US Army Corps of Engineers®
New York District

Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement

Atlantic Coast of New York

East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Appendix D

Environmental Compliance

Attachment D2a
Endangered Species Act Compliance
Biological Assessment For:

Piping Plover (*Charadrius melodus*)

Seabeach Amaranth (*Amaranthus pumilus*)

Rufa Red Knot (*Calidris canutus)*

USACE has requested that USFWS issue their Biological Opinion, which may include an Incidental Take Statement (ITS), as/if necessary, based upon the analyses provided in this Biological Assessment, according to and in compliance with our joint Section 7 obligations. USACE is in active coordination with USFWS regarding the preparation of the Biological Opinion which is expected mid-December.

November 2018

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Reformulation Study

Revised Draft General Reevaluation Report and Environmental Impact Statement

Environmental Compliance Appendix Attachment D2a Endangered Species Act Compliance

1 INTRODUCTION

1.1 Purpose and Objective of the Biological Assessment

This Biological Assessment (BA) has been prepared in accordance with requirements identified in the Endangered Species Act (ESA) of 1973, to identify and discuss potential impacts to federally-listed threatened and endangered (T&E) species caused by the U.S. Army Corps of Engineers (USACE), New York District (District) activities associated with implementation of the Atlantic Coast of New York, East Rockaway Inlet to Rockaway Inlet, New York Hurricane Sandy General Reevaluation (Project), Queens County, New York (Figure 1). T&E species include those species federally- listed and protected by the U.S. Department of the Interior, Fish and Wildlife Service (USFWS) under the ESA.

In accordance with Section 7(a)(2) of the ESA, as amended, federal agencies are required to ensure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of any habitat of such species determined to be critical unless an exemption has been granted. Additionally, a BA must be prepared if listed species or critical habitat may be present in an area to be impacted by a "major construction activity." A major construction activity is defined at 50 CFR §402.02 as a construction project (or an undertaking having similar effects) which is a major federal action significantly affecting the quality of the human environment as referred to in the National Environmental Policy Act (NEPA) (42 U.S.C. 4332(2)(C)).

1.2 List of Species

The USFWS, through its historical formal consultation with the District regarding implementation of the Project, identified three T&E species as being present in or near the Project Area. Based on habitat and life history assessments, recommendations from the USFWS in the original (currently being updated) Fish and Wildlife Coordination Act 2B Report (USFWS 1995a) and follow-up consultation for this Project with the New York State Department of Environmental Conservation (NYSDEC) and New York City Department of Parks and Recreation (DPR), the District has determined that the following federally-listed species are likely to occur in the East Rockaway Project Area and warrant impact analyses within a BA:

- Piping Plover (*Charadrius melodus*), federally threatened;
- Seabeach Amaranth (*Amaranthus pumilus*), federally threatened; and
- Rufa Red Knot (*Calidris canutus),* federally threatened.

Figure 1: Project Area Location

The state-listed threatened common tern (*Sterna hirundo*) and least tern (*Sterna antillarum*) and the federally and state-listed Endangered roseate tern (*Sterna dougallii*), utilize beach habitat similar to that of the piping plover and seabeach amaranth, and have been identified as species that may occur in the Project Area (USACE 1998, USFWS 1995a). Additionally, the state species of special concern, black skimmer (*Rynchops niger*), also is known to nest on coastal beaches and frequently nests in or near tern nesting areas (NatureServe 2002). None of these species have been identified by the USFWS as species requiring further ESA consultation (USFWS 1995a). However, measures taken to avoid and protect piping plover, red knot and seabeach amaranth habitats would benefit and protect these species as well.

1.3 Objectives for this BA

This BA will support the Environmental Impact Statement (EIS) that will identify and evaluate potential environmental impacts associated with the proposed Project, and will maintain compliance with Section 7(a)(2) of the ESA. The BA is designed to provide the USFWS with the required information for their assessment of the effects of the proposed Project on federally-listed endangered and threatened species.

Specific objectives of this BA are to:

1. Ensure Project actions do not contribute to the loss of viability of T&E species;
2. Comply with the requirements of the ESA, as amended, that Project actions not jeopardize or adversely modify critical habitat for federally-listed T&E species;
3. Analyze the effects of implementation of Project actions on federally-listed T&E species;
4. Recommend impact avoidance, minimization, and measures to offset impacts to federally- listed T&E species; and,
5. Provide biological input to ensure District compliance with the NEPA and the ESA.

1.4 Project Background

Rockaway, New York, has an extensive history of property damage and economic loss as a result of coastal flooding and erosion associated with frequent storms. Significant beach erosion and sand loss has reduced the width of the protective beach front and has exposed properties to a high risk of damage from ocean flooding and wave attack, and existing groins and jetties along the island have deteriorated and are becoming less effective at reducing sand loss along the shoreline and providing wave protection. Non shorefront flooding in Rockaway is attributed to storm surges in Jamaica Bay inundating the bay shorelines of Rockaway (Back Bay Flooding) and storm surges that overtop the high elevations located near the Rockaway beachfront flowing across the peninsula to meet the surge into Jamaica Bay (Cross Shore Flooding).

The Reformulation Study for East Rockaway Inlet to Rockaway Inlet and Jamaica Bay was authorized by the House of Representatives, dated 27 September 1997, as stated within the Congressional Record for the US House of Representatives. It states, in part:

> *"With the funds provided for the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay, New York project, the conferees direct the Corps of Engineers to initiate a reevaluation report to identify more cost-effective measures of providing storm damage protection for the*

project. In conducting the reevaluation, the Corps should include consideration of using dredged material from maintenance dredging of East Rockaway Inlet and should also investigate the potential for ecosystem restoration within the project area."

Public Law 113-2 (29Jan13), The Disaster Relief Appropriations Act of 2013 (the Act), was enacted in part to "improve and streamline disaster assistance for Hurricane Sandy, and for other purposes". The Act directed the Corps of Engineers to:

> *"…reduce future flood risk in ways that will support the long-term sustainability of the coastal ecosystem and communities and reduce the economic costs and risks associated with large-scale flood and storm events in areas along the Atlantic Coast within the boundaries of the North Atlantic Division of the Corps that were affected by Hurricane Sandy" (PL 113-2).*

In partial fulfillment of the requirements detailed within the Act, the Corps produced a report assessing "authorized Corps projects for reducing flooding and storm risks in the affected area that have been constructed or are under construction". The East Rockaway Inlet to Rockaway Inlet, NY project met the definition in the Act as a constructed project. In accordance with the Act, the Corps is proceeding with this GRR to address resiliency, efficiency, risks, environmental compliance, and long-term sustainability within the study area (USACE, 2013a).

1.5 Project Area Description

The communities located on the Rockaway peninsula from west to east include Breezy Point, Roxbury, Neponsit, Belle Harbor, Rockaway Park, Seaside, Hammels, Arverne, Edgemere and Far Rockaway. The former Fort Tilden Military Reservation and the Jacob Riis Park (part of the Gateway National Recreation Area) are located in the western half of the peninsula between Breezy Point and Neponsit. The characteristics of nearly all of the communities on the Rockaway peninsula are similar. Ground elevations rarely exceed 10 feet, except within the existing dune field. Elevations along the Jamaica Bay shoreline side of the peninsula generally range from 5 feet, increasing to 10 feet further south toward the Atlantic coast. An estimated 7,900 residential and commercial structures on the peninsula fall within the FEMA regulated 100-year floodplain.

During Hurricane Sandy, tidal waters and waves directly impacted the Atlantic Ocean shoreline. Tidal waters amassed in Jamaica Bay by entering through Rockaway Inlet and by overtopping and flowing across the Rockaway Peninsula. Effective coastal storm risk management for communities within the study area requires reductions in risk from two sources of coastal storm damages: inundation, wave attack with overtopping along the Atlantic Ocean shorefront of the Rockaway peninsula and flood waters amassing within Jamaica Bay via the Rockaway Inlet.

The study area (Figure 1), consisting of the Atlantic Coast of New York City between East Rockaway Inlet and Rockaway Inlet, and the water and lands within and surrounding Jamaica Bay, New York is vulnerably located within the Federal Emergency Management Agency (FEMA) regulated 100-year floodplain. The shorefront area, which is a peninsula approximately 10 miles in length, generally referred to as Rockaway, separates the Atlantic Ocean from Jamaica Bay immediately to the north. The greater portion of Jamaica Bay lies in the Boroughs of Brooklyn and Queens, New York City, and a section at the eastern end, known as Head-of-Bay, lies in Nassau County. More than 850,000 residents, 48,000 residential and commercial structures, and scores of critical infrastructure features such as hospitals, nursing homes, wastewater treatment facilities, subway, railroad, and schools are within the study area

The Project Area consists of beaches, sand dunes, low-growing shrubs, and tidal flats, and has been highly modified as a result of human development. Upland areas in the vicinity of the Project have been committed to residential, commercial and recreational development. Near shore and upper beach areas in the Project Area are heavily utilized for beach recreation. Numerous stone groins currently exist in the Project Area. The shoreline has been stabilized since the 1880s with beach fill, groins, bulkheads, and a stone jetty at Rockaway Inlet.

1.6 Description of Habitat and Species

Oceanfront beach, bayfront and deepwater ocean habitats constitute the majority of the Project Area. The beach community includes upper, intertidal, and nearshore subtidal areas. Except for the sparsely vegetated herb and herb/shrub community associated with the upper beach/dune area, most of the Project Area is devoid of vegetation and is significantly impacted from human use of the area for recreational activities. In addition, significant development abuts the upper beach zone in most of the Project Area.

Jamaica Bay which is located on the north side of the peninsula is the largest estuarine waterbody in the New York City metropolitan area covering an approximately 20,000 acres (17,200 of open water and 2,700 acres of upland islands and salt marsh). Jamaica Bay measures approximately 10 miles at its widest point east to west and four miles at the widest point north to south, including approximately 26 square miles in total. The mean depth of the bay is approximately 13 feet with maximum depths of 60 feet in the deepest borrow pits. Navigation channels within the bay are authorized to a depth of 20 feet. Jamaica Bay has a typical tidal range of five to six feet. The portions of New York City and Nassau County surrounding the waters of Jamaica Bay are urbanized, densely populated, and very susceptible to flooding. An estimated 41,000 residential and commercial structures within the FEMA regulated 100-year Jamaica Bay floodplain.

The Rockaway Beach Endangered Species Nesting Area was established in 1996 by New York City as a response to the piping plovers nesting in Far Rockaway, Queens.

1.6.1 Habitat Types

Jamaica Bay, formed by the barrier created by the Rockaway Peninsula, and its saltmarsh islands form one of the most recognizable and striking natural features within the urban landscape of NYC. Prior to the extensive urban development occurring over the past 150 years, tidewater grasslands colonized postglacial outwash plains at the ends of many creeks and streams in Jamaica Bay creating fringing salt marshes which encircled Jamaica Bay. Extensive saltmarsh islands and many more thousands of acres of fringing marshes and transitional uplands once adjoined the mainland, and the Rockaway peninsula did not extend much past what is now Jacob Riis Park. Under current conditions, the Rockaway peninsula has been substantially extended to the west, creating a more funnel shaped Rockaway Inlet; islands have been removed by dredging or extended to the nearby mainland by fill; shorelines have been altered by dredge and fill activities; bulkheads have been installed to stabilize and protect shorelines; channels and borrow areas have been dredged, altered bottom contours affecting flows; and natural tributaries have essentially disappeared causing sediment input from these tributaries to be mainly silts and particulates from urban runoff (DEP, 2007).

Existing coastal habitats within both planning reaches generally occur along an ecological continuum dependent upon tidal influence. The critical tidal elevations that help define these habitats include MLLW, MHW, and mean higher high water (MHHW).

Biological communities were classified into twelve distinct habitat types that were identified and mapped throughout the study area. They represent the range of conditions and habitat quality observed throughout the Atlantic Ocean Shorefront Planning Reach and the Jamaica Bay Planning Reach, including both native habitats and those resulting from long-term anthropogenic disturbances. Specifically, the Atlantic Ocean Shorefront Planning Reach consists of oceanfront beach habitat with isolated dune habitats. Most of the study area is devoid of vegetation and is significantly impacted by human use of the area for recreational activities and significant development that abuts the upper beach zone in most of the Study Area. The Jamaica Bay Planning Reach consists of a diverse mosaic of the twelve habitat types. While many native communities can be found throughout Jamaica Bay, it is also characterized by dense urban development that has altered and/or created new habitats indicative of the historic anthropogenic disturbance.

The intertidal zone extends from the low tide line to the high tide line and is submerged and exposed according to daily tidal cycles. The zone is unvegetated and consists of fine-grained sand substrate. Wrack and ocean debris are common within this zone. Species diversity is relatively low due to limited ability of species to withstand the daily submersion and exposure. Micro and macro-invertebrates known to inhabit this zone include crabs, shrimp, bivalves, and worms. The intertidal zone provides key foraging habitat for shorebirds/seabirds, which feed on these organisms.

The affected near shore subtidal zone extends from the low water line down to 25 feet (ft) below mean low water (MLW) and is nearly continuously submerged. The zone is unvegetated and consists of fine-grained sand substrate. The area contains a rich diversity of species including crabs, shrimp, bivalves, worms, and finfish. In addition, numerous man-made groins extend from the intertidal zone into the subtidal zone from 200 to 600 ft (USACE 1998). These structures provide habitat for numerous fish, macro-invertebrates, and birds.

Throughout both reaches of the study area, many natural shorelines have been replaced with hardened structures such as groins, bulkheads, revetments, or rip rap. These hardened structures have interrupted the naturally occurring ecological continuum and caused an unnatural transition from upland areas (i.e., usually impervious surfaces associated with urban areas) immediately into deep subtidal area. These shorelines provide limited habitats and services to a suite of resources identified as critical to the Jamaica Bay ecosystem.

1.6.2 Tides and Tidal Currents

The mean tidal range along the Atlantic Ocean Shorefront project area is 4.5 ft and the spring tidal range reaches 5.4 ft The Mean High Water (MHW) level and Mean Low Water (MLW) level relative to NAVD88 are +1.5 ft and - 3.0 ft, respectively for the Atlantic Coast.

With respect to the Bay, the MHW level and MLW level relative to NAVD88 within the Bay are +2.4 and -3.07 respectively.

Currents at East Rockaway Inlet have average maximum velocities of 3.1 and 2.3 knots at flood tide, and 2.6 and 2.2 knots at ebb tides. Rockaway Inlet is the only tidal inlet to Jamaica Bay with high currents at its narrowest point which is 0.63 miles with an average depth of 23 feet (USFWS 1997). At the entrance to Rockaway Inlet, the prevailing currents slow as they enter the mouth of the Bay and turn to the east and again slow which significantly reducing tidal exchange. Tides in Jamaica Bay are semi-diurnal and average 5 feet. Dredging has deepened the mean depth of the bay from approximately 3 feet in the past to 13 feet now, which has increased the residence time of water from 11 days to an average of 33 days but varying by depth and location (USFWS 1997). The maximum tidal current speeds in North Channel at Canarsie Pier are 0.5 knots (0.84 ft/s) flood and 0.7 knots (0.84 ft/s) ebb (USACE 2005). USGS observations of flow speeds at the USGS Rockaway Inlet gage are generally 1.0 knots or less during neap tide periods and 1.7 knots or less during spring tide periods (Arcadis 2016b).

1.6.3 Finfish and Shellfish

The nearshore waters of the Project Area support seasonally abundant populations of many recreational and commercial finfish (USACE 1998, USFWS 1982, 1995a). Primary recreational fish species include black sea bass (*Centropristis striata*), summer flounder (*Paralichthysdentatus*), winter flounder (*Pseudopleuronectes americanus*), weakfish (*Cynosion regalis*), bluefish (*Pomatomus saltatrix*), scup (*Stenotomus chrysops*), striped bass (*Morone saxatillis*), and Atlantic mackerel (*Scomber scombrus*) (USFWS 1989). Nearshore waters also contain a number of migrant anadromous and catadromous species such as the Atlantic sturgeon (*Acipenser oxyhinchus*), blueback herring (*Alosa aestivalis*), alewife (*Alosa pseudoharengus*), American shad (*Alosa sapidissima*), striped bass, and American eel (*Anguilla rostrata*) (Woodhead 1992).

1.6.4 Invertebrate Communities

The benthic community of the greater Project Area is dominated by polychaetous annelids, followed by malacostracans, bivalves, and gastropods (Reid et al. 1991, Ray and Clarke 1995, Ray 1996, USACE 2006). Common shellfish species in the Project Area are the hardshell clam (*Mercenaria mercenaria*), softshell clam (*Mya arenaria*), telling (*Tellina agilis*), razor clam (*Ensis directus*), rock crab (*Cancer irroratus*), lady crab (*Ovalipes ocellatus*), American lobster (*Homarus americanus*), hermit crab (*Homarus americanus*) and blue crab (*Callinectes sapidus*) (USACE 1998, 2005). Mussels (*Mytilus* spp) dominate man-made structures such as groins and jetties in the Project Area (USACE 1998). Ghost crabs (*Ocypode* spp) and sand fleas (*Talorhestia* spp.) dominate the beach community (USACE 1998). Surveys conducted by the USACE in 2003 indicate that the borrow area itself contains very small, to no, localized populations of surf clam (USACE 2006).

1.6.5 Significant Habitats

No federally designated critical habitat is found within or near the proposed project area. Jamaica Bay and Breezy Point have been designated Significant Coastal Fish and Wildlife Habitat by the New York State Department of State (NYSDOS), Division of Coastal Resources. Jamaica Bay, Breezy Point, and Rockaway Beaches have also been designated globally Important Bird Areas by Audubon New York. The federally-listed threatened piping plover (Charadrius melodus) and threatened seabeach amaranth (Amaranthus pumilus) have been identified within the project area.

1.6.6 Listed Species

The federally and state-listed piping plover, seabeach amaranth, rufa red knot, and roseate tern, as well as the state-listed common tern and least tern, and the state species of special concern black skimmer, all nest or carry out a major portion of their life cycle activities (i.e., breeding, resting, foraging) within essentially the same habitat (Table 1). This habitat encompasses areas located between the high tide line and the area of dune formation and consists of sand or sand/cobble beaches along ocean shores, bays and inlets and occasionally in blowout areas located behind dunes (Bent 1929, NatureServe 2002, NJDEP 1997, USACE 2006, USFWS 2004a).

Table 1: Protection Status of Species that Utilize Habitats Similar to those in the Project Area

Common Name	Federal Status	State Status
Common Tern	Not Listed	Threatened
Least Tern	Not Listed	Threatened
Piping Plover	Threatened	Endangered
Roseate Tern	Endangered	Endangered
Seabeach Amaranth	Threatened	Threatened
Rufa Red Knot	Threatened	Endangered

Piping plover have been identified and are known to nest within upper beach areas located within the Project Area (USACE 1998, USFWS 1995a, b, 2002). Red knots migrate through the project area and are dependent on intertidal and sand and mud flats for foraging and resting. Although not commonly seen in large numbers, there have been recent sightings of a few red knots in the vicinity of the Project. The USFWS has determined that habitats that occur in the Project Area are suitable for piping plover and seabeach amaranth (USFWS 1995a). Therefore, the life histories of piping plover and seabeach amaranth and potential impacts to these species and their associated habitats are discussed in detail in this Biological Assessment. The black skimmer and least, roseate, and common terns, could potentially utilize habitats within the Project Area. Measures taken to avoid and protect plover and seabeach amaranth habitats would benefit and protect these species, as well as numerous other shorebird/seabird species that depend on coastal habitats.

2 PROPOSED FEDERAL ACTION

The Recommended Plan for this Project is a component of the USACE response to the unprecedented destruction and economic damage to communities within the study area caused by Hurricane Sandy. The recommendations herein include a systems-based approach for coastal storm risk management that provides a plan for the entire area, which has been formulated with two planning reaches to identify the most efficient solution for each reach. Project partners include the New York State Department of Environmental Conservation, the New York City (NYC) Mayor's Office of Recovery and Resiliency, the NYC Department of Parks and Recreation, the NYC Department of Environmental Protection, and the National Park Service.

2.1 Study Objectives

Five principal planning objectives have been identified for the study, based upon a collaborative planning approach. These planning objectives are intended to be achieved throughout the study period, which is from 2020 – 2070:

1. Reduce vulnerability to storm surge impacts;
2. Reduce future flood risk in ways that will support the long-term sustainability of the coastal ecosystem and communities;
3. Reduce the economic costs and risks associated with large-scale flood and storm events;
4. Improve community resiliency, including infrastructure and service recovery from storm effects
5. Enhance natural storm surge buffers and improve coastal resilience.

2.2 Recommended Plan Description

The Coastal Storm Risk Management (CSRM) Recommended Plan for the area from East Rockaway Inlet to Rockaway Inlet and the lands within and surrounding Jamaica Bay New York consists of the following components, which are generally described for 2 Planning Reaches: 1) A reinforced dune and Berm Construction, in conjunction with groins in select locations along the Atlantic Ocean Shoreline; 2) High Frequency Flood Risk Reduction Features (HRFRRF) features in locations surrounding Jamaica Bay. In general, these features are intended to provide a design height of +6 ft NAVD through various methods to reduce frequent flooding. As HRFRRF features are further developed, additional NEPA documentation and resource agency coordination would be provided, as necessary. This Recommended Plan description includes the maximum footprint for the plan; however the footprint may be changed based on public and agency comments as well as new information.

2.3 Recommended Plan: Atlantic Shorefront

The general approach to developing CSRM along Rockaway Beach (between Beach 9th Street and Beach 169th Street, which the east and west tapers are included) was to evaluate erosion control alternatives in combination with a single beach restoration plan to select the most cost effective renourishment approach prior to the evaluation of alternatives for coastal storm risk management. The most cost effective erosion control alternative is beach restoration with increased erosion control. This constitutes of a beach berm width of 60ft at an elevation of +8ft NAVD88 constructed by a beach fill quantity of 1.6 million CY for the initial placement and with a 4-year 1,021,000 CY renourishment cycle, as needed, for the life of the project (50 years). In addition, a screening analysis was performed to evaluate the level of risk reduction provided by a range of dune and berm dimensions and by reinforced dunes, which would be combined with the beach restoration with increased erosion control to optimize CSRM at Rockaway Beach. A composite seawall was selected as the best coastal storm risk management alternative. The composite seawall protects against erosion and wave attack and also limits storm surge inundation and cross-peninsula flooding. The Recommended Plan spans from Beach 20th Street to Beach 149th Street (Reach 3 through Reach 6b) and combines Beach Restoration and Erosion Control and two tapered beach sections at both the east and west end of the project (Beach 9-19, and Beach 150-Beach 169, respectively), which are described below. In summary, the Recommended Plan has the following features:

- A composite seawall with a structure crest elevation of +17 feet (NAVD88), the dune elevation is +18 feet (NAVD88), and the design berm width is 60 feet;
- A beach berm elevation of +8 ft NAVD and a depth of closure of -25 ft NAVD;
- A total beach fill quantity of 1.6 million CY for the initial placement, including tolerance, overfill and advanced nourishment with a 4-year renourishment cycle of 1,021,00 cy, resulting in a minimum berm width of 60 feet;
- Extension of 5 existing groins; and
- Construction of 13 new groins.

The east beachfill taper is approximately 3,000 ft in shorefront length from Beach 19th Street east to Beach 9th Street. The taper comprises of approximately 1,000 ft of dune and beach taper including reinforced dune feature and approximately 2,000 ft of dune and beach fill without reinforced dune feature. In addition to the tapering of berm width, the dune elevation also tapers from an elevation of +18 ft NAVD at 19th Street down to approximately +12 ft NAVD at Beach 9th Street which will be tied into the existing grade. The west beachfill taper is approximately 5,000 ft in shorefront length from Beach 149th Street west to Beach 169th street fronting Riis Park. The beachfill taper will be beach fill only with a berm width tapered from the design width at 149th Street to the existing width and height at 169th Street. In addition to the beachfill taper, a tapered groin system comprised of three (3) rock groins is included for this section.

Figures 2a through 2d show the Atlantic Ocean Shorefront component of the Recommended Plan.

