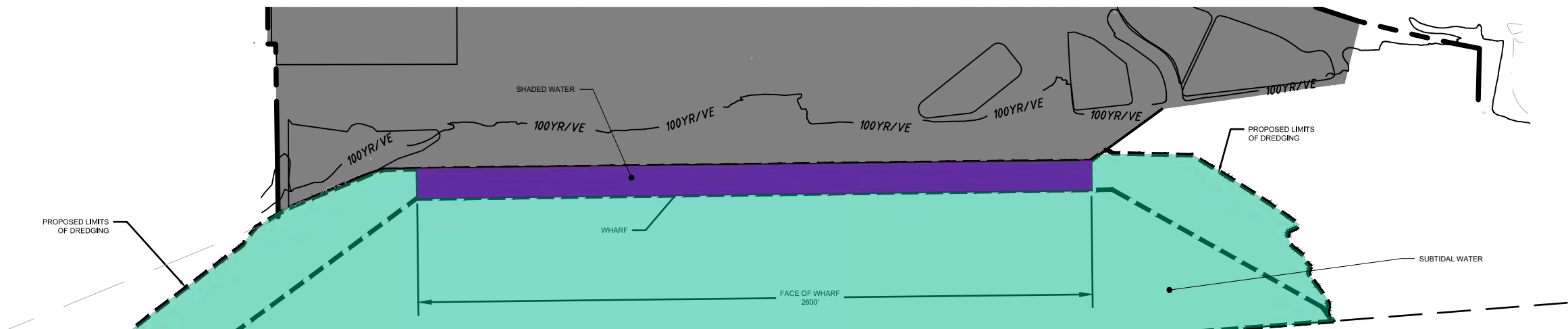


DESIGNED BY: MRB  
DRAWN BY: AR  
CHECKED BY: BJD  
FILE: EX-Impact-11139LH

EXISTING CONDITION



PROPOSED CONDITION



CHANGES



	AREA (ACRES)
SUBTIDAL WATER TO BE FILLED	0.35
INTERTIDAL WATER TO BE FILLED	5.15
SUBTIDAL WATER TO BE SHADED	7.13
SHADED WATER TO BE EXPOSED WATER	0.43
EXISTING FILL TO BE SUBTIDAL WATER	0.10

LEGEND	
---	PROPERTY LINE
---	ADJOINER LINE
100YR	100 YEAR FLOODPLAIN (BASE FLOOD ELEVATIONS, BFE DETERMINED)
100YR/VE	100 YEAR FLOODPLAIN (COASTAL FLOOD ZONE WITH VELOCITY HAZARD, BFE DETERMINED)
ZONE AE (EL. 9)	FLOODPLAIN DIVIDE
ZONE VE (EL. 12)	
HTL	HIGH TIDE LINE
MLW	MEAN HIGH WATER LINE
MLW	MEAN LOW WATER LINE
MLW	CHANNEL LIMITS
	EL. = 4.56' (N.A.V.D. 88)
	EL. = 2.51' (N.A.V.D. 88)
	EL. = -2.79' (N.A.V.D. 88)

PROJECT IMPACT SUMMARY  
PORT OF WILMINGTON EDGE MOOR EXPANSION  
BRANDYWINE HUNDRED ~ NEW CASTLE COUNTY ~ DELAWARE

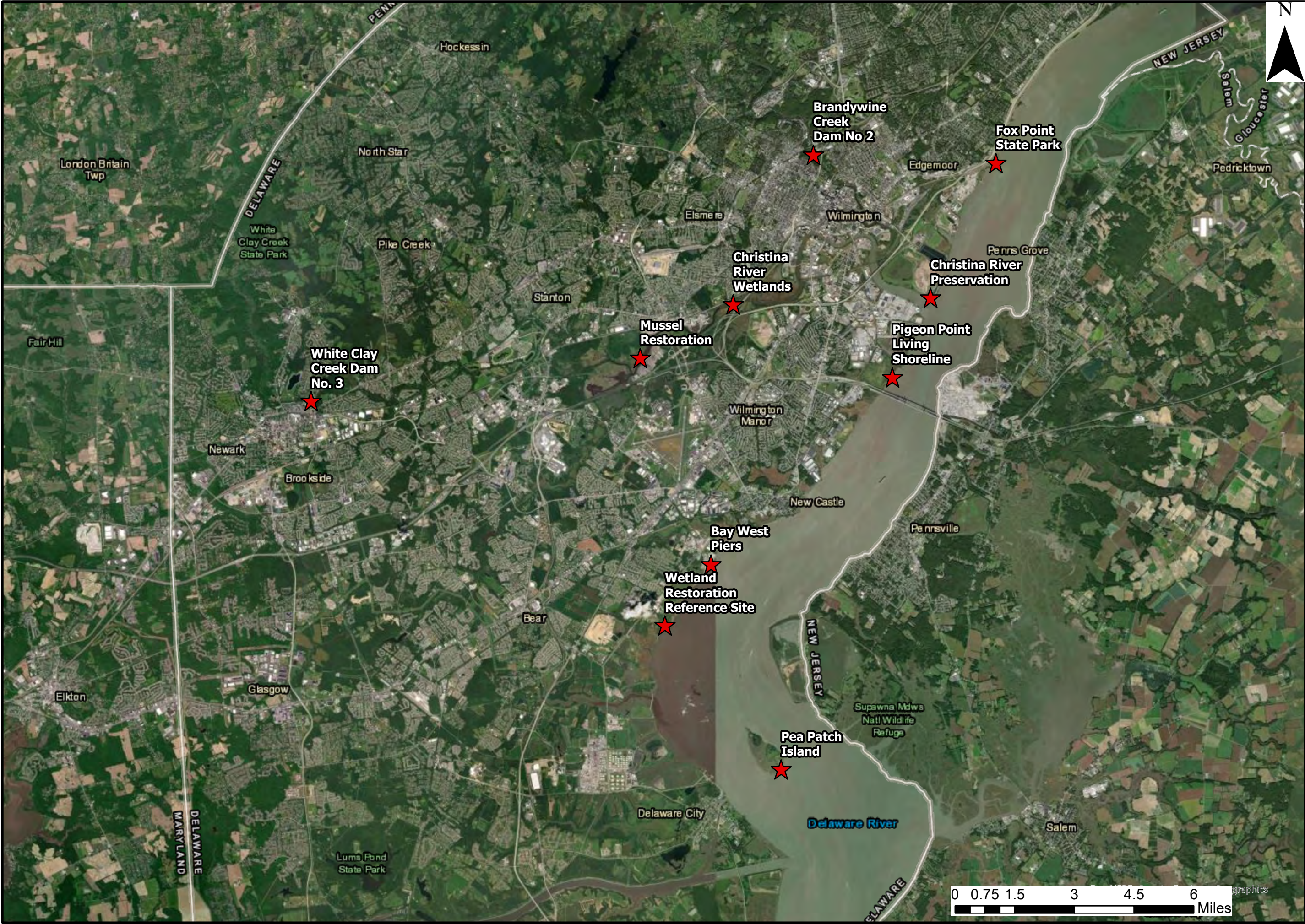
DATE: JULY 8, 2021

SCALE: 1" = 500'

PROJECT NO. 11139.LH

SHEET: FIGURE 3





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Soil, Water & the Environment

5400 LIMESTONE ROAD  
WILMINGTON, DE 19808  
TEL. (302)239-6634  
FAX (302)239-8485

OFFICES IN DELAWARE, MARYLAND,  
PENNSYLVANIA, AND NEW JERSEY

E-MAIL: DUFFIELD@DUFFNET.COM

**Legend**

 Mitigation Locations

BASEMAP:  
ESRI Aerial

DRAWN BY:  
FAW

CHECKED BY:  
BD

FILE:

Potential Mitigation Site Locations

**Port of Wilmington Edgemoor Expansion**

WILMINGTON-NEW CASTLE-DELAWARE

DATE:  
OCTOBER 2021

SCALE:  
AS SHOWN

DUFFIELD PROJECT NO.  
11139LH

FIGURE:  
4







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E-MAIL: DUFFIELD@DUFFNET.COM

Legend

 Mitigation Locations

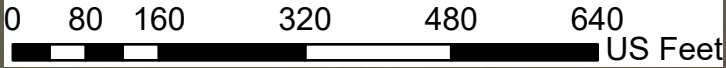
BASEMAP:
ESRI Aerial
DRAWN BY:
FAW
CHECKED BY:
BD
FILE:

Wetland Reference Site

Port of Wilmington Edgemoor Expansion

WILMINGTON-NEW CASTLE-DELAWARE

DATE:
OCTOBER 2021
SCALE:
AS SHOWN
DUFFIELD PROJECT NO.
11139LH
FIGURE:
5







**Port of Wilmington – Edgemoor Expansion**  
 Fox Point State Park Wetland Enhancement  
 Existing Conditions

PHOTO PAGE 1 OF 2



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 E-MAIL: duffield@duffnet.com

Project No. 11139.LH.08

Figure 6

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**Port of Wilmington – Edgemoor Expansion**  
 Fox Point State Park Wetland Enhancement  
 Existing Conditions

PHOTO PAGE 2 OF 2



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Figure 6

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**Port of Wilmington – Edgemoor Expansion**  
 Fox Point State Park Wetland Enhancement  
 Reference Site

