US Army Corps of Engineers®
New York District

REVISED DRAFT

Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement

Atlantic Coast of New York

East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

August 2018

EXECUTIVE SUMMARY

This Revised Draft Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement (HSGRR/EIS) examines coastal storm risk management (CSRM) problems and opportunities for the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay study area, which was devastated by the impacts of Hurricane Sandy in 2012. This report is considered a General Reevaluation Report (GRR) because there is an existing, authorized project for the area that was constructed in 1977 and renourished through 2004, based upon the 1965 construction authorization. A Reformulation effort was initiated in 2003 to revisit the authorized plan, and make recommendations for a long-term solution.

Draft HSGRR/EIS

Consistent with current U.S. Army Corps of Engineers (USACE) planning guidance, alternatives were identified and screened to address CSRM, and presented a tentatively selected plan (TSP) in the Draft HSGRR/EIS. The TSP identified overall project features, with the acknowledgement that specific dimensions of the TSP were not finalized in the Draft HSGRR/EIS, which was released to the public in August 2016. The Draft HSGRR/EIS proceeded through concurrent public review, policy review, Agency Technical Review (ATR), and Independent External Peer Review (IEPR).

As a result of significant (extent and content) partner, agency, and public comments received on the TSP, as well as the feedback to the New York District resulting from the concurrent policy and technical review conducted by USACE Headquarters (HQUSACE), the New York District determined that substantial revision to the Draft HSGRR/EIS would be required in order to proceed to a final decision document.

The 25 May 2017 USACE Agency Decision Milestone (ADM) resulted in the decision to move all further evaluation of the Jamaica Bay storm surge barrier measure, a significant component of the TSP, to the ongoing New York and New Jersey Harbor and Tributaries (NYNJHATs) Feasibility Study. The NYNJHATs study was initiated in the summer of 2016, and is evaluating large-scale CSRM strategies for the New York metropolitan area, which includes Jamaica Bay. A suite of storm surge barriers is being evaluated in the NYNJHATs study, including an alignment from Breezy Point to Sandy Hook that would obviate the need for the proposed Jamaica Bay barrier. As such, any further evaluation of a storm surge barrier for Jamaica Bay is a more appropriate fit for the NYNJHATs study.

Revised Draft HSGRR/EIS

In this Revised Draft HSGRR/EIS, documentation of the Recommended Plan is presented, which reflects changes to the TSP as described above. Also included in this document is a further refinement and development of 'residual risk' measures[1] in areas bordering Jamaica Bay, now termed high frequency flooding risk reduction features (HFFRRFs). The HFFRRFs documented in this report have been developed to a full feasibility level of design and environmental

[1] The term 'residual risk measure' was used in various discussions throughout the Draft HSGRR/EIS.

analysis[2], and include natural and nature-based features, as well as HFFRRFs for areas outside of New York City in Nassau County.

This report and its recommendations are a component of the USACE response to the unprecedented destruction and economic damage to communities within the study area caused by Hurricane Sandy. The State of New York through the Department of Environmental Conservation (NYSDEC) is the non-federal sponsor, and the City of New York through the New York City Mayor's Office of Recovery and Resiliency is the local sponsor to the NYSDEC. Project partners include the New York City (NYC) Department of Parks and Recreation, and the NYC Department of Environmental Protection. The National Park Service, Gateway National Recreation Area (NPS) is a consulting party under Section 106 of the National Historic Preservation Act.

Based upon the review of the proposed project during the feasibility phase, the NYSDEC will require during the PED Phase further justification or component revisions to ensure the protection of water quality, habitat quality, and public access.

Study Area

The study area (Figure ES-1) consists of the Atlantic Coast of NYC between East Rockaway Inlet and Rockaway Inlet, and the water and lands within and surrounding Jamaica Bay, New York. The study area (unchanged from the Draft HSGRR/EIS) also includes the low lying Coney Island section of Brooklyn, which can be overtopped by floodwaters that flood the Brooklyn neighborhoods surrounding Jamaica Bay. The area is located within the Federal Emergency Management Agency (FEMA) regulated one percent Annual Exceedance Probability (AEP) floodplain, or the 100-year floodplain. The Atlantic Ocean shoreline, which is a peninsula approximately 10 miles in length, generally referred to as the Rockaways, 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, NYC, and a section at the eastern end, known as Head-of-Bay, lies in Nassau County. More than 850,000 residents, over 46,000 residential and non-residential structures (which includes scores of critical infrastructure features such as schools, hospitals, and nursing homes), and additional wastewater treatment, subway, and railroad infrastructure are located within the study area.

