Supawna Meadows National Wildlife Refuge: Marsh Restoration Project (Goose Pond)

Environmental Assessment

U.S. Fish and Wildlife Service

August 2022

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LIST OF ACRONYMS

Amec Foster Wheeler	Amec Foster Wheeler Environment &
Infrastructure, Inc.BGEPA	Bald and Golden Eagle Protection Act
˚C	Degrees Celsius
CCP	Comprehensive Conservation Plan
CEQ	Council for Environmental Quality
CFR	Code of Federal Regulations
DA	Design Alternative
dB	Decibels
dBA	A weighted sound level measured in decibels
dBC	C weighted sound level measured in decibels
DEBI	Delaware Estuary Benthic Inventory
DFW	Division of Fish and Wildlife
DLUR	Division of Land Use Regulation
DNREC	Delaware Department of Natural Resources and EnvironmentalControl
DO	Dissolved oxygen
DuPont	E.I. DuPont de Nemours and Company
EA	Environmental Assessment
EFH	Essential Fish Habitat
EFHA	Essential Fish Habitat Area
ESA	Endangered Species Act
FONSI	Findings of No Significant Impact
HAPC	Habitat Areas of Particular Concern
Hz	Hertz
IPaC	Information, Planning, and Conservation
IPCC	Intergovernmental Panel on Climate Change
LiDAR	Light Detection and Ranging
MBTA	Migratory Bird Treaty Act
mg/L	Milligrams per liter
Mid-TRAM	Mid-Atlantic Tidal Rapid Assessment Method
msl	Mean sea level
NAAQS	National Ambient Air Quality Standards
NAVD 88	North American Vertical Datum 1988
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NJAAQS	New Jersey Ambient Air Quality Standards
N.J.A.C.	New Jersey Administrative Code

NJDEP	New Jersey Department of Environmental Protection
N.J.S.A.	New Jersey Statutes Annotated
NJSM	New Jersey State Museum
NMFS	National Marine Fisheries Service
NO	Nitric oxide
NO_2	Nitrogen dioxide
NOAA	National Oceanic and Atmospheric Administration
NTU	Nephelometric Turbidity Units
NWI	National Wetlands Inventory
NWR	National Wildlife Refuge
O_3	Ozone
OSHA	Occupational Safety and Health Administration
PDE	Partnership of the Delaware Estuary
$PM_{2.5}$	Particulate matter less than 2.5 micrometers in diameter
ppt	Parts per thousand
SAV	Submerged Aquatic Vegetation
Service	United States Fish and Wildlife Service
SHPO	State Historic Preservation Office
SILs	Significant Impact Levels
SLAMM	Sea Level Affecting Marshes Model
SMA	Special Management Area
SWQS	Surface Water Quality Standards
TSS	Total Suspended Solids
U.S.C.	United States Code
USACE	United States Army Corps of Engineers
USDOI	United States Department of the Interior
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
WOTUS	Waters of the United States

Chapter 1 – Purpose and Need

The Preferred Alternative (Proposed Action) is the restoration of tidal marsh hydrology at the Supawna Meadows ProjectArea (Project) (**Figure 1.1**) through implementation of the following restoration techniques:

- Removal of portions of an offshore stone breakwater dike in select areas to improve tidal exchange
- Enhancement of the stone breakwater dike in select areas to provide shoreline protection and protection for anticipated and current sea level rise

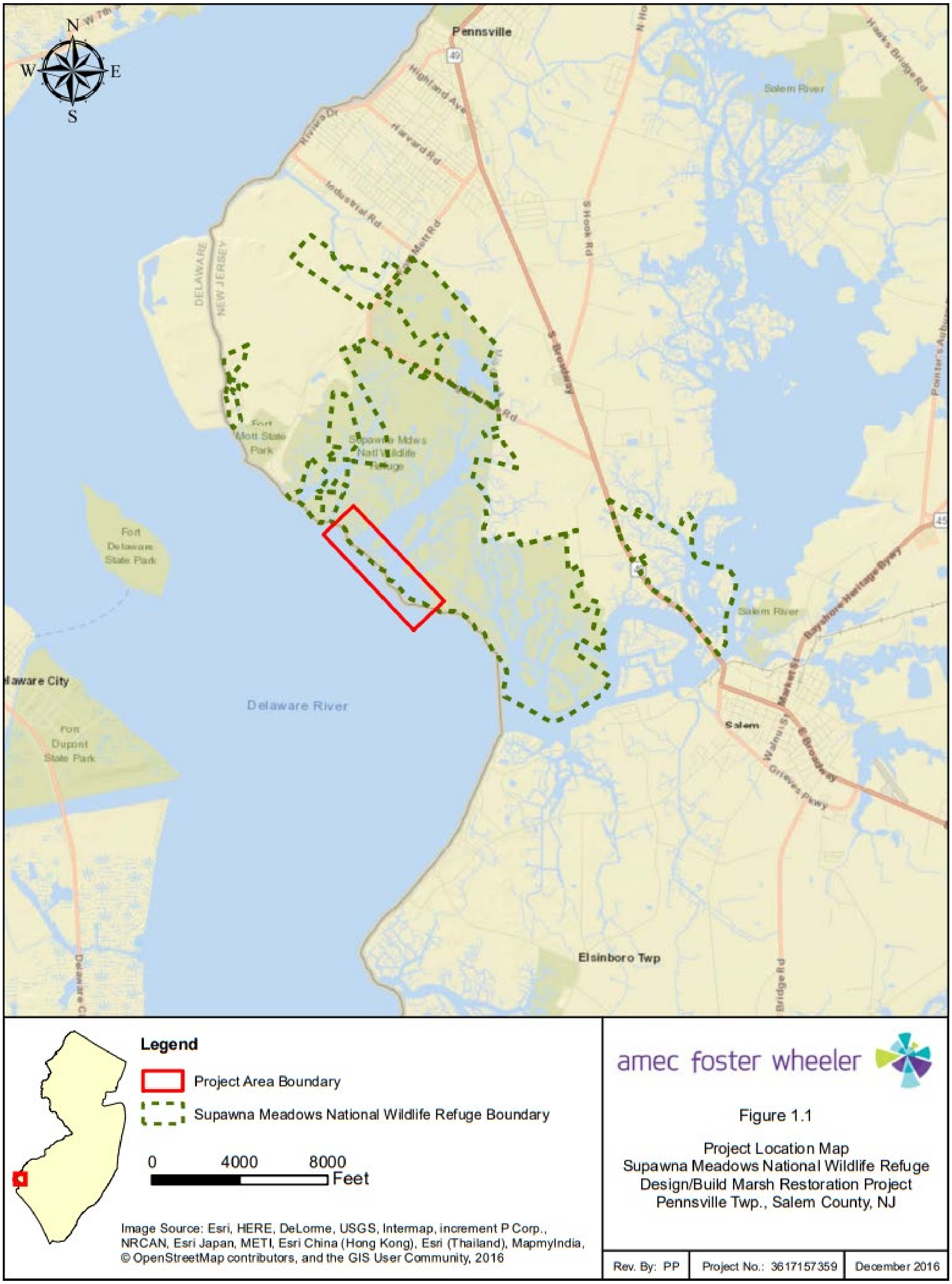
The purpose of the Preferred Alternative is to increase the resiliency of degraded salt marshes within the Supawna Meadows National Wildlife Refuge (refuge) in response to ecosystem stressors, through a viable and cost-effective manner that upholds the United States Fish and Wildlife Service's (Service) and refuge's missions, purposes, and goals. The Preferred Alternative is needed because of the following:

- Loss of coastal wetlands within the Delaware Estuary has been documented to be occurring and are predicted to increase in the near future;
- Resulting vegetation die-back, or changes in vegetative community structure, and reduction in rates of salt marsh accretion may lead to permanent loss of marsh land and conversion to open water, thereby exacerbating the vulnerability these critical wetlands have to sea level rise and coastal storm surge events; and
- Primary productivity of the marsh is critical in maintaining the role that these wetlands play in providing the necessary feeding, nesting, and resting habitat for coastal wildlife, particularly shorebirds, waterfowl, and migratory birds.

The Preferred Alternative will result in resilient wetlands that function as healthy living resources thatprovide ecosystem value, specifically by the following:

- Facilitating a more natural hydrologic regime;
- Enhancing salt marsh resilience from the impacts of sea level rise, large storm events, and other ecosystem stressors; and
- Improving rates of accretion.

The Preferred Alternative will protect the degrading marsh within Supawna Meadows NWR by protecting the marsh from the effects of boat and wave action. The enhancement of the stone breakwater will help the marsh keep up with sea level rise and storm events and will help the marsh accrete sediment which will help sustain the marsh in the face of the sea level rising and the marsh breaking down.


N
S
W
E
Pennsville
Highland Ave
Harvard Rd
Industrial Rd
S Hook Rd
S Broadway
Salem River
DELAWARE
NEW JERSEY
Fort Mott State Park
Supawna Mdws Natl Wildlife Refuge
Fort Delaware State Park
Delaware City
Fort Dupont State Park
Delaware River
Salem
Market St
E Broadway
Grieves Pkwy
Bayshore Heritage Byway
Elsinboro Twp
Bridge Rd
Legend
Project Area Boundary
Supawna Meadows National Wildlife Refuge Boundary
0
4000
8000
Feet
Image Source: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the GIS User Community, 2016
amec foster wheeler
Figure 1.1
Project Location Map
Supawna Meadows National Wildlife Refuge
Design/Build Marsh Restoration Project
Pennsville Twp., Salem County, NJ
Rev. By: PP
Project No.: 3617157359
December 2016

1.1 Statement of the Problem

Global climate change is threatening our nation's coastal environments, producing a number of far-reaching environmental effects of which sea level rise is one of the most pronounced (Climate Institute 2010). Small increases in sea level dramatically affects the world's coastlines, physically, biogeochemically, and economically through impacts such as erosion, flooding, salinization, and habitat transformation for wildlife and plants (Climate Institute 2010, UCS 2013). Although coastlines are naturally dynamic, being shaped and re-shaped through the actions of ocean waves, currents, and tides, rising sea levels alter these dynamics by amplifying their effects. Thus, large storm surges such as those caused by Hurricane Sandy can have catastrophic effects upon the coastline (UCS 2013). These impacts are a substantial and growing threat in the coastal region of New Jersey, which contains some of the most valuable estuarine and wetland ecosystems in the United States (Cooper et al. 2005).

The degradation of coastal wetlands within the Delaware Estuary has been documented to be rapidly occurring. A 2012 report by the Partnership of the Delaware Estuary (PDE) estimated that between 1996 and 2006, the rate of loss was approximately one acre per day, with the expectation of that rate increasing due to climate change and sea level rise. In 2010, another paper by PDE projected the future acreage of tidal wetland will decrease by approximately two-thirds of its current (2006) acreage by 2100.

In addition to increased water levels from sea level rise, the widespread practice of grid ditching, used to increase the production of salt marsh hay and control mosquitoes, has altered the natural salt marsh hydro-period (depth and duration of inundation) and caused the loss of important associated functions and the loss of vegetation. Inadequate tidal flushing and man-made barriers to tidal flow (e.g., roads, berms, dikes, under-sized culverts, etc.) have also added to the degraded condition and productivity of the tidal marshes, further impacting wetlands at the refuge.

The resulting vegetation die-back, or changes in vegetative community structure, and reduction in rates of salt marsh accretion may lead to permanent loss of marsh land and conversion to open water, thereby exacerbating the vulnerability these critical wetlands have to sea level rise and coastal storm surge events. Such degradation and loss runs counter to the mission of the National Wildlife Refuge System, the refuge, and the refuge's Comprehensive Conservation Plan (CCP) (USFWS 2011).

The importance of wetlands are well understood for providing fish and wildlife habitat, natural water quality improvement, flood storage, shoreline erosion protection, opportunities for recreation and aesthetic appreciation, and for the production of natural products (USEPA 2016). Wetlands are generally considered to be the major contributor to primary production within an ecosystem, and coastal wetlands, primarily salt marshes, are among the most productive ecosystems in the world (Tiner 1987). However, salt marshes only exist within a narrow range of elevations that bracket mean sea level (msl) (USFWS 2015). Because salt marshes only exist within this narrow range of elevation, they are highly susceptible to the effects of sea level rise and extensive drainage caused by anthropogenic stressors, such as the extensive dikes and ditches that were dug to covert the marshland in the refuge to salt hayfields and those dug for mosquito control (USFWS 2004).

Salt marshes normally keep pace with sea level rise through a process of vertical accretion and inland migration. Salt marsh accretion is a process by which the deposition of sediment and the accumulation of organic matter collectively raise the marsh elevation incrementally over time (Zhigang et al. 2014). However, due to extensive anthropogenic effects the marsh has either stopped or decreased its accretion rates. Today, New Jersey's salt marshes such as the Project area cannot keep pace with the rate of sea level rise. Therefore, these salt marshes risk permanent inundation (i.e. loss) if the sea level rises faster than the rate by which the marsh can accrete (Cooper et al. 2005).

Global climate change has already had an observable impact in the Northeastern United States. According to the Intergovernmental Panel on Climate Change (IPCC), sea level has risen worldwide approximately 4.8 to 8.8 inches during the last century and will continue to rise an additional 7.1 to 23.2 inches between 1999 and 2099 at a rate of approximately 0.07 to 0.23 inches per year (IPCC 2007). The historic trend for sea level rise within the refuge is 0.136 inches per year, about twice the global average for the last 100 years (USFWS 2011).

The refuge is located along the Delaware River, an area that is threatened by the effects of sea level rise. In 2010, a report by the PDE projected the future acreage of tidal wetland in the Delaware Estuary will decrease by approximately two-thirds by the year 2100 due to the rapid changes in sea levels. NOAA's SLAMM predictive tool indicated that saltwater intrusion is predicted to increase salinity within the refuge boundary by the year 2025, thereby increasing the amount of saltmarsh between 140 and 200 percent (adding between 219 and 300 acres). However, other tidal marsh habitats are predicted to decrease between 14 and 18 percent (losing about 300 to 400 acres). Over this same time span, tidal creeks are predicted to increase between 22 and 31 percent (between 150 and 220 acres). Because much of the habitat is tidally influenced, sea level rise will likely change the species composition and associated habitatmanagement for much of the refuge (USFWS 2011).

The rock dike that was built in 1900 along the marsh edge to prevent erosion failed early in the 1930s, re-flooding the tidal marsh. Remains of the dike are still present between the marsh and the Delaware Bay Estuary, which may be leading to restricted tidal flow and decreased quality of the marsh habitat. Drainage ditches and earthen dikes are also still present within the tidal marsh, altering hydrology. Data suggests it is possible that water moving into the Supawna Meadows Marsh Complex on flood tides is unable to escape on ebb tides and is being confined within the intra-marsh creek system and in pools in the interior of the marsh platform (Haaf et al. 2015b). The Marsh Futures Field Study Assessment performed by Haaf et al. (2015b) summarized that there is potential for marsh expansion from sediment collecting along theinterior edges and fringes of the marsh islands. However, the lack of accretion along the main river channel edge indicates that the historical stone breakwater system is currently contributing to the prevention of lateral change along this edge.

Increased water levels, inadequate tidal flushing, historical impacts (mosquito control and salt hay farming), erosion, and man-made barriers to tidal flow have degraded the condition and productivity of the tidal marshes within the refuge. The resulting vegetation die-back and reduction in rates of salt marsh accretion may lead to permanent loss of marsh land and conversion to open water, thereby exacerbating the vulnerability these critical wetlands have to sea level rise and coastal storm surge events. Therefore, the Service believes the Project area would benefit from various modifications to the existing breakwater dike to combat future impacts to the Supawna Meadows Marsh Complex.

The Delaware Bay coastline is under threat of permanent changes from the loss of salt marshes and subsequently, a loss of wetland function. These changes will reduce the quality of habitat for fish, birds, invertebrates, and plants that use rely on salt marshes along the Delaware Bay. The Service is concerned that these changes will result in conversion of the marsh to mudflat and open water. Since marshes provide storm and flood protection, these changes in the landscape could exacerbate the frequency and intensity of inland flooding from coastal storm surge events (Haaf et al. 2015a).

Photograph 1. 1931 Aerial Photography of a portion of Supawna Meadows NWR (NJGIN 1930-1939).

Photograph 2. 1939 Aerial Photography of a portion of Supawna Meadows NWR (NJGIN 1930-1939).