PHOTO PAGE 1 OF 1



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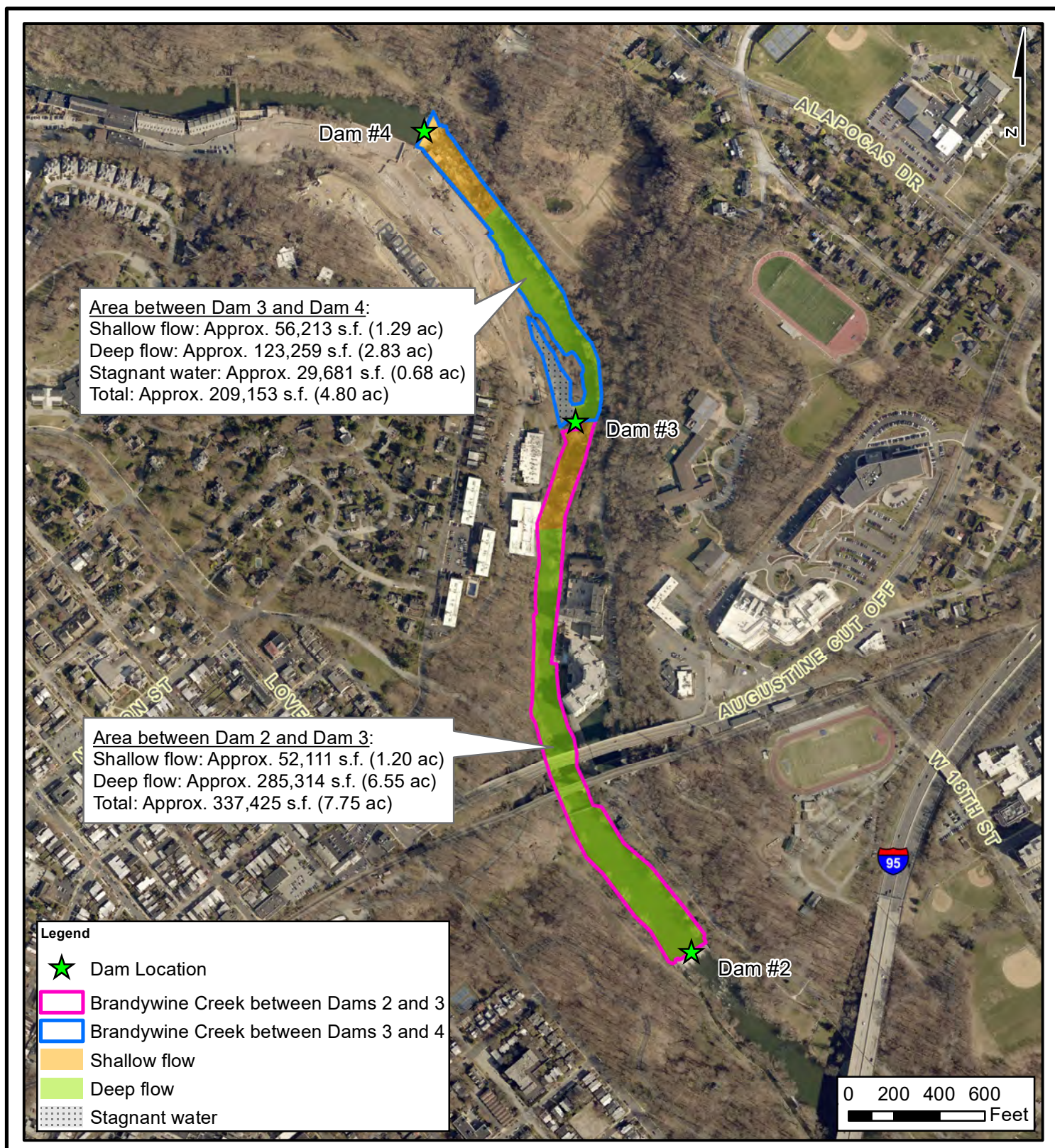
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 E-MAIL: duffield@duffnet.com


Project No. 11139.LH.08

Figure 7

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Date: 09/2021	<b>BRANDYWINE CREEK AVAILABLE HABITAT AREA</b>  <b>PORT OF WILMINGTON EDGEMOOR EXPANSION</b>  WILMINGTON~NEW CASTLE~DELAWARE	DESIGNED BY: BD	 <b>DUFFIELD ASSOCIATES</b> <small>Soil, Water &amp; the Environment</small>  5400 LIMESTONE ROAD WILMINGTON, DE 19808-1232 TEL. (302)239-6634 FAX (302)239-8485  OFFICES IN PENNSYLVANIA, SOUTHERN DELAWARE, MARYLAND AND NEW JERSEY EMAIL: DUFFIELD@DUFFNET.COM
SCALE: AS SHOWN		DRAWN BY: KLS	
PROJECT NO. 11139.LH		CHECKED BY: BD	
FIGURE: 8		FILE: 11139.LH.Available_Habitat_Area	

# **APPENDIX A**

## **City of Wilmington Letter of Support for Brandywine Dam 2**



# City of Wilmington



**MICHAEL S. PURZYCKI**  
Mayor

September 20, 2021

VIA EMAIL: [gbailey@port.state.de.us](mailto:gbailey@port.state.de.us)

Mr. Eugene Bailey, Director  
Diamond State Port Corporation  
Carvel State Office Building  
820 N. French Street  
Wilmington, DE 19801

Re: Expansion of Port of Wilmington – Rock Ramp at Dam 2 on Brandywine Creek

Dear Eugene,

You have requested a letter of support for the construction of a full-width rock ramp on the face of Dam 2 on the Brandywine Creek in the City of Wilmington to allow passage of migratory and resident fish species. It is my understanding this project is being proposed in the context of the various pending permit applications before federal regulatory agencies for the proposed expansion of the Port of Wilmington on the Edgemoor site. Specifically, the federal regulatory agencies are requiring mitigation as part of the permitting process, and the above-referenced proposed project is a critical component of the mitigation plan.

As you are aware, Dam 2 on the Brandywine Creek is critical to the City's water supply as it is the primary mechanism by which the City provides potable water to its residents. As a result, any project along the lines suggested must not negatively impact this critical dam and the City's water supply. It is my understanding engineering consultants for the Diamond State Port Corporation have reviewed this issue carefully and have consulted with the Department of Public Works for the City of Wilmington and that based on that review and consultation, preliminary assessments indicate such a project is feasible without jeopardizing the City's water supply. It is also my understanding that the various state and federal regulatory agencies are fully aware of the mission critical importance of Dam 2 to the City's potable water supply and accept the necessity of protecting the City's water supply in the construction of any such project.

With that understanding, it is important to note that I view this issue through the larger lens of job creation and environmental justice as it relates to the residents of the City of Wilmington. Simply put, we need to assure that historically marginalized communities have access to badly needed investments to rebuild our economy and infrastructure. Historically, the Port of Wilmington provides some of the best opportunities for residents of the City to secure family-sustaining jobs, thanks in large part to the strong efforts of the International Longshoremen's Association. However, too often in the past, communities like the City of Wilmington have disproportionately absorbed the negative impacts of industry, without the economic benefits. Thus, the proposed expansion of the Port of Wilmington at the Edgemoor site by way of public-private partnership investments presents an incredibly important opportunity to help address this long-standing disparity by providing economic/employment opportunities for lower income residents of the City of Wilmington. It is this opportunity that drives my support for this issue.

**OFFICE OF THE MAYOR**

**LOUIS L. REDDING CITY/COUNTY BUILDING • 800 FRENCH STREET • WILMINGTON, DELAWARE • 19801-3537**

**WWW.WILMINGTONDE.GOV • PHONE: (302) 576-2100 • FAX: (302) 571-4102**



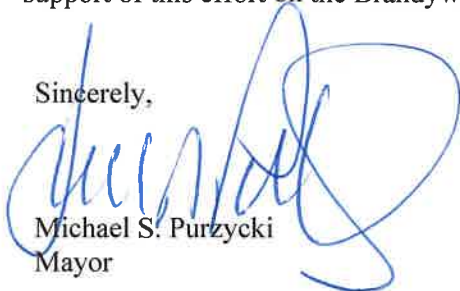
Mr. Eugene Baily  
September 20, 2021  
Page 2

Second, I also understand the benefit of the proposed rock ramp on the Brandywine Creek includes increased recreational fishing opportunities for residents of the City of Wilmington. Championed by the Brandywine Shad 2020, this is also an important environmental justice component and one that I support. Similarly, I understand the expansion at the Edgemoor will also help better manage the legacy environmental issues at the site and electrification of Port operations is also contemplated, which will improve air quality.

I have spent much of my professional life seeking out economic opportunities for the City of Wilmington that also preserve and enhance the environment. This can be difficult but with this project, we have the rare opportunity to create family-sustaining jobs while improving the environment by restoring habitat currently inaccessible to anadromous fish, electrifying port operations and better managing a site with environmental challenges. We need to get this done.