Figure 2a: Atlantic Ocean Shorefront Component of Recommended Plan (1 of 4)

Figure 2b: Atlantic Ocean Shorefront Component of Recommended Plan (2 of 4)

Figure 2c: Atlantic Ocean Shorefront Component of Recommended Plan (3 of 4)

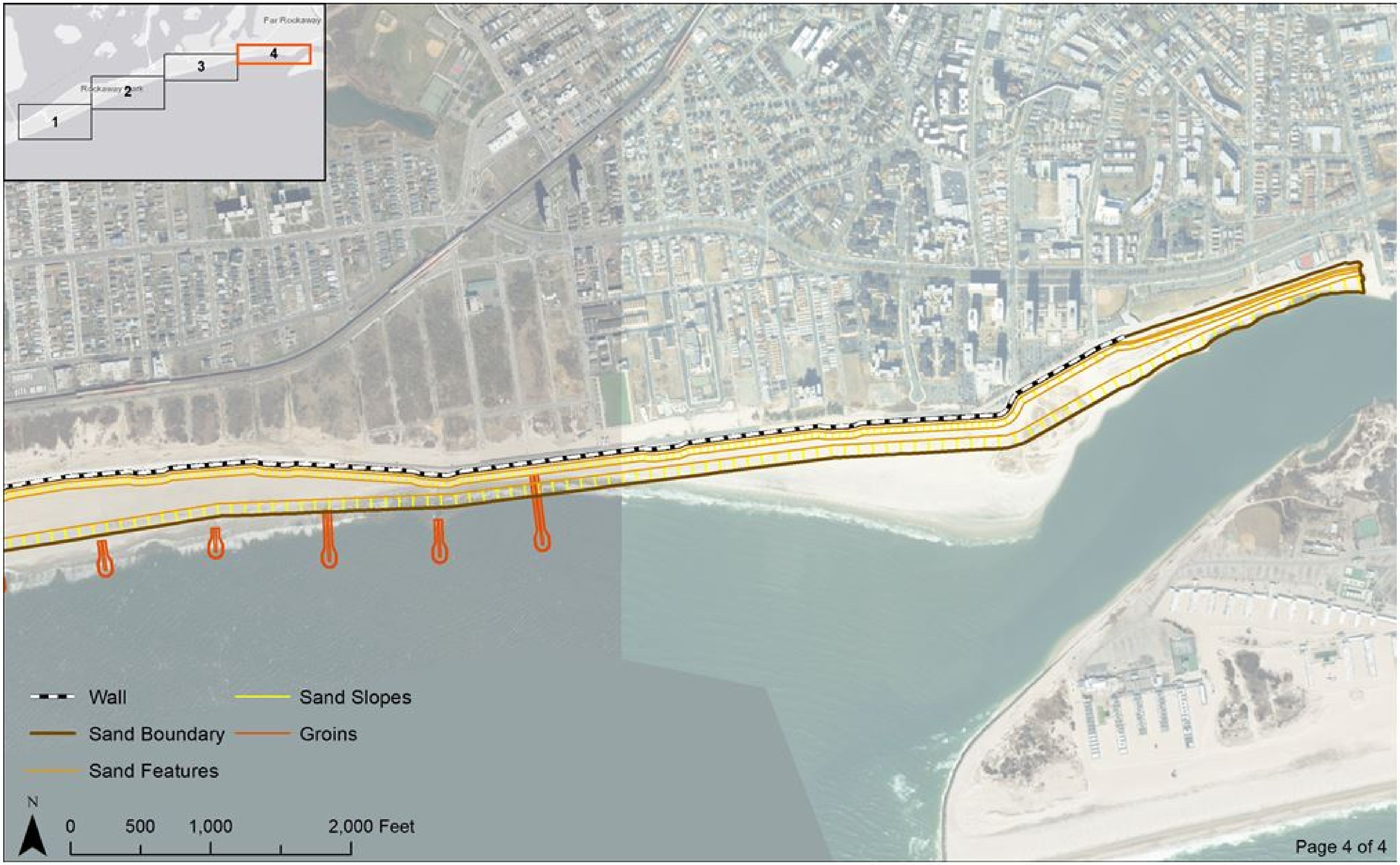


Figure 2d: Atlantic Ocean Shorefront Component of Recommended Plan (4 of 4)

2.4 Recommended Plan: Jamaica Bay

2.4.1 Cedarhurst-Lawrence

The Cedarhurst-Lawrence project (Figure 3) begins on the east side of the channel near the driveway to Lawrence High School. It consists of approximately 1000 feet of deep bulkhead that follows the existing bulkhead line around the southern end of the channel at Johnny Jack Park, and continues north along the west side before being connected to high-ground behind the Five Towns Mini Golf & Batting Facility with a 23 foot segment of medium floodwall. The project is located in Nassau County and crosses the border between the Village of Cedarhurst and the town of Hempstead. Project design elevations have preliminarily been established based on expected wave exposure are set at an elevation of +10.0ft NAVD88.

There are three existing outfalls in the area where the bulkhead will be raised. Each of the outlets will be modified to add a valve chamber that will include a sluice gate and flap valve to prevent high tides or storm surge from flooding through the drainage system. The outlet pipes will be replaced if the design phase indicates it is necessary. Drainage along the landward side of the bulkhead will be provided by a small ditch or drainage collection pipe, with inlets that will be connected to the existing or additional drainage outlets. When the drainage outlets are blocked by a storm tide the ditch or pipes will direct runoff towards a pump station. The preliminary pump station capacity is estimated to be approximately 40 cubic feet per second (cfs), which will be refined during the design phase.

CEDARHURST-LAWRENCE OUTLET TABLE

Drainage Area	**Outfall Size**	**Outfall Location**
Drainage Basin L1	TBD	Existing Outfall
Drainage Basin L1	TBD	Existing/New Culvert (500 feet from Peninsula Boulevard).
Drainage Basin L1	TBD	Existing/New Culvert (500 feet from Peninsula Boulevard).
Drainage Basin L1	5’x3’	Outfall L-1, Approximately 250 feet from Peninsula Boulevard

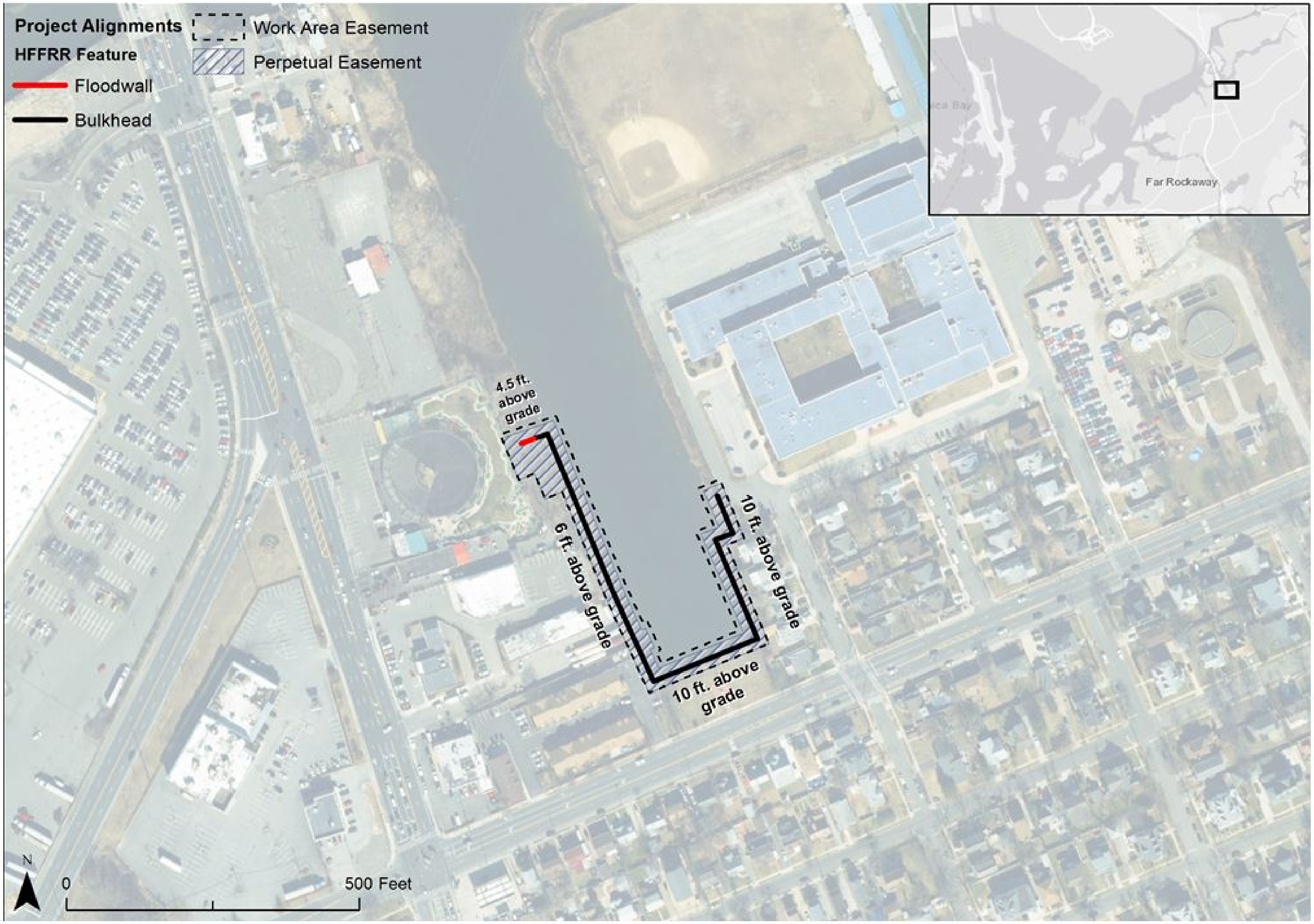


Figure 3: Cedarhurst-Lawrence HFFRRF Project Plan

2.4.2 Motts Basin North

This project consists of a medium floodwall beginning just north of the corner of Alemada Ave. and Waterfront Blvd. and continuing to the east along the south side of Waterfront Blvd. for approximately 540 feet (Figure 4). The line of protection then shifts to a section of medium floodwall above an existing outfall, continuing east for 47 feet before transitioning back into a low floodwall for an additional 105 feet. Project design elevations vary have preliminarily been established based on the expected wave exposure and are +8.0ft.

The existing outlet will be modified to add a valve chamber that will include a sluice gate and flap valve to prevent high tides or storm surge from flooding through the drainage system. The outlet pipes will be replaced if the design phase indicates it is necessary. Drainage along the landward side of the bulkhead will be provided by a small ditch. Inlets will connect to the existing and one proposed additional drainage outlets.

THIS PROJECT ELEMENT OF THE JAMAICA BAY PLAN HAS BEEN ELIMINATED FROM CONSIDERATION.

MOTTS OUTLET TABLE

Drainage Area	Outfall Size	Outfall Location
Drainage Basin L1	TBD	Existing Outfall

Figure 4: Motts Basin North HFFRRF Project Plan- ELIMINATED FROM THE RECOMMENDED PLAN

2.4.3 Mid-Rockaway - Edgemere Area

The eastern end of the project area (Figure 5) begins at high ground near the intersection of Beach Channel Drive and Beach 35th Street. The project moves north and then west following parallel to Beach 35th Street before jogging to the north and crossing the abandoned portion of Beach 38th Street and continuing west. The project turns north and runs along the peninsula between Beach 43rd Street and the coastal edge. This approximately 3,200 foot section of hybrid berm has been maintained as far landward as possible and weaves in and out between the properties. The hybrid berm is strategically used at these locations to minimize and avoid impacts to existing healthy wetland habitats. This area has also been identified as a good candidate for the use of Natural and Nature Based Features (NNBFs). The NNBF design includes placement of a stone toe protection and rock sill structure just off the existing shoreline to attenuate wave action and allow tidal marsh to establish between the rock sill and the berm. In some locations the eroded/degraded shoreline (subtidal) will be regraded to allow for the development of low marsh (*Spartina alterniflora*) to provide productive nursery habitats behind the sill structures. The shore slope behind the structure will be regraded to reduce risk of erosion further and create suitable elevation gradients and substrates for establishment of a high tidal marsh, designated as scrub shrub areas in the figure. In addition, the graded habitat behind the structure will be designed to allow the shoreward migration of various habitats with rising sea levels, thereby extending the life of these important ecological systems. On the north east of the Edgemere peninsula the project then transitions into 200 feet of shallow bulkhead, which continues north along existing water front properties and bulkheads. Approximately 200’ of medium floodwall then cuts west across, at the tip of the Edgemere peninsula. A road ramp on Beach 43rd Street has been included to maintain both pedestrian, and vehicle access to the coastal edge at north end of Beach 43rd street. The floodwall continues in southwest direction along the coastline after which it transitions into a 750 foot section of high berm. The berm continues west from Beach 43rd Street before turning south just to the east of the unpaved extension of Beach 44th Street. The project then transitions into a 660 foot section of high floodwall which continues southwest staying as far landwards as possible to avoid an existing restoration project. Near the intersection of Norton Avenue and Beach 46th Street, north of Norton Avenue, the floodwall transitions back into a low berm which runs parallel to Norton Avenue southwest and then turns northwest along Conch Place. The area waterward of this berm has also been identified as a good location for the use of NNBFs and to restore high marsh habitat. Project design elevations vary and have preliminarily been established based on expected wave exposure. Project elevations range between +8.0ft and +9.5t NAVD88.

The Edgemere interior drainage basin has two subbasins, E1 and E2 covering approximately 194 acres and 274 acres, respectively. The Edgemere drainage basin is almost fully developed and predominantly residential, except for a stretch of undeveloped, grassy area along the southern part of E1 and southwestern part of E2. Subbasin E1 was estimated to require 9 outlets, including 2 existing outlets. Subbasin E2 was estimated to require 6 outlets, including 1 existing outlet (See Edgemere Outlet Table). Each of the existing outlets will be modified to add a valve chamber that will include a sluice gate and flap valve to prevent high tides or storm surge from flooding through the drainage system. The existing outlet pipes will be replaced if the design phase indicates it is necessary due to the condition of the pipes or a need for additional capacity. The new outlets are generally assumed to be 5 ft. wide by 3 ft. high box culverts. Drainage along the landward side of the berm/floodwall structures will be provided by a small ditch or drainage collection pipe, with some inlets that will be connected to the existing or additional drainage outlets. When the drainage outlets are blocked by a storm tide the ditch or pipes will direct runoff towards a pump station. The preliminary pump station analysis indicates that three pump stations are desired in the Edgemere Area. Due to the length of the area and difficulties in draining all of the area to a single site, drainage subbasin E1 is proposed to have two pump stations one pump station would be located near Norton Avenue and Beach 49th Street and the other near Beach 43rd Street and Hough Place with a combined capacity of about 210 cfs. Subbasin E2 is proposed to have one pump station located near Beach 38th Street with an estimated capacity of 120 cfs. It should be noted that each pump station will include additional gravity capacity that will operate when the pump station is not in operations mode. The capacity of each pump station and drainage outlet will be refined during the project design phase.

EDGEMERE OUTLET TABLE

Drainage Basin	**Outfall Size**	**Outfall Location**
Drainage Basin E1	TBD	Existing Outfall ROC-648
Drainage Basin E1	5'x3'	Outfall E1-1 located on Norton Avenue between Beach 47th and 48th Streets.
Drainage Basin E1	5'x3'	Outfall E1-2 located on Norton Avenue between Beach 46th and 45th Streets.
Drainage Basin E1	5'x3'	Outfall E1-3 located on Beach 45th Street north of Hough Place.
Drainage Basin E1	5'x3'	Outfall E1-4 located on the north end of Beach 45th Street.
Drainage Basin E1	5'x3'	Outfall E1-5 located 550 feet north of Hough Place.
Drainage Basin E1	5'x3'	Outfall E1-6 located 500 feet north of Hough Place.
Drainage Basin E1	TBD	Existing Outfall ROC-637
Drainage Basin E1	5'x3'	Outfall E1-7 located north of Beach 40th Street.
Drainage Basin E2	TBD	Existing Outfall ROC-638
Drainage Basin E2	5'x3'	Outfall E2-1 located 50 feet east of Beach 37th Street.
Drainage Basin E2	5'x3'	Outfall E2-2 located 50 feet east of Beach 37th Street.
Drainage Basin E2	5'x3'	Outfall E2-3 located 50 feet east of Beach 36th Street.
Drainage Basin E2	5'x3'	Outfall E2-4 located 50 feet east of Beach 36th Street.
Drainage Basin E2	5'x3'	Outfall E2-5 located between Beach 36th Street and Beach 35th Street.

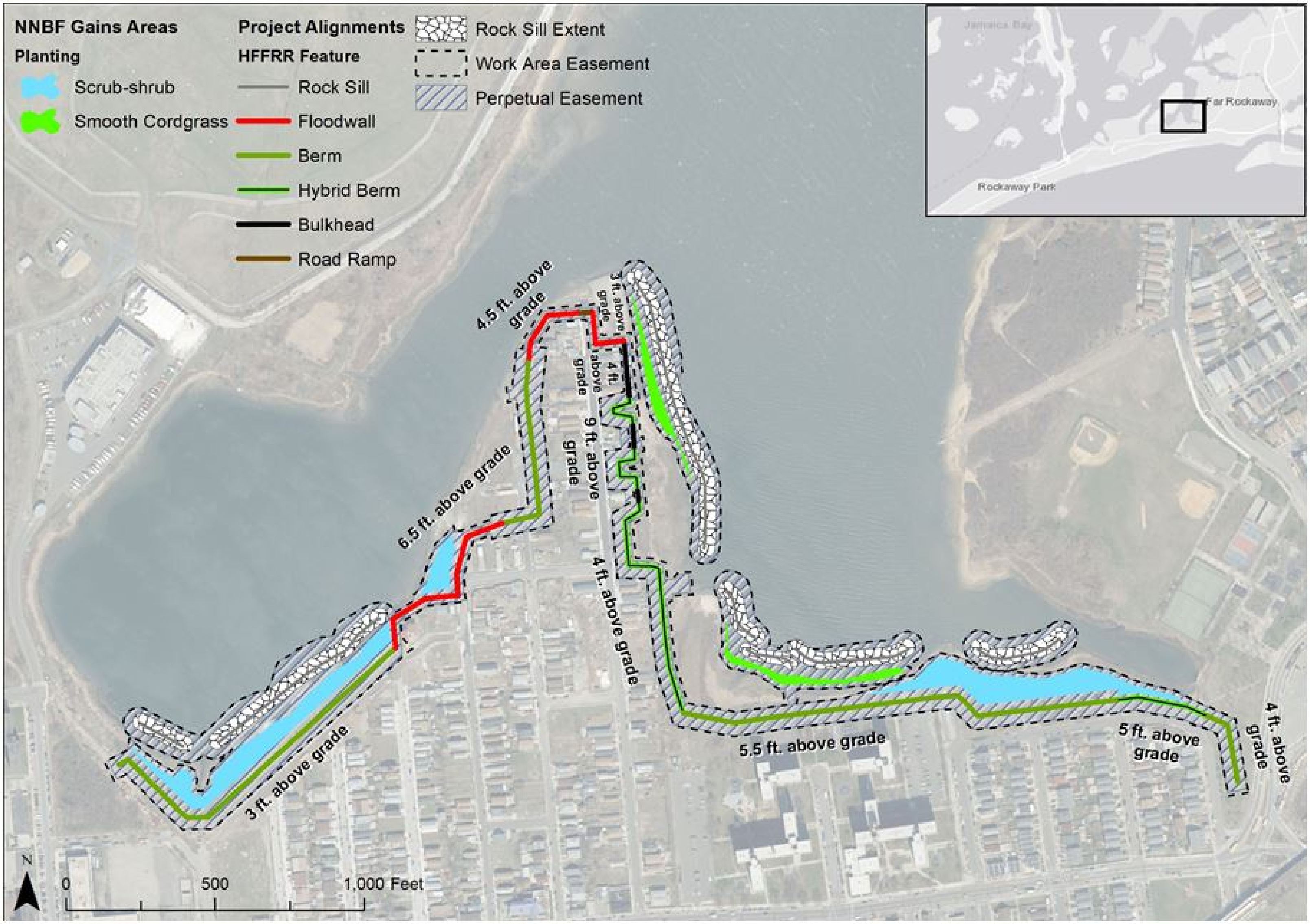


Figure 5: Mid Rockaway – Edgemere Area HFFRRF Project Plan

2.4.4 Mid-Rockaway - Arverne Area

This area of the project (Figure 6) begins at high ground to the north of Almeda Avenue and Beach 58th Street. An approximately 1,100 foot section of low berm runs south along Beach 58th Street. The berm has been maintained as far landward as possible to avoid healthy habitat. This segment has been identified as a candidate for the use of NNBFs. Much of the area is identified as existing quality wetlands, but a portion of fill area has been identified where intermediate marsh (*Spartina patens*) will be restored. The project then transitions to an approximately 1,200 foot long medium floodwall which, for feasibility level analysis, is purposefully sited along property boundaries at the southern end of the channel to minimize impacts to the existing waterfront businesses. A road ramp has been included to maintain access to the marina. At the southwest corner of the channel the project transitions to run along the coastal edge north for approximately 1,700 feet. This segment transitions between revetments and bulkheads to match the existing coastline conditions and uses. The portion between Thursby Avenue and Elizabeth Road has been aligned such that it can be integrated into the planned NYC DPR Thursby Basin Park project. Just north of De Costa Avenue, the project transitions to low berm for approximately 1,600 feet and runs west along De Costa Avenue and around the edges of healthy habitat while also creating an area for stormwater storage and a pump station just north of Beach Street. At the corner of De Costa Avenue and Beach 65th Street the low berm transitions into a hybrid berm to minimize habitat impacts. The hybrid berm continues west and then north for 300 feet to the corner of Beach 65th Street and Bayfield Avenue. The project then transitions to a 2,400 foot long shallow bulkhead which travels west along the line of existing bulkheads where they exist and parallel with Bayfield Avenue in areas without existing bulkhead. The bulkhead section ends just west of the corner of Bayfield Avenue and Beach 72nd Street. The area west of Beach 69th Street and the eastern end of De Costa Ave has been identified as a good candidate for NNBF. Based on existing elevations and profiles, a combination of either fill or excavation is used to provide the appropriate elevations shoreward of the rock sills to maximize healthy subtidal habitats, with restoring a transition area for low to high intertidal marsh. Eroded shorelines were replaced with low intertidal (*Spartina alternaflora*) habitats, and transition to either intermediate (*Spartina patens*) and/or high marsh (scrub-shrub) habitats. From the end of the bulkhead section the project continues south with a 120 foot section of medium floodwall connecting the bulkhead to a 1,080 foot section of high berm. The berm runs south along Beach 72nd Street and turns west at Hillmeyer Avenue and continues west past the corner of Barbados Drive and Hillmeyer Avenue, where it turns north and transitions to a flood wall to minimize the features footprint. The berm section has been position close to the roads to minimize impacts on habitat. The berm section transitions into a high floodwall which goes west and then runs parallel to the coast southwest for 440 feet, ending at a bulkhead section just west of the end of Hillmeyer Avenue. The Brant Point area includes the creation of wetlands between the berm and the rock sills that are placed just off the coastal edge. The rock sill will protect the shoreline where eroded areas will be restored to low marsh habitats protecting the existing high quality habitats shoreward. The areas behind the existing wetlands areas will be graded to provide a transition area to high marsh and then uplands where practical. The existing uplands areas will be replanted as necessary to provide for a high quality maritime forest habitat, with appropriate tree species. South of Hillmeyer Avenue the alignment follows the bulkheaded coastal edge. The project proposes a high frequency flood risk reduction bulkhead feature that follows an existing bulkhead along the coastal edge for approximately 270 feet ending just south of Almeda Avenue. From this point a low floodwall runs parallel with the coastal edge southeast for 700 feet then transitions into a deep bulkhead. This section of bulkhead continues southeast along the line of existing bulkhead for approximately 540 feet to the end of Thursby Avenue. The project continues as a low floodwall for approximately 1,400 feet, traveling east along Thursby Avenue and then south, parallel with Beach 72nd Street turning west and running along Amstel Boulevard, ending just past Beach 74th street. Two road ramps and one vehicular gate are included to maintain access to the waterfront. The final segment is approximately 250 feet of medium floodwall which runs along the coastal edge and connect the low floodwall to high ground in the west. Project design elevations vary and have preliminarily been established based on the expected wave exposure. Project elevations range between +8.0ft and +11.5t.