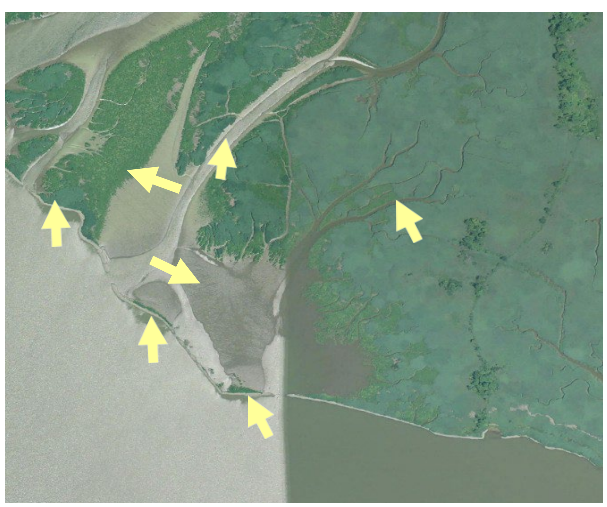
At the refuge, natural processes (e.g., sea level rise and erosion) began to damage the original dike system. Therefore, a more than 2-mile long stone breakwater was constructed circa 1900 along the marsh edge for the purposes of protecting the marsh and the original failing dike and ditch system (USFWS 2011). However, during the early 1930s, likely during Hurricane #6 of 1933, the stone breakwater breached in a number of locations (Mitchell 1933). As can be deduced from historical aerial photography, many of the salt hayfields flooded. This conversion of tidal marshes to open water and mudflats likely occurred for the following reasons: (1) a century's worth of agricultural practices that did not let these areas accrete the natural biomass necessary to help keep up with rising sea levels; (2) the agricultural practices that eliminated much of the micro-topography, leaving the marsh susceptible to wave scouring; (3) the breaches that did not support proper tidal flushing; and (4) the remaining earthen dikes and ditch system behind the failed stone breakwater that did not allow for natural drainage patterns. During this time Mill Creek moved south hundreds of feet and Goose Pond greatly enlarged (see Photographs 1 and 2).

Since then, it seems the Supawna Meadows Marsh Complex has been slowly returning to a state of equilibrium. From 2001 aerial imagery, it can be deduced that more natural dendritic patterns of channels are beginning to re-establish at the major breaches near the mouths of tributaries, Mill Creek has returned to a more traditional location in the marsh, and the marsh is slowly encroaching on Goose Pond. By 2006, the most notable observation is that large areas of formerly unvegetated open water became densely vegetated (mud flat/low marsh), primarily in the areas between Mill Creek and Goose Pond (see Photographs 3 and 4).

Photograph 3. 2001 Aerial Photography of a portion of Supawna Meadows NWR (Google Earth 2001).

Photograph 4. 2006 Aerial Photography of a portion of Supawna Meadows NWR (NJGIN 2006).

This observed marsh rejuvenation trend has slowly continued since that time. Photograph 5 appears to depict further indication of sediment retention and marsh expansion over the past decade, suggesting the existing portions of the stone breakwater are providing some level of protection to the marsh behind it. However, review of recent imagery suggests the rate of marsh formation is slowing, indicating that the current stone breakwater configuration can no longer support further marsh expansion.



Photograph 5. 2013 Aerial Photography of a portion of Supawna Meadows NWR (Post Hurricane Sandy); notice accretion and/or marsh expansion areas (NJGIN 2012-

1.2 Effects on the Service's and Refuge's Mission

The refuge marshes are critical in providing the necessary feeding, nesting, and resting habitat for coastal wildlife, particularly shorebirds, waterfowl, and migratory birds. Galbraith et al. (2002) reports that even a modest estimate of sea level rise could impair the ability of the Delaware Bay region to support the current number of migratory birds. Under a more realistic, but dire scenario, the Delaware Bay is predicted to lose at least 60% of its shorebird feeding habitats by the Year 2100. These habitat losses are not only restricted to marshes. As saline intrusion occurs, and as the salt marsh attempts to shift more landward, there is also the potential loss of maritime forest and coastal dune forest which is critical habitat for many wildlife species, such as the state-threatened black-crowned night-heron (*Nycticorax nycticorax*). Also at risk are fragile foredune habitats for a number of plant and animals species, such as the federally-listed seabeach amaranth (*Amaranthus pumilis*) (Cooper et al. 2005).

The reduction or loss of habitat and wetland functions run counter to the mission of the Service and the refuge. The mission of the National Wildlife Refuge (NWR) System is as follows:

- "…to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans." (National Wildlife Refuge System Improvement Act of 1997, Public Law 105-57).

The Supawna Meadows NWR was originally established as an addition to the Killcohook Migratory Bird Refuge and now is composed of 3,016 acres of tidal waters and marsh, grassland, shrubland, and forest habitats. More specifically, the refuge was established for the following purposes (USFWS 2011):

- "…as property with particular value in carrying out the national migratory bird management program (The Transfer of Certain Real Property for Wildlife Conservation Purposes Act, as amended [16 United States Code (U.S.C.) §667b-667d; 62 Stat. 240])";
- "…for use as an inviolate sanctuary, or for any other management purpose, for migratory birds (The Migratory Bird Conservation Act [16 U.S.C. §715D])"; and
- "…as a refuge suitable for (1) incidental fish and wildlife-oriented recreational development, (2) the protection of natural resources, (3) the conservation of endangered species or threatened species (Refuge Recreation Act, as amended [16 U.S.C. 460k-1])."

A few key objectives of the refuge include the following (USFWS 2011):

- "Protect, enhance, and restore biological integrity, diversity, and environmental health of tidally influenced habitats to support native wildlife and plant communities including species of conservation concern."
- "Protect, enhance, and restore biological integrity, diversity, and environmental health of upland habitats to support native wildlife and plant communities with emphasis on migrating and wintering birds and other species of concern."

- "Protect, enhance, and restore biological integrity, diversity, and environmental health of non-tidal wetland habitats to support native wildlife and plant communities with emphasis on breeding, migrating, and overwintering birds and other species of conservation concern."

The mission of the refuge is to "continue to provide essential tidal marsh habitat to feed and shelter migrating waterfowl and to feed nearby colonial-nesting wading birds, thereby maintaining its significant role as part of the Delaware Bayshore system of wetlands and upland buffers that is one of the most important migratory bird habitats in the nation." (USFWS 2011). All of the above conditions are vulnerable to the adverse impacts of sea level rise, erosion, and historic anthropogenic disturbances. Thus, there is a strong need for implementing the Preferred Alternative inorder to increase resiliency and uphold the mission, purpose, and goals of the Service and refuge.

As this Project is an action proposed by the Service, a Federal agency, the National Environmental Policy Act [42 U.S.C. 4321 et seq.; NEPA] and the Council on Environmental Quality's (CEQ) NEPA regulations [40 Code of Federal Regulations (CFR), Parts 1500 to 1508] require that the potential environmental impacts of this Preferred Alternative be considered before a final decision to carry through with the Preferred Alternative is made. In compliance with these regulations, this EA hasbeen developed which examines the need for the Preferred Alternative, the potential environmental impacts of the Preferred Alternative and the No Action Alternative, and identifies the unavoidable adverse environmental impacts identified as a result of the Preferred Alternative, if it were to be implemented.

The Service is committed to working closely with Federal and state resources, prior to and during Project construction to continue monitoring and collection of additional data, provide relevant supplemental information as needed, and to apply adaptive management and best management practices as appropriate. The United States Army Corps of Engineers (USACE) and the National Marine Fisheries Service (NMFS) are serving as cooperating agencies in the preparation and review of the NEPA documentation for this Project.

The refuge had been identified as a candidate for enhancement as it had been determined to be deficient in sediment deposition and tidal flow due to alterations of the hydrologic patterns from anthropogenic structures and actions. The first phase of this project (Mill Creek) was completed as the Service's Design/Build Marsh Restoration at the Cape May National Wildlife Refuge Complex Project (Resiliency Project # 37) (**Figure 1.2**). This second phase consists of wetland restoration at Goose Pond.

1.2 Regulatory Framework

NEPA requirements help ensure that environmental information is made available to the public during the decision-making process and prior to implementing an action. The premise of NEPA is that the quality of decisions will be enhanced if proponents provide information to the public and involve the public in the planning process. The Service conducted public outreach for the first phase of the Project through website updates, press releases, and public meetings. The Service has been, and will continue to be, coordinating efforts with other Federal, and New Jersey State agencies throughout this Project. State and Federal application reviews will also include public comment periods and meetings. The Federal and state laws most relevant to this Project are as follows:

- Federal level:
  - Federal Water Pollution Control Act (Clean Water Act; 33 U.S.C. 1251 *et seq.*).
  - Rivers and Harbors Act of 1899 (33 U.S.C. 407).
  - North American Wetlands Conservation Act (103 Stat. 1968; 16 U.S.C. 4401-4412)
  - Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531-1544).
  - National Historic Preservation Act (NHPA) (16 U.S.C. 470).
    - In the event archeological relics or sites are discovered during Project operations, actions will be taken to be consistent and compliant with the following additional Federal laws:
      - The Antiquities Act of 1906 (16 U.S.C. 433).
      - The Archeological Resources Protection Act of 1979 (16 U.S.C. 470aa-47011).
      - The Archeological and Historic Preservation Act of 1960 (16 U.S.C.469-469C).
      - The Historic Sites, Buildings and Antiquities Act of 1935 (HistoricSites Act) (16 U.S.C. 461-462, 464-467).
      - National Historic Preservation Act of 1966 (12 U.S.C 470-470b,470c-470n)
  - National Wildlife System Improvement Act of 1997 (Public Law 105-57).
  - Migratory Bird Treaty Act of 1918 (MBTA) (16 U.S.C. 703–712).
  - Migratory Bird Conservation Act of 1929 (16 U.S.C. 715-715d, 715e, 715f-715r)
  - Bald and Golden Eagle Protection Act (BGEPA) (16 U.S.C. 668-668c).
  - NEPA (83 Stat. 852; 42 U.S.C. 4321 *et seq*.) and the CEQ's NEPA regulations 40CFR, Parts 1500-1508).
    - Tribal consultation in accordance with both Section 106 NHPA and Section40 CFR 1501.2(d)(2) of the CEQ's NEPA regulations.
  - Executive Order 11988, Flood Plain Management
  - Fish and Wildlife Improvement Act of 1978 (16 U.S.C. 7421, 92 Stat. 3110)

- New Jersey State level:
  - Waterfront Development Act (New Jersey Statutes Annotated (N.J.S.A.) 12:5-3).
  - Wetlands Act of 1970 (N.J.S.A. 13:9A).
  - Tidelands Act (N.J.S.A. 12:3).
  - Surface Water Quality Standards (SWQS) (New Jersey Administrative Code(N.J.A.C.) 7:9B).

- Delaware State Level:
  - Title 7 of the Delaware Code (Chapter 72-Subaqueous Land).

A number of agencies have been and will be involved in the review of the Federal Consistency of this Project. These agencies are as follows:

- Federal level:
  - USACE.
- New Jersey State level:

  - NJDEP, Division of Land Use Regulation (DLUR).
  - NJDEP, Bureau of Coastal Management.
  - NJDEP, Bureau of Tidelands.
  - NJDEP, State Historic Preservation Office (SHPO).
  - NJDEP, Division of Fish and Wildlife (DFW).

- Delaware State Level:
  - Delaware Department of Natural Resources and Environmental Control(DNREC), Natural Heritage Program
  - DNREC, Fish and Wildlife
  - DNREC, Coastal Zone Program
  - DNREC, SHPO

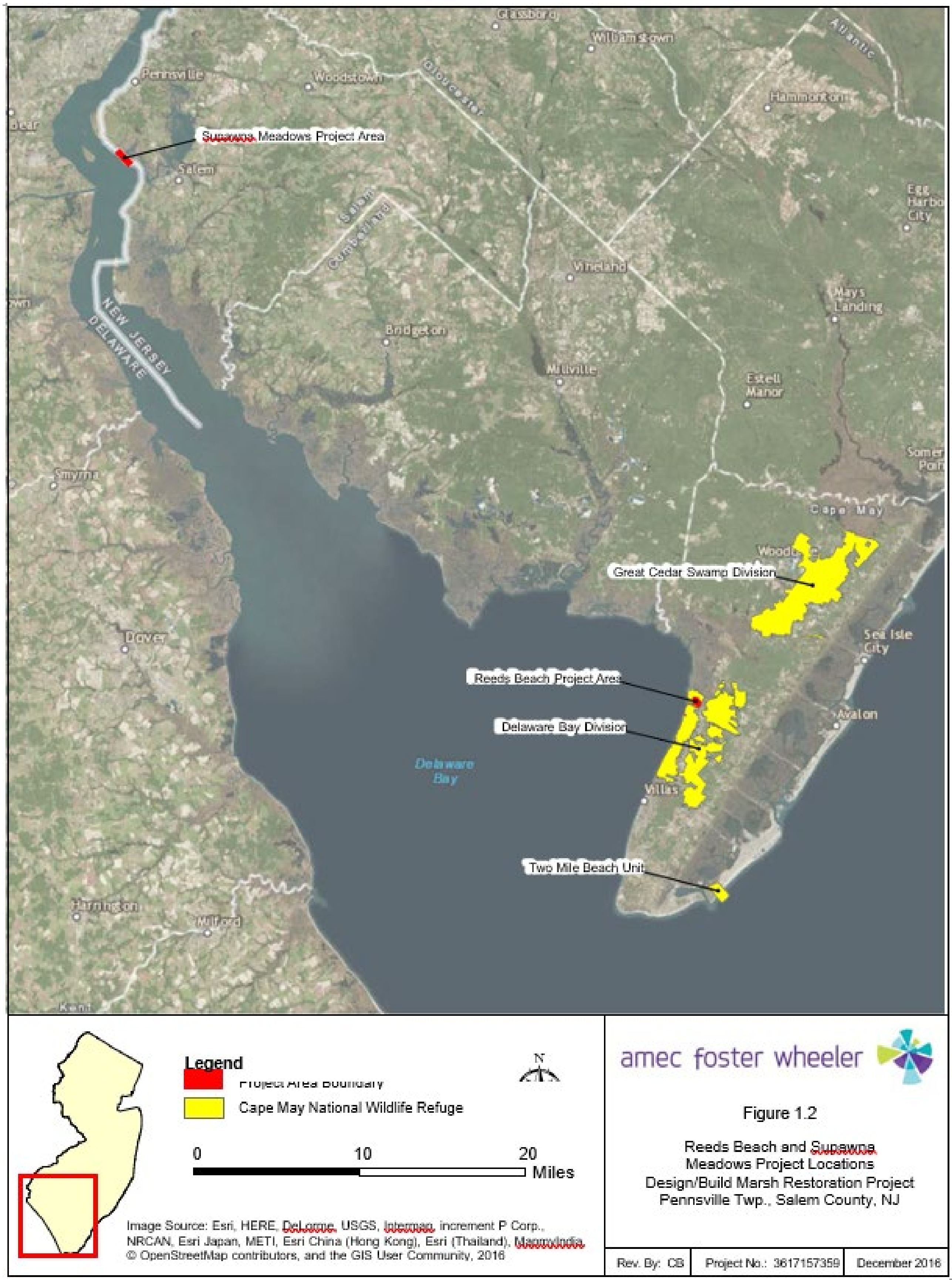


Figure 1.2

Reeds Beach and Supawna Meadows Project Locations
Design/Build Marsh Restoration Project
Pennsville Twp., Salem County, NJ

1.3 Report Structure

This EA examines the Preferred Alternative to increase the resiliency[1] of salt marshes within the refuge in response to these ecosystem stressors. Chapter 2 presents a description of the existing physical and environmental conditions of the Project area, Chapter 3 presents the proposed scope of work and the alternatives that were considered for the Project, and Chapter 4 presents an assessment of the consequences for each alternative. The EA concludes with literature references in Chapter 5, and list of report preparers in Chapter 6. Photographs depicting the condition of the refuge are presented in **Appendix A**, 60% Design Plans are presented in **Appendix B**, information on threatened and endangered species is presented in **Appendix C**, and information on cultural and historical resources is presented in **Appendix D**.

Chapter 2 – Affected Environments and Their Existing Conditions

2.1 Introduction

This section describes the existing environmental resources in the Supawna Meadows Project Area, including physical resources (topography, geology, etc.), biological resources (vegetation, wildlife, etc.), and other categories such as cultural resources, socioeconomic and environmental justice, and transportation. As stated previously, these areas within the refuge were selected for their long history of anthropogenic alterations, their advanced state of degradation, their vulnerability to sea level rise and other stressors, and their anticipated positive responses to increased resiliency.