To that end, it is my belief that the City and DSPC will be able to develop and implement plans and measures to ensure that the construction, operation and long-term maintenance of the full-width rock ramp supports the structure's design and function. The City also understands these issues will need to be formalized with appropriate agreements between the City and the DSPC, including a commitment from DSPC to manage the rock ramp once constructed. In short, provided the rock ramp project can be constructed and managed in a manner that does not jeopardize the City's water supply and the planned expansion of the Port of Wilmington at the Edgemoor site can move forward expeditiously, the City is in support of this effort on the Brandywine Creek.

Sincerely,

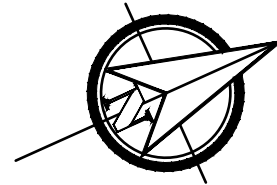


Michael S. Purzycki  
Mayor

## **APPENDIX B**

### **Fox Pont State Park Intertidal Wetland Concept Drawings**





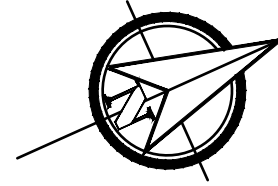
DRAWING SCALE 1" = 20'

DESIGNED BY:	CHECKED BY:
BID	BID
DRAWN BY:	FILE NAME:
GM	FFSG-CONSULTING\JHILL

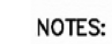
**FOX POINT STATE PARK CONCEPT PLANS  
INTERTIDAL WETLAND PLAN VIEW  
PORT OF WILMINGTON  
EDGEMOOR EXPANSION  
BRANDYWINE HUNDRED ~ NEW CASTLE COUNTY ~ DELAWARE**

DATE: SEPTEMBER 202  
SCALE: 1" = 20  
PROJECT NO. 11139.LH.08  
SHEET: 2 (OF 3)





**SCALE: HORIZ. 1"=20'**



1. PLANTS SHALL BE SOURCED FROM A LOCAL REGIONAL VENDOR WHO PROPAGATES ITS OWN PLANTS FROM REGIONALLY-OBTAINED NATIVE STOCK OR SEED, VERIFIED NATIVE SPECIES. ORDERS SHALL BE PREORDERED THE YEAR PRIOR TO PLANTINGS, GROWN SPECIFICALLY FOR THE PROJECT IN APPLICABLE SOILS. PLANTS SHOULD BE PROPERLY ASSESSED PRIOR TO PLANTING.
2. PLANTING SHALL BE PERFORMED PEAK GROWING SEASON, PLANTING IN GROUPS OF 6-10 PER SPECIES. PLANT IN HOLES WITH PROPER DIMENSIONS FOR ROOT STRUCTURE, BACKFILLED AND TAMP SOIL. INDIVIDUAL PLUGS SHOULD BE PLANTED AT 12 INCHES APART ON CENTER.

### DETAIL: TYPICAL INTERTIDAL WETLAND PLANTING SCHEDULE

Botanical Name		Common Name	Indicator Status	Size	Spacing	Percent planted	Plants Per Cell*
Deep Intertidal Emergent Wetland Zone (DIEW)							
Zizania aquatica	ZIAq	Wild Rice	OBL	2" pot or tube	Plant 12" to 18" centers	0.2	1138
Eleocharis parvula	ElPa	Small Saltmarsh Spikerush	OBL	2" pot or tube	Plant 12" to 18" centers	0.2	1138
Schoenoplectus pungens	ScPu	Chairmakers Bulrush	OBL	2" pot or tube	Plant 12" to 18" centers	0.2	1138
Pontederia cordata	PoCo	Pickerselweed	OBL	2" pot or tube	Plant 12" to 18" centers	0.1	569
Nuphar advena	NuAd	Spatterdock	OBL	2" pot or tube	Plant 12" to 18" centers	0.1	569
Schoenoplectus tabernaemontani	ScTa	Softstem Bulrush	OBL	2" pot or tube	Plant 12" to 18" centers	0.2	1138
Shallow Intertidal Emergent Wetland Zone (SIEW)							
Leersia oryzoides	LeOr	Rice cutgrass	FACW	2" pot or tube	Plant 12" to 18" centers	0.2	1138
Cyperus spp.	CySp	Flatsedges	FACW	2" pot or tube	Plant 12" to 18" centers	0.1	569
Panicum virgatum	PaVi	Switch grass	FAC	2" pot or tube	Plant 12" to 18" centers	0.2	1138
Juncus acuminatus	JuAc	Sharp-fruited Rush	FACW	2" pot or tube	Plant 12" to 18" centers	0.2	1138
Echinodoa walteri	EcWa	Walter's Barnyard grass	OBL	2" pot or tube	Plant 12" to 18" centers	0.2	1138
Hibiscus moscheutos	HiMo	Rose mallow	OBL	2" pot or tube	Plant 12" to 18" centers	0.1	569

PROJECT PURPOSE:

THE PURPOSE OF THESE DRAWINGS IS TO PROVIDE THE CONCEPTUAL PLANS AND DETAILS FOR THE CONSTRUCTION OF A ONE ACRE INTERTIDAL WETLAND AREA AS NOTED IN THE COMPENSATORY MITIGATION PLAN. THIS DESIGN IS CONCEPTUAL AND IS NOT FOR CONSTRUCTION.



**DUFFIELD  
ASSOCIATES**

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WILMINGTON, DE 19808-1232  
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FAX 302.239.8485

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PENNSYLVANIA AND NEW JERSEY  
WEB: [HTTP://DUFFNET.COM](http://duffnet.com)  
E-MAIL: [DUFFIELD@DUFFNET.COM](mailto:duffield@duffnet.com)

[illegible]

**OWNER:**

DELAWARE DEPARTMENT OF NATURAL  
RESOURCES AND ENVIRONMENTAL CONTROL  
DIVISION OF PARKS AND RECREATION

**APPLICANT:**

DIAMOND STATE PORT CORPORATION  
800 N. FRENCH STREET, 4TH FLOOR  
WILMINGTON, DE 19801

**FOX POINT STATE PARK CONCEPT PLANS  
INTERTIDAL WETLAND DETAILS AND SECTION**

# PORT OF WILMINGTON EDGEMOOR EXPANSION

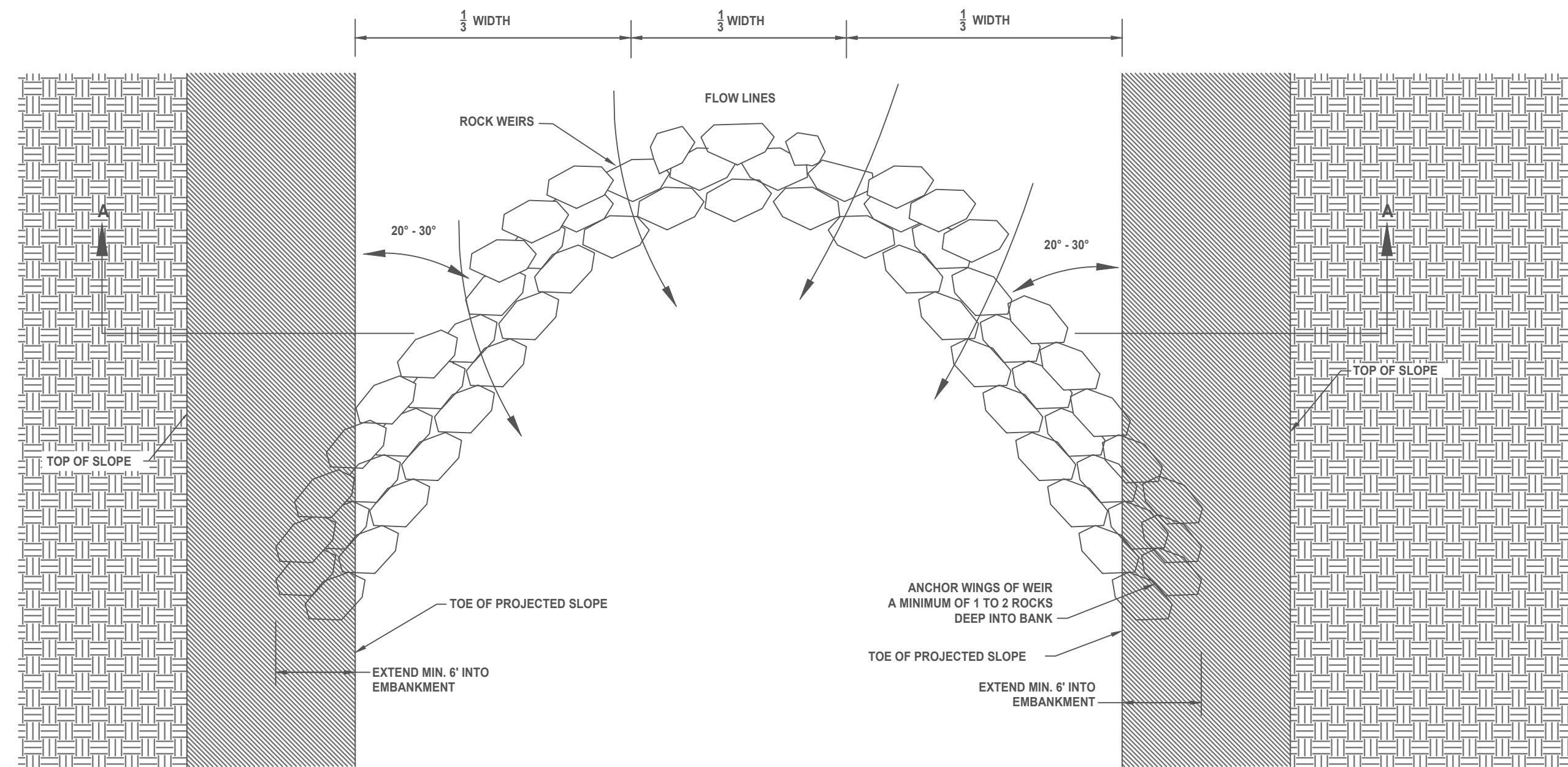
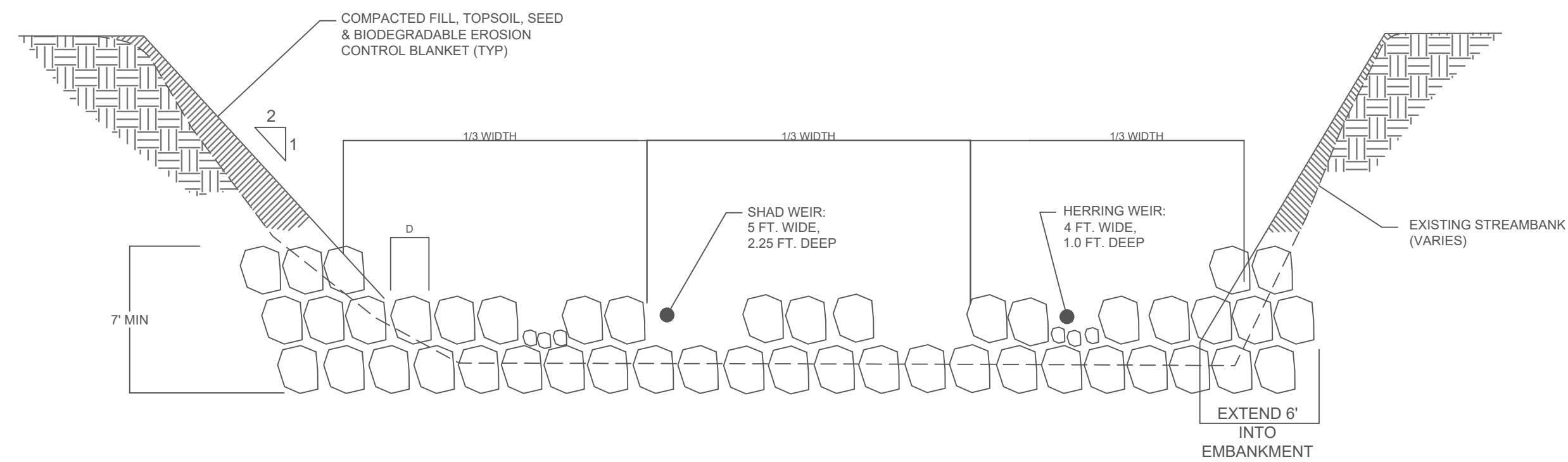
**BRANDYWINE HUNDRED ~ NEW CASTLE COUNTY ~ DELAWARE**