The Arverne drainage basin has three subbasins A1, A2, and A3, covering 76 acres, 139 acres, and 209 acres, respectively. The Arverne drainage basin is almost fully developed and predominantly residential, with a few, scattered undeveloped areas.. Subbasin A1 was estimated to require 8 outfalls, including 5 existing outfalls. Subbasin A2 was estimated to require 3 outlets. Subbasin A3 was estimated to require 5 outlets, including 3 existing outlets. Each of the existing outlets will be modified to add a valve chamber that will include a sluice gate and flap valve to prevent high tides or storm surge from flooding through the drainage system. The existing outlet pipes will be replaced if the design phase indicates it is necessary due to the condition of the pipes or a need for additional capacity. The new outlets are generally assumed to be 5 ft. wide by 3 ft. high box culverts (See Arverne Outlet Table). Drainage along the landward side of the berm/floodwall structures will be provided by a small ditch or drainage collection pipe, with some inlets that will be connected to the existing or additional drainage outlets. When the drainage outlets are blocked by a storm tide the ditch or pipes will direct runoff towards a pump station. The preliminary pump station analysis indicates that three pump stations are desired in the Arverne Area. Drainage subbasin A1 is proposed to have a pump station located adjacent to DE Costa Avenue near Beach 72nd with a capacity of about 70cfs. Subbasin A2 is proposed to have one pump station located on DE Costa Avenue near Beach 63rd Street with an estimated capacity of 180 cfs. Subbasin A3 is proposed to have one pump station located south of Thursby Avenue with an estimated capacity of 300 cfs. It should be noted that each pump station will include additional gravity capacity that will operate when the pump station is not in operations mode. The capacity of each pump station and drainage outlet will be refined during the project design phase.

ARVERNE OUTLET TABLE

Drainage Basin	Outfall Size	Outfall Location
Drainage Basin A1	TBD	Existing Outfall ROC-633
Drainage Basin A1	TBD	Existing Outfall ROC-634
Drainage Basin A1	TBD	Existing Outfall ROC-40062
Drainage Basin A1	5'x3'	Outfall A1-1 located at the end of Hillmyer Avenue.
Drainage Basin A1	5'x3'	Outfall A1-2 located adjacent to Hillmyer Avenue and Barbadoes Avenue.
Drainage Basin A1	TBD	Existing Outfall ROC-658
Drainage Basin A1	5'x3'	Outfall A1-3
Drainage Basin A1	TBD	Existing Outfall ROC-659
Drainage Basin A2	5'x3'	Outfall A2-1 located on Bayfield Avenue 150 feet west of Beach 65th Street.
Drainage Basin A2	5'x3'	Outfall A2-2 located at the east end of DE Costa Avenue.
Drainage Basin A2	5'x3'	Outfall A2-3 located at the east end of Burchell Road.
Drainage Basin A3	TBD	Existing Outfall ROC-??? Located at the east end of Thursby Avenue.
Drainage Basin A3	TBD'	Existing Outfall ROC-636
Drainage Basin A3	5'x3'	Outfall A3-1 located 250 north of Beach Channel Drive on 58 Street.
Drainage Basin A3	TBD	Existing Outfall ROC-635
Drainage Basin A3	5'x3'	Outfall A3-2 located 50 north of Beach Channel Drive on 58 Street.

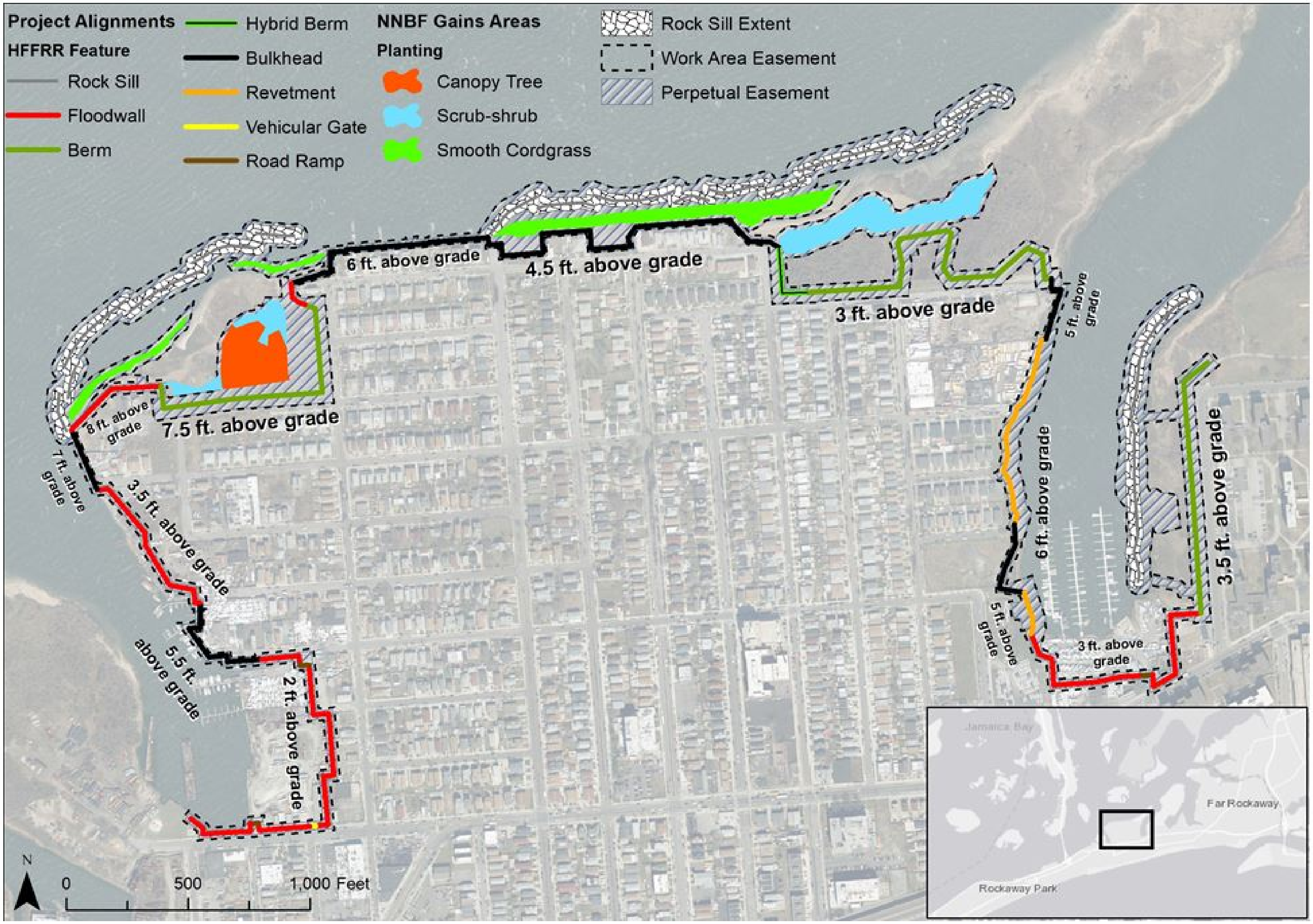


Figure 6: Mid Rockaway – Arverne Area HFFRRF Project Plan

2.4.5 Mid-Rockaway - Hammels Area

Two separate segments compose the Hammels area of the Mid-Rockaway project (Figure 7). The east segment begins approximately 320 feet west of the intersection of Beach 75th Street and Beach Channel Drive. It is composed of approximately 1,400 feet of low floodwall, running west along the north side of Beach Channel Drive, and parallel with the Rockaway Line elevated subway track. Three road ramps have been included to maintain access to the water front properties. The west segment consists of 1,400 feet of low floodwall beginning to the west of the MTA facility Hammels Wye adjacent to the Rockaway Line. The project heads west and south in a stair-step fashion avoiding impacts on existing structures, ending on the north side of Beach Channel Drive just west of Beach 87th Street. Three road ramps have been included to maintain access to the waterfront. Project design elevations have preliminarily been established based on the expected wave exposure, which is expected to be low, and are set at +8.0ft NAVD88.

The Hammels drainage basin includes two subbasins, H1 and H2, approximately 105 acres and 139 acres respectively. The Hammels drainage basin is almost fully developed, except for a few scattered grassy areas and is predominantly residential, with some commercial development. Subbasin H1 was estimated to require 3 outlets, including 2 existing outlets. Subbasin H2 was estimated to require 3 outlets, including 1 existing outlet. Each of the existing outlets will be modified to add a valve chamber that will include a sluice gate and flap valve to prevent high tides or storm surge from flooding through the drainage system (See Hammels Outlet Table). The existing outlet pipes will be replaced if the design phase indicates it is necessary due to the condition of the pipes or a need for additional capacity. The new outlets are generally assumed to be 5 ft. wide by 3 ft. high box culverts. Drainage along the landward side of the berm/floodwall structures will be provided by a small ditch or drainage collection pipe, with some inlets that will be connected to the existing or additional drainage outlets. When the drainage outlets are blocked by a storm tide the ditch or pipes will direct runoff towards a pump station. The preliminary pump station analysis indicates that two pump stations are desired in the Hammels Area. Drainage subbasin H1 is proposed to have a pump station located at the southern end of Hammels near Beach 87th Street with a capacity of about 100cfs. Subbasin H2 is also proposed to have one pump station which is located at the northern end of Hammels near Beach Channel Drive with an estimated capacity of 180 cfs. It should be noted that each pump station will include additional gravity capacity that will operate when the pump station is not in operations mode. The capacity of each pump station and drainage outlets will be refined during the project design phase.

HAMMELS OUTLET TABLE

Drainage Area	Outfall Size	Outfall Location
Drainage Basin H1	TBD	Existing Outfall ROC-656
Drainage Basin H1	5’x3’	Outfall H1-1, Approximately 70 feet east of Beach 85th Street
Drainage Basin H1	TBD	Existing Outfall ROC-657
Drainage Basin H2	5’x3’	Outfall H2-1, Approximately 350 feet west of Beach 80th Street
Drainage Basin H2	5’x3’	Outfall H2-2, Approximately 100 feet east of Beach 79th Street
Drainage Basin H2	TBD	Existing Outfall ROC-653

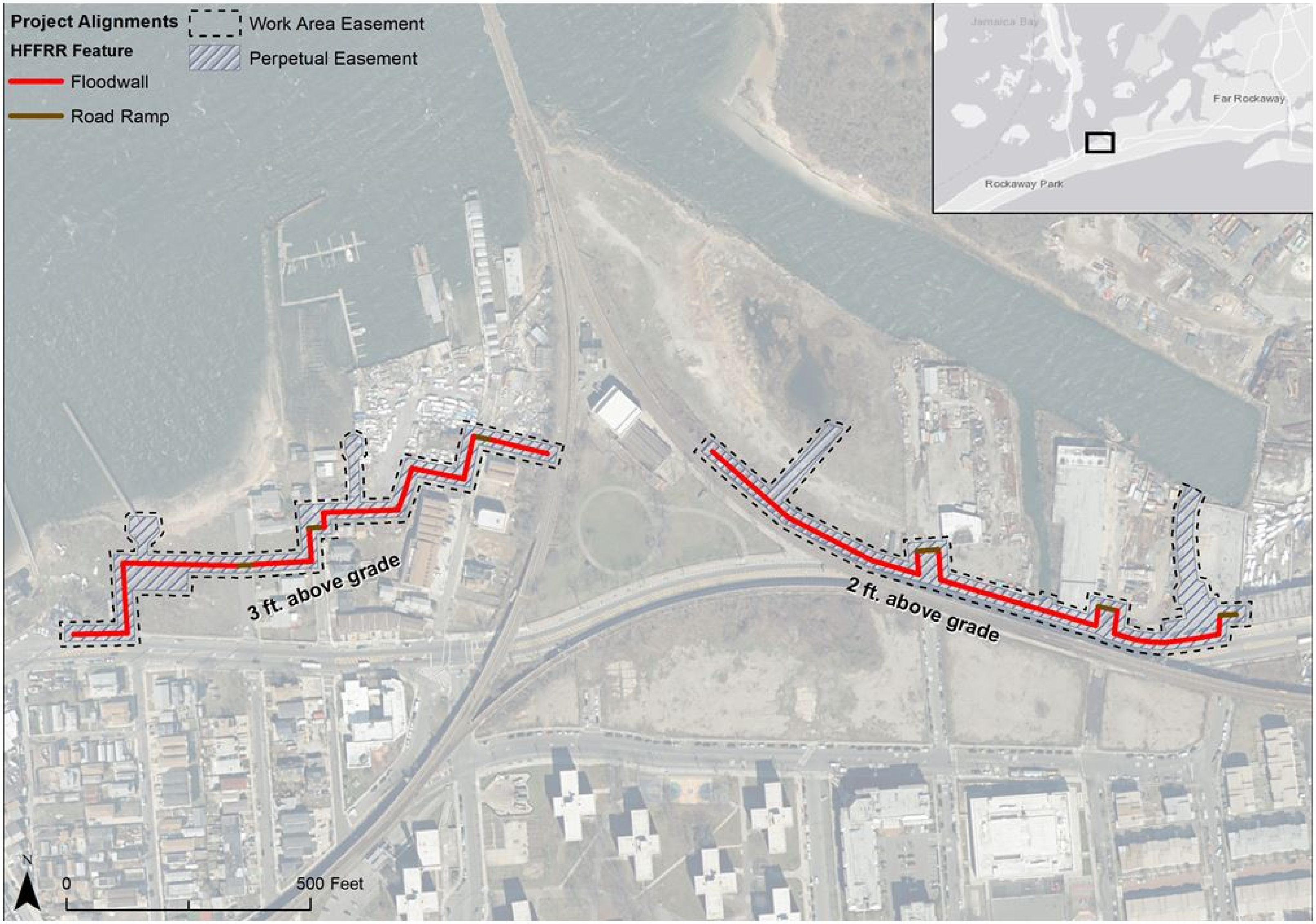


Figure 7: Mid Rockaway – Hammels Area HFFRRF Project Plan

2.5 Project Elements

Structural and non-structural management measures, including Natural and Nature-Based Features (NNBF), were developed to address one or more of the planning objectives for the project. Management measures were developed in consultation with the non-federal sponsor (NYSDEC), state and local agencies, and non-governmental entities. Measures were evaluated for compatibility with local conditions and relative effectiveness in meeting planning objectives. Effective measures were combined to create CSRM alternatives for two geographically discrete reaches: the Atlantic Ocean shorefront and Jamaica Bay. Integrating CSRM alternatives for the two reaches provides the most economically efficient system-wide solution for the vulnerable communities within the study area. It is important to note that any comprehensive approach to CSRM in the study area must include an Atlantic Ocean shorefront component because overtopping of the Rockaway peninsula is a source of flood waters into Jamaica Bay. Efficient CSRM solutions were formulated specifically to address conditions at the Atlantic Ocean shorefront. The best solution for the Atlantic Shorefront reach was included as a component of the alternative plans for the Jamaica Bay reach.

Project elements determined to potentially elicit adverse effects to protected species under USFWS jurisdiction are those alternatives identified for the Atlantic Ocean shorefront component of the project, only. The Jamaica Bay/Back Bay component of the project, therefore, has been determined not to introduce risk to the protected species due to the fact that there is no documentation of protected species occurrence or habitat in this area of effect, and, the CSRM features identified for this component of the project would not pose any risk or threat to protected species under USFWS jurisdiction if any occurrence or utilization were documented.

The Atlantic Ocean shorefront reach is subject to wave attack, wave run up, and over topping along the Rockaway peninsula. The general approach to developing CSRM along this reach was to evaluate erosion control alternatives in combination with a single beach restoration plan to select the most cost effective renourishment approach prior to the evaluation of alternatives for coastal storm risk management. The most cost effective erosion control alternative is beach restoration with increased erosion control (See Figures 2a through 2d). This erosion control alternative had the lowest annualized costs over the 50-year project life and the lowest renourishment costs over the project life. A screening analysis was performed to evaluate the level of risk reduction provided by a range of dune and berm dimensions and by reinforced dunes, which would be combined with beach restoration with increased erosion control to optimize CSRM at the Atlantic Ocean shorefront.

Beach fill for the Atlantic Shoreline component of the proposed project is available from an offshore borrow area. The borrow area is located approximately two miles offshore (south) of the Rockaway peninsula.

Other factors such as prior projects at Rockaway Beach, project constraints, stakeholder concerns, and engineering judgment were also applied in the evaluation and selection. A composite seawall was selected as the best coastal storm risk management alternative. The composite seawall protects against erosion and wave attack and also limits storm surge inundation and cross-peninsula flooding (Figures 8 and 9). The structure crest elevation is +17 feet (NAVD88), the dune elevation is +18 feet (NAVD88), and the design berm width is 60 feet. The armor stone in horizontally composite structures significantly reduces wave breaking pressure, which allows smaller steel sheet pile walls to be used in the design if the face of the wall is completely protected by armor stone. The composite seawall may be adapted in the future to rising sea levels by adding 1-layer of armor stone and extending the concrete cap up to the elevation of the armor stone.

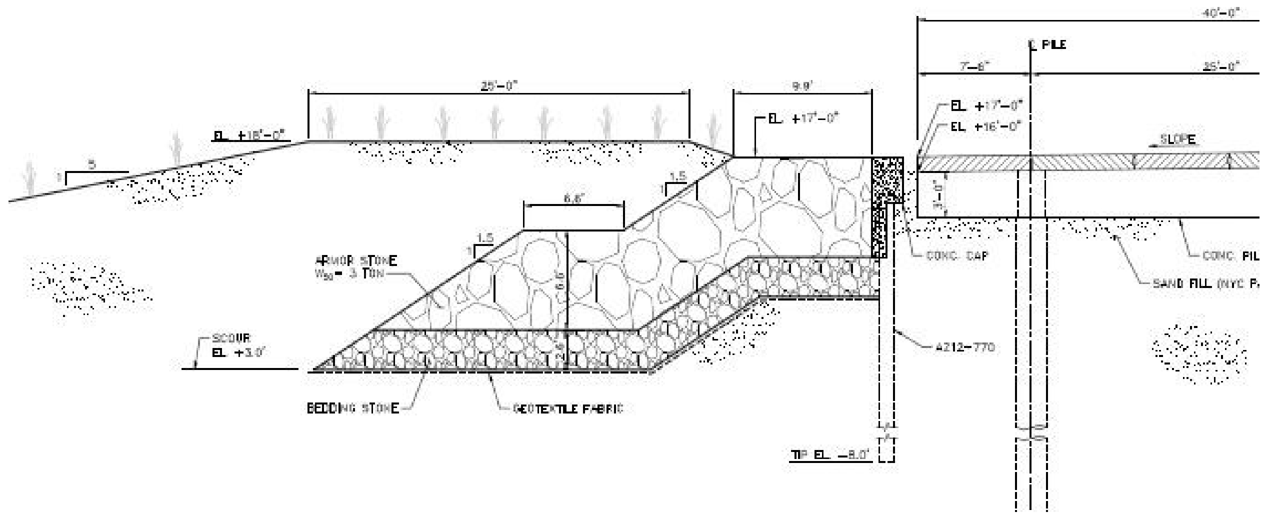


Figure 8: Composite Seawall Beach 19th St. to Beach 126th St

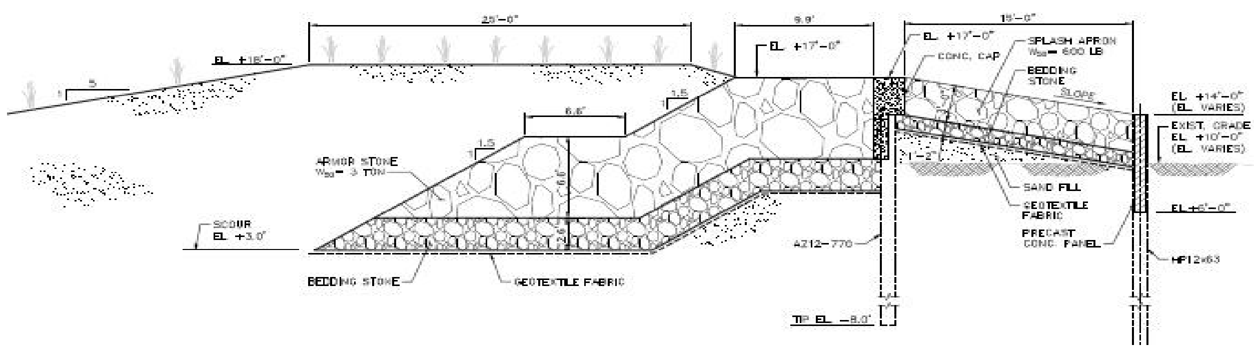


Figure 9: Composite Seawall Beach 126th St. to Beach 149th St.

2.5.1 The Atlantic Ocean Shorefront Beachfill

The selected storm damage reduction plan including changes from the authorized project, comprises approximately 152,000 lf of dune and beach fill and generally extends from the eastern end of the barrier island at Beach 19th street to the western boundary of Breezy Point. This component of the Project includes the following: 1) a dune with a top elevation of +18 ft above NAVD88, a top width of 25 ft, and landward and seaward slopes of 1V:5H that will extend along the entire footprint (1V:3H on landward slope fronting the boardwalk). See Table 2.

All beachfill quantities include an overfill factor of 11% based on the compatibility analysis for the borrow areas. In addition the initial construction quantities include an additional 15% for construction tolerance. It is noted that the advance fill and renourishment quantities do not include tolerance since the purpose of the advance fill and renourishment is to place a specific volume of sediment to offset anticipated losses between renourishment operations, rather than build a specific template. Beachfill quantities required for initial construction of each alternative are estimated based on the expected shoreline position in June of 2018. It is impossible to predict the exact shoreline position in June 2018 since the wave conditions vary from year to year and affect shoreline change rates. The shoreline position in June of 2018 was estimated based on a 2.5 year GENESIS-T simulation representative of typical wave conditions.

Table 2: Initial Construction Beachfill Quantities

Reach	Reach Length (ft)	Recommended Plan Fill Quantity (CY)
West Taper		306,000
Reach 3	10,320	356,000
Reach 4	5,380	294,000
Reach 5	10,650	321,000
Reach 6a	3,730	250,000
Reach 6b	2,000	20,000
East Taper		49,000
Total		**1,596,000**

2.5.2 Atlantic Ocean Shorefront: Construction of New Groins and Extension of Existing Groins

Three types of groin measures are considered in the alternative analysis: new groin construction, groin extension, and groin shortening. The exact dimensions and stone sizes of the existing groins at Rockaway is not available. Therefore, it is assumed that the existing groins in Reaches 5 and 6 are similar to the proposed new groin designs. Generally a groin is comprised of three sections: 1) horizontal shore section (HSS) extending along the design berm; (2) an intermediate sloping section (ISS) extending from the berm to the design shoreline, and (3) an outer sloping section (OS) that extends from the shoreline to offshore. The head section (HD) is part of the OS and is typically constructed at a flatter slope than the trunk of the groin and may require larger stone due to the exposure to breaking waves.

The spacing between groins in this study is based on the existing spacing in Reach 5 (720 ft) and Reach 6a (780 ft). The required lengths of the new groins is based on the GENESIS-T model simulations.

The Project requires the immediate construction of a 12 new groins in reach 3 and 4 (between 92nd Street to 121st Street) and an additional groin in reach 6a (34th street). The 5 groin extension are located in Reach 6a (between 37th Street – 49th Street). The extension of the groin lengths vary and range from 75 ft to 200 ft. Groin widths will be 13 ft. See Table 3.