2.2 Supawna Meadows NWR Project Area

Officially established in 1974, the Supawna Meadows NWR is currently 3,016 acres of tidal waters and marsh, grassland, shrubland, and forested habitats. It is located in the Township of Pennsville, Salem County, New Jersey, along the Delaware River where it widens to become the Delaware Bay estuary (USFWS 2011) (**Figure 2.1**). The refuge boundaries include the Delaware River to the southwest, Salem River to the southeast, Lighthouse Road to the northeast, and Fort Mott State Park to the northwest. It is located in the Service's Northeastern Region.

The Supawna Meadows NWR Preferred Alternative area consists of an old stone breakwater alongthe Delaware River and approximately 60 acres of open water and marsh complexes

[1] Salt marsh resiliency is defined here as the ability of a salt marsh to return to a sustainable state after impacts fromsea level rise, large storm events, and other ecosystem stressors (USFWS 2015).

locatedaround it. These marsh complexes are reclaimed agricultural land, having been abandoned sometime after 1938 due to significant inundation. These fields likely lost value as salt hay farming declined and soils became too saturated for other crops. The Project area is primarily contained within Block 5501, Lot 17 and the Delaware River, and meanders through both New Jersey state-owned lands and Delaware state-owned lands.

2.2.1 Topography

The topography of the Project area is relatively flat and is situated between 0 and 10 feet above msl (**Figure 2.2**). Net local surface water drainage from the marsh in this area drains into unnamed tributaries of the Delaware River, Mill Creek, Baldridge Creek, or the Salem River, which ultimately flow into the adjacent Delaware River to the southwest.


N
W
E
S
48
Lighthouse Road
Mill Creek
Goose Pond
Pea Patch Island
Mill Creek tributary
Baldridge Creek Complex
Delaware River
Baldridge Creek tributary
Salem River
Chestnut St.
Legend
Project Area Boundary
Supawna Meadows National Wildlife Refuge Boundary
0 2000 4000
Feet
Image Source: Esri, HERE, DeLorme, USGS, Intermap, Increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the GIS User Community, 2016
amec foster wheeler
Figure 2.1
Aerial Photograph Map
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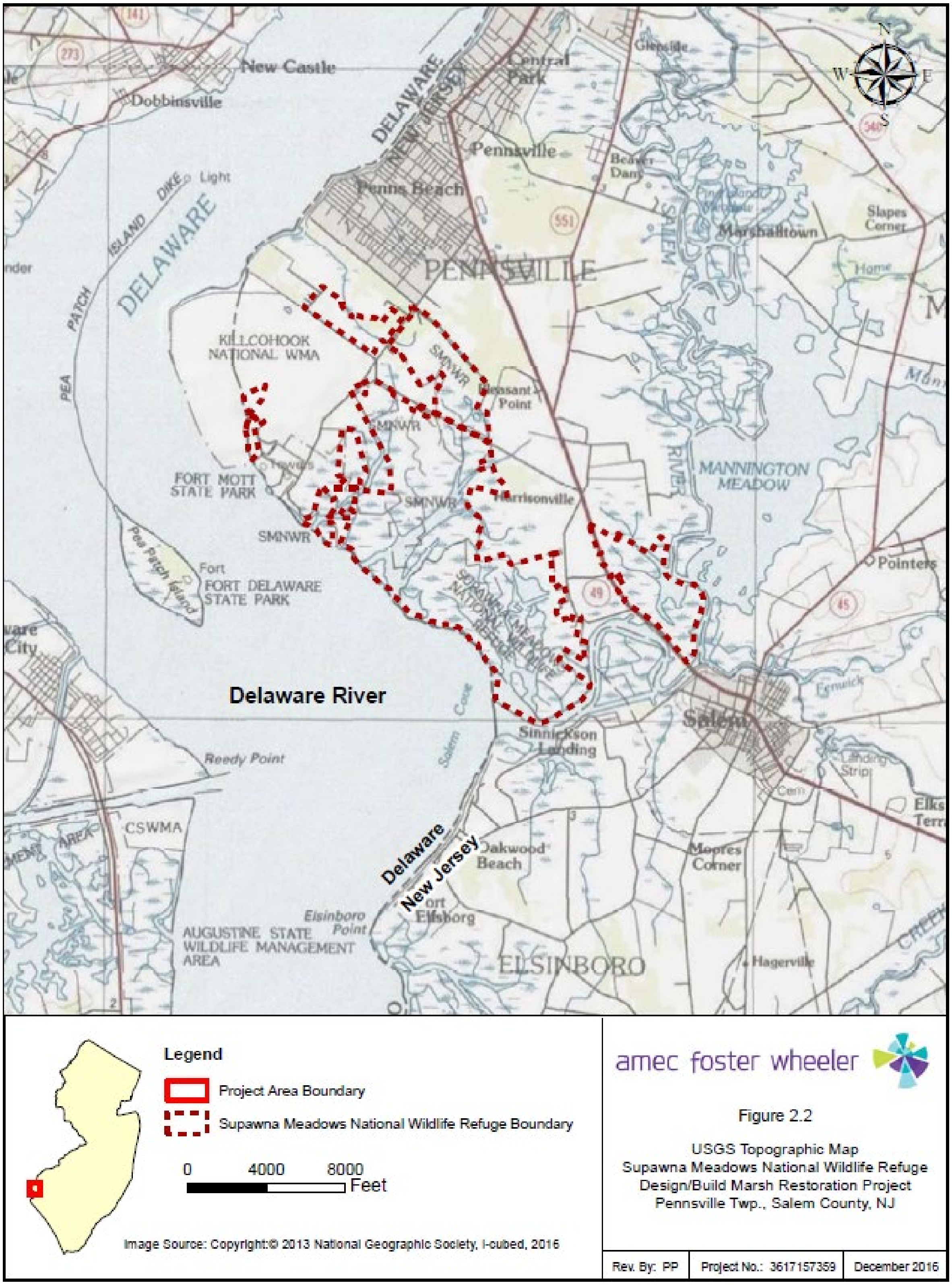


Figure 2.2

USGS Topographic Map
Supawna Meadows National Wildlife Refuge
Design/Build Marsh Restoration Project
Pennsville Twp., Salem County, NJ

2.2.2 Geology and Soils

The Project area is located within the outer Coastal Plain Physiographic section of New Jersey (NJDEP 2014). The unconsolidated deposits of this province range in age from the Cretaceous to the Miocene (135 to 5.3 million years old) and gently dip to the southeast, towards the coast and extend beneath the Atlantic Ocean to the edge of the Continental Shelf (Dalton 2003; NJDEP 1999). The topography of the Coastal Plain is relatively flat to very gently undulating. The sediments consist of alternately-deposited layers of sand, silt, and clay which outcrop in irregular bands that trend northeast to southwest within deltaic and marine environments occurring at sea level (NJDEP 1999).

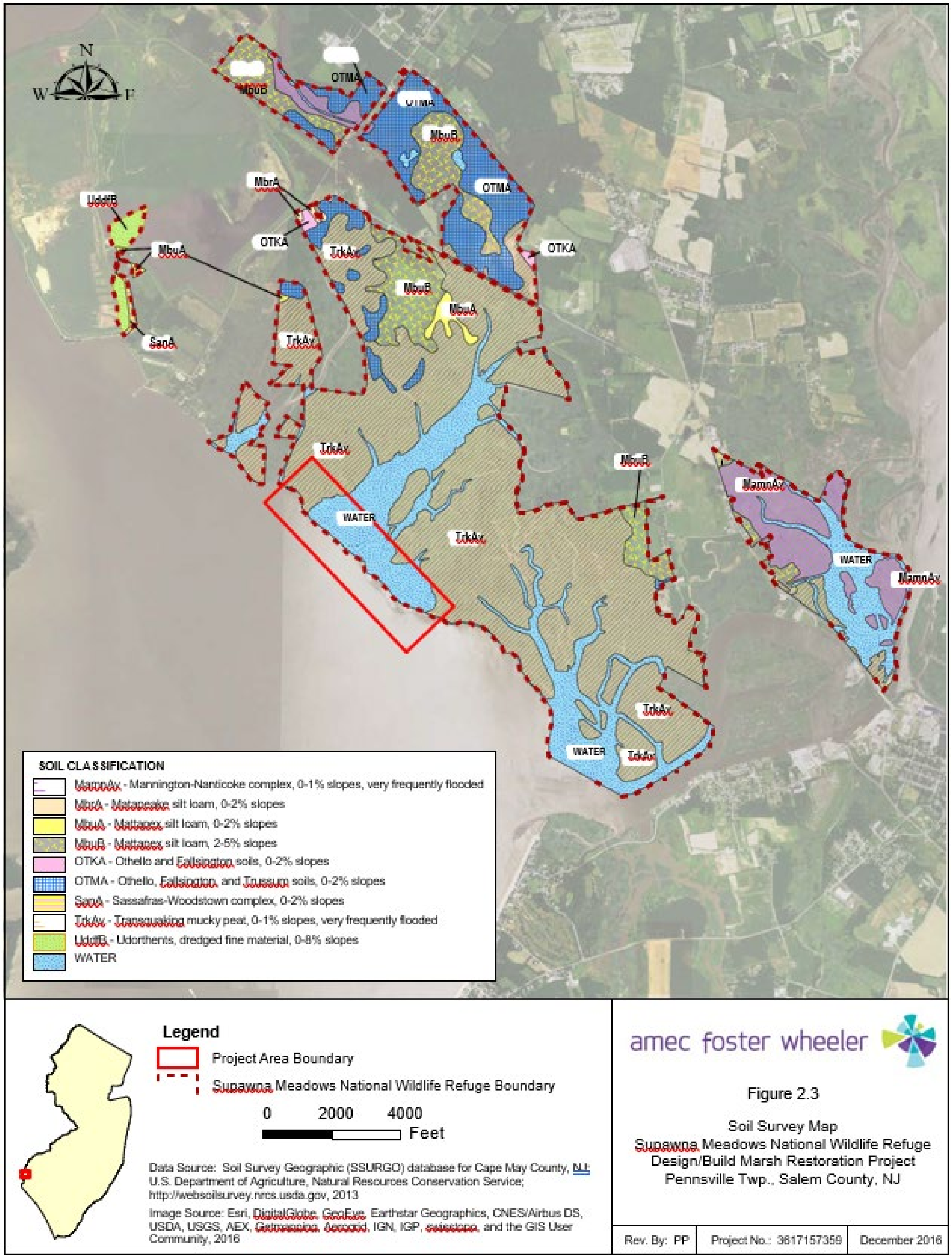
The bedrock geology of the Project area is made up primarily of the Marshalltown Formation (NJDEP 2014). The Marshalltown Formation is described as an upper Cretaceous to upper and medium Campanian Era aged unit that is composed primarily of a dark gray, fine- to medium-grained, quartz and glauconite sand that weathers to light brown or pale red (USGS 2016).

The surficial geology within the Project area is primarily composed of Salt Marsh and Estuarine Deposits. These soils are described as dark in color, ranging from brown, dark brown, gray, or black, and composed of silt, sand, peat, and clay with minor pebble gravel. They contain abundant organic matter and were deposited during the Holocene Era in salt marshes, estuaries, and tidal channels and can be as thick as 300 feet in some areas (NJDEP 2014).

The Project area is mapped to occur primarily over water. However, small portions of the affected area occur over Transquaking mucky peat, very frequently flooded soils with 0 to 1 percent slopes (**Figure 2.3**). This soil is described as mucky silt loam, silt loam and mucky peat associated with tidal marshes (Maser 2012).

2.2.3 Air Quality

The United States Environmental Protection Agency (USEPA) has set National Ambient Air Quality Standards (NAAQS) for six commonly found air pollutants as part of the Federal Clean Air Act requirements. These pollutants (also known as criteria pollutants) include particle pollution (often referred to as particulate matter), ground-level ozone, carbon monoxide, sulfur oxides, nitrogen oxides, and lead. These pollutants are known to harm human health and the environment and also cause property damage. The USEPA regulates pollutants by developing human health-based and environmentally-based criteria (science-based guidelines) for setting permissible levels (NJDEP 2016). New Jersey is located in the Ozone Transport Region, an area that covers 13 northeastern ozone nonattainment states from Maine to Virginia (Trinity Consultants 2014). Salem County, along with the rest of New Jersey, is designated as a marginal nonattainment area for the 8-hour ozone standard, but it is in attainment of all other standards (NJDEP 2016).


N
W
E
SOIL CLASSIFICATION
MamnAv - Mannington-Nanticoke complex, 0-1% slopes, very frequently flooded
MbrA - Matapeake silt loam, 0-2% slopes
MbuA - Mattapex silt loam, 0-2% slopes
MbuB - Mattapex silt loam, 2-5% slopes
OTKA - Othello and Fallsington soils, 0-2% slopes
OTMA - Othello, Fallsington, and Trussum soils, 0-2% slopes
SapA - Sassafras-Woodstown complex, 0-2% slopes
TrkAv - Transquaking mucky peat, 0-1% slopes, very frequently flooded
UddfB - Udorthents, dredged fine material, 0-8% slopes
WATER
Legend
Project Area Boundary
Supawna Meadows National Wildlife Refuge Boundary
0 2000 4000
Feet
Data Source: Soil Survey Geographic (SSURGO) database for Cape May County, NJ; U.S. Department of Agriculture, Natural Resources Conservation Service; http://websoilsurvey.nrcs.usda.gov, 2013
Image Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community, 2016
amec foster wheeler
Figure 2.3
Soil Survey Map
Supawna Meadows National Wildlife Refuge
Design/Build Marsh Restoration Project
Pennsville Twp., Salem County, NJ
Rev. By: PP
Project No.: 3617157359
December 2016

The NJDEP Bureau of Air Monitoring maintains an air quality monitoring station for Salem and Cumberland Counties in Millville, New Jersey, approximately 30 miles southeast of the refuge. The Millville site is currently monitoring for nitrogen dioxide (NO_2), ozone (O_3), nitric oxide (NO), and particulate matter less than 2.5 micrometers in diameter ($PM_{2.5}$) (NJDEP 2016).

The USEPA and NJDEP regulations require proposed projects to demonstrate that predicted impacts will not cause or significantly contribute to a violation of the NAAQS or the New Jersey Ambient Air Quality Standards (NJAAQS). Toward that end, the USEPA and NJDEP have established Significant Impact Levels (SILs), which are a lesser fraction of the NAAQS/NJAAQS. Predicted impacts less than SILs are deemed insignificant, and therefore will not cause or contribute to an air quality standard violation.

2.2.4 Water Quality

According to the NJDEP (2008), "The Surface Water Quality Standards are developed and administered in conformance with requirements of the Federal Water Pollution Control Act 33 U.S.C. §1251 (also called the Clean Water Act) and the Federal regulatory program established by the USEPA at 40 C.F.R. Part 131. The Surface Water Quality Standards are also developed pursuant to the New Jersey Water Quality Planning Act, N.J.S.A. 58:11A et. seq. and the New Jersey Water Pollution Control Act, N.J.S.A. 58:10A et. seq. Surface Water Quality Standards establish designated uses, classify streams based on uses, designate anti-degradation categories, and develop water quality criteria to protect those uses. In addition, the standards specify general, technical, and interstate policies, and policies pertaining to establishment of water quality-based effluent limitations."

All waters within the Project area are classified as FW2-NT/SE1 waters according to New Jersey SWQS (NJDEP 2011). The FW2-NT/SE1 classification indicates a waterway in which there may be a freshwater/saltwater interface between a non-trout, freshwater stream (category 2) and a saline estuary with shellfish harvesting as a designated use.

The portion of the Delaware River (Zone 5), in which the Project area is located, is classified as waters protected for the following uses (DRBC 2013):

- Industrial water supplies after reasonable treatment.
- Maintenance of resident fish and other aquatic life.
- Propagation of resident fish from river mile 70.0 to river mile 48.2.
- Passage of anadromous fish.
- Wildlife.
- Recreation.
- Navigation.

Water quality parameters were recorded in a benthic inventory study of the Delaware Estuary. Results from the station adjacent to the Project area indicates a salinity reading of between 5.01 and 18 parts per thousand (ppt), rendering this portion of the Delaware River as a mesohaline zone. Turbidity adjacent to the Project area was recorded between -0.2 and 33.8 Nephelometric Turbidity

Units (NTUs). Dissolved oxygen (DO) farther upstream of the refuge (just north of the I-295 Bridge) was recorded between 4.27 and 6.73 milligrams per liter (mg/L) and pH was recorded between 6.1 and 7.54 (Kreeger et al. 2011).