DATE: SEPTEMBER 2021  
SCALE: AS SHOWN  
PROJECT NO. 11139.LH.08  
SHEET: 3 (OF 3)

# **APPENDIX C**

## **Brandywine Dam 2 Concept Drawings**






### DETAIL: TYPICAL ROCK WEIR

SCALE: NOT TO SCALE

**SITE DATA:**

1. ADDRESS: 1001 NORTH PARK DRIVE  
WILMINGTON, DE 19802
2. OWNER: CITY OF WILMINGTON  
800 FRENCH STREET  
WILMINGTON, DE 19801
3. DATUM: N.A.V.D. 88
4. TOPOGRAPHY: BASED ON KLEINSCHMIDT SURVEY, "BRANDYWINE RIVER  
DAMS 2-6 ENGINEERING FEASIBILITY ASSESSMENTS, NEW  
CASTLE COUNTY LIDAR AND FIELD SURVEY PERFORMED  
BY DUFFIELD ASSOCIATES ON JULY 9, 2021



**DUFFIELD  
ASSOCIATES**  
Soil, Water & the Environment

5400 LIMESTONE ROAD  
WILMINGTON, DE 19808-1232  
TEL. 302.239.6634  
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WEB: [HTTP://DUFFNET.COM](http://duffnet.com)  
E-MAIL: [DUFFIELD@DUFFNET.COM](mailto:dufffield@duffnet.com)

[illegible]

**PRELIMINARY  
NOT FOR  
CONSTRUCTION**

**TYPICAL SECTION**

**WILMINGTON HARBOR - EDGEMOOR EXPANSION**

**BRANDYWINE DAM 2 ROCK WEIR**

**NATURE-LIKE FISHWAY CONCEPT**

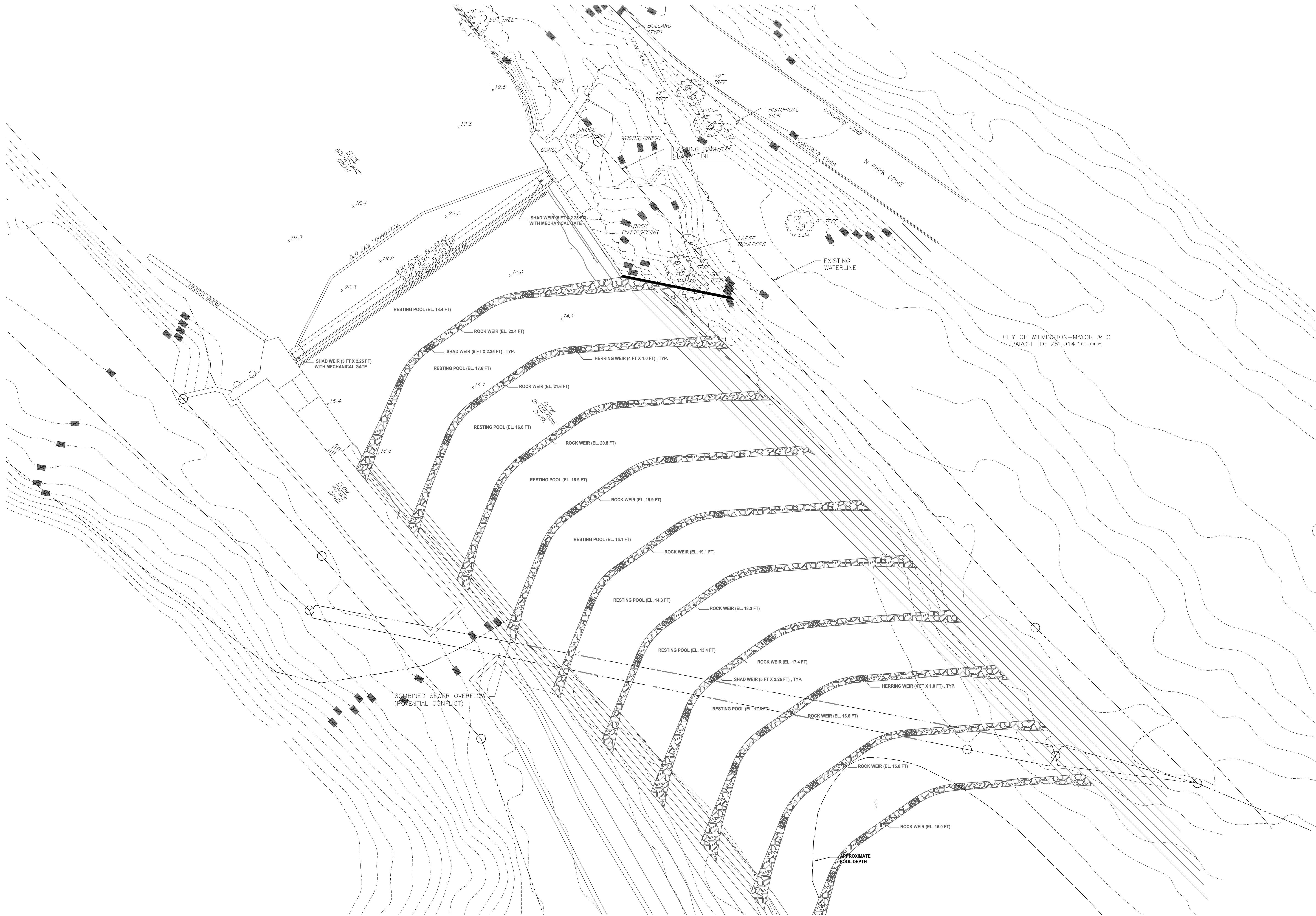
**WILMINGTON ~ NEW CASTLE COUNTY ~ DELAWARE**

DATE: AUGUST 2021  
SCALE: N.T.S.  
PROJECT NO. 11139.LH  
SHEET: 1 (OF 5)









PREFERRED ALTERNATIVE - FULL WIDTH ROCK RAMP  
WILMINGTON HARBOR - EDGEMOOR EXPANSION  
BRANDYWINE DAM 2 ROCK WEIR  
NATURE-LIKE FISHWAY CONCEPT  
WILMINGTON ~ NEW CASTLE COUNTY ~ DELAWARE