Table 3: Summary of Groin Lengths

Alt	Reach	Number	Street	HSS (ft)	ISS (ft)	OS (ft)	Total (ft)	Notes:
3	6a	1	34th St	90	108	328	526	New 526'
3	6a	2	37th St	90	108	328	526	Extension 175'
3	6a	3	40th St	90	108	328	526	Extension 200'
3	6a	4	43rd St	90	108	228	426	Extension 75'
3	6a	5	46th St	90	108	228	426	Extension 150'
3	6a	6	49th St	90	108	228	426	Extension 200'
3	4	1	92nd St	90	108	128	326	New 326'
3	4	2	95th St	90	108	128	326	New 326'
3	4	3	98th St	90	108	128	326	New 326'
3	4	4	101st St	90	108	128	326	New 326'
3	4	5	104th St	90	108	128	326	New 326'
3	4	6	106th St	90	108	128	326	New 326'
3	4	7	108th St	90	108	128	326	New 326'
3	3	8	110th St	90	108	153	351	New 351'
3	3	9	113th St	90	108	178	376	New 376'
3	3	10	115th St	90	108	178	376	New 376'
3	3	11	118th St	90	108	178	376	New 376'
3	3	12	121st St	90	108	128	326	New 326'

2.5.3 Sand Removal from Offshore Borrow Area

An offshore borrow area which is 2.6 miles long and 1.1 miles wide, located approximately 2 miles south of East Rockaway (Figure 10) between 35 feet mean low water and about 60 feet mean low water, has been identified as a potential source of sand material for beach fill and dune construction activities.

Figure 10: Location of the East Rockaway Borrow Area

2.6 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions of the Project include beach renourishments and maintenance of beach access locations. Renourishments will be conducted every 4-years or as needed over the 50-year life of the Project. During each renourishment, approximately 1,100,000 CY of sand will be added to the beach from the borrow area located approximately 2 miles offshore to the south of East Rockaway. Inlet maintenance dredging (115,000 cy/yr) is included in the 1.1 million cy of material needed for the renourishment.

3 SPECIES OCCURENCE

Previous surveys conducted by USFWS and NYC DPR confirmed presence of piping plover and seabeach amaranth, as well as suitable habitat for red knot in the Atlantic Ocean Shoreline component of the Project Area (USFWS 1982, 1994a, 1995a, 1995b, 1996; NYC DPR 2017). Therefore, in accordance with the ESA recommendations, the following section provides species profiles for each of these federally-listed T&E species. This information, along with the knowledge of local experts, wildlife biologists, botanists, and District and USFWS personnel, was utilized to identify potential impacts to these species as a result of implementation of the proposed action.

3.1 PIPING PLOVER

On January 10, 1986, the piping plover was listed as threatened and endangered under provisions of the ESA. Three distinct populations were identified by the Service during the listing process: Atlantic Coast (threatened), Great Lakes (endangered), and Northern Great Plains (threatened). No critical habitat has been designated or proposed in the Atlantic Coast breeding area which is the focus of this BA.

The Atlantic Coast population breeds on coastal beaches from Newfoundland to North Carolina (NC) (and, occasionally, in South Carolina) and winters along the Atlantic Coast from NC southward, along the Gulf Coast, and in the Caribbean (Section 3 cited as Biological Assessment, Fire Island Inlet to Montauk Point Coastal Storm Risk Management, Suffolk County, New York. Prepared and submitted by: U.S. Fish and Wildlife Service, Chesapeake Bay Field Office and U.S. Army Corps of Engineers, New York District).

3.1.1 Life History

Piping plovers are small, sand-colored shorebirds approximately 7 inches long, with a wingspread of about 15 inches.

Breeding-Piping plovers begin returning to their Atlantic Coast nesting beaches in mid-March (Coutu et al. 1990; Cross 1990; Goldin 1990; MacIvor 1990; Hake 1993). Males establish and defend territories and court females by early April (Cairns 1982). Piping plovers are monogamous, but usually shift mates between years (Wilcox 1959; Haig and Oring 1988; MacIvor 1990; Strauss 1990) and, less frequently, between nesting attempts in a given year (Haig and Oring 1988, MacIvor 1990, Strauss 1990). Plovers are known to breed at one year of age (MacIvor 1990; Haig 1992), but the rate at which this occurs is unknown. Egg-laying and incubation can start as early as mid-April (USFWS 1996a).

Piping plovers nest on coastal beaches (NC to Newfoundland), sand spits at the end of barrier islands, gently sloping foredunes, blowout areas behind primary dunes, and in overwash-created bare sand areas cut into or between dunes. In the central portions of their Atlantic Coast range (including NY-NJ), they may also nest on areas where suitable dredged material has been deposited.

Nest sites are shallow-scraped depressions in substrates ranging from fine-grained sand mixtures to sand and pebbles, shells, or cobble (Bent 1929; Cairns 1982; Burger 1987; Patterson 1988; Flemming et al. 1990; MacIvor 1990; Strauss 1990). Nests may be difficult to detect, especially during the six-to seven-day egg-laying phase when the birds generally do not incubate (Goldin 1994). Eggs may be present on the beach from mid-April through late July and clutch size for an initial nest attempt is usually four eggs, with one egg laid every other day.

Full-time incubation usually begins with the completion of the clutch and is shared equally by both sexes for a period lasting from 27 to 28 days (Wilcox 1959; Cairns 1977; MacIvor 1990). Eggs in a clutch usually hatch within four to eight hours of each other, but the hatching period may extend to 48 hours.

Piping plovers generally fledge only a single brood (one or more chicks from a nest) per season, but may re nest several times if previous nests are lost or, infrequently, if a brood is lost within several days of hatching. A few rare instances of adults re-nesting following fledging of an early brood have also been observed. Chicks are precocial and are capable of foraging for themselves within several hours of hatching (Wilcox 1959; Cairns 1982) and may move hundreds of feet from the nest site during their first week of life (USFWS 1996a). Chicks may increase their foraging range up to 3,280 ft (Loegering 1992) or more based on observations from Fire Island to Moriches Inlet monitoring in 2016 (Carey et al. 2017), and will remain with both parents until they fledge at 25 to 35 days of age. Depending on the date of hatching, flightless chicks may be present from mid-May until late August, although most fledge by the end of July (Patterson 1988; Goldin 1990; MacIvor 1990; Howard et al. 1993). Nest success depends heavily on camouflage (Hull 1981). Cryptic coloration is a primary defense mechanism for this species; nests, adults, and chicks all blend in with their beach surroundings. Chicks sometimes respond to off-road vehicles (ORVs) and/or pedestrians by crouching and remaining motionless (Cairns 1977). Adult piping plovers respond to avian and mammalian predators by displaying a variety of distraction behaviors including squatting, false brooding, running, and injury feigning. Distraction displays may occur at any time during the breeding season, but are most frequent and intense during the time of hatching (Cairns 1977).

Migration-Fall migration to southern wintering grounds begins in mid-to late summer. Juvenile plover may remain on breeding grounds later but are generally gone mid-to late August (Cuthbert and Wiens 1982). A study of migration routes, duration, stopovers, and other behaviors of radio-tagged plovers is in progress (Loring et al. 2017). But the pattern of both spring and fall counts at migration suites along the southeastern Atlantic Coast demonstrates that many piping plovers make intermediate stopovers lasting from a few days up to one month during their migrations (Noel et al. 2006; Stucker and Cuthbert 2006).

Feeding-Piping plovers feed on invertebrates such as marine worms, fly larvae, beetles, crustaceans, and mollusks (Bent 1929; Cairns 1977; Nicholls 1989). Important feeding areas may include intertidal portions of ocean beaches, overwash areas, mudflats, sandflats, wracklines, sparse vegetation, and shorelines of coastal ponds, lagoons, or salt marshes (Gibbs 1986; Coutu et al. 1990; Hoopes et al. 1992; Loegering 1992; Goldin 1993; Elias-Gerken 1994; Cohen 2005; Houghton 2005). Studies by Cuthbert and Weins (1982) indicate that open shoreline areas are preferred and vegetated beaches are avoided. In Massachusetts, plover preferred mudflat, intertidal and wrack habitats for foraging (Hoopes et al. 1992). The relative importance of various feeding habitats may vary by site (Gibbs 1986; Coutu et al. 1990; McConnaughey et al. 1990; Loegering 1992; Goldin 1993; Hoopes 1993; Elias-Gerken 1994) and by stage in the breeding cycle (Cross 1990). Adults and chicks on a given site may use different feeding habitats in varying proportion (Goldin 1990). Most time-budget studies reveal that chicks spend a very high proportion of their time feeding. Cairns (1977) found that chicks typically tripled their weight during the first two weeks post-hatching; chicks that failed to achieve at least 60 percent of this weight-gain by day 12 were unlikely to survive. Feeding territories are generally contiguous to nesting territories (Cairns

1977). Feeding activities of both adults and chicks may occur during all hours of the day and night (Burger 1994) and at all stages during the tidal cycle (Goldin 1993; Hoopes 1993).

3.1.2 Life History

The piping plover is a small robin-sized shorebird 17–18 cm (7.25 in) in length, a wingspan of 47 cm (19 in), and an average weight of 55 g (1.9 oz) (Sibley 2000). Piping plover breed and nest on coastal beaches from Newfoundland and southeastern Quebec to North Carolina and winter primarily on the Atlantic coast from North Carolina to Florida. Along the Atlantic coast, plover nest mainly on gently sloping foredunes above the high tide line, in blow-out areas behind primary dunes of sandy coastal beaches, and on suitable dredge spoil deposits (USFWS 1988, Cashin Associates 1993, NPS 1994). Nests are usually found in sandy areas with little or no vegetation. Vegetation, when present, consists of beach grass, sea rocket, and/or seaside goldenrod.

Plover begin northward migration to breeding grounds from southern U.S. wintering areas in March, and arrive on nesting grounds from March – May; males arrive prior to females. Fall migration to southern wintering grounds begins in mid- to late summer. Juvenile plover may remain on breeding grounds later but are generally gone by mid- to late August (Cuthbert and Wiens 1982). Atlantic coast breeders migrate primarily to Atlantic coast sites located farther south of breeding areas (i.e., Virginia to Florida, Bahamas) (Haig and Oring 1988, Haig and Plissner 1993).

The adult males arrive earliest, select beach habitats, and defend established territories against other males (Hull 1981). When adult females arrive at the breeding grounds several weeks later, the males conduct elaborate courtship rituals including aerial displays of circles and figure eights, whistling song, posturing with spread tail and wings, and rapid drumming of feet. The breeding season begins when adult female plovers reach the breeding grounds in mid- to late-April or in mid-May in northern parts of the range. (Bent 1929, Hull 1981).

Plover typically return to the same general nesting area in consecutive years (but few return to natal sites). Plover are known to shift breeding location by up to several hundred kilometers between consecutive years (NatureServe 2002). However, Wilcox (1959) found that plover a relatively site faithful and only 20 percent settled at a nest site farther than 1,000 ft from the previous year's locality. Previous reproductive success does not appear to increase the probability of returning to specific breeding sites (NatureServe 2002).

Nest sites are simple depressions or scrapes in the sand (Bent 1929, Wilcox 1959). The average nest is about 6 to 8 cm in diameter, and is often lined with pebbles, shells, or driftwood to enhance the camouflage effect. Males make the scrapes and may construct additional (unused) nests in their territories, which may be used to deceive predators or may simply reflect over-zealousness (Wilcox 1959, Hull 1981). Occupied nests are generally 50 to 100 meters apart (Wilcox 1959, Cairns 1977, Cuthbert and Wiens 1982).

Egg-laying commences soon after mating (Hull 1981, Cuthbert and Wiens 1982). Eggs are laid every second day. The average clutch size is four eggs (Wilcox 1959) and three-egg clutches occur most commonly in replacement clutches. The average number of young fledged per nesting pair usually is two or fewer. The young hatch about 27 to 31 days after egg laying. Incubation is shared by both adults (Wilcox 1959, Hull 1981).

Young plover leave the nest about two hours after hatching and immediately are capable of running and swimming. The young usually remain within about 200 meters of the nest, although they do not return after hatching (Wilcox 1959, Johnsgard 1979, Hull 1981). When disturbed or threatened, the young either freeze or combine short runs with freezing and blend very effectively into their surroundings (Wilcox 1959, Hull 1981). Adults will feign injury to draw intruders away from the nest or young (Bent 1929, Wilcox 1959). Adults also defend the nest territory against other adult piping plovers, gulls, and songbirds (Wilcox 1959, Matteson 1980). First (unsustained) flight has been observed at around 18 days, with chicks molting into first juvenile plumage by day 22 (NatureServe 2002).

Nest success depends heavily upon camouflage (Hull 1981). Hatching success ranges widely as follows: 91 percent for undisturbed beaches on Long Island (Wilcox 1959), 76 percent for undisturbed beaches in Nova Scotia (Cairns 1977), 44 percent on relatively undisturbed beaches at Lake of the Woods (Cuthbert and Wiens 1982), and 30 percent maximum at disturbed Michigan beaches (Lambert and Ratcliff 1979).

Plover diet consists of worms, fly larvae, beetles, crustaceans, mollusks, and other invertebrates (Bent 1929). In New Jersey, intertidal polychaetes were the main prey of plovers (Staine and Burger 1994). Plover forage along ocean beaches, on intertidal flats and tidal pool edges. Studies by Cuthbert and Weins (1982) indicate that open shoreline areas are preferred and vegetated beaches are avoided. Plover obtain their food from the surface of the substrate, or occasionally will probe into the sand or mud.

Most time-budget studies reveal that chicks spend a very high proportion of their time feeding. Cairns (1977) found that chicks typically tripled their weight during the first two weeks post-hatching; chicks that failed to achieve at least 60 percent of this weight-gain by day 12 were unlikely to survive. Courtship, nesting, brood-rearing, and feeding territories are generally contiguous to nesting territories (Cairns 1977), although instances when brood-rearing areas are widely separated from nesting territories are common, thus increasing the geographic boundaries of their breeding area. Feeding activities of both adults and chicks may occur during all hours of the day and night (Burger 1994) and at all stages during the tidal cycle (Goldin 1993; Hoopes 1993).

In New York, 95.8 percent of piping plover pairs nested on non-federal land in 1999 (Rosenblatt 2000). Piping plover protection in this recovery unit, therefore, is highly dependent on the efforts of state and local government agencies, conservation organizations, and private landowners. Landowner efforts are often contingent on annual commitments. While many landowners are supportive and cooperative, others are not.

In Massachusetts, plover preferred mudflat, intertidal and wrack habitats for foraging (Hoopes et al. 1992a). On Assateague Island, bay beaches and island interiors were much more favorable as brood-rearing habitats than were ocean beaches (Patterson et al. 1992).

3.1.3 Threats to Species

The wide, flat, sparsely vegetated barrier beaches preferred by the piping plover are an unstable habitat, dependent on natural forces for renewal and susceptible to degradation by development and shoreline stabilization efforts. In high use recreational areas such as East Rockaway, the primary threat to piping plover is disturbance by recreational beach users during the breeding season. Other significant threats include destruction and degradation of habitat and predation (USFWS 1988, 1995b, Burger 1993, NJDEP 1997).

Inundation of piping plover habitat by rising seas could lead to permanent loss of habitat if natural coastal dynamics are impeded by numerous structures or roads, especially if those shorelines are also armored with hardened structures. Without development or armoring, low undeveloped islands can migrate toward the mainland, pushed by the overwashing of sand eroding from the seaward side and being re-deposited in the bay (Scavia et al. 2002). Overwash and sand migration are impeded on developed portions of islands. Instead, as sea-level increases, the ocean-facing beach erodes and the resulting sand is deposited offshore. The buildings and the sand dunes then prevent sand from washing back toward the lagoons, and the lagoon side becomes increasingly submerged during extreme high tides (Scavia et al. 2002), diminishing both barrier beach shorebird habitat and protection for mainland developments.

Modeling for three sea-level rise scenarios (reflecting variable projections of global temperature rise) at five important U.S. shorebird staging and wintering sites predicted loss of 20-70 percent of current intertidal foraging habitat (Galbraith et al. 2002). These authors estimated probabilistic sea-level changes for specific sites partially based on historical rates of sea-level change (from tide gauges at or near each site); they then superimposed this on projected 50 percent and 5 percent probability of global sea-level changes by 2100 of 34 cm and 77 cm, respectively.

3.1.4 Human Disturbance

Recreational disturbance: Disturbance, i.e., human and pet presence that alters bird behavior, disrupts piping plovers as well as other shorebird species. Disturbance can cause shorebirds to spend less time roosting or foraging and more time in alert postures or fleeing from the disturbances (Johnson and Baldassarre 1988; Burger 1991; Burger 1994; Elliott and Teas 1996; Lafferty 2001a, 2001b; Thomas et al. 2002), which limits the local abundance of piping plovers (Zonick and Ryan 1995; Zonick 2000). Shorebirds that are repeatedly flushed in response to disturbance expend energy on costly short flights (Nudds and Bryant 2000). Shorebirds are more likely to flush from the presence of dogs than people, and birds react to dogs from farther distances than people (Lafferty 2001a, 2001b; Thomas et al. 2002). Dogs off leash are more likely to flush piping plovers from farther distances than are dogs on leash; nonetheless, dogs both on and off leashes disturb piping plovers (Hoopes 1993). Pedestrians walking with dogs often go through flocks of foraging and roosting shorebirds; some even encourage their dogs to chase birds.

Off-road vehicles (ORVs) can significantly degrade piping plover habitat (Wheeler 1979) or disrupt the birds' normal behavior patterns (Zonick 2000). The FWS Piping Plover Atlantic Coast Population Revised Recovery Plan cites tire ruts crushing wrack into the sand, making it unavailable as cover or as foraging substrate (Hoopes 1993; Goldin 1993). The Recovery Plan also notes that the magnitude of the threat from ORVs is particularly significant, because vehicles extend impacts to remote stretches of beach where human disturbance will otherwise be very slight. Godfrey et al. (1980 as cited in Lamont et al.1997) postulated that ORVs may compact the substrate and kill marine invertebrates that are food for the piping plover. Zonick (2000) found that the density of ORVs negatively correlated with abundance of roosting piping plovers on the ocean beach. Cohen et al. (2008) found that radio-tagged piping plovers using ocean beach habitat at Oregon Inlet in North Carolina were far less likely to use the north side of the inlet where ORV use is allowed, and recommended controlled management experiments to determine if recreational disturbance drives roost site selection. Ninety-six percent of piping plover detections were on the south side of the inlet even though it was farther away from foraging sites (1.8 km from the sound side foraging site to the north side of the inlet versus 0.4 km from the sound side foraging site to the north side of the inlet; Cohen et al. 2008).

3.1.5 Habitat Loss/Alteration

Along the Atlantic coast, development, encroachment of beach vegetation, flooding and erosion are primary factors in the loss of suitable breeding and nesting habitat for piping plover (Haig 1992). In Maine, construction of seawalls, jetties, piers, homes, parking lots, and other structures has reduced historic nesting habitat by more than 70%; where more than 20 miles of historic habitat may have supported more than 200 pairs of piping plovers, 32 pairs nested in 1993 on habitat with an estimated capacity of 52 pairs (Maine Department of Inland Fisheries and Wildlife 1995). Wilcox (1959) pointed to summer home and road construction as causes of declining plover nesting along Moriches Bay on Long Island, New York, between 1939 and 1951. Raithel (1984) cited coastal development and shoreline stabilization, including construction and dredging of permanent breachways, building of breakwaters, and planting of dune areas, as major contributors to the decline of the piping plover in Rhode Island. Analysis of 4 years of piping plover nest location data on a New York site revealed that the nests were significantly farther from concrete walkways leading from the dunes to the berm than were random points, suggesting that the walkways decrease the carrying capacity of the beach (Hoopes 1995). In 1993 NYSDEC documented a reduction in nest sites and habitat use by piping plover and least terns at a colony on Long Island and attributed the reduction to severe erosion and loss of suitable habitat in the area (USACE 1998, USACE 2006).

The location of development on beaches where they are vulnerable to erosion often leads to impacts that go far beyond the footprint of the facilities themselves. Requests from private communities within the Fire Island National Seashore, New York, to construct artificial dunes on adjacent undeveloped National Park Service lands in 1993 (NPS 1992, 1993) exemplify situations where shoreline development has created demand to modify and stabilize habitat suitable for plover nesting.

Plover are also likely experiencing loss of habitat in areas where the vegetation in the upper beach zone exceeds levels desired by piping plover. In general, plover prefer to nest in sparsely vegetated areas (Cohen et al. 2002, 2003a, 2003b). However, dense vegetation located near the breeding area is also desirable for plover foraging and cover.

Important factors influencing future habitat losses and gains include the amount of sea-level rise, which may vary regionally due to subsidence or uplift and the specific landforms occurring within a region (Galbraith et al. 2005; Gutierrez et al. 2007). Gutierrez et al. (2007) predicted varying responses of spits, headlands, wave-dominated barriers, and mixed-energy barriers for four sea-level rise scenarios in the U.S. mid-Atlantic region (overlapping most of the piping plover's New York-New Jersey and southern recovery units). Development and testing of models linking predictions of sea-level rise, changes in beach geomorphology, and piping plover nesting habitat is currently in progress (Gutierrez et al. 2011; Gieder et al. 2014; Gutierrez et al. 2015). Human responses, especially coastal armoring, will play key roles in the effects of sea-level rise on the quantity, quality, and distribution of piping plover habitats.

3.1.6 Predation

Predation has been identified as a major factor limiting piping plover reproductive success at many Atlantic Coast sites (Burger 1987a, MacIvor 1990, Patterson et al. 1991, Cross 1992, Elias-Gerken 1994). As with other limiting factors, the nature and severity of predation is highly site-specific. Predators of piping plover eggs and chicks include red fox, striped skunk, raccoon, Norway rat, opossum, crows, ravens, gulls, common grackles, American kestrel, domestic and feral dogs and cats, and ghost crabs.

Human activities affect the types, numbers, and activity patterns of predators, thereby exacerbating natural predation. Human activities have abetted the expansions in the populations and/or range of other species such as gulls (Drury 1973, Erwin 1979) and opossum (Gardner 1982). The availability of trash at summer beach homes increases local populations of skunks, raccoons and fox (Raithel 1984, Strauss 1990). In Massachusetts, predators, primarily red fox (*Vulpes vulpes*), destroyed 52 – 81 percent of nests in one study area (MacIvor et al. 1990). Similarly, on Assateague Island, Maryland and Virginia, predators, mainly red fox and raccoon (*Procyon lotor*), accounted for about 90 percent of the known causes of nest loss (Patterson et al. 1992). In addition, gulls, grackles (*Quiscalus quiscula*), crows (*Corvus* spp.), and in developed, high recreational use areas such as East Rockaway, domestic and free-roaming cats and dogs are equally as detrimental to plover populations by direct predation or disturbance of nest sites (Cartar 1976, Lambert and Ratcliff 1979, Cairns and McLaren 1980, Nol 1980, USFWS 1988, Patterson et al. 1990, NJDEP 1997).

3.2 Seabeach Amaranth

Seabeach amaranth is a native annual plant that inhabits barrier island beaches along the Atlantic Coast. This plant historically occurred in 31 counties in nine states from Cape Cod in Massachusetts to South Carolina. However, by 1990, only 55 populations remained, which were located in South Carolina, North Carolina, and New York (USFWS 1996). In 1993, the USFWS listed the plant as a federally-threatened species because of the declining population and its overall vulnerability to habitat destruction (USFWS 1993). Seabeach amaranth is also listed as threatened or endangered throughout its current and historical range, including New York where it is imperiled (i.e., endangered). Accordingly, the ESA, as well as several state-level endangered species laws and regulations, protect this species.