Water quality monitoring station data from the National Water Quality Monitoring Council water quality portal website (NWQMC 2016) were evaluated from stations near the refuge in order to determine basic water quality characteristics of the surrounding area. Two stations (EMAP_CS-NJ02-0272-C and EMAP_CS_WQX-NJ04-0272-A) located inside Salem Creek, approximately 1.6 miles east of the Project area, were sampled in September of 2002 and August of 2004, respectively. Results from those stations revealed the following:

- Temperature ranged from 24.58 degrees Celsius (ºC) to 26.09 ºC.
- Salinity ranged from 7.84 dissolved ppt to 7.88 dissolved ppt.
- DO ranged from 6.44 mg/L to 6.98 mg/L.
- pH ranged from 7.2 to 7.29.
- Total suspended solids (TSS) ranged from 79.8 mg/L to 54 mg/L.
- Conductivity was not analyzed.

2.2.5 Wetlands and Streams

The Clean Water Act (40 CFR 230.3) defines wetlands as "those areas that are inundated or saturated by surface or groundwater at a frequency or duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas." Using that definition, wetlands are defined based on certain characteristics of vegetation, soils, and hydrology. For vegetation, the majority of the plant species must be categorized as hydrophytic, or adapted to living in saturated areas. Soils are considered hydric (permanently or seasonally saturated by water) if they meet the criteria defined by the National Technical Committee for Hydric Soils (USDA 2016). Hydrology is determined based on having a sufficient amount of water, whether saltwater, brackish, or fresh, that the soil is saturated during long periods of the vegetative growing season (FIC 1989).

The most common method of characterizing wetlands is under the system developed by the Service. As described in *Classification of Wetlands and Deepwater Habitats of the United States* (Cowardin et al. 1979), wetland types can be broken down into five basic categories. These categories include marine, estuarine, riverine, lacustrine, and palustrine wetlands. The major categories or systems are based mostly on the hydrologic base for the wetlands. Each of these systems can be further broken down into subsystems, classes, subclasses and dominance types based on the type of vegetation present and/or the bottom substrate for the wetlands.

Defining areas that meet the regulatory definition of a wetland (33 CFR 328.3(b)) is important in determining the jurisdiction of those areas by the Federal government (i.e. the USACE), and in some areas of the United States, state, county, and/or local governments. Jurisdiction over wetlands subsequently determines their regulation and the types of activities that are permittable. The USACE reviews permit applications for activities proposed within Waters of the United States

(WOTUS). As the Project occurs on jurisdictional wetlands, it is subject to regulation by the USACE, NJDEP, and DNREC.

The main waterbodies in or near the refuge include the Delaware and Salem Rivers, Mill Creek, Baldridge Creek, other unnamed tributaries to the Delaware River, and an area impounded by the breakwater referred to as Goose Pond. The Service's National Wetlands Inventory (NWI) indicates that the wetlands within the Project area boundaries are classified as follows (**Figure 2.4**):

- Estuarine, subtidal, unconsolidated bottom, subtidal, habitat (E1UBL).
- Estuarine, intertidal, emergent, persistent, regularly flooded habitat (E2EM1N).
- Estuarine, intertidal, emergent, *Phragmites australis*/persistent, irregularly flooded habitat(E2EM5P).
- Estuarine, intertidal, emergent, persistent, irregularly flooded habitat (E2EM1P).

  The NJDEP indicates that the Project area is mapped as containing the following wetland habitats(**Figure 2.5**):

- Freshwater tidal marshes.
- Tidal rivers, inland bays, and other tidal waters.
- Tidal mud flat.
- *Phragmites* dominant coastal wetlands.

2.2.6 Vegetation

The largest single habitat type within the Supawna Meadows NWR is slightly brackish tidal marsh (0 to 8 ppt), which composes 2,423 acres, or approximately 80 percent of the refuge. This habitat type includes both marsh habitat (1,931 acres) and open water tidal rivers and creeks (492 acres). The marshes associated with Baldridge Creek in the southwestern portion of the refuge contain a diversity of vegetation including species such as smooth cordgrass (*Spartina alterniflora*), pickerelweed (*Pontederia cordata*), water hemp (*Amaranthus cannabinus*), wild rice (*Zizania aquatica*), rice cutgrass (*Leersia oryzoides*), and common reed (*Phragmites australis*). The marshes associated with Mill Creek in the northwestern portion of the refuge are extensively dominated by common reed, which is the most prevalent invasive plant found within the Project area boundaries. There are a few rare plant species that occur within the tidal marshes, such as seashore mallow (*Kosteletzkya virginica*) and long-awned sprangletop (*Leptochloa fascicularis* var. *maritima*) (USFWS 2011).

Forested wetlands in this refuge are closed canopy swamps interspersed with permanent and vernal ponds. These wetlands cover approximately 182 acres of the refuge and are dominated by deciduous species such as red maple (*Acer rubrum*), willow oak (*Quercus phellos*), sweetgum (*Liquidambar styraciflua*), and black gum (*Nyssa sylvatica*). Upland forested areas cover approximately 240 acres with at least 75 percent of the canopy coverage from deciduous trees. Dominant species include sweetgum, black gum, black cherry (*Prunus serotina*), black oak

(*Quercus velutina*), southern red oak (*Quercus falcata*), American persimmon (*Diospyros virginiana*), American holly (*Ilex opaca*), and red maple (USFWS 2011).

Grassland habitat within the refuge composes approximately 86 acres and includes a diversity of grasses and forbs. Important grassland plant species include cool season grasses, such as orchard grass (*Dactylis glomerata*), warm season grasses, such as switch grass (*Panicum virgatum*), and forbs, such as goldenrods (*Euthamia* spp. and *Solidago* spp.), and eupatoriums (*Eupatorium* spp.) (USFWS 2011).

The approximately 122 acres of scrub/shrub and early successional habitats spread across the refuge are dominated by a mixture of native plants (e.g., blackberry (*Rubus* sp), goldenrod, grape (*Vitis* sp.), bayberry (*Myrica pensylvanica*)) and invasive plants (e.g., multiflora rose (*Rosa multiflora*), autumn olive (*Elaeagnus umbellata*), Japanese honeysuckle (*Lonicera japonica*), mile-a-minute (*Persicaria perfoliata*), and common reed) (USFWS 2011).

A field investigation was conducted at the Supawna Meadows Marsh Complex to assess the vegetation communities. During that investigation, the Mid-Atlantic Coastal Wetland Assessment method was used to assess the condition of the marsh. For this assessment, 100 points were randomly generated with an established 164-foot radius assessment area and 820-foot buffer area surrounding the center point. In the field, four 164-foot transects were run at 90-degree angles from each other. After all transects were measured, direct observations and aerial photography were used to make observations on hydrology, buffer condition, and overall plant community structure. The attributes were then averaged to provide a composite Mid-TRAM final score (Haaf et al. 2015b).

The results placed the Supawna Meadows Marsh Complex in the category of "moderately stressed" (< 81.4, but > 66.6) with an average final Mid-TRAM score of 67.4. That is the lowest scoring watershed to be named moderately stressed of those assessed to date (i.e., extreme low end of the category range). The Supawna Meadows Marsh Complex rated a score of 29.3 (severely stressed) for habitat metrics due to low plant diversity and lack of community structure driven by the prevalence of the invasive species common reed. Historical agricultural and mosquito control practices, which created a level of disturbance, may have allowed this invasive plant to prevail (Haaf et al. 2015b).

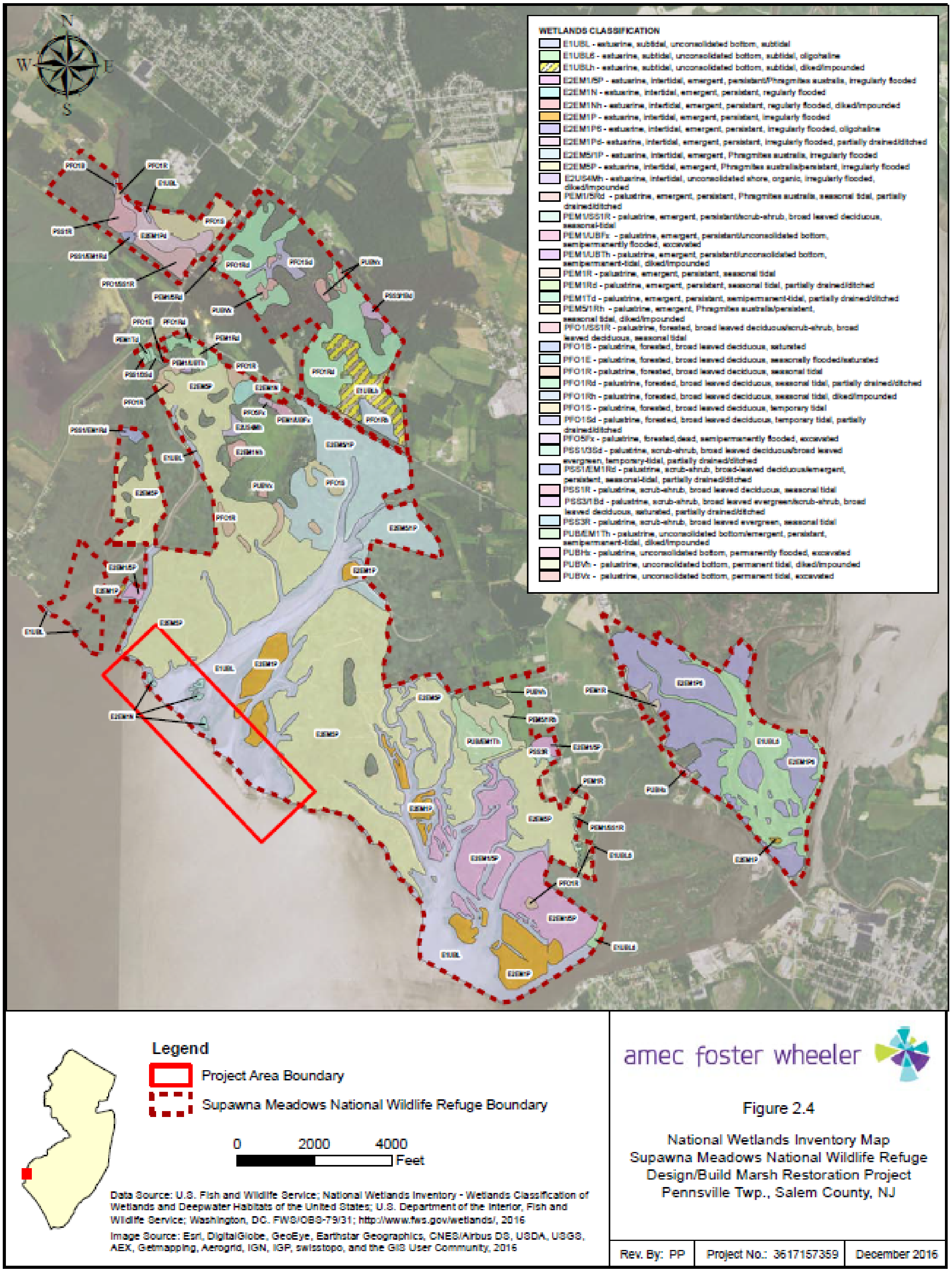
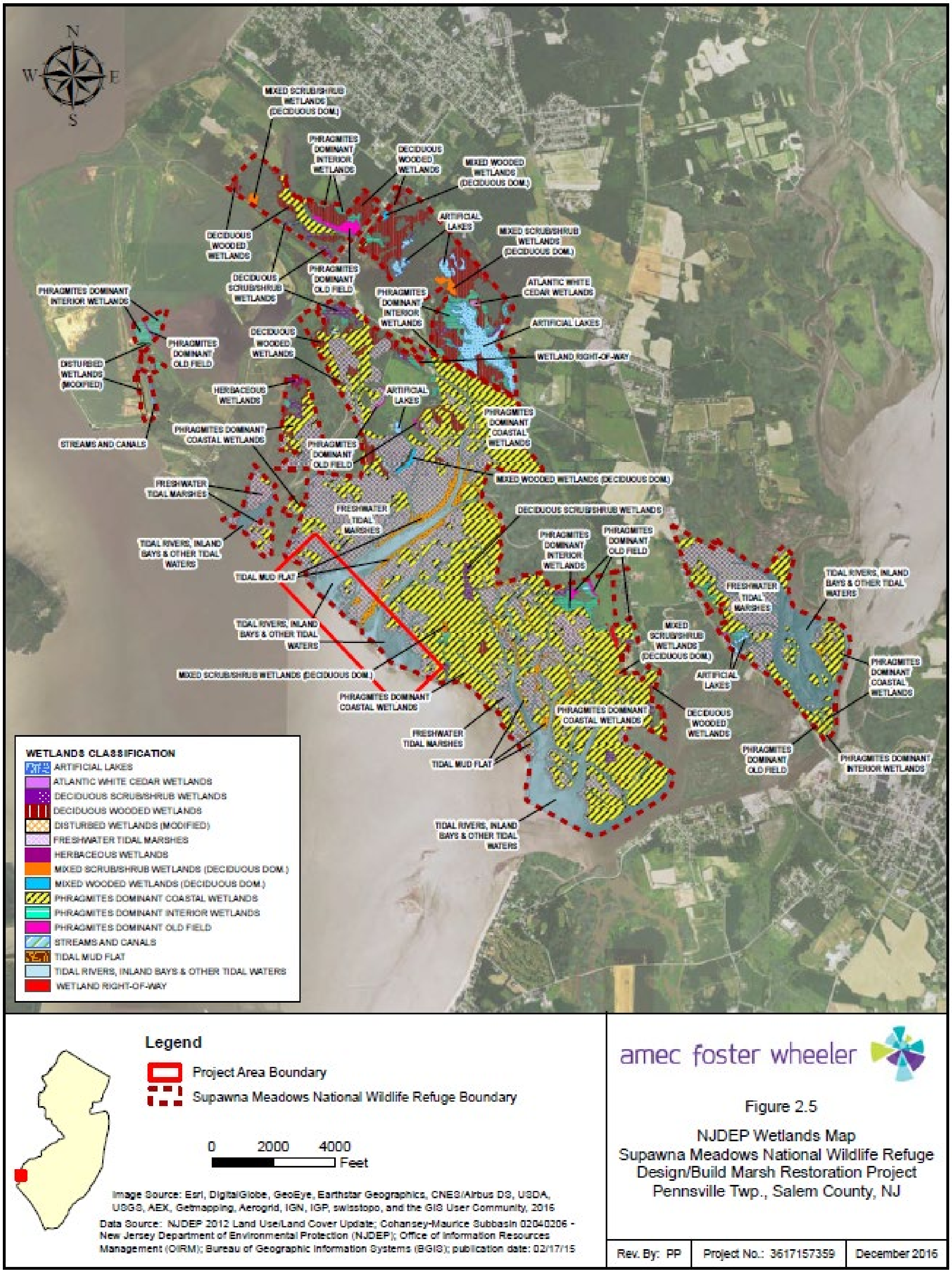


Figure 2.4

National Wetlands Inventory Map
Supawna Meadows National Wildlife Refuge
Design/Build Marsh Restoration Project
Pennsville Twp., Salem County, NJ



N
S
E
W
WETLANDS CLASSIFICATION
ARTIFICIAL LAKES
ATLANTIC WHITE CEDAR WETLANDS
DECIDUOUS SCRUB/SHRUB WETLANDS
DECIDUOUS WOODED WETLANDS
DISTURBED WETLANDS (MODIFIED)
FRESHWATER TIDAL MARSHES
HERBACEOUS WETLANDS
MIXED SCRUB/SHRUB WETLANDS (DECIDUOUS DOM.)
MIXED WOODED WETLANDS (DECIDUOUS DOM.)
PHRAGMITES DOMINANT COASTAL WETLANDS
PHRAGMITES DOMINANT INTERIOR WETLANDS
PHRAGMITES DOMINANT OLD FIELD
STREAMS AND CANALS
TIDAL MUD FLAT
TIDAL RIVERS, INLAND BAYS & OTHER TIDAL WATERS
WETLAND RIGHT-OF-WAY
Legend
Project Area Boundary
Supawna Meadows National Wildlife Refuge Boundary
0 2000 4000
Feet
Image Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community, 2016
Data Source: NJDEP 2012 Land Use/Land Cover Update; Cohansey-Maurice Subbasin 02040206 - New Jersey Department of Environmental Protection (NJDEP); Office of Information Resources Management (OIRM); Bureau of Geographic Information Systems (BGIS); publication date: 02/17/15
amec foster wheeler
Figure 2.5
NJDEP Wetlands Map
Supawna Meadows National Wildlife Refuge
Design/Build Marsh Restoration Project
Pennsville Twp., Salem County, NJ
Rev. By: PP
Project No.: 3617157359
December 2016

2.2.7 Marine Resources

<u>Sediment Features:</u> Sediment characterization from a benthic invertebrate study by Kreeger et al. (2011) revealed that the Delaware bottom substrate adjacent to the Project area is composed of 0.00 to 30.1 percent sand. This indicates the sediment on or near the Project area may contain a higher percentage of finer silts and clays. Five additional individual sediment samples were collected by Amec Foster Wheeler Environment & Infrastructure, Inc. (Amec Foster Wheeler) for grain size analysis within and near the refuge. The location of each sample corresponded to the location of each piezometer/transducer established to provide information on creek bed composition, general flow conditions, as well potential for resuspension and transport during major runoff events or general tidal exchange. The results confirmed that the sediments closest to the Project area are predominantly composed of silts and clays (97.9% to 98.3%).