DATE: AUGUST 2021  
SCALE: 1" = 20'  
PROJECT NO. 11139.LH  
SHEET: 3 (OF 5)

OWNER: OWNER'S NAME

REVISION

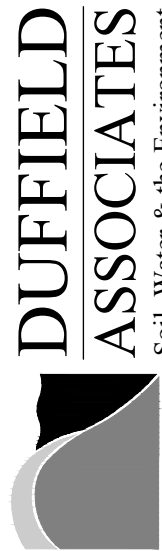
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CHECKED BY:  
DATE

DESIGNED BY:  
BID

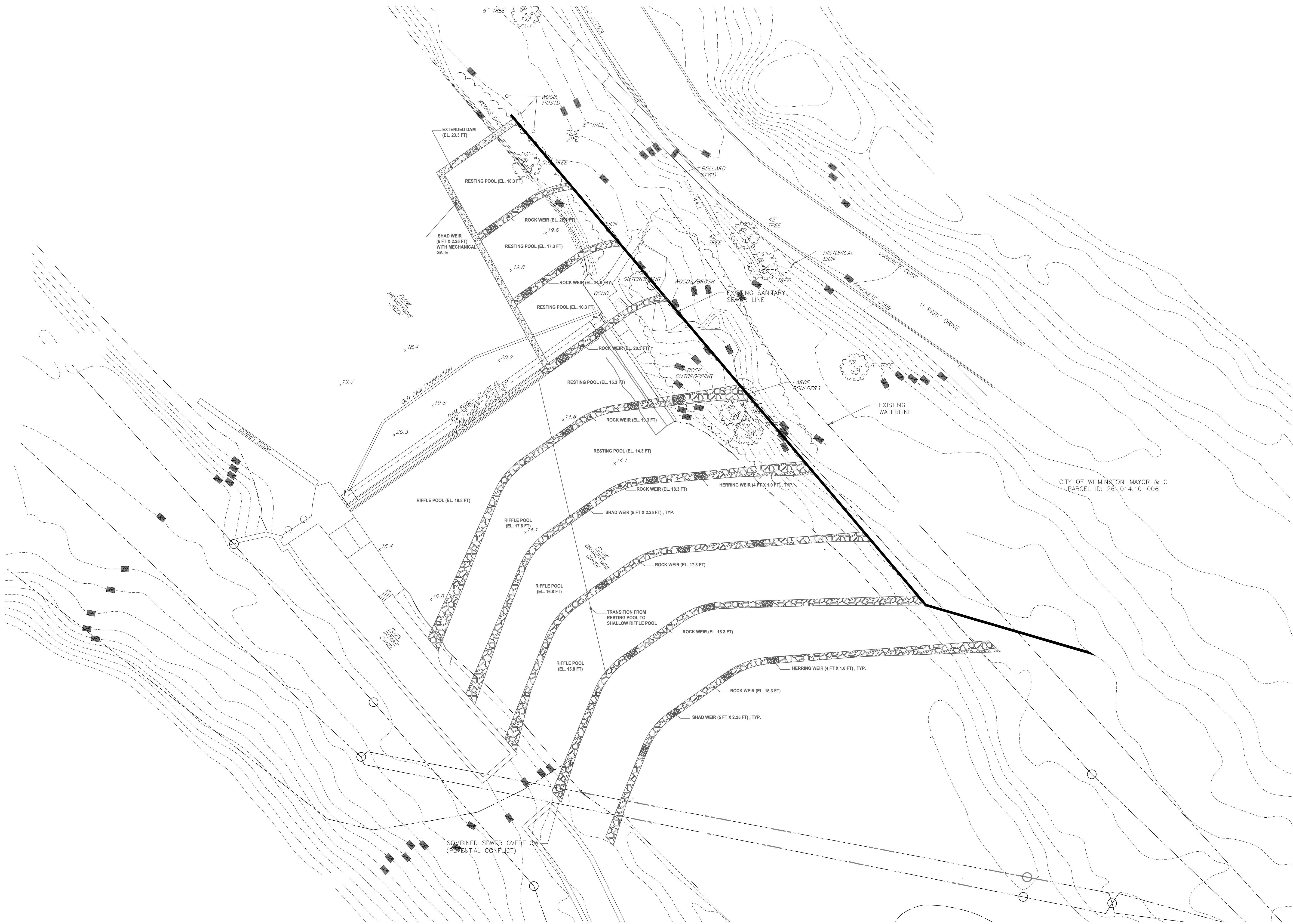
CHECKED BY:  
BID

PRELIMINARY  
NOT FOR  
CONSTRUCTION



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PENNSYLVANIA AND NEW JERSEY  
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E-MAIL: DUFFIELD@DUFFNET.COM





ALTERNATIVE - PARTIAL FULL WIDTH ROCK RAMP  
WILMINGTON HARBOR - EDGEMOOR EXPANSION  
BRANDYWINE DAM 2 ROCK WEIR  
NATURE-LIKE FISHWAY CONCEPT  
WILMINGTON ~ NEW CASTLE COUNTY ~ DELAWARE

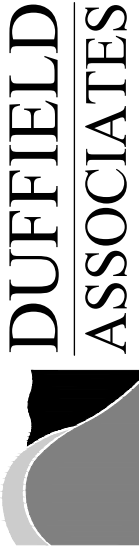
DATE: AUGUST 2021  
SCALE: 1" = 20'  
PROJECT NO. 11139.LH  
SHEET: 4 (OF 5)

OWNER: OWNER'S NAME

REVISION		No.
PRELIMINARY NOT FOR CONSTRUCTION		

CHECKED BY:	BID
DESIGNED BY:	BID
DRAWN BY:	GAZ

CHECKED BY:	BID
FILE NAME:	Stream Concept 11139.LH



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WEB: HTTP://DUFFNET.COM  
E-MAIL: DUFFIELD@DUFFNET.COM





<p><b>PROFILES</b></p> <p><b>WILMINGTON HARBOR - EDGEMOOR EXPANSION</b></p> <p><b>BRANDYWINE DAM 2 ROCK WEIR</b></p> <p><b>NATURE-LIKE FISHWAY CONCEPT</b></p> <p><b>WILMINGTON ~ NEW CASTLE COUNTY ~ DELAWARE</b></p>		<p><b>OWNER: OWNER'S NAME</b></p>	
DATE:	AUGUST 2021	No.	REVISION
SCALE:	N.T.S.		
PROJECT NO.	11139.LH		
SHEET:	5 (OF 5)		

## **APPENDIX D**

### **Preliminary Ecological Performance Standards**

# ECOLOGICAL PERFORMANCE CRITERIA FOR THE PROPOSED BRANDYWINE DAM 2 NATURE-LIKE FISHWAY

ASSOCIATED WITH THE EDGEMOOR  
PORT MITIGATION

Prepared for:  
**Diamond State Port Corporation**

Prepared by:  
**Kleinschmidt Associates**

**August 2021**

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## 1.0 INTRODUCTION

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The success of any upstream fishway is dependent on local hydrology, target species, life stage, dam orientation, and numerous other site-specific considerations that are incorporated into the design of the fishway. An important component of fishway design is defining the level at which the fishway is required to perform. The first step in any fishway design is to establish the restoration and fish passage objectives, which inform the design criteria for that project. After restoration and fish passage objectives have been established, the next step is to establish performance criteria to evaluate the fishway. Performance criteria typically are developed in accordance with the fishway's intended function and relate to evaluating if design criteria are attained and assessing if the target species are utilizing the fishway as intended.

The Performance Criteria for the proposed Rock Weir Nature-Like Fishway (NLF) at Brandywine Dam 2 (Brandywine Park Dam) fall into three major categories outlined as follows:

1. NLF Design Criteria
2. Fish Passage Effectiveness and Migration Delay
3. Demonstration of Spawning/Foraging Habitat Use

## 2.0 NLF DESIGN CRITERIA

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The following criteria will be used to guide the design of the NLF. The design process generally is iterative in nature, often with input from involved fisheries resource agencies and private fish passage professionals, non-governmental organizations, and the dam owners. As such, design criteria may be modified or "fine-tuned" as the design process progresses.

The NLF at Dam 2 is being designed to pass three primary target species:

1. American Shad,
2. Alewife, and
3. Blueback Herring

Additional migratory species such as Hickory Shad, and American Eel, as well as many resident fish species are expected to use the NLF, but the design of the fishway will focus on providing passage for these target species. Physical design criteria will follow the fish passage criteria for the target species as summarized below in Table 1 from the Federal Interagency Nature-like Fishway Passage Design Guidelines for Atlantic Coast Diadromous Fishes (Turek et al., 2016) ensuring that adequate water depth, velocity, and resting habitat for target species are provided. The most restrictive criteria for each of the three target species will be used to develop the fishway,

with multiple zones of passage established to provide variable flows and depths to accommodate the target species. This approach ensures passage for the weakest swimmers from the target species. The NLF will have pools with depths of at least 4 feet, widths of at least 20 feet, and lengths of 30 feet. Velocities in weir notches will target less than 6.0 feet per second (fps) for river herring (alewives and blueback herring) and less than 8.25 fps for American Shad. The slope will be set to 1:30 (or shallower) to minimize hydraulic drops and maintain the recommended hydraulics in the channel. The hydraulics will be modeled with a 2-D hydraulic model and validated in the field after the project is constructed (see Section 10 Monitoring Plan).