Due to the protection afforded to it by the ESA and state laws, seabeach amaranth has returned to several states after years of extirpation. Known populations of this species occur in New York, Delaware, Maryland, Virginia, North Carolina, and South Carolina (USFWS 2004b). Many of these new occurrences are the result of reintroduction and restoration programs conducted by federal, state, and local governments and non-profit organizations. Long Island supports the largest population of seabeach amaranth within its historical range, which extends from South Carolina to Massachusetts. Each year Endangered Species Biologists from the Long Island Field Office of the USFWS assist the New York Natural Heritage Program in conducting annual surveys for this threatened species. Within New York and across its range, seabeach amaranth numbers vary from year to year. Data in New York is available from 1987 to 2016. Recently, the number of plants across the entire state dwindled from a high of 244,608 in 2000 to 4,985 in 2016. This trend of decreasing numbers is seen throughout its range. A total of 249,261 plants were found throughout the species' range in 2000. By 2016, those numbers had dwindled to 9,221 plants. Seabeach amaranth is dependent on natural coastal processes to create and maintain habitat. However, high tides and storm surges from tropical systems can overwash, bury, or inundate seabeach amaranth plants or seeds, and seed dispersal may be affected by strong storm events (per Biological Assessment, Fire Island Inlet to Montauk Point Coastal Storm Risk Management, Suffolk County, New York. Prepared and submitted by: U.S. Fish and Wildlife Service, Chesapeake Bay Field Office and U.S. Army Corps of Engineers, New York District April 2018).

Life History

Seabeach amaranth germinates as small, unbranched, fleshy red colored sprigs between June and July in New York State (USFWS 2004b). These sprigs develop into a rosette of small, wrinkled leaves that branch out from the low-lying reddish stems. As the plant matures, it develops into a clump with numerous stems, which can reach a diameter of 3 ft. The small (1.3 to 2.5 centimeters in diameter) rounded leaves are clustered around the tip of the stems, exhibit a spinach-green color, and have a small notch at the rounded tip of the leaf (USFWS 1996). Inconspicuous flowers develop in clusters around the stem in mid-summer and can produce seed by July. Seed production continues until the plant dies, usually in mid to late fall, but can continue into January (USFWS 1996).

Seabeach amaranth is most likely wind-pollinated, based on the morphology of the flower and inflorescence and lack of visual, chemical, or nectar attractants. Additionally, this species is capable of self-pollination, as are other species of *Amaranthus* (USFWS 1996). Seed dispersal is carried out by water (hydrochory) and wind (anemochory) (USFWS 1996).

The primary habitat for seabeach amaranth consists of the dynamic and ever changing seaward facing areas of barrier islands, including overwash flats at accreting ends of islands, lower foredunes, and upper strands of non-eroding beaches located landward of the wrack line (USFWS 1996). Seabeach amaranth occasionally establishes populations in other habitats, including sound-side beaches, foredune blowouts, and on replenished beaches. Typical of the species, on Fire Island in New York, seabeach amaranth tends to grow on the ocean beach in bare or sparsely vegetated swales and along overwash zones (National Park Service [NPS] 1998).

Seabeach amaranth occupies a narrow beach zone that lies above mean high tide at the lowest elevations at which vascular plants regularly occur. Seaward, the plant grows only above the high tide line, as it is intolerant of even occasional flooding during the growing season.

Landward, seabeach amaranth does not occur more than a meter or so above the beach elevation on the foredune, or anywhere behind it, except in overwash areas. The species is, therefore, dependent on a terrestrial, upper beach habitat that is not flooded during the growing season.

This zone is absent on beaches that are experiencing high rates of erosion. Seabeach amaranth is never found on beaches where the foredune is scarped by undermining water at high or storm tides (Weakley and Bucher 1992).

No other vascular plant species regularly occupies a lower topographic position than seabeach amaranth (USFWS 1996). Seabeach amaranth's range correlates with a zone of tidal amplitude of 5 or 6 ft and occupies elevations that range from 8 inches (in) to 5 ft above high mean high tide (USFWS 1996). Although it grows in a very low topographical position, it is highly intolerant of inundation by saltwater, and often perishes if exposed (USFWS 1996). The plant is usually found growing on nearly pure silica sand substrate, which is mapped as 'Beach-Foredune Association' or 'Beach (occasionally flooded)' by the U.S. Natural Resources Conservation Service (NRCS).

In areas where it occurs, seabeach amaranth is an important beach stabilizing and dune building species because it acts as a 'sand binder' by trapping wind-blown sand under its lower leaves and branches. This trapped sand accumulates in a mound and eventually buries the lower leaves and stems, while the plant continues to grow. A single large clump of seabeach amaranth can trap a mound of 2 to 3 cubic yards (cy) of sand (USFWS 1996).

Seabeach amaranth has a very low tolerance for vegetative competition and does not occur on well-vegetated sites. However, habitat occupied by seabeach amaranth may be sparsely vegetated with other annual forbs, or less commonly, perennial grasses and scattered shrubs (USFWS 1996). Once other vegetation, such as American beach grass, begins to encroach upon habitat occupied by seabeach amaranth, the amaranth is quickly out competed and the individual or population is replaced by the encroaching vegetation. Scientists believe that availability of water and certain plant species are probably the limiting factors because the more extensive root systems of species such as beach grass are more efficient for the uptake of these resources (USFWS 1996).

Ecologists consider seabeach amaranth a 'fugitive' species because of its ability to escape competition and to quickly occupy new habitat as it becomes available (Randall 2002). Hurricanes and storms that re-shape shorelines may have both a positive and negative effect on the species. For example, a storm event that causes severe beach erosion may displace existing individuals, but also may uncover seed banks that have been buried for years. Following hurricanes Bertha and Fran in 1996, several new populations of seabeach amaranth appeared that were likely linked to the effects of the storms (Randall 2002).

3.2.1 Threats to Species

Seabeach amaranth has been and continues to be threatened by destruction or adverse alteration of its habitat. As a fugitive species dependent on a dynamic landscape and large-scale geophysical processes, it is extremely vulnerable to habitat fragmentation and isolation of small populations. Further, because this species is easily recognizable and accessible, it is vulnerable to taking, vandalism, and the incidental trampling by curiosity seekers. The most serious threats to the continued existence of seabeach amaranth are construction of beach stabilization structures, natural and man-induced beach erosion and tidal inundation, fungi (i.e., white wilt), beach grooming, herbivory by insects and mammals, and off-road vehicles. Herbivory by webworms, deer, feral horses, and rabbits is a major source of mortality and lowered fecundity for seabeach amaranth. However, the extent to which herbivory affects the species as a whole is unknown.

Potential effects to seabeach amaranth from vehicle use on the beaches include vehicles running over, crushing, burying, or breaking plants, burying seeds, degrading habitat through compaction of sand and the formation of seed sinks caused by tire ruts. Seed sinks occur when blowing seeds fall into tire ruts, then a vehicle comes along and buries them further into the sand preventing germination. If seeds are capable of germinating in the tire ruts, the plants are usually destroyed before they can reproduce by other vehicles following the tire ruts. Those seeds and their reproductive potential become lost from the population.

Pedestrians also can negatively affect seabeach amaranth plants. Seabeach amaranth occurs on the upper portion of the beach which is often traversed by pedestrians walking from parking lots, hotels, or vacation property to the ocean. This is also the area where beach chairs and umbrellas are often set up and/or stored. In addition, resorts, hotels, or other vacation rental establishments may set up volleyball courts or other sporting activity areas on the upper beach at the edge of the dunes. All of these activities can result in the trampling and destruction of plants. Pedestrians walking their dogs on the upper part of the beach, or dogs running freely on the upper part of the beach, may result in the trampling and destruction of seabeach amaranth plants. The extent of the effects that dogs have on seabeach amaranth is not known (per Biological Assessment, Fire Island Inlet to Montauk Point Coastal Storm Risk Management, Suffolk County, New York. Prepared and submitted by: U.S. Fish and Wildlife Service, Chesapeake Bay Field Office and U.S. Army Corps of Engineers, New York District. April 2018). .

3.2.2 Human Disturbance

Vehicular use on beaches generally has an adverse effect on seabeach amaranth. The plant is a brittle species and individuals generally do not survive even a single pass by an off road vehicle (ORV) tire (USFWS 1996). In northern beaches, such as in New York, these beaches are relatively narrow and vehicular traffic is often concentrated in the elevation zone required by seabeach amaranth (USFWS 1996). Accordingly, areas open to moderate to heavy ORV use during the seabeach amaranth growing season typically do not have populations of the plant in ORV travel corridors. However, during the dormant season, limited ORV use may actually be beneficial to seabeach amaranth because physical disturbance of the beach helps prevent colonization by perennial species, such as beach grass (USFWS 1996).

Another detrimental vehicle-based activity to seabeach amaranth is beach grooming (USFWS 1996). Mechanical rakes are dragged along the beach surface by a tractor or other vehicle to rid the beach of vegetation, trash, and wrack. This practice is usually carried out on heavily used bathing beaches and results in the exclusion of seabeach amaranth by precluding the plant from becoming established.

Humans use beaches for a variety of activities, including sunbathing, swimming, jogging, walking, birding, and beachcombing. Accordingly, pedestrians walking on beaches occupied by seabeach amaranth have the potential to crush individual plants. However, because most pedestrians prefer to walk on packed sand near the wetted shoreline seaward of seabeach amaranth habitat, the effects of pedestrian traffic are generally negligible (USFWS 1996).

3.2.3 Habitat Loss/Alteration

Shoreline stabilization is detrimental to pioneer species, such as seabeach amaranth, that require unstable, unvegetated, or 'new' land (USFWS 1996). Construction of both 'hard' and 'soft' shoreline stabilization structures are often associated with deteriorated seabeach amaranth habitat (USFWS 1996).

Hard structures are constructed of stone, concrete, steel, or wood and include rip-rap, seawalls, revetments, groins, terminal groins, and breakwaters. Soft structures include construction using non-permanent materials, such as sand, for replenishing beaches and dune construction, rehabilitation, or enhancement.

Many of these structures, both hard and soft, often occupy the same elevation range that is required by seabeach amaranth. Additionally, when structures such as bulkheads and seawalls are built, wave action and wind often lower the beach profile seaward of the structure, creating an area unsuitable for seabeach amaranth (USFWS 1996). During seabeach amaranth status surveys conducted from 1987 to 1990, no seabeach amaranth populations were observed on shorelines that were associated with bulkheads, sea walls, or rip-rap zones (USFWS 1996).

Beach nourishment and dune stabilization have varying degrees of potential effects on seabeach amaranth. Beach nourishment, for example, may have both a negative and positive effect on seabeach amaranth populations (USFWS 1996). On one hand, an adverse effect of sand placement is burial of the existing seed bank within the placement zone. On the other hand, the new beach created by placement is without other vegetation that might out compete seabeach amaranth and would likely be at an elevation that is suitable for the reestablishment of seabeach amaranth if there is a seed source nearby.

Beach nourishment can have positive site-specific impacts on seabeach amaranth. Although more study is needed before the long-term impacts can be accurately assessed, seabeach amaranth has colonized several nourished beaches, and has thrived in some sites through subsequent re-applications of fill material (FWS 1993). However, on the landscape level, beach nourishment is similar to other beach stabilization efforts in that it stabilizes the shoreline and curtails the natural geophysical processes of barrier islands.

3.2.4 Herbivory/Predation

Herbivory by webworms (caterpillars of small moths) may be detrimental to localized populations of seabeach amaranth (USFWS 1996). Although not unheard of in the northern part of seabeach amaranth range, herbivory appears to be a much more common problem in southern populations (USFWS 1996). In South Carolina, four species of webworm are known to consume seabeach amaranth and include beet webworm (*Loxostege similialis*), garden webworm (*Achyra rantilis*), southern beet webworm (*Herpetogramma bipunctalis*), and Hawaiian beet webworm (*Spoladea recurvalis*) (USFWS 1996). The ranges of several of these species extend into New York. In 1994, an infestation of saltmarsh moth (*Estigmene acraea*) caterpillars totally consumed leaves of many seabeach amaranth plants at Jones Beach Island East (USFWS 1996).

3.3 RUFA RED KNOT

The red knot (*Calidris canutus*) was added to the list of federal candidate species in 2006. The species was listed as Endangered in 2014. Red knots are federally protected under the Migratory Bird Treaty Act, and are New Jersey State-listed as endangered. The red knot is currently listed as endangered or threatened in New York State.

Red knots were heavily hunted for both market and sport during the 19th and early 20th centuries in the Northeast and the mid-Atlantic. Red knot population declines were noted by several authors of the day, whose writings recorded a period of intensive hunting followed by the introduction of regulations and at least partial population recovery.

Calidris canutus is classified in the Class Aves, Order Charadriiformes, Family Scolopacidae, Subfamily Scolopacinae. Six subspecies are recognized, each with distinctive morphological traits (i.e., body size and plumage characteristics), migration routes, and annual cycles. Each subspecies is believed to occupy a distinct breeding area in various parts of the Arctic but some subspecies overlap in certain wintering and migration areas. (FWS BO for Long Beach, NY Project 2014).

Calidris canutus canutus, C. c. piersma, and *C. c. rogersi* do not occur in North America. The subspecies *C.c. islandica* breeds in the northeastern Canadian High Arctic and Greenland, migrates through Iceland and Norway, and winters in Western Europe (Committee on the Status of Endangered Wildlife in Canada. *C. c. rufa* breeds in the central Canadian Arctic (just south of the *C. c. islandica* breeding grounds) and winters along the Atlantic coast and the Gulf of Mexico coast (Gulf coast) of North America, in the Caribbean, and along the north and southeast coasts of South America including the island of Tierra del Fuego at the southern tip of Argentina and Chile (Ibid).

3.3.1 Life History

The rufa red knot is a medium-sized shorebird about 9 to 11 inches (in) (23 to 28 centimeters (cm)) in length. The red knot migrates annually between its breeding grounds in the Canadian Arctic and several wintering regions, including the Southeast United States (Southeast), the Northeast Gulf of Mexico, northern Brazil, and Tierra del Fuego at the southern tip of South America. During both the northbound (spring) and southbound (fall) migrations, red knots use key staging and stopover areas to rest and feed (Ibid).

The red knot is a large, bulky sandpiper with a short, straight, black bill. During the breeding season, the legs are dark brown to black, and the breast and belly are a characteristic russet color that ranges from salmon-red to brick-red. Males are generally brighter shades of red, with a more distinct line through the eye. When not breeding, both sexes look alike – plain gray above and dirty white below with faint, dark streaking. As with most shorebirds, the long-winged, strong-flying knots fly in groups, sometimes with other species. Red knots feed on invertebrates, especially small clams, mussels, and snails, but also crustaceans, marine worms, and horseshoe crab eggs. On the breeding grounds, knots mainly eat insects (Ibid).

Small numbers of red knots may occur in New Jersey year-round, while large numbers of birds rely on New Jersey's coastal stopover habitats during the spring (mid-May through early June) and fall (late-July through November) migration periods. Smaller numbers of knots may spend all or part of the winter in New Jersey. Red knots also rely on New York’s coastal stopover habitats during the spring and fall migration periods. As stated above, several stopover habitats in New York are being proposed for critical habitat designations (Ibid).

The primary wintering areas for the rufa red knot include the southern tip of South America, northern Brazil, the Caribbean, and the southeastern and Gulf coasts of the U.S. The rufa red knot breeds in the tundra of the central Canadian Arctic. Some of these robin-sized shorebirds fly more than 9,300 miles from south to north every spring and reverse the trip every autumn, making the rufa red knot one of the longest-distance migrating animals. Migrating red knots can complete non-stop flights of 1,500 miles or more, converging on critical stopover areas to rest and refuel along the way. Large flocks of red knots arrive at stopover areas along the Delaware Bay and New York/New Jersey's Atlantic coast each spring, with many of the birds having flown directly from northern Brazil. The spring migration is timed to coincide with the spawning season for the horseshoe crab (*Limulus polyphemus*). Horseshoe crab eggs provide a rich, easily digestible food source for migrating birds. Mussel beds on New Jersey's southern Atlantic coast and intertidal/wrack line areas on New York’s coast are also important forage habitats for migrating knots. Birds arrive at stopover areas with depleted energy reserves and must quickly rebuild their body fat to complete their migration to Arctic breeding areas. During their brief 10- to 14-day spring stay in the mid-Atlantic, red knots can nearly double their body weight.

Major spring stopover areas along the Atlantic coast include Río Gallegos, Península Valdés, and San Antonio Oeste (Patagonia, Argentina); Lagoa do Peixe (eastern Brazil, State of Rio Grande do Sul); Maranhão (northern Brazil); the Virginia barrier islands (United States); and Delaware Bay (Delaware, New Jersey and New York, United States) (Cohen *et al.*. 2009, p. 939; Niles *et al.*. 2008, p. 19; González 2005, p. 14). However, large and small groups of red knots, sometimes numbering in the thousands, may occur in suitable habitats all along the Atlantic and Gulf coasts from Argentina to Massachusetts (Niles *et al.*. 2008, p. 29). In Massachusetts, red knots use sandy beaches and tidal mudflats during fall migration. In New York and the Atlantic coast of New Jersey, knots use sandy beaches during spring and fall migration (Niles *et al.*. 2008, p. 30).

From geolocators, examples of spring migratory tracks are available for three red knots that wintered in South America. One flew about 4,000 mi (6,400 km) over water from northeast Brazil in 6 days. Another flew about 5,000 mi (8,000 km) from the southern Atlantic coast of Brazil (near Uruguay) over land and water (the *eastern* Caribbean) in 6 days. Both touched down in North Carolina, and then used Delaware Bay as the final stopover before departing for the arctic breeding grounds (Niles *et al.*. 2010a, p. 126). A third red knot, which had wintered in Tierra del Fuego, followed an overland route through the interior of South America, departing near the Venezuela-Colombia border. This bird then flew over the Caribbean to Florida, and finally to Delaware Bay (Niles 2011a).

In Delaware Bay, red knots preferentially *feed* in microhabitats where horseshoe crab eggs are concentrated, such as at horseshoe crab nests (Fraser et al.. 2010, p. 99), at shoreline discontinuities (e.g., creek mouths) (Botton et al.. 1994, p. 614), and in the wrack line (Nordstrom et al.. 2006a, p. 438; Karpanty et al.. 2011, pp. 990, 992). (The wrack line is the beach zone just above the high tide line where seaweed and other organic debris are deposited by the tides.) Wrack may also be a significant foraging microhabitat outside Delaware Bay, for example, where mussel spat (i.e., juvenile stages) are attached to deposits of tide-cast material. Wrack material also concentrates certain *invertebrates* such as amphipods, insects, and marine worms (Kluft and Ginsberg 2009, p. vi), which are secondary prey species for red knots.

For many shorebirds, the supra-tidal (above the high tide) sandy habitats of inlets provide important areas for roosting, especially at higher tides when intertidal habitats are inundated (Harrington 2008, pp. 4–5). Along the Atlantic coast, dynamic and ephemeral features are important red knot habitats, including sand spits, islets, shoals, and sandbars, often associated with inlets (Harrington 2008, p. 2). From South Carolina to Florida, red knots are found in significantly higher numbers at inlets than at other coastal sites (Harrington 2008, pp. 4–5).

The District has been undertaking comprehensive monitoring of red knots on the South Shore of Staten Island (SSSI), New York project area for two years. To date, no rufa red knot have been observed within the SSSI project are, but, red knot were observed at Great Kills, NY (Ebird website-http://ebird.org/ebird/subnational2/US-NY-103/hotspots).

3.3.2 Threats to Red Knot

Much of the U.S. coast within the range of the red knot is already extensively developed. Direct loss of shorebird habitats occurred over the past century as substantial commercial and residential developments were constructed in and adjacent to ocean and estuarine beaches along the Atlantic and Gulf coasts. In addition, red knot habitat was also lost indirectly, as sediment supplies were reduced and stabilization structures were constructed to protect developed areas.

Sea level rise and human activities within coastal watersheds can lead to long-term reductions in sediment supply to the coast. Damming of rivers, bulkheading highlands, and armoring coastal bluffs have reduced erosion in natural source areas and, consequently, the sediment loads reaching coastal areas. Although it is difficult to quantify, the cumulative reduction in sediment supply from human activities may contribute to the long-term shoreline erosion rate. Along coastlines subject to sediment deficits, the amount of sediment supplied to the coast is less than that lost to storms and coastal sinks (inlet channels, bays, and upland deposits), leading to long- term shoreline recession.

Red knots require open habitats that allow them to see potential predators and that are away from tall perches used by avian predators. Invasive species, particularly woody species, degrade or eliminate the suitability of red knot roosting and foraging habitats by forming dense stands of vegetation. Although not a primary cause of habitat loss, invasive species can be a regionally important contributor to the overall loss and degradation of the red knot's nonbreeding habitat.

Commercial harvest of horseshoe crabs has been implicated as a causal factor in the decline of the rufa red knot by decreasing the availability of horseshoe crab eggs in the Delaware Bay stopover (Niles *et al*.. 2008, pp. 1-2). Notwithstanding the importance of the horseshoe crab and Delaware Bay, other lines of evidence suggest that the rufa red knot also faces threats to its food resources throughout its range.

About 40 percent of the U.S. coastline within the range of the red knot is already developed, and much of this developed area is stabilized by a combination of existing hard structures and ongoing beach nourishment programs. In those portions of the range for which data are available (New Jersey and North Carolina to Texas), about 40 percent of inlets, a preferred red knot habitat, are hard-stabilized, dredged, or both. Hard stabilization structures and dredging degrade and often eliminate existing red knot habitats, and in many cases prevent the formation of new shorebird habitats. Beach nourishment may temporarily maintain suboptimal shorebird habitats where they would otherwise be lost as a result of hard structures, but beach nourishment also has adverse effects to red knots and their habitats. Demographic and economic pressures remain strong to continue existing programs of shoreline stabilization and to develop additional areas, with an estimated 20 to 33 percent of the coast still available for development. However, we expect existing beach nourishment programs will likely face eventual constraints of budget and sediment availability as sea level rises. In those times and places that artificial beach maintenance is abandoned, the remaining alternatives would likely be limited to either a retreat from the coast or increased use of hard structures to protect development. The quantity of red knot habitat would be markedly decreased by a proliferation of hard structures. Red knot habitat would be significantly increased by retreat, but only where hard stabilization structures do not exist or where they get dismantled. The cumulative loss of habitat across the nonbreeding range could affect the ability of red knots to complete their annual cycles, possibly affecting fitness and survival, and is thereby likely to negatively influence the long-term survival of the rufa red knot.

In wintering and migration areas, the most common predators of red knots are peregrine falcons (*Falco peregrinus*), harriers (*Circus* spp.), accipiters (Family Accipitridae), merlins (*F. columbarius*), shorteared owls (*Asio flammeus*), and greater black-backed gulls (*Larus marinus*) (Niles *et al*. 2008, p. 28). In addition to greater black-backed gulls, other large gulls (e.g., herring gulls (*Larus argentatus*)) are anecdotally known to prey on shorebirds. Predation by a great horned owl (*Bubo virginianus*) has been documented in Florida Nearly all documented predation of wintering red knots in Florida has been by avian, not terrestrial, predators (2014 FWS BO). However, in migration areas like Delaware Bay, terrestrial predators such as red foxes (*Vulpes vulpes*) and feral cats (*Felis catus*) may be a threat to red knots by causing disturbance, but direct mortality from these predators may be low (Niles *et al.* 2008, p. 101).

Red knots' selection of high-tide roosting areas on the coast appears to be strongly influenced by raptor predation, something well demonstrated in other shorebirds (Niles *et al.*. 2008, p. 28). Red knots require roosting habitats away from vegetation and structures that could harbor predators (Niles *et al.*. 2008, p. 63). Red knots' usage of foraging habitat can also be affected by the presence of predators, possibly affecting the birds' ability to prepare for their final flights to the arctic breeding grounds (Watts 2009) (e.g., if the knots are pushed out of those areas with the highest prey density or quality). In 2010, horseshoe crab egg densities were very high in Mispillion Harbor, Delaware, but red knot use was low because peregrine falcons were regularly hunting shorebirds in that area (Niles 2010a). Growing numbers of peregrine falcons on the Delaware Bay and New Jersey's Atlantic coasts are decreasing the suitability of a number of important shorebird areas (Niles 2010a). Analyzing survey data from the Virginia stopover area, Watts (2009) found the density of red knots far (greater than 3.7 mi (6 km)) from peregrine nests was nearly eight times higher than close (0 to 1.9 mi (0 to 3 km)) to peregrine nests. In addition, red knot density in Virginia was significantly higher close to peregrine nests during those years when peregrine territories were not active compared to years when they were (Watts 2009).