<u>Planktonic and Benthic Organisms:</u> Estuarine benthic communities play an important role in the Delaware Estuary's food chain as food for more than 200 migrant and resident finfish species that use the Estuary for feeding, spawning, or nursery grounds (Dove and Nyman 1995). They also play an important role in maintaining water and sediment quality by cycling nutrients and contaminants between sediments and the water column. In 2005, the PDE recognized a data gap in the knowledge and understanding of the physical and biological conditions of the benthic habitats and communities within the tidal portion of the Delaware River and Bay. Beginning in the summer of 2008, a three year assessment was conducted and the resulting Delaware Estuary Benthic Inventory (DEBI) became the most intensive and comprehensive assessment of the Delaware Estuary's benthic fauna ever conducted (Kreeger et al., 2011).

From a set of 230 sampling stations, results indicated that there are 235 benthic species present in 112 families and 9 phyla within the Delaware tidal system. The mean species richness (number of species) at each station was 14 with a mean abundance of 9,000 individuals per square meter. The most diverse groups were polychaetes (27 families, 79 species), amphipods (15 families, 35 species), bivalves (17 families, 27 species), and gastropods (15 families, 25 species). The dominance by polychaetes, bivalves and amphipods was expected for the estuary's mixed sand-silt sediment as well as from previously published studies (Kreeger et al., 2011).

Historic records of planktonic species within the Delaware Estuary include 11 primary species, including *Acartia tonsa* (copepod), *Pseudodiaptomos coronatus* (copepod), *Neomysis americana* (mysid shrimp), *Labidocera aestiva* (copepod), *Sagitta elegans* (arrow worm), *Temora longicornis* (copepod), *Eurytemora hirundoides* (copepod), *Eurytemora affinis* (copepod), *Nemopsis bachei* (ctenophore, comb jelly), *Cyclops viridis* (cyclopoid copepod), and *Balanus* sp. (common barnacle) larvae (Kreeger et al., 2011).

Benthic macroinvertebrate sampling data collected in August of 2004 were available from the National Water Quality Monitoring Council water quality portal website (NWQMC 2016) for water quality monitoring station EMAP_CS_WQX-NJ04-0272-A, located near the refuge. Results from that station revealed the following:

- Amphipods were the most prevalent with 704 individuals counted (12 *Leptocheirus plumulosus*, 592 *Gammarus tigrinus*, and 100 *Corophium lacustre*
- 76 isopods were collected (*Cyathura polita*)
- 24 unnamed mollusks were collected (Bivalvia)
- 12 unnamed oligochaete worms were collected (Tubificidae)
- 4 chironomid larvae were collected (*Polypedilum simulans*)

Submerged Aquatic Vegetation: Approximately 12 species of Submerged Aquatic Vegetation (SAV) have been observed in the tidal portions of the Delaware Estuary since 1970. These species include eelgrass (*Vallisneria americana*), Eurasian watermilfoil (*Myriophyllum spicatum*), Nuttall's waterweed (*Elodea nuttallii*), nodding waternymph (*Najas flexillis*), pondweed (*Potamogeton* sp.), and others (Schuyler, 1988). However, SAV has not been documented within the Project area boundaries.

Fish and Shellfish: The tidal marshes, creeks, and ditches of the Supawna Meadows NWR provide spawning, nursery, and feeding habitat for a variety of fish common to the Delaware River.The most abundant forage fish within the Delaware River is the mummichog (*Fundulus heteroclitus heteroclitus*). Striped bass (*Morone saxatilis*) and white perch (*Morone americana*) are two of the more important anadromous species on or near the refuge. American eel (*Anguilla rostrata*), a catadromous species, is also found within the Delaware River, and is currently a species of concern in New Jersey and for the Mid-Atlantic Fisheries Council. Commercial nettingof elvers (immature American eel) is common. Other important fish species found near, and potentially affected by, Project activities include menhaden (*Brevoortia tyrannus*), blueback herring (*Alosa aestivalis*), alewife (*Alosa pseudoharengus*), and American shad (*Alosa sapidissima*). The refuge provides nursery habitat to all of the above species. Perch, brown trout,and bullhead are caught within Goose Pond that the Project site is located. Blue crabs (*Callinectessapidus*) are also found within tidal waters near the refuge and are part of the local recreational shellfishery (USFWS 2011).

Horseshoe crabs are very important to shore birds including the red knot (*Calidris canutus*), ruddy turnstone (*Arenaria interpres*), sanderling (*Calidris alba*), semipalmated sandpiper (*Calidris pusilla*), and least sandpiper (*Calidris minutilla*). The long migration of these species is highly dependent on food availability. For birds to gain weight 3-6 grams a day, they must consume 18,000 eggs. However, the Project area is north of the horseshoe crabs range but birds are still drawn to the area for other marine invertebrate food sources and the proximity to the horsehoe crab laying areas.

Hard-bottom surveying during the DEBI research collection identified the most abundant single species at any station was the amethyst gem clam (*Gemma gemma*) (71,000 individuals per square meter) near Nantuxent Creek. Other common shellfish included oysters (*Crassostrea* spp.), whelks (*Busycon* spp. and *Busycotypus* spp.), hermit crabs (Paguriodea), blue crabs, lady crabs (*Ovalipes ocellatus*), spider crabs (*Libinia emarginata*), mud crabs (*Panopeus herbstii*), horseshoe crabs (Limulidae), dove snails (Columbellidae), moon snails (Naticidae), slipper snails (Calytraeidae), razor clams (*Ensis directus*), hard clams (*Mercenaria mercenaria*), and seven native species of mussels including the pond mussel (*Ligumia nasuta*), tidewater mucket (*Leptodea ochracea*), alewife floater (*Anodonta implicata*), creeper (*Strophitus undulatus*), eastern floater (*Pyganodon cataracta*), yellow lampmussel (*Lampsilis cariosa*), and eastern elliptio (*Elliptio complanata*) (Kreeger et al., 2011).

Essential Fish Habitat: The 10' x 10' Square Coordinates data lists of the NOAA Guide to Essential Fish Habitat (EFH) Designations in the Northeastern United States and the aerial coverage from the EFH Designations for New England Skate Complex were used as consultation with NMFS to determine which fish species habitat may be located on or near the Project area with the potential of being affected by the Proposed Action (NOAA 2016a). The closest designated EFH near the Project area is shown in **Table 2.1** below:

Table 2.1 Documented EFH Near the Project Area Based on NOAA's Guide to Essential Fish Habitat Designations in the Northeastern United States		
Common Name	**Scientific Name**	**Life Stage**
Winter flounder	*Pseudopleuronectes americanus*	Eggs Larvae Juveniles Adult
Windowpane flounder	*Scophthalmus aquosus*	Eggs Larvae Juveniles Adult
Bluefish	*Pomatomus saltatrix*	Juveniles Adult
Atlantic butterfish	*Peprilus triacanthus*	Juveniles
Summer flounder	*Paralichthys dentatus*	Juveniles Adult
Scup	*Stenotomus chrysops*	Juveniles
Black sea bass	*Centropristis striata*	Juveniles
King mackerel	*Scomberomorus cavalla*	Eggs Larvae Juveniles Adult
Spanish mackerel	*Scomberomorus maculatus*	Eggs Larvae Juveniles Adult
Cobia	*Rachycentron canadum*	Eggs Larvae Juveniles Adult
Clearnose skate	*Raja eglanteria*	Juveniles Adults
Little skate	*Leucoraja erinacea*	Juveniles Adults
Winter skate	*Leucoraja ocellata*	Juveniles Adults

There are no Habitat Areas of Particular Concern (HAPC) or EFH Areas Protected from Fishing(EFHA) documented on or near the Project area (NOAA 2016b).

2.2.8 Terrestrial Resources

<u>Birds</u>: Over 300 species of birds can be observed throughout the year in Salem County. The refuge is located in the Atlantic Flyway and serves not only as an important migration stop, but also habitat for regionally and nationally significant species such as rails, neotropical migrants, and raptors (USFWS 2011; USFWS 2005).

The refuge also provides habitat for thousands of waterfowl that use the tidal marshes through winter and during migration (USFWS 2011). Coastal salt marsh wetland habitat, such as that found at the refuge, has been identified by the Black Duck Joint Venture as the most important habitat for wintering American black duck (*Anas rubripes*), annually wintering 34 percent of the entire Atlantic Flyway American black duck population (Black Duck Joint Venture 2008). During the 2009 midwinter count, inventory flights for the Salem River watershed averaged more than 2,000 dabbling ducks and more than 11,500 Canada geese (*Branta canadensis*) (USFWS 2009). Additional waterfowl species that can be found within the refuge include American widgeon (*Anas americana*), blue-winged teal (*Anas discors*), green-winged teal (*Anas carolinensis*), gadwall (*Anas strepera*), mallard (*Anas platyrhynchos*), northern pintail (*Anas acuta*), snow goose (*Chen caerulescens*), and tundra swan (*Cygnus columbianus*) (USFWS 2005).

Raptor species that have been observed at the refuge include sharp-shinned hawk (*Accipter striatus*), Cooper's hawk (*Accipter cooperii*), red-shouldered hawk (*Buteo lineatus*), red-tailed hawk (*Buteo jamaicensis*), American kestrel (*Falco sparverius*), and peregrine falcon (*Falco peregrinus*). Cooper’s hawks have also been noted within the forested areas of refuge. The forest also supports breeding populations of wood thrush (*Hylocichla mustelina*), eastern wood pewee (*Contopus virens*), northern flicker (*Colaptes auratus*), and Baltimore oriole (*Icterus galbula*) as well as migrating populations of black-and-white warbler (*Mniotilta varia*), hooded warbler (*Wilsonia citrina*), and Kentucky warbler (*Oporornis formosus*) (USFWS 2011).

The refuge’s grassland habitat supports migrating and wintering songbirds, including the bobolink (*Dolichonyx oryzivorus*), vesper sparrow (*Pooecetes gramineus*), eastern meadowlark (*Sturnella magna*), and savannah sparrow (*Passerculus sandwichensis*), as well as raptor species such as northern harrier and short-eared owl (*Asio flammeus*) (USFWS 2011).

Pea Patch Island, one of the largest rookeries on the East Coast, is located in the center of the Delaware River, approximately 1.5 miles off shore of the Project area. The refuge provides foraging habitat for the more than 6,000 pairs (9 species) of wading birds that nest on the island, including black-crowned night heron (*Nycticorax nycticorax*), yellow-crowned night heron (*Nyctanassa violacea*), great egret (*Ardea alba*), and little blue heron (*Egretta caerulea*). These waders forage in the tidal marsh within the refuge boundaries throughout the breeding season. Because of its importance, Pea Patch Island and the surrounding area, including the refuge, have been designated as a Special Management Area (SMA) by the States of New Jersey and Delaware in accordance with the Coastal Zone Management Act (USFWS 2011).

Shorebirds also use the marshes within the refuge during spring and fall migrations, including species such as the least sandpiper (*Calidris minutilla*) and semipalmated sandpiper (*Calidris pusilla*). Species such as the king rail (*Rallus elegans*) and least bittern (*Ixobrychus exilis*) use the marshes for breeding. Based on the importance of the Delaware estuary to migrating shorebirds, both the New Jersey and Delaware shores of the Delaware Bay are designated as International Shorebird Preserves (USFWS 2011).

Mammals: According to the USDA Natural Resources Conservation Service (NRCS) only 8 out of 23 wetland species found in North America have the potential to be found in southern New Jersey's saltwater marshes (NRCS 2001). This includes seven rodent species (masked shrew (*Sorex cinereus*), meadow vole (*Microtis pennsylvanicus*), meadow jumping mouse (*Zapus hudsonisu*), marsh rice rat (*Oryzomys palustris*), beaver (*Castor canadensis*), invasive nutria (*Myocastor coypus*), muskrat (*Ondatra zibethicus*)) and mink (*Mustela vison*). (USFWS 2011, NRCS 2001). Many of these rodents are a good food source to the raptors within the refuge.

Specific to the Supawna Meadows NWR, bats including little brown bats (*Myotis lucifugus*) and big brown bats (*Eptesicus fuscus*) use refuge habitats as maternity sites. Bats may tend to use the refuge looking for insects, which are abundant within the marshes. The federally listed Northern long-eared bat (*Myotis septentrionalis*) has been found on the refuge during the breeding season. Other bats species found within the refuge include the eastern small-footed myotis (*Myotis leibii*), eastern red bat (*Lasiurus borealis*), hoary bat (*Lasiurus cinereus*), and silverhaired bat (*Lasionycteris noctivagans*). (USFWS 2011).

Species that may be found in the marsh but typically stay in the upland habitats include the raccoon (*Procyon lotor*), black bear (*Ursus americanus*), and white tailed deer (*Odocoileus virginianus*) (USFWS 2011, NRCS 2001). There is a large white-tailed deer population within the refuge, with an estimated density around Salem County Hunting Management Zone 63 to be 41 deer per square mile. (USFWS 2011).

Other mammalian species that can be commonly found within the refuge include the white-footed mouse (*Peromyscus leucopus*), short-tailed shrew (*Blarina brevicauda*), eastern cottontail (*Sylvilagus floridana*), groundhog (*Marmota monax*), opossum (*Didelphis virginiana*), skunk (*Mephitis mephitis*), red fox (*Vulpes vulpes*), long-tailed weasel (*Mustela frenata*), river otter (*Lontra canadensis*) and the southern bog lemming (*Synaptomys cooperi*). (USFWS 2011).

Reptiles and Amphibians: A variety of amphibians and reptiles are found within the refuge, including the eastern painted turtle (*Chrysemys picta*), common snapping turtle (*Chelydra serpentina*), eastern garter snake (*Thamnophis sirtalis*), black rat snake (*Elaphe obsoleta*), southern leopard frog (*Lithobates sphenocephalus*), green frog (*Rana clamitans melanota*), and American bullfrog (*Rana catesbeiana*) (USFWS 2011).

2.2.9 Threatened and Endangered Species

The unique habitats of the Supawna Meadows NWR attract a wide variety of wildlife including threatened and endangered species, and species of conservation concern. Sensitive mammalian species include the northern long-eared bat (*Myotis septentrionalis*), eastern small-footed myotis (*Myotis leibii*), eastern red bat (*Lasiurus borealis*), hoary bat (*Lasiurus cinereus*), silverhaired bat (*Lasionycteris noctivagans*), and southern bog lemming (*Synaptomys cooperi*). Federally listed endangered fish species recorded near the refuge include the short-nosed sturgeon (*Acipenser brevirostrum*), and the Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*). The refuge also contains habitat to support reptilian and amphibian species of conservation concern, including northern diamondback terrapin (*Malaclemys terrapin*), eastern box turtle (*Terrapene carolina carolina*), spotted turtle (*Clemmys guttata*), and Fowler's toad (*Anaxyrus fowleri*). A number of State-listed endangered northern harriers (*Circus cyaneus*) and State-listed threatened osprey (*Pandion haliaetus*) have nested in the tidal marsh within the refuge and a pair of bald eagles (*Haliaeetus leucocephalus*) has nested there since 1998 (USFWS 2011).