**Table 1. Summary of Federal Interagency Nature-like Fishway Passage Design Guidelines for American Shad, Blueback Herring, and Alewife**

	Minimum Pool/ Channel Width (ft)	Minimum Pool/ Channel Depth (ft)	Minimum Pool/ Channel Length (ft)	Minimum Weir Opening Width (ft)	Minimum Weir Opening Depth (ft)	Maximum Weir Opening Water Velocity (ft/second)	Maximum Fishway Channel Slope
Species	$W_p$	$d_p$	$L_p$	$W_N$	$d_N$	$V_{max}$	$S_o$
American shad ( <i>Alosa sapidissima</i> )	20.0	4.00	30.0	5.00	2.25	8.25	1:30
Blueback herring ( <i>Alosa aestivalis</i> )	5.0	2.00	10.0	2.25	1.0	6.00	1:20
Alewife ( <i>Alosa pseudoharengus</i> )	5.0	2.25	10.0	2.50	1.0	6.00	1:20

Note: Blue shaded cells indicate most restrictive design guidelines for American Shad and river herring.

Additional design criteria for this project are proposed to include:

1. Fish passage type: full-width Rock Weir Nature-like Fishway
2. Location: immediately downstream of Brandywine River Dam 2
3. NLF Operational Range: River flows of 95% (246 cfs) to 5% (1,418 cfs) exceedance flows during the fish passage season (as measured at the Brandywine Creek at Wilmington, DE USGS gage (01481500) and reduced by the daily average withdrawal for Wilmington's water supply [estimated at 19 MGD/35 cfs])
4. Design Flood/Stability Event: 100-year flood
5. There will be no substantial impact to Wilmington's water withdrawal operations at the Dam or at their intake facility upstream of the Dam.
6. The fishway will have three "Zone of Passage" (ZOP) notches at varying elevations along each of the rock weirs below the concrete dam.



7. The fish passage season is considered as March 15 through June 15 of each year.
8. The 2016 Federal Interagency Nature-like Fishway Passage Design Guidelines for Atlantic Coast Diadromous Fishes (Turek et al., 2016) will be used to guide the design, but given the infrastructure constraints at the site, the design will be in accordance with the guidelines as much as practical and agreed to by the regulatory agencies.
9. Mechanical gates to be provided that allow the City of Wilmington to close the notches in Dam 2 during periods of extremely low flow (<150 cfs).
10. Provide capabilities for downstream passage that provide deeper water than just over the dam crest.

### **3.0 FISH PASSAGE EFFECTIVENESS AND MIGRATION DELAY**

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Biological performance criteria for the fishway will focus on two major areas: 1) passage effectiveness (i.e., how many fish that encounter the fishway successfully exit upstream), and 2) limiting migration delay (i.e., for fish motivated to migrate, is the fishway easy to navigate so their migration upstream is not unduly delayed).

Although NLFs are currently considered a preferred option when fish passage is required at low-head dams there is limited data available on their effectiveness. A study conducted in 2013-2015 by Raabe et al., (2019) to determine passage effectiveness of American Shad in a large rock weir NLF constructed on the Cape Fear River in 2012, reported 53% to 65% of tagged shad passed upstream. This facility was the first NLF constructed on the East Coast for American Shad. Since that time, design standards have been modified to better emulate natural river conditions and provide hydraulic conditions commensurate with target species' swimming abilities. Also, it should be noted that the fisheries biologists who led the monitoring studies for the Cape Fear River NLF noted their concern that the collection and tagging methods used for that study may have had an impact on the migratory motivation (fallback) of the fish used in the study, which likely impacted the results of that study. Current professional opinion is that a properly designed and constructed Rock Weir NLF for American Shad and other Alosine species in relatively small rivers should be able obtain passage efficiencies of 70 – 95% and with a minimal migration delay of 4 – 5 days (Kleinschmidt, 2021). As such, the proposed target passage efficiency for a Rock Weir NLF for American Shad at Dam 2 is a 3-year running average of 70% with a migration delay of 4 days or less.

## 4.0 DEMONSTRATION OF SPAWNING/FORAGING HABITAT USE

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While passage of fish through the NLF achieves the objectives of removing the upstream migration barrier, additional documentation of successful use of spawning and foraging/rearing habitat upstream of Dam 2 is necessary. Approaches to document successful use of upstream habitat by Alosine species are detailed in the biological monitoring plan and include haul seining, targeted surveys by skilled anglers, ichthyoplankton sampling, visual observations of spawning activities, and eDNA studies. The following biological performance criteria will be used to evaluate the success of the upstream fish passage at Dam 2.

### **Documentation of Alosine Spawning Success**

The successful spawning by the target species up to the vicinity of Dam 4 will be assessed. This will be accomplished through methods identified in the Monitoring Plan. To successfully meet this performance criteria, successful spawning of at least one of the target species shall be qualitatively documented by at least two of the methods (as listed in the Monitoring Plan) for three consecutive years or four out of five consecutive years, sampling conditions permitted. If this criterion is achieved in the first 3 years of monitoring, no further monitoring is required for this criterion.

## 5.0 REFERENCES

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- Kleinschmidt. 2021. Brandywine River Dams 2-6 Engineering Feasibility Assessment and Fish Passage Alternatives Analysis. 54 pp.
- Turek, J., A. Haro, and B. Towler. 2016. Federal Interagency Nature-like Fishway Passage Design Guidelines for Atlantic Coast Diadromous Fishes. Interagency Technical Memorandum. 47 pp.
- Raabe, J.K., J.E. Hightower, T.A. Ellis, and J. J. Facendola. April 2019. Evaluation of Fish Passage at a Nature-Like Rock Ramp on a Large Coastal River. Trans. Am. Fish. Soc., 148, pp. 798-816.

# **APPENDIX E**

## **Preliminary Monitoring Plan**

# BIOLOGICAL MONITORING PLAN FOR THE PROPOSED BRANDYWINE DAM 2 NATURE-LIKE FISHWAY

ASSOCIATED WITH THE EDGEMOOR  
PORT MITIGATION

Prepared for:  
**Diamond State Port Corporation**

Prepared by:  
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**August 2021**

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## 1.0 INTRODUCTION

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Diadromous fish species require safe, timely, and effective access to high quality habitats at different life stages in order to successfully survive and reproduce. On the Brandywine River multiple low head dams currently prevent upstream migrations. These adverse impacts can be mitigated by implementing properly designed nature-like fishways (NLF) using criteria provided by the United States Fish and Wildlife Service (USFWS, 2019) and in the Federal Interagency Nature-Like Fishway Passage Design Guidelines for Atlantic Coast Diadromous Fishes (Turek et al., 2016). After the fishway is installed, monitoring is critical to document that the Performance Criteria for the proposed NLF are achieved. The following is a monitoring program set out to assess the Performance Criteria that are generally grouped into the following categories (see corresponding Ecological Performance Criteria; Kleinschmidt, 2021), with the proposed monitoring method included below each category and more fully described below:

1. NLF Design Criteria
  - a) As-Built Survey
  - b) Hydraulics Verification
2. Fish Passage Effectiveness and Migration Delay
  - a) Radio Telemetry Studies
3. Demonstration of Spawning/Foraging Habitat Use
  - a) PIT Tagging/Skilled Angler Survey
  - b) Haul Seining
  - c) Ichthyoplankton Sampling
  - d) eDNA Sampling

Any substantial modifications to this plan will be submitted to the resource agencies for review and approval prior to implementation.

## 2.0 NLF DESIGN CRITERIA

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As described in the Performance Criteria for this project (Kleinschmidt, 2021), the criteria that inform the design will be evaluated against the as-built condition to ensure that the actual fishway layout and flow conditions generally meet the overall objectives for the target species. The following actions will be completed to document compliance.

### 2.1 As-Built Survey

DSPC shall complete an as-built survey within 60 days of project completion. The survey will compare as-built dimensions and elevations to those in the final design drawings, including red-



line markups of the design drawings. This survey shall capture the following components of the design at a minimum:

1. dam notch width and invert elevation
2. top of boulder locations and elevations across each weir
3. zone of passage notch widths and invert elevations
4. maximum pool depths
5. profile along each of the zones of passage that captures the breadth of the weir (upstream to downstream dimension), pool depth, and distance between weirs at all weirs below the dam

The as-built survey shall be stamped by a Professional Surveyor licensed in Delaware and filed with the resource agencies and City of Wilmington, Delaware. All average notch and boulder elevations shall be within 0.25-feet of the design elevation.

## **2.2 Hydraulics Verification**

This phase is essential to developing proper hydraulics in the fishway, as this allows for field adjustments to achieve the desired geometry and hydraulic conditions. After the fishway is functionally complete, but before the contractor demobilizes, DSPC shall complete a survey of the average water levels in the pools and velocities in the zone of passage (Marsh McBirney flow meter or similar), along with performing observations of the overall hydraulics for consistency with the design. The results of this hydraulic verification shall be presented in a short memo and filed with the resource agencies and City of Wilmington, DE.