The quantity and quality of red knot prey may also be affected by the placement of sediment for beach nourishment or disposal of dredged material. Invertebrates may be crushed or buried during project construction. Although some benthic species can burrow through a thin layer of additional sediment, thicker layers (over 35 in (90 cm)) smother the benthic fauna. By means of this vertical burrowing, recolonization from adjacent areas, or both, the benthic faunal communities typically recover. Recovery can take as little as 2 weeks or as long as 2 years, but usually averages 2 to 7 months (Burlas et al 2001; Peterson and Manning 2001, p.1). Although many studies have concluded that invertebrate communities recovered following sand placement, uncertainty remains about the effects of sand placement on invertebrate communities and how these impacts may affect red knots.

3.3.3 Human Disturbance

Sea level rise and human activities within coastal watersheds can lead to long-term reductions in sediment supply to the coast. Damming of rivers, bulkheading highlands, and armoring coastal bluffs have reduced erosion in natural source areas and, consequently, the sediment loads reaching coastal areas. Although it is difficult to quantify, the cumulative reduction in sediment supply from human activities may contribute substantially to the long-term shoreline erosion rate. Along coastlines subject to sediment deficits, the amount of sediment supplied to the coast is less than that lost to storms and coastal sinks (inlet channels, bays, and upland deposits), leading to long-term shoreline recession

In addition to reduced sediment supplies, other factors such as stabilized inlets, shoreline stabilization structures, and coastal development can exacerbate long-term erosion (Herrington 2003). Coastal development and shoreline stabilization can be mutually reinforcing. Coastal development often encourages shoreline stabilization because stabilization projects cost less than the value of the buildings and infrastructure. Conversely, shoreline stabilization sometimes encourages coastal development by making a previously high-risk area seem safer for development (U.S. Climate Change Science Program [CCSP] 2009). Protection of developed areas is the driving force behind on-going shoreline stabilization efforts. Large-scale shoreline stabilization projects became common in the past 100 years with the increasing availability of heavy machinery. Shoreline stabilization methods change in response to changing new technologies, coastal conditions, and preferences of residents, planners, and engineers. Along the Atlantic and Gulf coasts, an early preference for shore-perpendicular structures (e.g., groins) was followed by a period of construction of shore-parallel structures (e.g., seawalls), and then a period of beach nourishment, which is now favored (Morton et al. 2004; Nordstrom 2000).

3.3.4 Habitat Loss

Structural development along the shoreline and manipulation of natural inlets upset the naturally dynamic coastal processes and result in loss or degradation of beach habitat (Melvin et al. 1991). As beaches narrow, the reduced habitat can directly lower the diversity and abundance of biota (life forms), especially in the upper intertidal zone. Shorebirds may be impacted both by reduced habitat area for roosting and foraging, and by declining intertidal prey resources, as has been documented in California (Defeo et al. 2009; Hubbard 2003). In an estuary in England, Stillman et al. (2005) found that a 2 to 8 percent reduction in intertidal area (the magnitude expected through sea level rise and industrial developments including extensive stabilization structures) decreased the predicted survival rates of 5 out of 9 shorebird species evaluated (although not of *Calidris canutus*).

In Delaware Bay, hard structures also cause or accelerate loss of horseshoe crab spawning habitat (U.S. Climate Change Science Program [CCSP] 2009; Botton et al. *in* Shuster et al. 2003; Botton et al. 1988), and shorebird habitat has been, and may continue to be, lost where bulkheads have been built (Clark 2009). In addition to directly eliminating red knot habitat, hard structures interfere with creation of new shorebird habitats by interrupting the natural processes of overwash and inlet formation. Where hard stabilization is installed, the eventual loss of the beach and its associated habitats is virtually assured (Rice 2009), absent beach nourishment, which may also impact red knots as discussed below. Where they are maintained, hard structures are likely to significantly increase the amount of red knot habitat lost as sea levels continue to rise.

3.3.5 Predation

In wintering and migration areas, the most common predators of red knots are peregrine falcons (*Falco peregrinus*), harriers (*Circus* spp.), accipiters (Family Accipitridae), merlins (*F. columbarius*), shorteared owls (*Asio flammeus*), and greater black-backed gulls (*Larus marinus*) (Niles et al. 2008). In addition to greater black-backed gulls, other large gulls (e.g., herring gulls [*Larus argentatus*]) are anecdotally known to prey on shorebirds (Breese 2010). Predation by a great horned owl (*Bubo virginianus*) has been documented in Florida (Schwarzer, *pers. comm.*, June 17, 2013). Nearly all documented predation of wintering red knots in Florida has been by avian, not terrestrial, predators (Schwarzer, *pers. comm.*, June 17, 2013). However, in migration areas like Delaware Bay, terrestrial predators such as red foxes (*Vulpes vulpes*) and feral cats (*Felis catus*) may be a threat to red knots by causing disturbance, but direct mortality from these predators may be low (Niles et al.et al. 2008).

At key stopover sites, however, localized predation pressures are likely to exacerbate other threats to red knot populations, such as habitat loss, food shortages, and asynchronies between the birds' stopover period and the occurrence of favorable food and weather conditions. Predation pressures worsen these threats by pushing red knots out of otherwise suitable foraging and roosting habitats, causing disturbance, and possibly causing changes to stopover duration or other aspects of the migration strategy.

4 EFFECT ANAYLSIS

4.1 Piping Plover

The piping plover area managed by the NYC Department of Parks and Recreation (DPR) is located at the Rockaway Peninsula which extends from Beach 9th Street to Beach 149th Street on the ocean side, accounting for 6.5 miles of coastline. This stretch of beach is split into three continuous management areas Far Rockaway (Beach 9th Street - Beach 35th Street), Arverne by the Sea (Beach 35th Street – Beach 73rd Street) and Rockaway Beach (Beach 73rd Street - Beach 149th Street). Collectively, these three management areas are known as the Rockaway Beach Endangered Species Nesting Area (RBESNA). RBESNA has been managed as a breeding site for piping plovers since 1996.

According to the 2017 RBESNA Final Report (DPR 2017) 20 pairs of piping plovers had a total of 42 fledglings resulting in a productivity of 2.1 for all of RBESNA. Overall, piping plovers had a nest success rate of 79%, with 19 out of the 24 nests created resulting in at least one fledgling per nest. When separated by location, Arverne by the Sea had the highest productivity rate: 15 piping plover pairs fledged 35 chicks with a productivity rate of 2.33 and a nest success of 88% (15 out of 17 nests). The success of this area is partly due to the fencing off of the dunes and shore areas, which are essential for chick survival. Interestingly, the pair that nested at the B64th Street site, in a swim beach, fledged four chicks, for a productivity rate of 4.0 in that site.

Far Rockaway had five piping plover pairs that fledged seven chicks for a productivity rate of 1.40, and 57% of its nests succeeded (four out of seven nests). It is also interesting to note that the vegetation density and overall layout of the beach in Far Rockaway differed greatly from Arverne by the Sea, with Far Rockaway being a flat and open beach with a sparsely vegetated back dune, compared to Arverne by the Sea which has a higher density of vegetation. Far Rockaway also does not host any colonies of terns or black skimmers. Because of the high success during the breeding seasons of 2014 (UPR, 2014) and 2015 (UPR, 2015), the 2015 seasonal science team recommended that Far Rockaway become a pre-fenced area as suggested by the Piping Plover (Charadrius melodus) Atlantic Coast Population Revised Recovery Plan (USFWS, 1996), for areas with recurring nesting three years in a row.

4.1.1 Historic Trends

According to the 2017 RBESNA Final Report, the 2017 piping plover breeding season had a total of 20 nesting pairs, an increase over the 17 pairs from 2016 (UPR, 2016). There were a record number of fledglings for RBESNA in 2017, with a total of 42 fledglings, compared to 31 fledglings in 2016 (Table 4).

Figure 11: 2017 Nesting Season

Table 4: Piping plover pair and fledgling count at RBESNA from 1996 to 2017

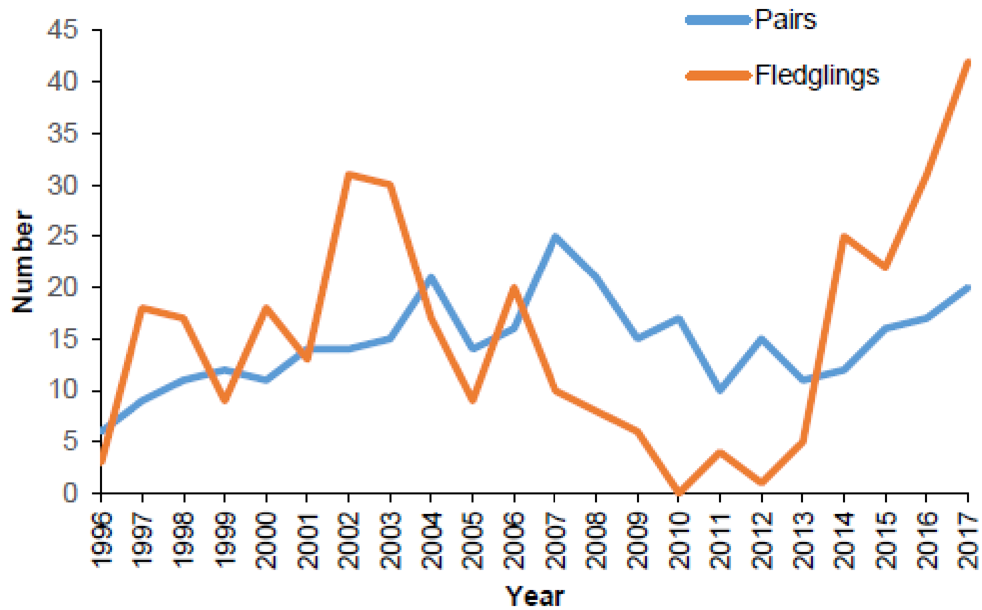
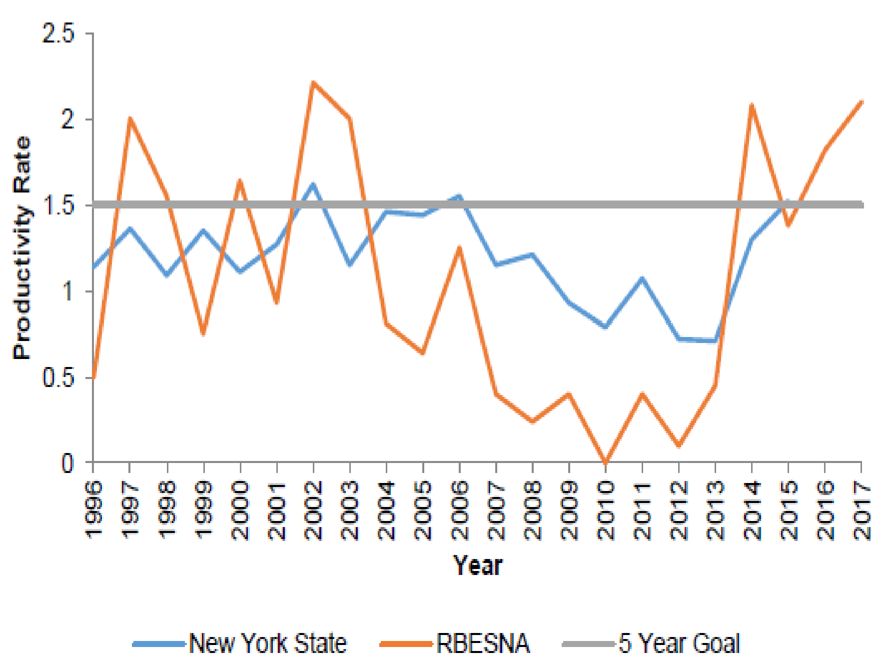


Table 5: Piping plover productivity rate for RBESNA and New York State (USFWS, 2016) from 1996 to 2017



According to the 2017 RBESNA Final Report, the RBESNA exceeded the productivity goal set out by the USFWS. The RBESNA productivity generally follows the same trend that the New York State productivity follows. If the productivity trend continues to increase as it has since 2013, RBESNA and New York State might be able to reach the goal of achieving a productivity rate of 1.5 for five years in a row. The piping plover productivity in 2017 was 2.1, an increase from 2016, and the second highest productivity at RBENSA in 21 years. Table 6 presents a summary of data collected from 1996-2017.

Table 6: Data Collected from 1996 to the present (2017) for piping plovers nesting at RBESNA

Year	Pairs	Nests	Eggs	Chicks	Fledglings	Productivity Rate
1996	6	8	26	3	3	0.50
1997	9	11	39	27	18	2.00
1998	11	16	62	30	17	1.55
1999	12	18	64	24	9	0.75
2000	11	17	53	35	18	1.64
2001	14	20	63	38	13	0.93
2002	14	18	65	44	31	2.21
2003	15	28	87	47	30	2.00
2004	21	27	95	53	17	0.81
2005	14	18	68	39	9	0.64
2006	16	27	103	40	20	1.25
2007	25	35	128	53	10	0.40
2008	21	32	108	29	8	0.24
2009	15	23	68	41	6	0.40
2010	17	23	83	51	0	0.00
2011	10	12	42	30	4	0.40
2012	15	19	69	50	1	0.10
2013	11	14	51	36	5	0.45
2014	12	14	54	43	25	2.08
2015	16	18	64	51	22	1.38
2016	17	22	80	49	31	1.82
2017	20	24	83	56	42	2.10

4.1.2 No Action

Future habitat conditions in the Project Area without the Project would be varied. Based on past experience in coastal areas of New York and New Jersey, the upper beach zone and dunes would continue to erode in many areas and may even be eliminated entirely in areas of severe erosion. This would result in significant loss of habitat upon which the piping plover and other shorebirds/seabirds depend on for nesting habitat. However, in other areas along the shoreline, the upper beach zone could accrete sand and increase in size, thereby potentially increasing available piping plover habitat. Although some accretion may occur in the Project Area over time, many areas are expected to experience erosion and loss of upper beach and dune habitats without the proposed Project activities (USACE 1989, 1998, 2002, 2005). The intertidal and subtidal zones would retain their current width and substrate composition. However, the locations of these zones would shift off-shore or on-shore depending on erosion and accretion rates in the area. Accordingly, the overall impact of the No Action alternative on piping plover habitat would likely be negative.

4.1.3 Proposed Action

Although some minor, short-term, impacts to plover food resources and habitat could result from proposed Project modifications, overall improvements to plover habitat can be expected to result from the proposed activity. Therefore, after a full evaluation of plover life history, habitats in the Project Area, plover management activities, and proposed Project activities, a conservative May Affect, Likely to Adversely Affect (LAA) determination was made by the District on populations of piping plover as a result of implementation these proposed activities (Table 7). Details of this determination are provided below.

Table 7: Summary of Project Effects on Populations of Piping Plover

Activities	Potentially Beneficial	Not Likely to Adversely Affect	Likely to Adversely Affect	No Effect
No-Action				
Project				
Staging Area Construction and Use				X
Beach Fill			X	
Groin Extension			X	
Groin Construction			X	
Dune and Seawall Construction			X	
HRFRRF				X
Cumulative Impacts				
Periodic re-nourishment	X	X		
Periodic maintenance of infrastructure			X	
Long Term Impacts from Groins	X	X	X	
Long Term Impacts from HRFRRF	X			

The primary direct impacts resulting from implementation of the Project will be disturbance and direct impact of benthic, immobile invertebrate and plant communities currently living in these areas due to burial from beach fill material. As a result, piping plover could experience some short-term loss of food resources within the beach fill placement. However, the direct placement of beach fill is not expected to cause long-term significant impacts on the piping plover. The area of actual permanent plover habitat loss due to permanent structures is small and would result in a negligible loss of foraging substrate for the species. In addition, although plover would avoid foraging within areas of direct sand placement in the intertidal zone until benthic food sources recolonized the site, recolonization of benthic communities in the intertidal zones typically takes place within six months to two years following beach fill placement activities (USFWS 1991, Burlas et al 2001, Peterson and Manning 2001). Regardless of the long term benefits resulting from the implementation of the project, a conservative May Affect (LAA), Likely to Adversely Affect determination was made by the District as a result of implementation of these proposed activities.

Placement of beach fill and dune restoration is likely to increase overall habitat value for piping plover along the affected beachfront by expanding the area of suitable breeding, nesting and foraging habitat. Therefore, a Potentially Beneficial Impact determination was made by the District for piping plover for this proposed Project activity for the reasons stated below. Studies of beach nourishment projects along the Atlantic Coast have documented that when construction windows and best plover management practices are adhered to, beach nourishment generally provides valuable habitat for beach nesting birds such as the piping plover (NJDEP 1997, USFWS 2004a). Construction activities occurring in the Project Area are likely to halt further loss of existing plover nesting habitat and will likely increase the amount of suitable habitat by increasing the size of the upper beach zone. Unpublished data from piping plover monitoring conducted by the District in beach fill placement areas near Shinnecock and the Hamptons, Long Island, NY, shows that piping plover and least terns (species that nest on upper beach habitats) returned to breed on sites within 1 year following construction activities (Cohen et al. 2002, 2003a, 2003b).

Permanent hard structures such as seawall, groins, sand fence, access ways, and walkovers also would eliminate any suitable foraging or nesting areas directly within the footprint of these structures. However, the area of overall impact from these structures is expected to be minimal (< 1.0 ac) and most of the habitat that will be impacted is not of high habitat value to plover. Specifically, plover forage primarily in the intertidal zone and nest in the upper beach zone in front of dunes. The areas in which hard structures are proposed include mostly subtidal areas that would be affected from groin placement, and portions of the upper dune that would be affected by buried seawall, fence, access ways, and walkovers. Overall impacts directly within the footprint of these structures would be permanent, but are not expected to significantly affect piping plover breeding or foraging activities for the long term. Regardless of the possible short term adverse effects vs. long term benefits, a conservative May Affect, Likely to Adversely Affect (LAA) determination was made by the District as a result of implementation of these proposed activities.

Other short-term impacts, such as a slight decrease in water quality and an increase in turbidity, also are likely to occur during beach fill and groin construction and rehabilitation activities. Changes in water quality and turbidity may cause some short-term avoidance of the intertidal zone by piping plover during periods of low water quality resulting from construction activities. These impacts to plover foraging activities will be short term and will have a minimal effect on plover because plover are mobile and can utilize unaffected foraging areas nearby. In addition, construction activities will be scheduled to avoid any active plover nesting periods (i.e., construction scheduled from approximately September 2 through March 31), which will avoid potential impacts to less-mobile plover chick foraging activities. Plover also are expected to avoid active construction areas due to noise and activities. Limiting construction in known active nesting areas to September 2 through March 31 will also minimize this impact. Impacts from these activities are expected to be short-term and cause no significant or long term negative effects on plover populations. Regardless of the mitigation measures incorporated as BMPs for the construction of the project, to be conservative, a May Affect, Likely to Adversely Affect (LAA) determination was made by the District for piping plover for these proposed activities.

Construction of new vehicle and pedestrian access points pose potential threat to piping plover because these activities are likely to provide access to new areas of the beach and may increase vehicle and public use of beach areas. This increase in human activity may disrupt nesting plover in areas in proximity to access points and beach activities. Plover are known to be sensitive to disturbance and experience lower reproductive success in areas where they are disturbed frequently (Flemming et al. 1988, Burger 1991, 1994, Goldin 1992, 1993, Cross and Terwilliger 1993, Collazo et al. 1995).

Despite the fact that much of the Project Area is currently highly developed and is used extensively for recreational activities by humans, the District will follow recommendations provided by the NYSDEC and USFWS, to reduce the impacts to plover in the Project Area (USFWS 1989, 1994, 1999, USACE 1998,). These impact minimization measures are detailed in Section 5.

Efforts to restrict human access and activities near the nest sites, and use of exclusion devices to reduce predation are believed to be major contributing factors in nesting success of plovers in coastal areas such as those found in the project area (USFWS 1995b, 2003, Cohen et al. 2002, 2003a, 2003b). In addition, NatureServe (2002) notes that population declines may have been countered with intensive management efforts that include creation of habitat using dredge material. Thus, a May Affect, Likely to Adversely Affect (LAA) determination was made by the District on piping plover for proposed Project activities.

4.1.4 Cumulative Effects

The proposed beach renourishment activities would cause short-term impacts to plover foraging by directly covering the benthic organisms that plover feed on and causing short term availability in benthic species (USFWS 1991, Burlas et al 2001, Peterson and Manning 2001). These impacts are similar to the impacts from initial beach fill activities as discussed above. However, as discussed previously, these impacts will have minimal short-term impact on plover populations. Renourishment activities will provide long-term protection of potential breeding and nesting areas in the upper beach and primary dune areas. To further reduce potential impacts, beach renourishment activities will adhere to recommended construction windows. In addition, the District will support the conduct of pre-nourishment field surveys for active piping plover nesting areas. Beach fill would not be placed within 1000 m of active populations of piping plover or other state or federally-listed shorebirds/seabirds during the breeding season. Even though multiple Potentially Beneficial activities were identified as compared with only one Likely to Affect activity, a conservative May Affect, Likely to Adversely Affect (LAA) determination has been made for these proposed activities.

Occasional maintenance of beach access locations, boardwalks, and comfort stations will be required. These activities have the potential to disturb plover. However, as noted above, the District will support NYC DPRs efforts to identify the location of nesting plover in the vicinity of these areas, and maintenance activities would be scheduled outside of key breeding and nesting periods.

Groin construction and extension may cause habitat degradation by robbing sand from the down-drift shoreline. For example, the Coastal Barriers Study Group (1987) and the Ocean City, Maryland and Vicinity Water Resources Study Reconnaissance Report (USACE 1994) attribute the accelerated, landward shoreline recession of the north end of Assateague Island in Maryland to cumulative effects on the natural drift system from inlet stabilization and nourishment of the rapidly eroding beaches at Ocean City. However, loss of sand down-drift of a jetty or groin may be partially off-set by habitat accretion on the up-drift side of a structure. Breezy Point at the western end of southern Long Island, New York, serves as an example of concentrated piping plover numbers on the accreting side of a jetty (Goldin 1990). Beaches on the accreting side of jetties may also be subject to plant succession that makes them less attractive to piping plovers over time (NJDEP 1997, USFWS 2004). The District will monitor the long-term effects of groin placement on habitat for known populations of piping plover or other state or federally-listed shorebirds/seabirds identified in the greater Project Area and appropriate ameliorative action would be taken. Even though the potential impacts and benefits are offsetting with the long term project condition ensuring the sustainability of nesting habitat, a May Affect, Likely to Adversely Affect (LAA) determination was made by the District for piping plover from this proposed Project activity.

4.2 Seabeach Amaranth

According to the 2017 RBESNA Final Report, a total of 4,881 seabeach amaranth plants were located, flagged, and measured in August and the first week in September (Table 8). This is a large increase from the 2,517 plants counted in 2016. Most plants were found in Arverne by the Sea between Beach 57th Street and Beach 38th Street inside the fenced off area. Diameter of the plants fluctuated from 0.30 to 47 centimeters. Most plants had a diameter of 2.0 centimeters, and the biggest plant presented mature infructescences with seeds. This year NRG put cage-like exclosures around plants not within symbolic fencing. These were used to prevent accidental crushing by pedestrians or vehicles.

Table 8: Seabeach Amaranth Survey Results

Count	Mean	Median	Mode	Minimum	Maximum
4,881 plants	3.14 cm	2.20 cm	2.0 cm	0.30 cm	47.0 cm

Figure 12: Seabeach Amaranth 2017 Location Map

4.2.1 Historic Trends

Historically, seabeach amaranth occurred in nine states from Massachusetts to South Carolina. The populations, which have been extirpated, are believed to have succumbed as a result of hard shoreline stabilization structures, erosion, tidal inundation, and possibly, herbivory by webworms (U.S. Fish and Wildlife Service 1994). The continued existence of the plant is threatened by these activities (Elias-Gerken 1994, Van Schoik and Antenen 1993), as well as the adverse alteration of essential habitat primarily as a result of "soft" shoreline stabilization (beach nourishment, artificial dune creation, and beach grass plantings), but also from beach grooming and other causes (Murdock 1993). Populations of seabeach amaranth at any given site are extremely variable (Weakley and Bucher 1992) and can fluctuate by several orders of magnitude from year to year. For example, seabeach amaranth declined from 55,832 plants in 2003 to 2,639 plants in 2006 at the Westhampton Island West survey site (NYNHP 2006). The primary reasons for the natural variability of seabeach amaranth are the dynamic nature of its habitat and the significant effects of stochastic factors, such as weather and storms, on mortality and reproductive rates. Although wide fluctuations in species populations tend to increase the risk of extinction, variable population sizes are a natural condition for seabeach amaranth; the species is well-adapted to its ecological niche (U.S. Fish and Wildlife Service 1996a).