The Service's online Information, Planning, and Conservation (IPaC) system indicated the presence of the following federally listed threatened and endangered species on or near the Project area (**Appendix C**):

Table 2.2

Service's IPaC Findings for Potential Federally Listed Threatened andEndangered Species On or Near the Project Area

Common Name	Scientific Name	Federal Status
Red knot	*Calidris canutus rufa*	Threatened
Sensitive joint-vetch	*Aeschynomene virginica*	Threatened
Northern long-eared bat	*Myotis septentrionalis*	Threatened
Bog turtle	*Clemmys muhlenbergii*	Threatened

There were no critical habitats documented within the Project area. However, the Service's IPaC system indicated the presence of 24 migratory birds protected under the MBTA and the BGEPA that could potentially move through the Project area, including the following:

Table 2.3

Service's IPaC Findings for Potential Migratory Bird Species On or Near the Project Area

Common Name	Scientific Name
Bald eagle	*Haliaeetus leucocephalus*
Black-billed cuckoo	*Coccyzus erythropthalmus*
Bobolink	*Dolichonyx oryzivorus*
Bonaparte's Gull	*Chroicocephalus philadelphia*
Canada Warbler	*Cardellina canadensis*
Clapper Rail	*Rallus crepitans*
Common Loon	*Gavia immer*
Double-created Cormorant	*Phalacrocorax auritus*
Dunlin	*Calidris alpina arcticola*
Great Black-backed Gull	*Larus marinus*
Herring Gull	*Larus argentatus*

Table 2.3

Service's IPaC Findings for Potential Migratory Bird Species On or Near the Project Area

Common Name	Scientific Name
Kentucky Warbler	*Oporornis formosus*
Lesser Yellowlegs	*Tringa flavipes*
Prairie Warbler	*Dendroica discolor*
Prothonotary Warbler	*Protonotaria citrea*
Red-breasted Merganser	*Mergus serrator*
Red-headed Woodpecker	*Melanerpes erythrocephalus*
Red-throated Loon	*Gavia stellata*
Ring-billed Gull	*Larus delawarensis*
Ruddy Turnstone	*Arenaria interpres morinella*
Rusty blackbird	*Euphagus carolinus*
Semipalmated Sandpiper	*Calidris pusilla*
Short-billed Dowitcher	*Limnodromus griseus*
Wood thrush	*Hylocichla mustelina*

The NJDEP Landscape 3.3 Viewer (NJDEP 2019) indicated the presence of the following State-listed threatened and endangered species on or near the Project area:

Table 2.4 NJDEP Landscape Project Findings for Potential State-Listed Threatened and Endangered Species On or Near the Project Area			
Common Name	**Scientific Name**	**Federal Status**	**State Status**
Great blue heron	*Ardea herodias*	Not listed	Special concern
Osprey	*Pandion haliaetus*	Not listed	Threatened
Bald eagle	*Haliaeetus leucocephalus*	Not listed	Threatened
Savannah sparrow	*Passerculus sandwichensis*	Not listed	Threatened
Atlantic Sturgeon	*Acipenser oxyrinchus*	Endangered	Endangered
Shortnose sturgeon	*Acipenser brevirostrum*	Endangered	Endangered
Bronze copper	*Lycaena hyllus*	Not listed	Endangered

Potential vernal pool habitat was also indicated within the refuge north of Harrisonville Lighthouse Road.

Since the NJDEP NJ-GeoWeb is a preliminary screening tool, a formal written request was submitted to the NJDEP Natural Heritage Program to confirm the possible presence of these species. The March 15, 2016 findings of the Natural Heritage Program are presented in **Appendix C**.

These results indicated the following additional plant species that have the potential to occur on or near the Project area:

Table 2.5 **NJDEP Natural Heritage Program Additional Findings for Potential State-Listed Threatened and Endangered Species On or Near the Project Area**			
Common Name	**Scientific Name**	**Federal Status**	**State Status**
Coast flat sedge	*Cyperus polystachyosvar. texensis*	Not listed	S1-Critically imperiled in New Jersey because of extreme rarity. E-Native New Jersey plant species whose survival in the Stateor nation is in jeopardy.
New England bulrush	*Schoenoplect usangliae*	Not listed	S2-Imperiled in New Jersey because of rarity.
Floating marsh-pennywort	*Hydrocotyl ranunculoid es*	Not listed	S1-Critically imperiled in New Jersey because of extreme rarity. E-Native New Jersey plant species whose survival in the Stateor nation is in jeopardy.

2.2.10 Cultural Resources

Section 106 of the NHPA requires Federal agencies to take into account the effects of their undertakings on historic properties that are included in the National Register of Historic Places or that meet the criteria for the National Register. Viewpoints of the public should be solicited and considered throughout the process, and Native American tribes must be consulted about undertakings on or affecting their lands under Executive Order 13175. If the agency's undertaking could affect historic properties, the next steps are to review background information, consult with the SHPO and any Indian tribe that may attach religious or cultural importance to them, seek information from knowledgeable parties, and conduct additional studies as necessary. If it is determined that the activity that has no potential to affect historic properties, the agency has no further Section 106 obligations (ACHP 2013).

To achieve compliance with the NHPA (Section 106), reviews of cultural resource files were performed at the offices of the NJDEP SHPO and the New Jersey State Museum (NJSM) to assess the potential for the Preferred Alternative to impact historic properties (listed or eligible for listing onthe National Register of Historic Places) within the Project area. Historic properties include archaeological sites, as well as historic structures and districts.

The search indicated that the refuge contains a historic property (Samuel Urion/Yerkes Farmstead [circa 1820]) that was previously determined to be eligible for listing on the National Register of Historic Places. The SHPO determined that the Samuel Urion/Yerkes Farmstead was eligible in 1994 because of its "association with Samuel Urion" and "as an example of architecture in Salem County during the latter half of the nineteenth century, particularly as a rural expression of the Italianate style." The historic properties were noted and the farmstead has since been demolished.

The file searches also indicated that there are previously inventoried archaeological artifacts discovered within the refuge boundary. There is a historic district (Fort Mott and Finn's Point National Cemetery Historic District) listed on the National Register of Historic Places adjacent to the refuge to the northwest. **Appendix D** presents relevant information from the SHPO files concerning the historical background of the Samuel Urion/Yerkes Farmstead and previous cultural resource studies that have been conducted in the vicinity.

Although archeological artifacts were recovered and an eligible property was located within the Supawna Meadows NWR boundary, they are not contained within the Project area boundary where activities are proposed. Therefore, the archaeological sensitivity of the Project area is considered to be low and the Preferred Alternative will have little potential to affect objects of archaeological significance. In addition, the Project will not incur any visual impacts on the nearby historic district, or the historic properties within the district, as there are no new structures being added to the viewshed. However, a follow-up consultation with the NJDEP SHPO was performed by the Service and a finding of No Historic Properties Adversely Effected was issued indicating no further Section 106 consultation being required.

2.2.11 Socioeconomic Resources and Environmental Justice

Salem County has managed to maintain its traditional industries and land use patterns. It contains a significant amount of low lying land, with 30 percent of its land covered by wetlands, and 5 percent covered by open waters. Upland forests (17 percent) and urban areas (10 percent)compose the remainder of the land use in Salem County. Approximately 25 percent of the 216,320 acres in in Salem County contains permanently protected open space lands, such as national wildlife refuges, wildlife management areas, and state, county, and local parks (AKRF 2015).

Agriculture has played an important role in Salem County, both prior to European settlement and through the 17th Century (Salem County Visitors Center 2010). Lumber and grain mills were established among the major creeks as early industry was supported by timber and agriculture. Today, approximately 40 percent of Salem County contains productive farmland (USFWS 2011).

Representing more than 10 percent of the State's agricultural market, Salem ranks first in the State for wheat, barley, sweet corn, and potatoes, and second for milk production, soybeans, asparagus, and corn harvested for grain (USDA 2002).

While agriculture is the mainstay of the eastern and central sections, western Salem County remains home to the county's major employer, industry. By the 1960s, E.I. DuPont de Nemours and Company (DuPont) employed 25 percent of Salem County households. Since then, the manufacturing industry in the United States has declined, including the outputs of DuPont and other companies in Salem County. The corresponding reduction in the industrial tax base, diminished employment opportunities, and significant loss of disposable income in the community has led to a compromise in the high quality of life associated with Salem County (USFWS 2011). By 2000, the county's per capita income was 23 percent lower than the state's per capita income (US Census 2000).

The commercial fishing industry within the Delaware Estuary has had a long and profitable history (Speiser 2013). By the end of the 19th century, the estuary supported the largest commercial American shad and Atlantic sturgeon fisheries along the east coast (Speiser 2013; DNREC n.d.). Today, commercial sturgeon fishing no longer exists. However, the estuary contains over 200 species of other resident and migrant fish and shellfish with commercial landings contributing $34 million annually to the Delaware Estuary's regional economy (Speiser 2013). Other traditional uses of the area include boat building and repair, muskrat (*Ondatra zibethicus*) trapping, and waterfowl hunting (USFWS 2011).

2.2.12 Recreation

From 2005 to 2010, visitation to the refuge ranged from 15,000 to 20,000 visits per year. Visitors participated in many Service approved refuge activities including hunting, fishing, crabbing, wildlife observation, photography, and interpretation (USFWS 2011).

The majority of the refuge is currently open for deer hunting for all four of New Jersey's bow hunting seasons, as per the State Deer Management Zone 63 regulations. Limited portions of the refuge are also open to waterfowl hunting, fishing, and crabbing. Aquatic species are primarily hunted by boat entry to the refuge from the Delaware River and Salem River using the tidal streams. While boating is prohibited on all of the freshwater ponds and impoundments, a youth fishing event is authorized on one of the freshwater tidal ponds on an annual basis (USFWS 2011).

There are two walking trails for visitors to enjoy wildlife observation, photography, and interpretation. The Grassland Trail offers visitors the opportunity to view grassland, forest, and tidal marsh habitat. The Forest Habitat Trail meanders through a forested upland and wetland section of the refuge, as well as through scrub/shrub habitat, to surround the Tract 11D impoundment. Wildlife observation, photography, and interpretation at the refuge can also be enjoyed by boat (USFWS 2011).

2.2.13 Transportation

The regional and State roads that convey traffic directly into and from Pennsville Township are as follows:

- The New Jersey Turnpike runs in a general northeast to southwest direction, extending approximately 120 miles from an interchange with Interstate Route 80 in Ridgefield Park

Village, Bergen County to the Delaware Memorial Bridge in northern PennsvilleTownship, Salem County.
- Interstate 295 runs in a general northeast to southwest direction, extending approximately 70 miles from an interchange with U.S. Highway 1 in Lawrence Township, Mercer County to the Delaware Memorial Bridge in northern Pennsville Township, Salem County.
- New Jersey State Highway 49 runs in a general northwest to southeast direction, extending approximately 54 miles from an interchange with the New Jersey Turnpike in northern Pennsville Township, Salem County to an intersection with State Route 50 in Upper Township, Cape May County.

Traffic volumes on a stretch of State Highway 49, just northeast of the Preferred Alternative in Pennsville Township, indicate that roadway's average annual daily traffic volume at 12,830 cars per day in June of 2013. Traffic volumes for Interstate 295, north of the Preferred Alternative in Pennsville Township, indicate that roadway's average annual daily traffic volume at 32,752 cars per day in January of 2013 (NJDOT 2016). The traffic volume for the New Jersey Turnpike between Exits 1 and 2, north of the Preferred Alternative in Pennsville Township, averaged just under50,000 cars, trucks, and buses per day in 2006 (SDG 2008).

2.2.14 Noise

Noise can be characterized by the following four factors: frequency, intensity, duration, and distance. Each of these factors is described below:

- Frequency – Sound travels in waves, and the frequency of a sound is the number of wave cycles per second, measured in hertz (Hz). High frequency sounds have many cycles per second; low frequency sounds have fewer.
- Intensity – Noise intensity is the power (average energy per unit time) transmitted through a unit area in a specific direction. Sound intensity (i.e. loudness) is measured in decibels (dB). The dB is a relative unit of measure describing the logarithm of the ratio of a sound's intensity to a reference intensity. Because of the logarithmic scale, decibels are not directly additive (e.g. two 70 dB sounds results in 73 dB cumulative sound, but not a doubling, or 140 dB sound). For broadband sounds, a 3 dB change is the minimum change perceptible to the human ear.
- Duration – The duration of a sound affects its potential impact. Generally, long-term sounds are considered more harmful than short bursts of sound. "Masking" occurs when the pressure of a sound masks a sound of interest, by being equal to or greater in sound.
- Distance – Sound radiates in all directions from the source, in a spherical pattern. As the sound radiates, the pressure wave increases in size and the power of the wave dissipates.

The two most common types of noise are point source and line source. This Preferred Alternative would generate point source noise, that is, noise associated with a source that remains in one place for extended periods of time, such as with most construction activities (WSDOT 2013). The Project will likely use the following pieces of equipment that will generate point source noise:

- Revolving barge crane (~77 dBA at 50 feet)
- Tug/push boat (~87 dBA at 50 feet)
- Crew vessel (~81 dBA at 50 feet)

Although material barges will also likely be used for the Project, these are not powered andwill not generate point source noise.

The Occupational Safety and Health Administration (OSHA) regulations state that workers must not be exposed to noise levels above 85 dBA as a 8-hour noise exposure level (A-weighted sound levels (dBA) are dB scale readings adjusted for the varying sensitivity of the human ear to different frequencies of sound) or to 140 dBC as a peak sound level (C-weighted sound levels (dBC) are dB scale readings used for specifying peak or impact noise levels). The New Jersey law allows a maximum of 90 dB for watercraft motors measured at idle.

Chapter 3 – Alternatives Including the Preferred Alternative

Several alternatives were assessed during the development of this EA. The Preferred Alternative, which includes breakwater removal in one area to improve tidal flow and breakwater enhancement in other areas to provide shoreline protection within the Project area, is considered to be the most direct and effective way of meeting the Project objectives. The "Alternatives Considered but Eliminated" section details potential actions that were considered as part of data gathering efforts, but have been removed from consideration due to disqualifying factors such as cost effectiveness and limited funding for this Project. The Preferred Alternative, the Alternatives Considered but Eliminated, and the No Action Alternative are discussed in the following sections.

3.1 Preferred Alternative

The Preferred Alternative is the removal of stone from some portions of the breakwater, and the addition of stone in other portions. This will be accomplished by a 5- to 8-person field crew over anapproximately six week period during the fall. Fall is preferred to reduce any disturbance to marine resource including essential fish and their habitats. The types of equipment anticipated for use includea revolver barge crane, material barges, a crew boat, and a tug/push boat. These pieces of equipmentwill be used in 8-hour shifts during 5-day work weeks. A turbidity curtain will be installed around the work area prior to any stone movement. Access to the site will be by vesselsfrom land areas and launch sites. These land areas will be the launch sites for vessels carrying personnel and materials. The proposed stone will have a density of 160 pounds per cubic foot with

a stone size and gradation of 100 percent passing 24 inches, with 15 to 50 percent passing 12inches, and no more than 15 percent passing the 6 inch.

In order to achieve the Project objectives, the Service researched plans to modify the stone breakwater to enhance functioning breaches and remove additional stone from other breaches that were identified to be detrimental to the resiliency of the Supawna Meadows Marsh Complex or were deemed no longer necessary. The removed stone, along with some additional new stone, would then be added to other areas of the breakwater dike to increase the height for added shoreline protection. The approach required consideration of short-term and long-term conditions of sea level conditions and hydrodynamic flow.

In the consideration of potential stone breakwater removal, modification, and enhancements, the Supawna Meadows site was divided into nine potential work areas (Areas 1 through 9). These work areas were selected based upon existing marsh mouth openings within the Marsh Complex that would be targeted for either reduction or expansion in size and are shown in **Diagram 1**.

After reviewing existing conditions model, the results from the hydrodynamic model, and theresults from the assessment of short-term sediment transport potential, the Project was narrowed down to two possible design alternatives focusing activities within work areas 3, 4, 5, 6, and/or 7. Of the two proposed designs, Design Alternative 2 was chosen, initiating Phase 1 of the Project within work areas 3 and 4 at the mouth of Mill Creek which was completed in August 2017. Phase 2, this project, proposes the modification and enhancement of work areas 5, 6, and 7, which surround the entrance to Goose Pond. Both of these designs consist of a combination of rock placement and removal with the goal of reducing sediment transport potential on ebb ties to decrease the rate of sediment loss from the Supawna Meadows Marsh complex.

3.1.1 Design Phase 1 – Completed

In Phase 1[2], completed in 2017, rock was removed at Area 3A to deepen an existing breach in the stone breakwater to the elevation of the existing mudline (**Diagram 2**). Also under this Design, reclaimed rock was placed at Areas 3 and 4 to raise the stone breakwater elevation approximately to that of mean high water (2.56 feet North American Vertical Datum of 1988 (NAVD88)) along approximately 400 feet of the existing stone breakwater and to 1.56 feet NAVD88 along approximately 830 feet of the existing breakwater.