## **3.0 FISH PASSAGE EFFECTIVENESS AND MIGRATION DELAY**

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Biotelemetry will be used to assess both fish passage effectiveness and migration delay for American Shad and river herring. These technologies include radio telemetry, acoustic telemetry, and passive integrated transponders. Each technology has its advantages and drawbacks and depending on study objectives and study conditions anyone technology is usually most appropriate for use.

Generally, radio telemetry to monitor fish behavior works well in shallow ( $> 15$  m), freshwater systems, either fast flowing and turbulent or slow moving and calm. Signals from the transmitter are received through above water, directional antennas or in some cases, specially designed underwater antennas. Range from radio transmitters can be lowered to as low as 5 feet to look at passage through a gate or increased up to over 1,000 feet to cover a full-river width Tracking of

test specimens is done from stationary receiving locations or mobile receivers (boat, vehicle, airplane).

Acoustic telemetry to monitor fish behavior works well in deep freshwater, brackish water, and saltwater environments with minimal turbulence. Air entrainment and turbulence commonly found in shallow rapids and riffles in freshwater river systems, as well as acoustic noise generated by machinery (boats, water intakes, etc.), especially when combined with hard bottom substrates (cobble/boulders) and bedrock outcroppings, can interfere with signal reception which is obtained by deployment of an underwater hydrophone. In a well-designed acoustic system in relatively deep water, a hydrophone array can provide very accurate three-dimensional location data. However, applicability of acoustic telemetry for evaluation of fish passage performance in a shallow turbulent NLF or free-flowing riffle sections of the Brandywine River will be limited.

Passive integrated transponders (PIT tags) are small transponder tags usually injected into the body cavity or musculature of a target species. The tag is “energized” and transmits its unique signal when the fish passes through an area energized by a wire antenna configured either in a loop or as a flat linear array. PIT tags are often used in evaluation of fish ladders, fish lifts, and downstream passage collection devices because of the confined nature of these structures that permits deployment of antennas in constricted areas that are relatively protected from damage due to debris and high water and where fish are forced to pass through a small space that is easily energized with a wire loop or linear antenna. Monitoring large notches in dams or long expanses on dam crests or stream beds has been problematic in many locations.

Based on the advantages and drawbacks of each technology relative to the objectives for evaluating fish passage effectiveness and migration delay for American Shad and river herring at the proposed rock weir NLF at Dam 2, radio telemetry is the most appropriate technology for use. A study approach is outlined below.

### **3.1 Radio Telemetry Studies**

Starting in the first spring migration season after confirmation that the rock weir NLF was constructed according to design and is operating properly, a 3-year telemetry study will be conducted for American Shad and river herring to determine fish passage effectiveness and migration delay. The study will be iterative in nature, utilizing lessons learned from one year in subsequent years to modify study approaches and techniques to ensure study objectives are attained. Study approach includes:

1. Sample size will be 30 adult American Shad and 30 adult river herring each year.
2. Radio telemetry technology will be utilized. Transmitter size and will be specific to species and study objectives relative to battery life required.

3. Transmitter "attachment" will be gastric insertion through the esophagus.
4. Transmitter frequency, antenna configuration, and receiver location will be determined after site-specific range and noise testing. At a minimum, receiver location will collect data to discern the entrance of individual fish into the fishway, residence time of fish within the fishway, exit of individual fish from the fishway, and identification of fish which have dropped back downstream beyond a specified location.
5. Test specimens will be collected in the Brandywine River by boat-mounted electrofishing, haul seining, and/or targeted angling by skilled/select anglers working in conjunction with fisheries technicians.
6. All radio-tagged test specimens will also be PIT tagged for additional study in upstream habitat and for potential recognition as return spawners in subsequent years.
7. Spring upstream migration season is considered as 15 March to 15 June. Three years of study are anticipated to determine fishway performance over a range of river flow during this time. In general, the range defining typical high and low flows during the American Shad upstream passage season is:
  - a) typical low flow range: 246 cfs to 478 cfs
  - b) typical high flow range: 579 cfs to 1,418 cfs
8. Studies may be modified/postponed/delayed, after consultation with the resource agencies for extenuating circumstances such as:
  - a) high water/flooding that necessitates the removal of monitoring equipment
  - b) repairs/physical adjustments to the fishway that require deployment of equipment (e.g., excavators, cranes, coffer dams) that would not make fish passage representative if monitored
  - c) lack of test specimens available in the Brandywine River
9. Study reporting and subsequent year study plan adjustments, if needed, shall be submitted for agency review by November 30 of the calendar year in which the work occurred.

At least 10 months prior to the start of the first upstream migration season following completion of the NLF, DSPC shall prepare and submit to the Resource Agencies for review a Dam 2 Fish Passage Monitoring Plan (the "Monitoring Plan") containing detailed protocols for the monitoring studies and target areas for receiver deployment/data collection.

## **4.0 DEMONSTRATION OF SPAWNING / FORAGING HABITAT USE**

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Ultimately the goal of fish passage is to provide access to suitable upstream habitats for adult spawning and rearing of juveniles to increase population abundance. The use of habitat upstream of Dam 2 by Alosine species (e.g., American Shad, alewife, and blueback herring) for spawning and foraging/rearing will be determined on a quantitative and qualitative bases as an additional measure of program success. In addition to the four methods described below, visual observations of spawning activities by the target species can be used to qualitatively confirm use of the upstream river reaches. Most of this work will build upon existing programs or begin implementation of new approaches. A brief summary of the annual field efforts and qualitative results related to the Project Performance Criteria will be presented in a Study Report (including any suggested subsequent year study plan adjustments, if needed) that is submitted for agency review by December 31 of the calendar year in which the work occurred.

### **4.1 PIT Tagging/Skilled Angler Survey**

Targeted angling by skilled anglers will be used to help determine the distribution of Alosines upstream of Dam 2 after the passage season starts. A systematic sampling program will target specific areas of the river based on a statistically derived study design. Additionally, migration timing above Dam 2 will be determined through this study by recapture of Alosines PIT tagged downstream of Dam 2 during collection of test specimens for the radio telemetry study. In addition to 30 American Shad and 30 herring that will be both radio-tagged and PIT tagged, an additional 75 American Shad specimens and 75 river herring specimens, (total of up to 150 fish, with exact ratio/quantity dependent on collection efforts below Dam 2) will be PIT tagged for potential recapture by anglers upstream of Dam 2. This study will last approximately 12 weeks over the migration season with collection for tagging conducted by the same methods utilized to tag fish for radio telemetry below Dam 2. Anglers will be accompanied by a biological technician to collect morphometric data on captured fish and to scan specimens for the presence of a PIT tag.

### **4.2 Haul Seining**

Haul seining is currently being conducted at one location downstream and one location upstream of Dam 2 (Brandywine, 2020 YOY Report) and is being used to examine the recovery of diadromous fish to the Brandywine River. Seining will be expanded to suitable locations upstream of Dam 2 and will be conducted twice monthly from July through October. Sampling via haul seining will be conducted at the two existing locations and a minimum of two additional locations upstream of Dam 2 and Dam 3. Haul seining will be conducted annually following installation of the NLF to document successful reproduction of Alosines between Dams 2 and 4 and the archival of the performance criteria for this project.

Seine samples will be conducted using a modified Swingle Method (Park & Stangl 2020; Swingle 1956) which includes anchoring one end of the net and then conducting a single arc through the water column. All fish collected will be enumerated and identified to the lowest taxonomic level possible and released alive. Length data will be obtained from a random subsample ( $n = 20$ ) of each Alosine species collected.

#### **4.3 Ichthyoplankton Sampling**

During the first spring season migratory fish passage is provided at Dam 2, qualitative ichthyoplankton samples will be collected upstream of Dams 2 and 3 to verify target fishes are spawning within the Dam 2 to Dam 4 reach. The intent of this work is not to quantify egg deposition but to confirm spawning is occurring in several locations where Alosines would be expected to spawn. Ichthyoplankton samples will be collected at a minimum of three locations upstream of Dam 2 and Dam 3 during three sampling events between April 15 and May 30. Samples will be collected by anchoring a half or full meter net just below the water surface for 10 minutes in area identified as a likely spawning location either by visual observation of spawning behavior or a concentration of fish identified by the skilled anglers participating in the distribution study. All samples will be preserved in 95% ethanol after collection. Samples will be sorted and eggs and ichthyofauna will be identified to species.

#### **4.4 eDNA Sampling**

The collection of eDNA allows the detection of fish without the visual identification/catching of the fish and will be used to confirm passage and utilization of spawning habitat between Dams 2 and 4. During the spawning season (March 15 to June 15), samples will be collected monthly (4 sampling events) at five locations. A reference sample will be collected downstream of Dam 2 and two samples will be collected upstream of both Dam 2 and Dam 3 during each sampling event. Each sample will be sent for analysis of the target species, as well as selected resident species. While the collection of eDNA samples can be used to document migratory fish passage above Dams 2 and 3, it also be used to obtain base line data to help determine the redistribution of resident species downstream of Dam 2 to upstream locations after fish passage is implemented. The results of the eDNA sampling are anticipated to confirm if any Alosines were present in those reaches at the time of the sampling, but they will not serve as a prediction of population size.