Seabeach amaranth has been identified as occurring within the Project Area. Seabeach amaranth inhabits dynamic, sparsely vegetated seaward facing beaches at elevations of 8 in to 5 ft above mean high water. Habitat such as this is known to be present within the Project Area and is likely to experience some impacts as a result of proposed Project activities. The following section provides an evaluation of the potential impacts from No-Action and proposed Project alternatives on populations of seabeach amaranth.

4.2.2 No Action

As with the no-action scenario for piping plover, future habitat conditions without the Project would include both loss and accretion of sediment in the upper beach and dune areas. However, much of the Project Area is expected to experience erosion and loss of upper beach and dune habitats without the proposed Project activities (USACE 1989, 1998, 2002, 2005). In these areas, the upper beach zone would lose sand and would decrease in size, thereby potentially reducing available seabeach amaranth habitat. The width of intertidal and subtidal zones will remain stable. But, locations of these zones may shift off-shore or on-shore depending on erosion and accretion rates in the area. Accordingly, the overall impact of the No Action alternative on seabeach amaranth habitat would likely be negative.

4.2.3 Proposed Action

Implementation of the Project actions will affect the upper, intertidal, nearshore subtidal beach zones and primary dune areas of coastal beaches in the Project Area through the direct placement of beach fill and structures such as retaining walls, walkovers, and beach access areas. These activities could bury amaranth communities and historic seed banks. In addition, hard structures such as groins, would not result in any permanent loss of potential habitat because these structures will impact areas of the beach/dune that are not typically suitable for amaranth. A summary of Project activities and their effects on populations of seabeach amaranth are presented in Table 9.

Table 9: Summary of Project Effects on Populations of Seabeach Amaranth

Activities	Potentially Beneficial	Not Likely to Adversely Affect	Likely to Adversely Affect	No Effect
No-Action				
Project				
Staging Area Construction and Use				X
Beach Fill			X	
Groin Extensions			X	
Groin Construction			X	
Dune and Seawall Construction			X	
HRFRRF				X
Cumulative Impact				
Periodic Re-nourishment	X	X		
Periodic Maintenance of Dunes and Infrastructure	X		X	
Long term impacts from Groins	X	X		
Long term impacts HRFFRF	X			X

Vehicle and pedestrian access points pose potential threats to seabeach amaranth because these activities are likely to provide access to new areas of the beach and may increase vehicle and public use of beach areas. This increase in human activity could directly impact unprotected amaranth if they were to occur in the Project Area. In addition, similar to the recommendations provided by NYSDEC and USFWS for the piping plover, the District will implement several measures in an effort to minimize potential adverse impacts to existing seabeach amaranth populations (USACE 1998, USFWS 1999). These impact minimization measures are detailed in Section 5 and in summary include the following: support NYC DPR pre and post-construction surveys of the Project Area to determine the presence/absence of seabeach amaranth as well as education of residents, landowners, beach visitors, and beach managers and the use of physical deterrents to deter human use of potential seabeach amaranth habitat and limiting construction activities during the growing season within areas of known amaranth populations (i.e., limited activities from approximately June through November); Even though mitigation measures will be taken to avoid and minimize access to areas that are shown to have seabeach amaranth, a conservative May Affect, Likely to Adversely Affect (LAA) determination was made by the District for populations of seabeach amaranth related to the implementation of the overall action.

Construction of the Project is likely to increase overall habitat suitability for seabeach amaranth along the affected beachfront in the long term. Although the planned beach berm is designed for an elevation of 9ft NAVD, which is slightly higher than seabeach amaranth's preferred elevation, as the beach berm slopes toward the ocean, there will be a zone that falls within the plants preferred elevation range. Expanding the beach and particularly the zone most suitable for amaranth would likely provide habitat for seabeach amaranth. Even though a Potentially Beneficial Impact determination is identified for some aspects of this proposed plan, to be conservative, a May Affect, Likely to

Adversely Affect (LAA) determination was made by the District for seabeach amaranth from this overall proposed Project activity.

4.2.4 Cumulative Effects

The proposed beach renourishment activities will provide long-term protection of potential habitat for seabeach amaranth in the upper beach and primary dune areas. Beach fill material would not be placed within 25 ft of the perimeter of population clusters or individual stems of seabeach amaranth. To further reduce potential direct impacts, the District will support NYC DPRs conduct of pre-nourishment field surveys for amaranth.

Although there is likely a limited extent of disturbance to seabeach amaranth from the project and because the species was identified as occurring in only a small portion of the Project Area, implementation of the proposed action could not reasonably be considered as contributing to cumulative adverse impacts on seabeach amaranth. Additionally, some elements of the proposed Project would serve to protect amaranth habitat. Regardless, so as to be conservative, a May Affect, Likely to Adversely Affect (LAA) determination was made by the District for seabeach amaranth from this proposed Project activity.

4.3 Red Knot

There have been recent sightings and documentation of a few red knots in the vicinity of the Project. Despite the development and high recreational use of the area by humans, red knot are utilizing the suitable habitats in the Project Area. As a result, the USFWS has requested a Potential Effect determination on populations of red knot related to the implementation of the proposed action. Red knot are typically dependent upon intertidal and upper beach zones, using gradually sloping sparsely vegetated areas of the upper beach, bay shoreline and intertidal areas for foraging. Habitats such as these are known to be present within the Project Area and are may experience some impacts as a result of proposed Project activities. The following section provides an evaluation of the potential impacts from No-Action and proposed the Project alternative on populations of red knot. Affect determinations for the No-Action alternative and for various components of the proposed Project are presented in Table 12.

4.3.1 No Action

As with the no-action scenario for piping plover, future habitat conditions without the Project would include both loss and accretion of sediment in the upper beach and dune areas. However, much of the Project Area is expected to experience erosion and loss of upper beach and dune habitats without the proposed Project activities (USACE 1989, 1998, 2002, 2005). In these areas, the upper beach zone would lose sand and would decrease in size, thereby potentially reducing available red knot habitat. The width of intertidal and subtidal zones will remain stable. But, locations of these zones may shift off-shore or on-shore depending on erosion and accretion rates in the area. Accordingly, the overall impact of the No Action alternative on red knot habitat would likely be negative.

Table 10: Summary of Project Effects on Populations of Red Knot

Activities	Potentially Beneficial	Not Likely to Adversely Affect	Likely to Adversely Affect	No Effect
No-Action				
Project				
Staging Area Construction and Use				X
Beach Fill			X	
Groin Extension			X	
Groin Construction			X	
Dune and Seawall Construction			X	
HRFRRF				X
Cumulative Impacts				
Periodic Re-nourishment	X	X		
Periodic Maintenance of Infrastructure				X
Long Term Impacts from Groins	X	X		
Long Term Impacts from HRFRRF	X	X		

4.3.2 Proposed Action

Although some minor, short-term, impacts to the red knot food resources and habitat will result from proposed Project modifications, overall improvements to habitat can be expected to result from the proposed activity. Therefore, after a full evaluation of red knot life history, habitats in the Project Area, management activities, and proposed Project activities, a May Affect, but Not Likely to Adversely Affect (NLAA) determination was made by the District on populations of red knot as a result of implementation the overall proposed activities (Table 10). Details of this determination are provided below.

The primary direct impacts resulting from implementation of the Project will be disturbance and direct impact of benthic, immobile invertebrate and plant communities currently living in these areas due to burial from beach fill material, and from addition of or extension of groins, which could provide habitat for predators of red knot. As a result, red knots will experience some short-term loss of food resources within the beach fill placement, and possible increased risk of predation. However, the direct placement of beach fill is not expected to cause long-term significant impacts on the red knot, and the predator population is not expected to increase due to human use of the project area. The area of actual permanent red knot habitat loss due to permanent structures is small and would result in a negligible loss of foraging substrate for the species. In addition, although the red knot would avoid foraging within areas of direct sand placement in the intertidal zone until benthic food sources recolonized the site, recolonization of benthic communities in the intertidal zones typically takes place within six months to two years following beach fill placement activities.

Therefore, because most elements of the proposed Project are expected to be short-term and insignificant, and not likely to negatively affect red knot populations in the long term, a May Affect, but Not Likely to Adversely Affect (NLAA) determination was made by the District as a result of implementation of the overall proposed activities.

Placement of beach fill and dune restoration is likely to increase overall habitat value along the affected beachfront by expanding the area of suitable foraging habitat. Therefore, a Potentially Beneficial Impact determination was made by the District for Red Knot for this proposed Project activity for the reasons stated below. Studies of beach nourishment projects along the Atlantic Coast have documented that when construction windows and best management practices are adhered to, beach nourishment generally provides valuable habitat for beach nesting birds such as the red knot. Construction activities occurring in the Project Area are likely to halt further loss of existing habitat and will likely increase the amount of suitable habitat by increasing the size of the upper beach zone.

Permanent hard structures such as groins, would eliminate any suitable foraging habitat directly within the footprint of these structures since red knot forage primarily in the intertidal zone along the coastline and bay shoreline, and they also could provide habitat for predators of red knot. However, the area of overall impact from these structures is expected to be minimal and most of the habitat that will be impacted is not of high habitat value to red knot, and predator populations are not anticipated to increase due to human use of the project area. The areas in which hard structures are proposed include mostly subtidal areas that would be affected from groin placement. Overall impacts directly within the footprint of these structures would be permanent, but are not expected to significantly affect red knot foraging activities in the long term. Therefore, a May Affect, but Not Likely to Adversely Affect (NLAA) determination was made by the District as a result of implementation of the overall activities.

Other short-term impacts, such as a slight decrease in water quality and an increase in turbidity, also are likely to occur during beach fill and groin construction and rehabilitation activities. Changes in water quality and turbidity may cause some short-term avoidance of the intertidal zone by the red knot during periods of low water quality resulting from construction activities. These impacts to their foraging activities will be short term and will have a minimal effect on them because red knot are mobile and can utilize unaffected foraging areas nearby. In addition, construction activities will be scheduled to avoid any active plover nesting areas (i.e., construction scheduled from approximately September 2 through March 31), which will avoid potential impacts to the red knot foraging activities. Impacts from these activities are expected to be short-term and cause no significant negative effects on plover populations. Therefore, a May Affect, but Not Likely to Adversely Affect (NLAA) determination was made by the District for the red knot, for the proposed activities.

These impact minimization measures are detailed in Section 5 and in summary include the following: supporting NYC DPRs pre and post-construction surveys of the Project Area to determine the presence of red knot; restricting construction activities within areas of known red knot populations; supporting NYC DPRs education of residents, landowners, beach visitors, and beach managers; Regardless, so as to be conservative, a May Affect, Likely to Adversely Affect (LAA) determination was made by the District for rufa red knot from this proposed Project activity.

4.3.3 Cumulative Effect

The proposed beach renourishment activities would cause short-term impacts to red knot foraging by directly covering the benthic organisms that red knot feed on and causing short term availability in benthic species (USFWS 1991, Burlas et al 2001, Peterson and Manning 2001). These impacts are similar to the impacts from initial beach fill activities as discussed above. However, as discussed previously, these impacts will have minimal short-term impact on red knot populations. Renourishment activities will provide long-term protection of potential stop over areas in the upper beach and primary dune areas. To further reduce potential impacts, beach renourishment activities will adhere to recommended construction windows. In addition, the District will conduct pre-nourishment field surveys for active red knots in the area. Therefore, a May Affect, but Not Likely to Adversely Affect (NLAA) determination was made by the District for red knot from the proposed Project activity.

Occasional maintenance of beach access locations, boardwalks, and comfort stations will be required. These activities have the potential to disturb red knots. However, as noted above, the District will conduct surveys to identify the location of red knots in the vicinity of these areas. Maintenance activities would be scheduled outside of key stop over periods.

Groin construction and extension may cause habitat degradation by robbing sand from the down- drift shoreline. For example, the Coastal Barriers Study Group (1987) and the Ocean City, Maryland and Vicinity Water Resources Study Reconnaissance Report (USACE 1994) attribute the accelerated, landward shoreline recession of the north end of Assateague Island in Maryland, to cumulative effects on the natural drift system from inlet stabilization and nourishment of the rapidly eroding beaches at Ocean City. However, loss of sand down-drift of a jetty or groin may be partially off-set by habitat accretion on the up-drift side of a structure. Therefore, a May Affect, but Not Likely to Adversely Affect (NLAA) determination was made by the District for red knot from this proposed Project activity.

5 RECOMMENDATIONS

To minimize potential adverse impacts on the piping plover and seabeach amaranth, the USACE will follow recommendations previously provided by the NYSDEC and USFWS as described below (USACE 1998, USFWS 1999). These measures are expected to minimize potential adverse impacts on numerous other species that may use coastal habitats in the Project Area, including several state-listed shorebird species. Time of year (TOY) no-dredge/work restriction recommendations are as follows: for piping plover and rufa red knot from April 1 through September 2, and for seabeach amaranth from June 1 through November 1, when the presence of these species within an area of potential effect is confirmed.

5.1 PIPING PLOVER and RUFA RED KNOT

1) The USACE will coordinate with NYCDPR, and as deemed necessary, will either provide funding for or supplement their monitoring surveys during the nesting season, and prior to and post construction activities, to identify nesting plover in the Project Area and to document all known locations of plover.
2) The USACE will conduct construction activities near active plover nesting areas only from September 2 through March 31 to avoid the protected shorebird nesting period.
3) Construction activities will avoid all delineated locations of the species during the breeding season and will undertake all practicable measures to avoid incidental taking of the species.
4) The USACE will reinitiate consultation with the USFWS to identify acceptable protective measures should any changes to the project or species elicit a trigger to support such reinitiation.
5) The USACE will coordinate with NYCDPR so as to support their endeavors to educate residents, landowners, beach visitors and beach managers on piping plover.

5.2 SEABEACH AMARANTH

1) The USACE will coordinate with NYCDPR, and as deemed necessary, will either provide funding for or supplement their monitoring surveys prior to and post construction activities, to identify SBA in the Project Area and to document all known locations of SBA.
2) The USACE will restrict construction activities in areas of known SBA populations during the growing season (allow limited activities only, from June through November).
3) Construction activities will avoid all delineated locations of the plant and will undertake all practicable measures to avoid incidental taking of the plant.
4) The USACE will reinitiate consultation with the USFWS to identify acceptable protective measures should any seabeach amaranth plants be identified within the direct construction footprint.
5) The USACE will coordinate with NYCDPR so as to support their endeavors to educate residents, landowners, beach visitors and beach managers on seabeach amaranth.

6 CONCLUSIONS

When trying to promote conservation goals using iconic species such as Piping Plover and Seabeach Amaranth, it is important to keep in mind that there are conflicting measures and recommendations among stakeholders with competing legitimate goals. When a consensus is met on the management goals among these stakeholders, the accomplishment of a more productive public policy to protect the species ensues.

To accomplish the goals of this management consensus for this project, USACE will coordinate and collaborate with USFWS, NYSDEC and NYC DPR to review management practices aimed at urban ecosystems, which differ greatly from managing forever wild or rural locations. There are many reports on urban ecosystems that successfully support native wildlife, as well as the active management efforts that accomplish this specific goal (DiCicco 2014, Feinburg et al. 2014, Fisher 2011, Flores et al. 1998,). Central Park is an example of an early planned construction intended as a naturalistic pastoral design (Brown 2013). Urbanization produces a variety of unprecedented and intense manipulations to an ecosystem. These include changes in disturbance regimes, biota, landscape structure, physiological stresses (e.g. air pollution), as well as include extensive cultural, economic and political factors (McDonnell and Pickett 1990).

It is the USACE's determination, that implementing the proposed action in accordance with the standards and guidelines (including mitigation measures that include protective and conservative best management practices) recommended by USFWS and NYSDEC, will not jeopardize the continued existence or contribute to the loss of viability of either piping plover or seabeach amaranth populations that occur or utilize the project area, and the proposed action would not significantly contribute to cumulative impacts associated with piping plover and seabeach amaranth, the USACE concludes that the overall project results in a May Affect is Likely to Adversely Affect (LAA) determination for piping plover and seabeach amaranth, and a May Affect, but Not Likely to Adversely Affect (NLAA) determination for red knot.

USACE has requested that USFWS issue their Biological Opinion, which may include an Incidental Take Statement (ITS), as/if necessary, based upon the analyses provided in this Biological Assessment, according to and in compliance with our joint Section 7 obligations. USACE is in active coordination with USFWS regarding the preparation of the Biological Opinion which is expected mid-December.

7 REFERENCES

Bent, A.C. 1929. Life histories of North American shorebirds (Part II). U.S. Natl. Mus. Bull. 146. Washington, D.C.

Bergstrom, P.W. 1991. Incubation temperatures of Wilson's plovers and killdeers. Condor 91: 634- 641.

Botton, M.L., Loveland, R.E., and T.R. Jacobsen. 1988. Beach Erosion and Geochemical Factors: Influence on Spawning Success of Horseshoe Crabs (*Limulus polyphemus*) in Delaware Bay. *Marine Biology* 99(3): 325-332.

Botton, M.L., R.E. Loveland, and T.R. Jacobsen. 1994. Site selection by migratory shorebirds in Delaware Bay, and its relationship to beach characteristics and abundance of horseshoe crab (*Limulus polyphemus*) eggs. The Auk 111(3):605-616.

Brotherton, D. K., J. L. Behler, and R. Cook. 2003. Fire Island National Seashore Amphibian and Reptile Inventory, March–September 2002. National Park Service and Wildlife Conservation Society Cooperative Agreement #1443CA4520-98-017. (In draft)

Brown, J.L., 2013. The making of central park. Civil Engineering—ASCE, 83:4043.

Burger, J. 1987. Physical and social determinants of nest-site selection in piping plover in New Jersey. Condor 89: 811-818.

Burger, J. 1991. Foraging Behavior and the Effect of Human Disturbance on the Piping Plover (*Charadrius melodus*). Journal of Coastal Research 7(1):39-52.

Burger, J. 1993. Shorebird squeeze. Natural History 5/93, pp. 8-14.

Burger, J. 1994. The effect of human disturbance on foraging behavior and habitat use in piping plover (*Charadrius melodus*). Estuaries 17(3): 695-701.

Burlas, M, GL Ray, and D. Clark. 2001. The New York District's Biological Monitoring Program for the Atlantic Coast of New Jersey: Asbury Park to Manasquan Section Beach Erosion Control Project, Final Report. US Army Corps of Engineers New York District, Engineer Research and Development Center, Waterways Experiment Station.

Cairns, W. E. 1977. Breeding biology and behavior of the piping plover (*Charadrius melodus*) in southern Nova Scotia. Dalhousie University, Halifax, Nova Scotia. M.S. thesis. 155 pp.

Cairns, W. E., and I. A. McLaren. 1980. Status of the piping plover (*Charadrius melodus*) on the East Coast of North America. American Birds 34:206-8.

Cartar, R. 1976. The status of the piping plover at Long Point, Ontario, 1966-1974. Ont. Field Biol. 30:42-5.

Cashin Associates, P.C. 1993. The environmental impacts of barrier island breaching with particular focus on the south shore of Long Island, New York. Prepared for State of New York, Division of Coastal Resources and Waterfront Revitalization, Albany, New York. 44 pp. and appendix.

Clark, K.E., Porter, R.R., and J.D. Dowdell. 2009. The Shorebird Migration in Delaware Bay. *New Jersey Birds* 35(4): 85-92.

Coastal Barriers Study Group. 1987. Draft report to Congress: Coastal barrier resources system.

Executive summary. Department of the Interior, Washington, D.C. 25 pp.

Cohen, J., L. Houghton, A. Novak, J. Fraser, and S. Elias-Gerken. 2002. Limiting Factors of Piping Plover Nesting Pair Density and Productivity on Long Island, New York. Interim Report for the 2001 Breeding Season. Department of Fisheries and Wildlife Sciences, Virginia Polytechnic Institute and State University, Blacksburg, VA. January 2002. 79pp.

Cohen, J., L. Houghton, A. Novak, J. Fraser, and S. Elias-Gerken. 2003a. Limiting Factors of Piping Plover Nesting Pair Density and Productivity on Long Island, New York. Interim Report for the 2002 Breeding Season. Department of Fisheries and Wildlife Sciences, Virginia Polytechnic Institute and State University, Blacksburg, VA. January 2003. 91pp.

Cohen, J., L. Houghton, A. Novak, J. Fraser, and S. Elias-Gerken. 2003b. Limiting Factors of Piping Plover Nesting Pair Density and Productivity on Long Island, New York. Interim Report for the 2003 Breeding Season. Department of Fisheries and Wildlife Sciences, Virginia Polytechnic Institute and State University, Blacksburg, VA. December 2003. 90pp.

Cohen, J.B., S.M. Karpanty, J.D. Fraser, B.D. Watts, and B.R. Truitt. 2009. Residence probability and population size of red knots during spring stopover in the mid-Atlantic region of the United States. Journal of Wildlife Management 73(6):939-945.

Collazo, J.A., J.R. Walters, and J.F. Parnell. 1995. Factors affecting reproduction and migration of waterbirds on North Carolina barrier islands. Final report to the National Park Service, Cape Hatteras and Cape Lookout National Seashores.

Connor, P.F. 1971. The Mammals of Long Island, New York. New York State Museum and Science Service Bulletin 416. 78 pp.

Cross, R. R. 1992. Effects of predator control on piping plover reproductive success. Abstract, 6th Annual Meeting of the Society for Conservation Biology, p. 49.

Cross, R.R. and K. Terwilliger. 1993. Piping plover flushing distances recorded in annual surveys in Virginia 1986-1991. Virginia Department of Game and Inland Fisheries, Richmond, Virginia. 5 pp

Cuthbert, F. J., and T. Wiens. 1982. Status and breeding biology of the piping plover in Lake of the Woods County, Minnesota. Report submitted to Non-Game Program, Minnesota Department of Natural Resources. 18 pp.

Defeo, O., McLachlan, A., Schoeman, D.S., Schlacher, T., Dugan, J.E., Jones, A., Lastra, M., and F. Scapini. 2009. Threats to Sandy Beach Ecosystems: A Review. *Estuarine, Coastal and Shelf Science* 81(1): 1-12.

DiCicco, J.M., 2014. LongTerm Urban park Ecological Restoration: A Case Study of Prospect Park, Brooklyn, NY. Ecological Restoration, 32:314326.

Downer, R.H, and C.E. Leibelt. 1990. 1989 Long Island colonial waterbird and piping plover survey. Research report of the New York State Department of Environmental Conservation, Stony Brook, New York. 200 pp.

Drury, W. H. 1973. Population changes in New England seabirds. Bird Banding 44: 267-313.

Ducey-Ortiz, A.M., T.S. Litwin and D.C. MacLean. 1989. 1988 Long Island colonial waterbird and piping plover survey. Unpublished report. Seatuck Research Program, Cornell Laboratory of Ornithology, Islip, New York. 8 pp.

Eddings, K.J., and S.M. Melvin. 1991. Biology and conservation of piping plovers at Breezy Point, New York, 1991. Unpublished report submitted to the U.S. Fish and Wildlife Service, Newton Corner, Massachusetts. 38 pp.

Elias-Gerken, S.P. 1994. Piping plover habitat suitability on central Long Island, New York barrier islands. M.S. Thesis. Virginia Polytechnic Institute and State University, Blacksburg, Virginia. 48 pp.

Elias-Gerken, S. P., J. D. Fraser, and P. A. Buckley. 1995. Piping plover habitat suitability on central Long Island, New York barrier islands. USDI National Park Service, North Atlantic region, Tech. Rep. NPS/NAROSS/NRTR/95-29. xvii + 246 pp.