[2] NEPA compliance process completed in 2017

Diagram 1. Potential work locations for stone breakwater removal and enhancement (WHGRP 2016)

3.1.2 Design Phase

Under Design Phase 2, the Preferred Alternative, rock will be removed at Area 5A (~140 ft) to deepen existing breaches in the stone breakwater to the elevation of the existing mudline (-5.15 feet NAVD88) (**Diagram 3**). Rock placement in Phase 2 would also raise the breakwater elevation to 2.56 feet NAVD88 along approximately 350 feet in Areas 5, 6 and 7. Barges will be mobilized and loaded with stone materials from vessels launched at off site staging areas. Work hours will be tidally dependent. Transporting material to the work site from the staging area will be done on a barge. Barges will be light loaded to limit draft to 4' or less. Anchoring and spudding will be accomplished in a manner not to disturb the existing breakwater. Sone will be placed mechanically or by a method that limits waste or loss during placement. The proposed quantity of stone to be placed is 4,860 tons. The stone shall be hard and angular with a density of 160 lb/cf. 100% of the stone shall pass 24", 15-50% shall pass 12" and no more than 15% shall pass 6".

Diagram 2. Design Phase 1 (WHGRP 2016).

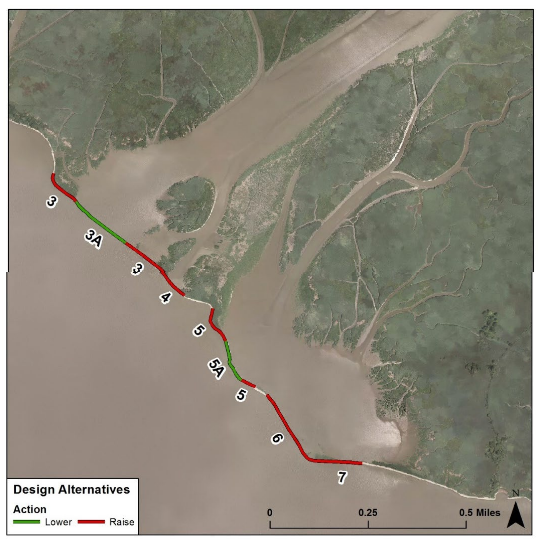


Diagram 3. Design Phase 2 (WHGRP 2016)

3.1.3 Design Alternatives Results

Phase 1, completed in 2017, provided added protection of the front edge of the Supawna Meadows Marsh Complex from wave action and the reduced risk of erosion during major storms. Phase 2, the preferred alternative, would also provide protection from waves and would result in an overall sediment transport benefit. A depiction of the proposed design plans are included in **Appendix B.** Components of the design are based on common design guidelines based on general USACE breakwater design guidance (USACE 1986) and include an approximate slope of 1V:2H with a crest width of approximately five feet.

3.2 No Action Alternative

A No Action Alternative is also explored as part of the EA process, in which the effect of not implementing the Preferred Alternative is assessed. This section of the report discusses the implicationsof not implementing the breakwater removal or modification activities within the Project area.

The condition of the currently degraded wetlands that have either a lost or a diminished ecosystem function will worsen over time, and wetlands that are not yet degraded will beginto lose their ecosystem function. The net result will be an overall loss of wetlands - wetlands that are on the Ramsar List of Wetlands of International Importance. This process of a loss of wetland function and loss of wetland area will occur through an increase in the rate, duration, and frequency of saltwater inundation, coupled with the impaired hydrology of the wetlands from the grid ditches and earthen dikes.

The increasing sea levels will perpetuate vegetation die-back and cause a shift in the vegetation community composition, as predicted by the SLAMM predictive model (Haaf et al. 2015b, USFWS 2011). This condition would result in the lowering of the primary productivity of the salt marsh (Ekberg 2014, Weinstein and Kreeger 2002), a community that is typically the leading primary producer in an ecosystem. This vegetation die-back results in the inability of the salt marsh to handle tidal flooding, thereby amplifying the effects of not only coastal storms but regular tidal cycles. The loss of vegetation and the increase in inundation create a negative feedback loop in which sediment accretion ceases and erosion increases, resulting in further inundation that reaches farther inland with subsequent saline intrusion into freshwater systems.

This encroachment of inundation into inland areas is problematic for the Supawna Meadows NWR as it contains historic properties and is generally surrounded by small rural farm properties that are, of themselves, important elements of the coastal ecosystem. Thus, the overall consequence of the No Action Alternative is that the mission and conservation goals of the Service, the refuge, and the CCP would not be met under the rapidly changing environmental conditions of sea level rise, and the coastline resiliency goals of Executive Order 13653 and United States Department of Interior (USDOI) Secretarial Order 3289 would not be addressed. The mission and goals would not be met as a result of a loss of wetland function, a physical loss of the wetlands themselves, the inland migration of tidal flooding and saline waters, which will negatively impact the surrounding ecosystem and public community, and the detrimental effectof direct and indirect impacts to wildlife populations that rely on the Supawna Meadows Marsh Complex community for foraging, reproduction and survival.

3.3 Alternatives Considered But Eliminated

In an effort to facilitate increased tidal flow and marsh accretion within the Supawna Meadows Marsh Complex, while alleviating ponding on the high marsh surface, several additional hydrologic restoration alternatives were considered. These alternatives included small channel excavation/modification/grading, removal of historical fill/dredge spoils, and the addition of living shoreline areas. These alternatives were either not applicable, or were not within the Service's budget for the current design/build construction scope.

3.3.1 Small Channel Excavation/Modification/Grading

The small channel excavation/modification/grading alternative was considered to reduce the amount of ponding on the marsh surface due to subsidence, sea level rise, and other factors which reduce the resiliency of the Supawna Meadows Marsh Complex. This restoration technique is used to alleviate waterlogged areas of a marsh that can allow for the recolonization of marsh vegetation, which in turn helps promote the accretion of the marsh surface. These drainage features also serve to provide a route for juvenile fish and crustaceans to access the marsh during incoming tides, and larger channels are used as migratory pathways and foraging areas by many species of predatory fish (Drummond 2013). This alternative was eliminated from further consideration due to cost effectiveness and funding for this Project.

3.3.2 Removal of historical Fill of Dredge Spoils

The removal of historical fill or dredge spoils was an alternative explored in an effort to return qualifying portions of the Supawna Meadows Marsh Complex to an elevation most suitable for desirable plant species. Additionally, this material could have been relocated and reused within the refuge for the targeted enhancement of marsh accretion at critical locations. This alternative was eliminated from further consideration as the investigative field study did not identify any qualifying areas that would have benefited from this procedure.

3.3.3 Living Shoreline

Another alternative explored for this Project was the creation of living shoreline structures to prevent erosion along the face of the Supawna Meadows Marsh Complex without expanding upon the existing stone breakwater/hardened structure. The living shoreline would allow the Supawna Meadows Marsh Complex the ability to continue carrying out its natural processes.

The creation of a living shoreline along the breakwater would be achieved through the strategic placement of plants, rock, sand, oyster castles, or other materials. It could add additionalprotection to the existing shoreline from erosion and could lead to increased marsh
accretion. Although this alternative could be completed with some on-site material, rock would need to be removed in order to place items like oyster castles. This option was eliminated due to due to cost eliminated effectiveness due to and cost funding for this Project.

Chapter 4 – Environmental Consequences and Cumulative Impacts

This chapter describes the environmental consequences of the Preferred Alternative (the Proposed Action), and the environmental consequences of the No Action Alternative. Environmental consequences can be short-term (i.e. temporary) or long-term, and may consist of adverse impacts, positive impacts, or no impacts at all. Furthermore, these impacts may also change over time, or affect one aspect of a resource differently from another. The Preferred Alternative is an effort to increase marsh resiliency by altering the hydrology that has been affected by the breakwater in light of sea level rise. In contrast, the No Action Alternative is anticipated to perpetuate the observed erosion and increase in inundation, resulting in the conversion of salt marsh to open water.

In order to better understand the impacts of the No Action Alternative that are presented in this chapter, the following preamble describes in greater detail the environmental consequences of this alternative. An increase in marsh erosion and inundation over the long term will result in vegetation die-back and cause a shift in the vegetation community composition. This condition would result in the lowering of the primary productivity of the salt marsh (Ekberg 2014, Weinstein and Kreeger 2002), a community that is typically the leading primary producer in an ecosystem. This vegetation die-back results in the inability of the salt marsh to handle tidal flooding, thereby amplifying the effects of not only coastal storms but regular tidal cycles. The loss of vegetation and the increase in inundation create a negative feedback loop in which sediment accretion ceases and erosion increases, resulting in further inundation that reaches farther inland with subsequent saline intrusion into freshwater systems.

The focus of the refuge is to restore tidal habitats to preserve migratory bird habitat for protection of key wildlife species and the enjoyment of wildlife enthusiasts. The mission would not be met if there was a loss of wetland function and a loss of wetlands acreage (i.e. a permanent loss of critical salt marsh). The loss of such vital habitat can have detrimental impacts on wildlife populations that rely on such marsh communities for foraging, reproduction and survival.

4.1 Topography

The Preferred Alternative involves the removal or modification of the breakwater in specific areas. There will be very small and unavoidable impacts to the local topography from the Preferred Alternative at the existing breakwater location site; however, the direct changes in topography within the Project area will occur to a man-made feature already present in the landscape. Indirect long-term changes in the topography will occur over many years as the Project area equalizes to the restored tidal hydrology and sediment accretion rates increase within the mash. These changes in topography are necessary to combat decreased quality of native marsh habitat. The restoration of proper tidal hydrology will create the conditions for which normal sediment exchange between the marsh and the Delaware Bay Estuary will occur.

The No Action Alternative would result in a negative impact to the local topography as there would be no corrective active taken to correct improper tidal hydrology. This would lead to increased erosion and continued low rates of accretion, perpetuating the existing degraded condition of the marsh.

4.2 Geology and Soils

The Preferred Alternative does not involve negative impacts to soil composition, nor will any of the Project activities extend down to surficial geological layers. The limited amount of sediment disturbance will occur underneath man-made features made of stone. Therefore, the Preferred Alternative will not have adverse impacts to the local or regional geology and soils. The Preferred Alternative will have a positive impact on soil/sediment development as deposition and accretion willoccur amongst the placed stone.

The No Action Alternative would not result in impacts to the local or regional geology and soils as no breakwater alteration activities would occur. However, a potential long-term adverse impact would be the loss of marsh soils through inundation and subsequent erosion as sediment accretion processes would no longer occur. The conversion of salt marsh to open water would submerge the normally intertidal sediments and soils, which will impact normal soil biogeochemical processes. The No Action Alternative would also not result in the positive impact on soil/sediment development, as new deposition and accretion would not occur.

4.3 Air Quality

The Preferred Alternative at the Project area is not expected to have a significant impact to air quality.Some temporary impacts are expected as the Preferred Alternative would involve the use of emission-producing vehicles and machinery. These pieces of equipment are anticipated to be used in 8- hour shifts over a 5-day work week for a period of about six weeks. However, those emissions are expected to be below SILs for all pollutants and averaging times for which a NAAQS or NJAAQS have been established. All on-road and off-road vehicles, boats, and machinery would be up-to-date in their registration and emission inspections (for those that require emissions testing), and thus compliant with current USEPA emission standards.

The No Action Alternative would not result in the use of any construction equipment; therefore, there would be no short-term direct impacts to air quality. There is a potential for long-term changes to air quality if the conversion of salt marsh to open water results in a change in the recreational use of the Project area by boaters. An increase in open water may result in an increase in boat traffic, which if non-electric motors are used, would contribute more emissions to the atmosphere.

4.4 Water Quality

The Preferred Alternative will have a positive impact to water quality. Healthy salt marshes are well documented to provide the important ecosystem service of improving water quality of their surrounding estuaries by removing nutrients, sediments, organic matter, and contaminants from surface water runoff and tidal influx (Koch and Gobler 2009, Nelson and Zavaleta 2012). The removal of nutrients occurs primarily through three major environmental processes: (1) plant uptake in tissue, (2) denitrification by microbial communities, and (3) burial in marsh sediments (Nelson and Zavaleta 2012, Velinsky et al. 2013).

To the contrary, a poorly vegetated salt marsh does not perform as well in nutrient and pollutant removal since the marsh lacks the plant biomass to assimilate these materials (Koch and Gobler 2009). Thus accelerated sea level rise has indirect adverse impacts to water quality by directly impacting the ability of a salt marsh to sustain a healthy vegetation community (NERRSSC 2015). This condition is further worsened by the decomposition of salt marsh vegetation that is killed by rising water levels, adding another nutrient and pollutant source into the surrounding estuaries (Nelson and Zavaleta 2012).

The Preferred Alternative is intended to preserve and enhance the salt marsh vegetation community by counteracting the deleterious effects of sea level rise and impaired tidal hydrology. The environmental consequence of the Preferred Alternative is a sustainment and improvement of the salt marshes' ability to provide water quality services in areas of currently healthy and degraded marsh, respectively. Nevertheless, there will be some unavoidable but temporary and minor adverse impacts resulting from the implementation of the Preferred Alternative.

The direct disturbance will primarily be caused by the removal of a small portion of the breakwater berm. This disturbance will be temporary and localized to an area of approximately 0.112 acres. This work area will return to stable conditions as sedimentation and tidal circulation occur over time. Sedimentation rates are difficult to predict and vary widely among different aquatic systems. While major factors such as grain size and water action play an obvious role, other factors such as the physiochemical interactions between saline and fresh water, the clay and organic matter content in the water column, temperature, and pH all play a role in determining the rate at which the clarity of the water will return (ERDC 2005). However, an indirect long-term benefit to the Proposed Action will be restored tidal hydrology and protection of the front edge of the Supawna Meadows Marsh Complexfrom wave action, reducing the risk of further erosion and impaired water quality.

The No Action Alternative would not result in direct impacts to water quality in the Project area as no activities that suspend sediment would occur. However, there will be indirect impacts to water quality as the salt marshes would continue to be subject to the adverse effects of sea level rise and altered tidal hydrology. These conditions would continue to reduce the extent and vigor of salt marsh vegetation, thereby reducing the ability of the marsh to intercept nutrient and pollutant runoff. A poorly vegetated salt marsh does not perform as well in nutrient and pollutant removal since the marsh lacks the plant biomass to assimilate these materials (Koch and Gobler 2009). Thus accelerated sea level rise has indirect adverse impacts to water quality by directly impacting the ability of a salt marsh to sustain a healthy vegetation community (NERRSSC 2015). This condition is further worsened by the decomposition of salt marsh vegetation that is killed by rising water levels, adding another nutrient and pollutant source into the surrounding estuaries (Nelson and Zavaleta 2012).

4.5 Wetlands and Streams

The Preferred Alternative will result in direct, unavoidable adverse impacts to wetlands and streams asa result of the breakwater alteration activities. Mechanized equipment and personnel will use openwater access points to reach the work areas to the extent practicable, but some intrusion into the wetlands will be necessary. The majority of the direct impact will be to existing wetland vegetationthrough trampling and boat compression, and to resuspension of sediments within the Delaware River; however, these disturbances will be limited to the work areas which are relatively small insize compared to the surrounding area. Additionally, these temporary and localized disturbances are for the long-term benefit of the larger wetland system. The disturbed areas are expected to rebound through tidal flushing and revegetation from the surrounding plant community. Mill Creek, Baldridge Creek, and the Salem River will not experience any adverse impacts.

The No Action Alternative would not have a direct adverse impact to wetlands; however, a long-term adverse impact may result as the wetlands will continue to degrade as a result of improper tidal hydrology, leading to a continued decrease in ecosystem function. A longer term consequence will be the eventual inundation of the marsh surface, converting this wetland to an open water system. While open waters are also considered to be wetlands, they do not provide the suite of functions that terrestrial wetlands do.

4.6 Vegetation

Similar to the impacts to wetlands described above, the Preferred Alternative would have unavoidable, but temporary impacts to vegetation as a result of mechanized equipment and personnel that will perform the breakwater dike alterations. The majority of this direct impact will be from tramplingand boat compression; however, this disturbance will be limited to small areas containingmonotypic stands of the invasive common reed. Additionally, these temporary and localized disturbances are for the long-term benefit of the larger vegetative community. These disturbed areas are expected to rebound through tidal flushing and revegetation from the surrounding plant community. It is anticipated that much of the vegetation rebound will be from desirable native marsh species as a result of restored hydrology, in contrast to the common reed that is likely takingadvantage of the impaired hydrology. Furthermore, the placement of stone will allow for new sediment deposition and accretion to occur, thus providing the opportunity for new vegetation establishment, or spread from surrounding vegetated areas.

The No Action Alternative would not have a direct adverse impact to vegetation; however, an indirect impact would be expected as the plant community will continue to degrade as a result of improper tidal hydrology, leading to a continued decrease in ecosystem function, and possibly an increase in common reed from the impaired hydrology. Similar to the adverse impacts described above for wetlands, a longer term consequence will be the eventual inundation of the marsh surface, converting this wetland to an open water system. This would result in a further loss of terrestrial wetland vegetation. The No Action Alternative would also not result in new sediment deposition or accretion, and thus would not provide new opportunities for vegetation establishment, or spread form surrounding vegetated areas.