## 5.0 REFERENCES

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- Hale, Edward A. 2020. An Annual Report Examining the Recovery of Diadromous Fishes in the Brandywine Creek, DE. 11 pg.
- Kleinschmidt. 2021. Brandywine River Dams 2-6 Engineering Feasibility Assessment and Fish Passage Alternatives Analysis. 54 pp.
- Kleinschmidt. 2021. Ecological Performance Criteria for the Proposed Brandywine Dam 2 Nature-Like Fishway. 6 pp.
- Kleinschmidt. 2021. Maintenance Plan for the Proposed Brandywine Dam 2 Nature-Like Fishway. 5 pp.
- Raabe, J.K., J.E. Hightower, T.A. Ellis and J. J. Facendola. April 2019. Evaluation of Fish Passage at a Nature-Like Rock Ramp on a Large Coastal River. Trans. Am. Fish. Soc., 148, pp. 798-816.
- Turek, J., A. Haro, and B. Towler. 2016. Federal Interagency Nature-like Fishway Passage Design Guidelines for Atlantic Coast Diadromous Fishes. Interagency Technical Memorandum. 47 pp.
- U.S. Fish and Wildlife Service. 2019. Fish Passage Engineering Design Criteria. 248 pp.

# **APPENDIX F**

## **Preliminary Maintenance Plan**



# MAINTENANCE PLAN FOR THE PROPOSED BRANDYWINE DAM 2 NATURE-LIKE FISHWAY

ASSOCIATED WITH THE EDGEMOOR  
PORT MITIGATION

Prepared for:

**Diamond State Port Corporation**

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**August 2021**

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Nature-like fishways (NLFs) are considered to have low maintenance requirements after they are constructed because they replicate a natural river systems. The proposed Rock Weir NLF design is intended to be self-flushing, which reduces, if not eliminates, the need to remove debris from the fishway. This self-flushing may take time and depends upon water level fluctuations to dislodge debris. One case example is the Midtown Rapids NLF, on the Red River in Minnesota, which required no maintenance in the 10-year period following construction despite the first, fourth, and sixth largest floods of a 125-year period of record (Aadland, 2010). Similarly, no maintenance has been required at the USACE Cape Fear NLF since it was constructed in 2012 and accordingly, the USACE has not found the need to prepare a Maintenance Plan (Yelverton, 2019). While logs and woody debris accumulate from time to time, they are generally flushed through on the next high flow event. Overall, a minimal amount of maintenance is anticipated, for a Rock Weir NLF at Dam 2 with most activity focused primarily around ensuring the initial stability of the structure post-construction. The maintenance activities anticipated for the Brandywine Dam 2 NLF are detailed below and include Initial NLF Structural Inspections (Years 0-5), Post 100-Year Storm Inspections, and Annual Maintenance (Years 6+).

**1. Initial NLF Structural Inspections (Years 0-5)** – Diamond State Port Corporation (DSPC) shall be responsible for the inspection and maintenance of the Rock Weir NLF during the first 5 years of operation.

- a. Visual Inspection – Visual inspections shall occur four times per year. The first inspection shall be conducted prior to the start of fish passage season (target March 1), twice during the fish passage season (target April 15 and May 15), and once during the seasonal low-flow period. The upstream fish passage season is generally considered to be March 15<sup>th</sup> to June 15<sup>th</sup> for American Shad, river herring, and blue back herring upstream passage. The seasonal low-flow period is generally considered August to November. It is recommended that shore-based visual observations be supplemented by drone-based aerial observation. The following shall be documented/observed during each visual inspection:

- i. River Flow:

- 1) Record flow at USGS Gage No. 01481500 Brandywine Creek at Wilmington, Delaware.
- 2) Request and record City of Wilmington combined water withdrawal from the Dam 2 Headrace and the Wills Raw Water Pumping Station.
- 3) Record local staff gage water level (staff gage to be installed during construction).

- ii. Weir Zone of Passage Notches

The NLF consists of a series of rock weirs. Each of the rock weirs is created by stacking boulders side by side at a consistent elevation in an arched

configuration. Each of the rock weirs will have a set of Zone of Passage Notches that consist of a series of boulders which are recessed at a lower height than the neighboring boulders. These notches are the primary flow path through the fishway and primary passage route for fish. During visual inspection the following observations should be made regarding these Zone of Passage Notches.

- 1) Are there blockages? If yes, indicate weir no. (numbering from upstream to downstream, with Dam 2 as weir no. 1), notch location (river left, center, river right), and cause of blockage.
- 2) What is flow type (Streaming or Plunging)? If plunging, indicate weir no. and notch location.

As an example, in the below picture, the flow is from top to bottom, with streaming flow on the left and plunging flow on the right.



- 3) Is the flow turbulent? If yes, indicate weir no. and notch location.
- 4) Is the drop per pool consistent across the fishway? If no, indicate which pool is the outlier (pools numbered from upstream to downstream).

### iii. Weir boulders

- 1) Are boulders dislodged or shifted? If yes, indicate weir no., boulder location, and cause (if it can be determined).
- 2) Are any boulders cracked? If yes, indicate weir no. and boulder location.

### iv. Foundation stone

- 1) Is the foundation stone dislodged or shifted, as observable during low flow periods or as evidenced by poor hydraulic conditions? If yes, indicate weir no. and location.

- v. Dam Gate/Fish Passage Notches
    - 1) Are there any blockages? If yes, indicate which gate.
    - 2) Is there any visible damage to the gate structure and controls? If yes, indicate which gate and describe damage.
  - vi. Photo Documentation - Provide photographic documentation of any noted items above, along with general fishway photographs from photo monitoring points (TBD).
  - vii. File a summary report from each inspection (including photos) with the City of Wilmington and the regulatory agencies.
- b. Accumulated Debris Removal
- In general debris removal is not anticipated to be required regularly, other than limited mobilization of smaller debris that can be easily freed with a pole from shore during the visual inspections. In-river debris removal shall be triggered only if two or more zone of passage notches are more than 75% blocked on a single weir and safe access to the river is feasible. Access to the NLF for debris removal will depend on river flows (safe access to the river is required to initiate debris removal), time of year (limited need for immediate debris removal in late summer, as higher fall flows will flush the NLF), and available equipment. Anticipated means of debris mobilization could include:
- i. pushing debris loose with a pole from shore
  - ii. wading into the water with a saw to cut debris up to free it from the NLF
  - iii. using a shore-based winch to pull debris off of the NLF
  - iv. using an excavator (shore based or in-water) to pick up and remove or free the debris from the zone of passage notches
- c. Gate Maintenance – The gate on the dam is anticipated to only require minimal maintenance if it is used several times per year. The maintenance is anticipated to include annual lubrication of the rotating parts, replacing seals ~5 years (depending on use), and replacing the bushings every ~10 years (depending on use). The exact gate maintenance requirements will be further developed once the gate design is finalized.
- d. Year 5 Survey – During the seasonal low-flow period of the 5<sup>th</sup> year of operation the rock weir fishway shall be resurveyed to capture top of boulder elevations/location of each boulder, zone of passage notch elevations and widths, and pool invert elevations. The survey data will be compared to the as-built survey and submitted to the resource agencies for review along with any repairs or modification that DSPC is proposing to re-align the fishway with the conditions anticipated during design.

## **2. Post 100-Year Storm Inspection**

This inspection shall occur whenever flows at the USGS Gage on the Brandywine River at Wilmington, DE reach the 100-year flood flow of 34,000 cfs or more. DSPC shall be responsible for these inspections for Years 0-5 of the fishway operation, with the City of Wilmington, DE responsible for the inspections after that time period. The 100-year storm inspection shall include the following tasks:

- a. Visual Inspection (as detailed above) – Allow time following the storm for flows to recede to allow for effective visual observation. Inspections shall occur within two weeks of the peak flow.
- b. Perform debris removal, as guided by the Accumulated Debris Removal guidance above.

## **3. Annual Maintenance (Years 6+)** – After the first 5 years of upstream fish passage operation (when DSPC is responsible for any inspections/maintenance), the City of Wilmington shall be responsible for the maintenance of the fishway as part of the Brandywine Park and the operation of the water intake at Dam 2. The following shall be performed annually, as detailed above:

- a. Visual Inspection – four inspections per year
- b. Gate Maintenance – annual
- c. Accumulated Debris Removal – as needed

## **4. Repairs** – If the hydraulics are substantially affected due to damage to the fishway, repairs may be required after consultation with the USFWS, NOAA, and DNREC. The critical components are the zone of passage notch depths and widths, drop per pool, and pool depth. The responsible party (DSPC Years 0-5 and City of Wilmington after) shall prepare a short proposal outlining the poor conditions and what is being proposed to remediate those conditions. This proposal shall be submitted to and accepted by the resource agencies prior to initiating the work. All repairs shall be developed to restore the initial design, unless determined otherwise in consultation with the resource agencies. The as-built drawings (to be attached to this plan post-construction) shall guide any repair efforts.

## **References**

Aadland, Luther. 2010. Reconnecting Rivers: Natural Channel Design in Dam Removals and Fish Passage. Minnesota Department of Natural Resources, Ecological Resources Division. Fergus Falls, Minnesota.

Yelverton, Frank. 2019. Personal Communication via email. August 16, 2019.