Erwin, R.M. 1979. Historical breeding records of colonial seabirds and wading birds, 1900-1977, Cape Elizabeth, Maine to Virginia. Supplement to final report prepared for U.S. Fish and Wildlife Service, Coastal Ecosystems Project, Newton Corner, Massachusetts.

Feinburg, J.A., C.E. Newman, G.J. WatkinsColwell, M.D. Schlesinger, B. Zarate, B.R. Curry,

H.B. Shaffer, J. Burger, 2014. Cryptic Diversity in Metropolis: Confirmation of a New Leopard Frog Species (Anura: Ranidae) from New York City and Surrounding Atlantic Coast Regions. DOI: 0.1371/journal.pone.0108213; http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0108213

Fisher, C., 2011. Nature in the City: Urban Environmental History and Central Park. OAH Magazine of History, 25(4):2731.

Flemming, S. P., R. D. Chiasson, P. C. Smith, P. J. Austin-Smith, and R. P. Bancroft. 1988.

Piping Plover status in Nova Scotia related to its reproductive and behavioral responses to human disturbance. Journal of Field Ornithology 59:321-330.

Flores, A., S.T.A. Pickett, W.C. Zipperer, R.V. Pouyat, and R. Pirani, 1998. Adopting a modern ecological view of the metropolitan landscape: the case of a greenspace system for the New York City region. Landscape and Urban Planning, 39:295308.

Fraser, J.D., S.M. Karpanty, and J.B. Cohen. 2010. Shorebirds forage disproportionately in horseshoe crab nest depressions. Waterbirds 33(1):96-100.

Galbraith H., Jones, R., Park, R., Clough, J., Herrod-Julius, S., Harrington, B, and G. Page.2002. Global Climate Change and Sea Level Rise: Potential Losses of Intertidal Habitat for Shorebirds. Waterbirds 25: 173–183.

Gardner, A.L. 1982. Virginia opossum. Pp. 3-36 *in* J.A. Chapman and G.A. Feldhamer (eds.), Wild mammals of North America. John Hopkins University Press. Baltimore, Maryland.

Goldin, M.R. 1990. Reproductive ecology and management of piping plovers (*Charadrius melodus*) at Breezy Point, Gateway National Recreation Area, New York -- 1990. Unpublished report. Gateway National Recreation Area, Long Island, New York. 16 pp.

Goldin, M. R., et al. 1992. The effects of human disturbance and off-road vehicles on piping plover (*Charadrius melodus*) behavior and reproductive success. Abstract, 6th Annual Meeting of the Society for Conservation Biology, p. 65.

Goldin, M.R. 1993. Effects of human disturbance and off-road vehicles on piping plover reproductive success and behavior at Breezy Point, Gateway National Recreation Area, New York. M.S. Thesis. University of Massachusetts, Amherst, Massachusetts. 128 pp.

González, P.M. 2005. Report for developing a red knot status assessment in the U.S. Unpublished report by Fundacion Inalafquen, Rio Negro, Argentina.

Griffin, C.R. and S.M. Melvin. 1984. Research plan on management, habitat selection, and population dynamics of piping plovers on outer Cape Cod, Massachusetts. University of Massachusetts. Research proposal submitted to U.S. Fish and Wildlife Service, Newton Corner, Massachusetts. 5 pp.

Haig, S. M., and L. W. Oring. 1988. Distribution and dispersal in the piping plover. Auk 105:630-638.

Haig, S.M. 1992. Piping Plover (*Charadrius Melodus*). In A. Poole, P. Stettenheim, and F. Gill, editors, The Birds of North America, No. 2. Academy of Natural Sciences, Philadelphia, and American Ornithologists' Union, Washington, DC. 18 pp.

Haig, S. M., and J. H. Plissner. 1993. Distribution and abundance of piping plovers: results and implications of the 1991 international census. Condor 95:145-156.

Halbeisen, R. 1977. Disturbances of incubating snowy plovers on Pt. Reyes. Point Reyes Bird Observatory. 42:2-3.

Harrington, B.A. 2008. Coastal inlets as strategic habitat for shorebirds in the southeastern United States. DOER technical notes collection. ERDC TN-DOERE25. U.S. Army Engineer Research and Development Center, Vicksburg, MS. Available at <http://el.erdc.usace.army.mil/elpubs/pdf/doere25.pdf>.

Herrington, T.O. 2003. Manual for Coastal Hazard Mitigation. New Jersey Sea Grant Consortium, Fort Hancock, NJ. Available at: <http://www.state.nj.us/dep/cmp/coastal_hazard_manual.pdf>.

Hoopes, E. M., C. R. Griffin, and S. M. Melvin. 1992. Foraging ecology of piping plovers in Massachusetts. Abstract, 6th Annual Meeting of the Society for Conservation Biology, p. 74.

Hoopes, E.M. 1993. Relationships between human recreation and piping plover foraging ecology and chick survival. M.S. Thesis. University of Massachusetts, Amherst, Massachusetts. 106 pp.

Hoopes, E.M. 1994. Breeding ecology of piping plovers nesting at Cape Cod National Seashore - 1994. National Park Service, South Wellfleet, Massachusetts. 34 pp.

Hoopes, E.M. 1995. Piping plover nest distribution with respect to concrete walkways at the Breezy Point Cooperative, New York, 1991-1994. Report for the U.S. Fish and Wildlife Service, Sudbury, Massachusetts. 6 pp.

Howard, J.M., R.J. Safran, and S.M. Melvin. 1993. Biology and conservation of piping plovers at Breezy Point, New York. Unpublished report. Department of Forestry and Wildlife Management, University of Massachusetts, Amherst. 34 pp.

Hubbard D.M., and J. E. Dugan. 2003. Shorebird Use of an Exposed Sandy Beach in Southern California. *Estuarine and Coastal Shelf Science* 58S: 169-182.

Hull, C. 1981. Great Lakes piping plover in trouble. Michigan Department of Natural Resources, Lansing, Michigan. 2 pp.

Johnsgard, P. A. 1979. Birds of the Great Plains: breeding species and their distribution. Univ. Nebraska Press, Lincoln. 539 pp.

Kluft, J.M., and H.S. Ginsburg. 2009. The effect of off-road vehicles on barrier beach invertebrates at Cape Cod and Fire Island National Seashores. Technical Report NPS/NER/NRTR—2009/138. Boston, MA.

Quinn, J. R., and R. B. Walden. 1966. Notes on the incubation and rearing of the piping plover (*Charadrius melodus*). Avicultural Mag. 72:145-6.

Lambert, A., and B. Ratcliff. 1979. A survey of piping plovers in Michigan, 1979. Report submitted to Michigan Department of Natural Resources, Lansing, Michigan.

Litwin, T.S., A. Ducey-Ortiz, R.A. Lent, and C.E. Liebelt. 1993. 1990-1991 Long Island colonial waterbird and piping plover survey. Volume I. New York State Department of Environmental Conservation, Stony Brook, New York. 109 pp.

Loegering, J.P. 1992. Piping plover breeding biology, foraging ecology and behavior on Assateague Island National Seashore, Maryland. M.S. Thesis. Virginia Polytechnic Institute and State University, Blacksburg, Virginia. 247 pp.

Loegering, J.P., and J.D. Fraser, 1995. Factors affecting Piping Plover chick survival in different broodrearing habitats.

MacIvor, L.H. 1990. Population dynamics, breeding ecology, and management of piping plovers on outer Cape Cod, Massachusetts. M.S. Thesis. University of Massachusetts, Amherst, Massachusetts. 100 pp.

MacIvor, L. H., S. M. Melvin, and C. R. Griffin. 1990. Effects of research activity on piping plover nest predation. J. Wildlife Management 54:443-447.

Maine Department of Inland Fisheries and Wildlife. 1995. Atlas of essential wildlife habitats for Maine's endangered and threatened species. 1995 edition. Augusta, Maine. Pp. 8-11.

Matteson, S. W. 1980. 1980 survey of breeding gulls and terns in Chequamegon Bay. Report submitted to Wisconsin Department of Natural Resources, Madison, Wisconsin. 19 pp.

Melvin, S.M., A. Hecht, and C.R. Griffin. 1994. Piping plover mortalities caused by off-road vehicles on Atlantic coast beaches. Wildlife Society Bulletin 22: 409-414.

Melvin, S.M., Griffin, C.R., and L.H. MacIvor. 1991. Recovery Strategies for Piping Plovers in Managed Coastal Landscapes. *Coastal Management* 19: 21-34.

Morton, R.A., Miller, T.L. and L.J. Moore. 2004. National Assessment of Shoreline Change: Part 1: Historical Shoreline Changes and Associated Coastal Land Loss Along the U.S. Gulf of Mexico. Open-file report 2004-1043. U.S. Geological Survey Center for Coastal and Watershed Studies, St. Petersburg, FL. Available at: <http://pubs.usgs.gov/of/2004/1043/>.

National Marine Fisheries Service (NMFS). 2004. Essential Fish Habitat. Available at: http://www.nmfs.noaa.gov/habitat/efh/

National Park Service. 1992. Environmental Assessment on management plan for the threatened piping plover, Sandy Hook Unit, Gateway National Recreation Area. Sandy Hook, New Jersey. 23 pp.

National Park Service. 1994. Environmental Assessment on management plan for shoreside species breeding habitat. Fire Island National Seashore, Patchogue, New York. 29 pp.

National Park Service. 1998. Fire Island National Seashore Environmental Assessment for Endangered Species Habitat Management. Prepared by National Park Service, Fire Island National Seashore, Patchogue, New York. http://www.nps.gov/fiis/plan/plan.html.

NatureServe. 2002. NatureServe Explorer: An online encyclopedia of life [web application].

Version 4.0. NatureServe, Arlington, Virginia. Available: http://www.natureserve.org/explorer. (Accessed: July 29, 2004).

New Jersey Department of Environmental Protection (NJDEP). 1997. Endangered Beach Nesting Bird Management on New Jersey's Municipal Beaches. NJDEP Division of Fish, Game and Wildlife: Endangered and Nongame Species Program, and the U.S. Fish and Wildlife Service (USFWS). http://www.state.nj.us/dep/fgw/ensphome.htm. (Retrieved 2001).

New York City Audubon. 2010. Shorebird and Horseshoe Crab Data Summary 2009 and 2010, Jamaica Bay, NY.

New York State Department of Environmental Conservation (NYSDEC). 2001. New York State Amphibians and Reptile Atlas Project. Available: http://www.dec.state.ny.us/website/dfwmr/wildlife/herp/index.html. Accessed July 2003.

New York City Department of Parks and Recreation, (NYCDPR), Wildlife Unit. 2017. Rockaway Beach Endangered Species Nesting Area (RBESNA) 2017 Final Report.

Niles, L.J. 2011. Blog - a rube with a view: Knot like quail. Available at <http://arubewithaview.com/2011/12/05/knot-like-quail/>.

Niles, L.J. 2010. Blog - A Rube with a View: Delaware Bay Update 5/28/10 - The Importance of Good Habitat. Available at: <http://www.arubewithaview.com/blog/2010/5/29/delaware-bay-update-52810-The importance-of-good-habitat.html>.

Niles, L.J., H.P. Sitters, A.D. Dey, P.W. Atkinson, A.J. Baker, K.A. Bennett, R. Carmona, K.E. Clark, N.A. Clark, and C. Espoza. 2008. Status of the red knot (*Calidris canutus rufa*) in the Western Hemisphere. Studies in Avian Biology 36:1-185.

Niles, L.J., J. Burger, R.R. Porter, A.D. Dey, C.D.T. Minton, P.M. González, A.J. Baker, J.W. Fox, and C. Gordon. 2010a. First results using light level geolocators to track red knots in the Western Hemisphere show rapid and long intercontinental flights and new details of migration pathways. Wader Study Group Bulletin 117(2):123-130.

Nol, E. 1980. Factors affecting the nesting success of the killdeer (*Charadrius melodus*) on Long Point, Ontario. University of Guelph, Ontario. M.S. thesis. 155 pp.

Nordstrom, K.F. 2000. Beaches and Dunes of Developed Coasts. Cambridge University Press, Cambridge, UK. 338 pp.

Patterson, M. E., J. D. Fraser and J. W. Roggenbuck. 1990. Piping plover ecology, management and research needs. Virginia Jour. Sci. 41(4A):419-26.

Patterson, M. E., J. D. Fraser, and J. W. Roggenbuck. 1991. Factors affecting piping plover productivity on Assateague Island. J. Wildlife Management 55:525-531.

Patterson, M. E., J. P. Loegering, and J. D. Fraser. 1992. Piping plover breeding biology and foraging ecology on Assateague Island National Seashore, Maryland. Abstract, 6th Annual Meeting of the Society for Conservation Biology, p. 103.

Peterson C. and L. Manning. 2001. How Beach Nourishment Affects the Habitat Value of Intertidal Beach Prey for Surf Fish and Shorebirds and Why Uncertainty Still Exists. Proceedings of the Coastal Ecosystems and Federal Activities Technical Training Symposium, August 20-22, 2001. University of North Carolina, Chapel Hill, Institute of Marine Sciences, Morehead City, NC, 2 pp.

Piersma, T., R. Hoekstra, A. Dekinga, A. Koolhaas, P. Wolf, P. Battley, and P. Wiersma. 1993. Scale and Intensity of Intertidal Habitat Use by Knots *Calidris canutus* in the Western Wadden Sea in Relation to Food, Friends and Foes. *Netherlands Journal of Sea Research* 31(4): 331-357.

Raithel, C. 1984. The piping plover in Rhode Island. Rhode Island Natural Heritage Program, Providence, Rhode Island. Unpublished report. 13 pp.

Randall, J. 2002. Bringing Back a Fugitive. U.S. Fish and Wildlife Service Endangered Species Bulletin, July-August, 2002.

Ray, G. and D. Clarke. 1995. Baseline Characterization of Benthic Resources and Their Use by Demersal Fishes at a Beach Renourishment Borrow Site off Coney Island, New York. Prepared for the U.S. Army Corps of Engineers, New York District, Environmental Analysis Branch.

Ray, G. 1996. Characterization of Benthic Resources at a Potential Beach Renourishment Borrow Site in the Vicinity of Coney Island, New York: June to September 1995. Prepared for the U.S. Army Corps of Engineers, New York District, Environmental Analysis Branch.

Reid, R.N., D.J. Rodosh, A.B. Frame, and S.A. Fromm. 1991. Benthic Macrofauna of the New York of the New York Bight, 1979-89, NOAA Tech. Report, NMFS 103. 50 pp. Rice, T.M. 2009. Best Management Practices for Shoreline Stabilization to Avoid and Minimize Adverse Environmental Impacts. Unpublished Report prepared for the U.S. Fish and Wildlife Service, Panama City Ecological Services Field Office. Available at: <http://www.fws.gov/charleston/pdf/PIPL/BMPs%20For%20Shoreline%20Stabilization%20To%20Avoid%20And%20Minimize%20Adverse%20Environmental%20Impacts.pdf

Roberts, T. S. 1955. A manual for the identification of the birds of Minnesota and neighboring states. University of Minnesota Press, Minneapolis, Minnesota. 738 pp.

Ryan, J. 1996. Plover on the run. Massachusetts Audubon Society. 31pp.

Sauer, J. R., J. E. Hines, and J. Fallon. 2005. *The North American Breeding Bird Survey, Results and Analysis 1966 - 2004. Version 2005.2. Available at* http://www.mbr-pwrc.usgs.gov/bbs/

Scavia, D., Field, J.C., Boesch,D.F., Buddemeier, R.W., Burkett,V., Cayan, D.R., Fogarty, M., Harwell, M.A., Howarth, R.W., Mason, C., Reed, D.J., and *et al.* 2002. Climate Change Impacts on U.S. coastal and Marine Ecosystems. *Estuaries* 25(2):149-164.

Schupp, C.A., N.T. Winn, T.L. Pearl, J.P. Kumer, T.J.B. Carruthers, and C.S. Zimmerman, 2013. Restoration of Overwash Processes Creates Piping Plover (Charadrius melodus) Habitat on a Barrier Island (Assateague Island, Maryland). Estuarine, Coastal, and Shelf Science 116: 1120.

Sibley, D.A. 2000. The Sibley Guide to Birds, National Audubon Society. Alfred A. Knopf, Inc, New York. 545 pp.

Staine, K.J. and J. Burger. 1994. Nocturnal foraging behavior of breeding piping plovers (*Charadrius melodus*) in New Jersey. Auk 111(3): 579-587.

Stillman, R.A., West, A.D., Goss-Custard, J.D., McGrorty, S., Frost, N.J., Morrisey, D.J., Kenny, A.J., and A.L. Drewitt. 2005. Predicting Site Quality for Shorebird Communities: A Case Study on the Humber Estuary, UK. *Marine Ecology Progress Series* 305: 203-217

Strauss, E. 1990. Reproductive success, life history patterns, and behavioral variation in a population of piping plovers subjected to human disturbance (1982-1989). Ph.D. Dissertation. Tufts University, Medford, Massachusetts. 143 pp.

Tull, C.E. 1984. A study of nesting piping plovers of Kouchibouguac National Park 1983.

Unpublished report. Parks Canada, Kouchibouguac National Park, Kouchibouguac, New Brunswick. 85 pp.

U.S. Army Corps of Engineers. 1994. Ocean City, Maryland and vicinity water resources study reconnaissance report. Baltimore District.

U.S. Army Corps of Engineers (USACE). 2018. Biological Assessment, Fire Island Inlet to Montauk Point Coastal Storm Risk Management, Suffolk County, New York. Prepared and submitted by: U.S. Fish and Wildlife Service, Chesapeake Bay Field Office and U.S. Army Corps of Engineers, New York District.

United States Army Corps of Engineers (USACE). 2003. Final Avian Survey Summary Report for the Reformulation of the Shore Protection and Coastal Storm Risk Management Project, South Shore of Long Island, New York - Fire Island Inlet to Montauk Point. USACE, New York District, North Atlantic Division, October 2003.

United States Army Corps of Engineers (USACE). 2004. Final Small Mammal and Herpetile Survey Summary Report for the Reformulation of the Shore Protection and Coastal Storm Rish Mamagement Project, South Shore of Long Island, New York - Fire Island Inlet to Montauk Point. USACE, New York District, North Atlantic Division, January 2004.

U.S. Climate Change Science Program [CCSP]. 2009. Coastal Sensitivity to Sea-Level Rise: A Focus on the Mid-Atlantic Region. U.S. Climate Change Science Program Synthesis and Assessment Product 4.1. U.S. Geological Survey, Reston, VA. Available at: <http://downloads.globalchange.gov/sap/sap4-1/sap4-1-final-reportall.pdf>.

United States Fish and Wildlife Service (USFWS). 1982. Fish and Wildlife Resource Studies for the Fire Island Inlet to Montauk Point, New York, Beach Erosion Control and Hurricane Protection Project Reformulation Study. U.S. Department of the Interior, Fish and Wildlife Service, Region 5, Cortland Office, Cortland, NY.112 pp.

United States Fish and Wildlife Service (USFWS). 1984. Piping Plover Proposed as an Endangered and Threatened Species. 50 CFR PART 17, 49 (218): 44712-44715.

United States Fish and Wildlife Service. 1985. Determination of endangered and threatened status for the piping plover: final rule. Federal Register 50(238): 50726-50734.

United States Fish and Wildlife Service (USFWS). 1988. Atlantic Coast Piping Plover Recovery Plan. U.S. Fish and Wildlife Service, Newton, MA. 77 pp.

United States Fish and Wildlife Service (USFWS). 1990. Endangered and threatened species recovery program: report to Congress. 406 pp.

United States Fish and Wildlife Service (USFWS). 1991. Characterization of the macro-infauna of the Lower Beach at Assateague Island, Maryland before and after dredged material disposal. Annapolis, Maryland. Report prepared for U.S. Army Corps of Engineers, Baltimore District, 14 pp.

United States Fish and Wildlife Service (USFWS). 1992. 1991 status update, U.S. Atlantic Coast piping plover. USFWS, Northeast Region, Newton Corner, Massachusetts.

United States Fish and Wildlife Service (USFWS). 1993. Endangered and threatened wildlife and plants: *Amaranthus pumilus* (Seabeach amaranth) determined to be threatened: Final rule. Federal Register 58 (65): 18035-18042.

United States Fish and Wildlife Service (USFWS). 1993a. Endangered and threatened wildlife and plants: *Amaranthus pumilus* (seabeach amaranth) determined to be threatened: Final rule. Federal Register 58 (65): 18035-18042.

United States Fish and Wildlife Service (USFWS). 1994. Guidelines for Managing Recreational Activities in Piping Plover Breeding Habitat on the U.S. Atlantic Coast to Avoid Take Under Section 9 of the Endangered Species Act. Northeast Region, U.S. Fish and Wildlife Service April 15, 1994. Available at: http://www.fws.gov/northeast/pipingplover/recguide.html

United States Fish and Wildlife Service (USFWS). 1995b. Piping plover (*Charadrius Melodus*), Atlantic Coast population, revised recovery plan. Technical/agency draft. Hadley, Massachusetts. 238 pp.

United States Fish and Wildlife Service (USFWS). 1996. Recovery plan for seabeach amaranth (*Amaranthus pumilus*) Rafinesque. Atlanta, GA. 59 pp.

United States Fish and Wildlife Service. 2003. 2000-2001, 2002, and Preliminary 2003 status updates: U.S. Atlantic Coast piping plover population. Sudbury, Massachusetts. http://pipingplover.fws.gov/status/

United States Fish and Wildlife Service (USFWS). 2004a. Piping Plover Species Profile, USFWS Endangered Species Division, Long Island Field Office, Islip, New York. Available at: http://nyfo.fws.gov/es/list.htm

United States Fish and Wildlife Service (USFWS). 2004b. Seabeach Amaranth Species Profile.

USFWS Endangered Species Division, Long Island Field Office, Islip, New York. Available at: http://nyfo.fws.gov/es/list.htm.

United States Fish and Wildlife Service (USFWS). 2014. Biological Opinion and Conference Opinion, Jones Inlet to East Rockaway Inlet, Long Beach Island, New York. USFWS Endangered Species Division, Long Island Field Office, Islip, New York.

Watts, B. 2009. Conservation in conflict: Peregrines vs red knots. Available at <http://www.ccb- wm.org/news/2009_SeptDec/bojymetahi/conservation_conflict.html>.

Weakley, A., and M. Bucher. 1992. Status survey of seabeach amaranth (*Amaranthus pumilus rafinesque*) in North and South Carolina, second edition (after Hurricane Hugo). Report to North Carolina Plant Conservation Program, North Carolina Department of Agriculture, Raleigh, North Carolina, and Asheville Field Office,

U.S. Fish and Wildlife Service, Asheville, North Carolina. 149 pp. + appendices.

Welty, J.C. 1982. The life of birds. Sauders College Publishing, Philadelphia, Pennsylvania. 754 pp.

Wilcox, L. 1939. Notes on the life history of the piping plover. Pages 3-13 in The Birds of Long Island. Bird Club of Long Island, New York, New York.

Wilcox, L. 1959. A twenty year banding study of the Piping Plover. Auk 75:129-152. Ziewitz, J. W., J. G. Sidle, and J. J. Dinan. 1992. Habitat conservation for nesting least terns and piping plovers on the Platte River, Nebraska. Prairie Naturalist 24(1):1-20.

Woodhead, P.M.J. 1992. Assessments of the Fish Community and Fishery Resources of the Lower New York Bay Area in Relation to a Program of Sand Mining Proposed by New York State. Stony Brook: Marine Science Research, SUNY at Stony Brook.

Zonick, C.A. 2000. The Winter Ecology of the Piping Plover (*Charadrius melodus*) Along the Texas Gulf Coast. Ph.D. Dissertation. University of Missouri, Columbia, MO.

Zonick, C., and M. Ryan. 1996. The Ecology and Conservation of Piping Plovers (*Charadrius melodus*) Wintering Along the Texas Gulf Coast. 1995 Annual Report. Department of Fisheries and Wildlife, University of Missouri, Columbia, MO.