4.7 Marine Resources

The Preferred Alternative will have unavoidable, but temporary and minor impacts to marine resourcesand EFH. A short-term direct impact includes the smothering or crushing of sessile or slow-movingorganisms. The digging activities may also kill, harm, or displace sessile or slow-moving organisms. Short-term indirect impacts include the re-shaping of the marsh surface which modifies the habitat for marine resources. Another indirect impact is increased turbidity at the work locations and the subsequent, but relatively minor sedimentation effects. Sediment suspension will occur but is expected to be limited to the immediate work area and not to be a long-term condition since a combination of settling and tidal flushing will attenuate the turbidity.

Mobile marine resources, such as gastropods, crustaceans, and fish can move away from and avoid areas where disturbances are occurring. Many crustaceans and immobile invertebrates, such as molluscs, are also highly adapted to turbid conditions. Nevertheless, since the Preferred Alternative isscheduled for the fall, the disturbance to marine resources will be reduced. If the work is performedduring the warmer months, disturbance to marine resources will also be reduced in accordance with any time of year restrictions imposed by the regulatory permits that are required for this Project.

The No Action Alternative would not result in the above impacts to marine resources or EFH; however, there would be long-term consequences to marine resources from this alternative. The improper tidal hydrology would continue to degrade the function of this salt marsh, and in turn, the marsh would not be able to support the healthy ecosystem that marine resources require. Furthermore, there may be a shift in the community assemblage over the long-term as the marsh continues to inundate at greater frequencies and for longer durations. If inundation continues to increase, the community assemblage will shift from a mix of intertidal and subtidal species, to a greater proportion of subtidal species.

4.8 Terrestrial Wildlife

The Preferred Alternative will not have substantial long-term adverse impacts to terrestrial wildlife. This is because of the temporary nature of the disturbance, the mobility of terrestrial wildlife, andthe resulting long-term benefits to terrestrial wildlife from the ecological uplift that is the goal of the Preferred Alternative. Most importantly, the work is scheduled to be conducted along the off-shore breakwater, away from terrestrial habitat. As discussed in Chapter 2, the management of migratorybird habitat is one of the primary purposes of the Service, and the management of terrestrial wildlife is an integral component of the Service's mission, the refuge's purpose, and the CCP. Thus, the potential for adverse impacts to terrestrial wildlife will be minimized by avoiding workin these areas. This protection applies not only to migratory birds, but to upland mammals and herpetofauna.

Terrestrial wildlife also have the ability to avoid or move out of the Project area if they find it unsuitable once work activities commence. This change in behavior is in itself an adverse impact in that the organism would use its time and energy to move out of the area - time and energy that would normally be used for feeding, resting, or mating. The movement of terrestrial wildlife to a new area also exposes those organisms to greater predatory risk and accident. However, the end result in this alteration of behavior is that the organisms would relocate to a more suitable and less stressful area. This is turn benefits the organisms in the long-term provided that they are not harmed along the way. Some terrestrial wildlife are also expected not to move, but to remain near the Project area if these individuals do not find the work activities to be disruptive to their normal functioning. While some organisms may be mildly disrupted by work activities, it may not reach the level at which relocation occurs.

Nevertheless, since the Preferred Alternative is tentatively scheduled for the fall, the disturbance to terrestrial wildlife will be reduced. If the work is performed during the warmer months, disturbance to terrestrial wildlife will also be reduced in accordance with any time of year restrictions imposedby the regulatory permits that are required for this Project. Because the Project will create temporary sediment plumes, the regulatory authorizations required for this Project are anticipatedto have an anadromous fish seasonal restriction condition imposed upon the work, from March 1 to June 30.

The No Action Alternative would not result in any short term impacts to terrestrial wildlife since no work activities would occur that could cause wildlife to move out of the work area or alter their behavior. However, there would be a long-term adverse impact to terrestrial wildlife from this alternative. This alternative would not attempt to correct the current degradation and continued degradation of the salt marsh from sea level rise and improper tidal hydrology, and thus would allow for the loss of important wildlife habitat. Such losses would run counter to the mission of the Service, the refuge, and CCP. The Service would not be able to fulfill its mission for the conservation and management of wildlife habitat, including migratory bird habitat.

4.9 Threatened and Endangered Species

There is one federally threatened plant species, sensitive joint-vetch, reported as having the potential to be within the Supawna Meadows Marsh Complex. However, this species is not expected to occur in, or within the vicinity of, the proposed Project area based on its preferred habitat. Sensitive joint-vetch, an annual legume, grows in fresh to slightly brackish tidal river systems within the intertidal zone, where populations are subject to flooding twice daily. It typically occurs at the outer fringe of marshes in localities where plant diversity is high and annual species are prevalent. Establishment and growth of this species relies on habitat containing bare to sparsely vegetated substrates (USFWS 2016a). There are only two documented populations of this species still in existence within southern New Jersey, one on the Wading River in Burlington County and one on the Manumuskin River in Cumberland County (USFWS 2012). The Preferred Alternative will occur over a breakwater dike near salt marsh habitat dominated by thick monotypic stands of common reed, as such, this species is not expected to be present within the Project area.Therefore, the Proposed Action will not have significant long-term environmental impacts to thisfederally listed sensitive plant species.

The Preferred Alternative will also not have significant environmental impacts to the three federally listed threatened animal species. The federally threatened northern long-eared bat uses mines andcaves in the winter to hibernate and uses upland forests to forage and roost throughout the rest of the year. Bog turtles (threatened) usually inhabit open-canopy emergent and scrub/shrub wetlands,such as shallow spring-fed fens, sphagnum bogs, swamps, marshy meadows, and wet pastures, bordered by wooded areas. They depend upon micro-habitats of interspersed wet and dry pockets,with soft muddy bottoms, vegetation dominated by low grasses and sedges, and a low volume of standing or slow-moving water (USFWS 2016b). The Project area does not contain habitat sufficient to support these two species. Data records from the International Shorebird Survey eBirdwebsite on red knots (ACLO 2016) revealed the nearest sighting was from Pea Patch Island, whichis over 1.5 miles west of the Project area. This record was from a single survey day in which the observers documented them migrating overhead. They were not recorded as foraging or nesting inthe area.

There may be some avoidance of the construction area by these federally listed threatened animal species as a result of increased noise and human activity; however, these impacts are notconsidered significant and will be temporary in nature. It is anticipated that the Preferred Alternative will result in the overall enhancement and naturalization of the local environment, including habitat that could support threatened and endangered species.

The additional State-listed threatened and endangered animal species or species of special concern that have the potential to be on or near the Project area (i.e., 4 bird species, 1 invertebrate, 2 fish), would also be expected to avoid the Project area due to the presence of the work crew and construction equipment. This indirect impact would be temporary, as the Project is only expected to take 45 working days to complete. In addition, the ecological upliftresulting from the restoration of healthy salt marsh habitat within their home range would have an indirect, long-term, and beneficial impact to these species, as well as other threatened and endangered wildlife living on or near the Project area.

Although the Supawna Meadows NWR may contain suitable habitat for the three State-listed plant species documented as having the potential to be in or near the area (i.e., coast flat sedge, New England bulrush, and floating marsh-pennywort), the breakwater dike does not contain such habitat. Because this is the only area where Project activities will occur, the Preferred Alternative wouldnot have the possibility of adversely impacting these species.

The No Action Alternative would not have any direct impacts to threatened and endangered species, as no activities would occur in the marsh. However, leaving the marsh in its current condition would lead to a further reduction of salt marsh surface area which is needed for breeding, nesting, and foraging for Federal and State-listed threatened and endangered species. A long-term consequence of the No Action Alternative is the eventual conversion of the salt marsh to open water, thereby eliminating this necessary habitat.

4.10 Cultural Resources

Although a listed historic property and inventoried archaeological artifacts have been documented within the refuge, the Project only involves the process of stone removal/movement along the man-made breakwater dike with no proposed below-ground work to be performed on native soils. The dike is not listed as eligible for inclusion in the National Register of Historic Places. Therefore, it has been concluded that the potential for intact cultural deposits within the Project area would be low and the Preferred Alternative would not have impacts on historic properties that are eligible for listing in the National Register of Historic Places or on known areas where historic or prehistoric archaeological artifacts have been previously recorded.

However, if any historic or prehistoric artifacts are discovered during the completion of this Project, work would be stopped immediately and the refuge management would be contacted to determine how to proceed. The Service, in consultation with the SHPO, will determine the appropriate management actions and additional Tribal consultation that shall be completed before construction may resume.

The No Action Alternative would not have any impacts to cultural resources, as no work would be performed in the Project area.

4.11 Socioeconomic Resources and Environmental Justice

The Preferred Alternative is not expected to have any impact, adverse or beneficial, on race, gender, age class, or the area schools. It will also not affect the county's leading employment industries, including agriculture, industry, or commercial fishing. It does not include long-term construction of any facility that would increase the number of permanent jobs in Pennsville Township or SalemCounty, nor would it have any effect on State or local tax revenue. Only minor, temporary, economic benefits may occur locally through Project personnel increasing spending at nearby gasstations, hotels, restaurants, hardware stores, other retail shops, etc.

The No Action Alternative would not have impacts on regional or local socioeconomic resources. No workforce would be present in the area to patronize retail services. A longer term impact to the local economy may result from the eventual conversion of salt marsh to open water, causing the public to use the refuge in different ways and for different purposes; however, the type of impact, adverse or positive, is unknown.

4.12 Recreation

Currently the refuge is open to the public and receives 15,000 to 20,000 visitors each year participating in recreational activities such as hunting, fishing, crabbing, wildlife observation, photography, and interpretation (USFWS 2011). There will be some minor and temporary disruptions in the use of the Project area by visitors. Disruptions may include the public avoiding the area during construction in response to construction activities and noise. Disruption to hunters, fishermen, crabbers, and wildlife observers may also occur due to Project activities causing some wildlife to temporarily move out of the area.

However, visitation also has the potential to increase as the public becomes aware of, and curious about, the marsh restoration activities, which in turn also presents an educational opportunity for the public. Furthermore, the long-term benefit of the Preferred Alternative is to enhance the marsh system, which in turn provides for better habitat for wildlife and, subsequently, better opportunities for the viewing and hunting public in the future. In addition, the work is scheduled to only take 45 days to complete. Therefore, recreational disruptions will be minimized further.

The No Action Alternative would not have any direct impacts on recreation, as no work would be performed in the Project area. However, this alternative would perpetuate the conditions leading to salt marsh degradation and loss. This would have a long-term adverse impact upon waterfowl and other coastal wildlife, leading to a diminished use of the refuge by nature enthusiasts and hunters in the future.

4.13 Transportation

The Project does not involve the building, removal, or repair of any major transportation infrastructure. In addition, the Project's scale is small, with minimal personnel required tocomplete the tasks. Personnel and vehicles would be required to travel along local roads leading to the Project area, such as Lighthouse Road and State Highway 49. The use of these local roads by Project crew would also be only very minor and temporary. Therefore, the resulting increase in traffic on local infrastructure, capable of handling a minimum of 12,830 cars per day, would not be significant. Furthermore, Project activities are only anticipated to require 45 working days to complete.

The No Action Alternative would not have any direct impacts on transportation, as no workforce would be required to travel to and from the Project area. However, there may be a long-term adverse impact on transportation within the refuge as the marshes continue to convert to open water, thereby causing possible road flooding conditions as water levels encroach upon the roadway and trails.

4.14 Noise

The Project area includes typical ambient noise from a park environment located on or near the water, such as boat or vehicular traffic and local pedestrian or trespasser activity. Although the noise generated from the equipment used during the Project are expected to be close to 8-hour threshold levels set for humans, the Project crew will wear any necessary hearing protection. In addition, the boat noise will be typical of area activities and the heavy equipment noise will be typical of any small construction project. The Project is also expected to require 45 days to complete, therefore, the noise will be temporary in nature. Wildlife that are present within the Project area during construction are expected to temporarily relocate due to the physical disruption. In addition, there are no humans living within the Project area. Therefore, Project-related noise would not jeopardize the health or welfare of the public or the wildlife in the area.

The No Action Alternative would not result in noise-related impacts, as no Project activities would be performed and the use of mechanized equipment within the Project area would not be necessary.

4.15 Cumulative Impacts

A cumulative impact analysis must consider the potential impact on the environment that may result from the incremental impact of the Project when added to other past, present, and reasonably foreseeable future actions (40 CFR 1508.7). The methodology for performing such analyses is set forth in *Considering Cumulative Effects under the National Environmental Policy Act* (CEQ 1997), and includes the following:

1. Identification of the geographic area in which effects of the Project may be felt.
2. Assessment of the impacts that are expected in that area from the Project.
3. Identification of other actions (past, present, and reasonably foreseeable) that have had or are expected to have impacts in the same geographic area.
4. Assessment of the impacts or expected impacts from these other actions.
5. Assessment of the overall impact that can be expected if the individual impacts are allowed to accumulate.

With the exception of two Service projects located at other refuges, the geographic area for the assessment of cumulative impacts from the Preferred Alternative at the refuge was primarily identified as the Pennsville/Penns Grove tributaries watershed. This watershed includes the municipalities of Oldmans Township, Carney's Point Township, Penns Grove Borough, and Pennsville Township. All of these municipalities are located in Salem County. However, Pennsville Township was the only municipality included in the geographic area of this cumulative impacts assessment as the Project area's drainage occurs only within this municipality.

Substantial changes were made to the aquatic environment by the creation of ditches for agricultural purposes (salt mash hay farming) and mosquito control. Additionally, other land use changes to the watershed have increased impervious surface area resulting in an increase in stormwater quantity and a subsequent decrease in stormwater quality. The Preferred Alternative is intended to provide long-term improvement to the environment through the restoration of coastal marsh habitat. The Preferred Alternative will not induce development, land use change, or other external pressure to the refuge.

Overall, the Preferred Alternative will serve to preserve and enhance the salt marsh vegetation community by counteracting the deleterious effects of sea level rise and impaired hydrologic function. The positive consequences of the preferred alternative include sustainment and/or improvement of the salt marshes' ability to provide water quality services, increased vegetative vigor which will create the conditions for marsh accretion to occur, minor economic benefits through personnel increasing spending near the Project location, and the restoration of healthy salt marsh habitat. These changes would lead to higher quality habitat for waterfowl, migratory birds, threatened and endangered species, and other wildlife as well as create a net positive impact for recreational hunters and nature observers. In addition, The Service would be able to fulfill its mission for the conservation and management of wildlife habitat, including migratory bird habitat.

A review of the Pennsville Master Plan (RRA 2002) revealed that there are no known present or future projects that are anticipated to impact or be impacted by the Preferred Alternative. One of the goals listed in the Pennsville Township's Master Plan is "to protect sensitive environmental resources from destruction or degradation, including…rivers, wetlands, stream corridors, potable water supplies, and aquifers." The Preferred Alternative would be in line with this goal.

A review of the *Salem County Growth Management Element of the Comprehensive County Master Plan* (SCPB 2016) did not reveal any potential conflicts between the Preferred Alternative and future planned activities for the county. While the Master Plan presents a number of improvements, pastand planned, within an area designated as the "Smart Growth Zone" located within the northwestern portion of the county, none are anticipated to adversely affect or be affected by the Preferred Alternative. One of the goals listed in the Growth Management Element of the Comprehensive County Master Plan is to "preserve and protect the County's valued resources including air and water quality, agricultural lands, historic areas, natural features such as floodplains, wetlands, woodlands, wildlife habitat areas, greenways, and scenic views." The Proposed Action would be in line with this goal.

As mentioned in Section 1.2 of this EA, the Supawna Meadows Project is one of two phases of the Service's Design/Build Marsh Restoration at the Cape May National Wildlife Refuge Complex (Resiliency Project #37) – the first phase of breakwater enhancement at Mill Creek was completed in 2017. This second phase of breakwater enhancement would impact Goose Pond. These two project areas are anticipated to work in concert with each other to improve marshresiliency in two different areas of the Delaware River coastline.

Similarly, a number of Service projects currently underway at the Cape May NWR alongthe Delaware Bay and Edwin B. Forsythe NWR along the Atlantic coastline are also designedto increase marsh resiliency in response to sea level rise and other anthropogenic effects. These projects are all intended to increase marsh resiliency, counter anthropogenic effects, and provide ecological uplift to the refuges. All of the above Service projects will have a combined positive impact upon each other.

In summary, there would not be any substantial cumulative adverse environmental impacts from the Marsh Restoration Project at the Supawna Meadows NWR when considered together with other past, present, and reasonably foreseeable future projects in the area.

Chapter 5 – References

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Chapter 6 – List of Preparers

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