[2] The feasibility level design includes enough detail to achieve reasonable confidence to support plan formulation and the preparation of the EIS on the Recommended Plan. This level of design is prepared in order to support the decision makers in their determination on whether to authorize the implementation of the Recommended Plan. The final design will be prepared during the Preconstruction Engineering and Design (PED) Phase. Additional surveys or analyses conducted during PED may result in changes to the design. Changes to design made during PED may trigger the need for additional environmental analyses, as appropriate. Any changes which cause the overall cost to increase by more than 20% will require a Post-Authorization Change Report in order for the revised plan to remain authorized for implementation.

Figure ES-1: East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Study Area

Study Area Problems

The study area was one of the areas most devastated by Hurricane Sandy – there were 10 fatalities[3], and more than 1,000 structures were either substantially damaged[4] to restrict re-entry or were destroyed by Hurricane Sandy. The NYC Department of Buildings post-Hurricane Sandy damage assessment indicates the disproportionate vulnerability of the study area to storm surge[5] damage. Of all buildings city-wide identified as unsafe or structurally damaged, 37 percent were located in the southern Queens portion of the study area. In addition to the structural impacts caused by waves and inundation, fires ignited by the storm surge inundation of electrical systems destroyed 175 homes along the Rockaway Peninsula portion of the study area.

Hurricane Sandy hit the study area at nearly high tide. Waves eroded beaches, breached boardwalks and seawalls, and broke against buildings in the oceanfront communities. Storm surge inundation reached as much as 10 feet above ground in some portions of the study area. In addition, more than 1.5 million cubic yards of sand was removed from Rockaway Beach and deposited on oceanfront communities or washed out to sea.

Floodwaters funneled through Rockaway Inlet amassing a storm surge that inundated all of the neighborhoods surrounding Jamaica Bay. The low-lying neighborhoods in the central and northern portions of Jamaica Bay, where the narrow creeks and basins provide the marine aesthetic of the neighborhood, were especially devastated by flood waters. Damage to the elevated portion of the subway system in Jamaica Bay and Rockaway (the A-line) disrupted service for over six months, affecting about 35,000 riders daily. In the southern Queens portion of the study area 37 schools were closed for up to two months.

Habitats important to waterfowl and coastal water birds, including shorebirds, wading birds, and seabirds, were also impacted by Hurricane Sandy. High winds and storm-driven water moved masses of coastal sediments, changed barrier landscapes, and breached dikes on impoundments managed specifically for migratory birds.

Study Area Opportunities

Prior to Hurricane Sandy, the Corps was undertaking a Reformulation effort to identify a long-term solution for the study area. These CSRM efforts focused on Atlantic Ocean Shoreline features with the State of New York as the local sponsor. Awareness of the need for an integrated approach to CSRM opportunities in Jamaica Bay and surrounding communities has increased since Hurricane Sandy impacted the area in 2012, and an integrated approach is presented through the combination of this Revised Draft HSGRR/EIS and the NYNJHATs study. As a result of the devastation associated with Hurricane Sandy, the USACE has been tasked to address "coastal resiliency" and "long-term sustainability" in addition to the traditional USACE planning report categories of "economics, risk, and environmental compliance" (USACE 2013).

3 *New York Times*, 17 November 2012.

4 Substantial damage to a structure occurs when the total cost of repair is 50 percent or more of the structure's market value prior to a storm event.

5 Storm surge is an abnormal rise of water generated by a storm, over and above the predicted astronomical tides. Storm surge should not be confused with storm tide, which is defined as the water level rise due to the combination of storm surge and the astronomical tide. (NOAA 2018, accessed at https://www.nhc.noaa.gov/surge/)

The goal of the Revised Draft HSGRR/EIS is to identify and develop solutions that will reduce vulnerability to the Atlantic Ocean Shoreline and Jamaica Bay system to storm damage over time, in a way that is sustainable over the long-term.

Study Objectives

Five principal planning objectives were identified for the study, based upon a collaborative planning approach. These planning objectives are intended to be achieved throughout the 50-year period of analysis, which is from 2020 to 2070:

1. Reduce vulnerability to coastal storm risks;
2. Reduce future coastal storm risks 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 coastal storm events; and
5. Improve coastal resilience by reducing erosion and risk caused frequent flooding through the enhancement of natural storm surge buffers, also known as natural and nature-based features (NNBFs).

Project Constraints

A portion of the study area falls within the boundary of Gateway National Recreation Area, Jamaica Bay. The enabling legislation for the NPS Gateway National Recreation Area requires that any plan for CSRM within park boundaries be mutually acceptable to the Secretary of the Army and the Secretary of the Interior. This report includes project features along the Atlantic Shorefront that are located within the park boundaries, but plans have not been eliminated based upon this constraint. USACE and the NPS intend to use the public and agency review of this report, and the subsequent design efforts in order to establish a plan that meets the requirement as a mutually acceptable plan.

Future Without Project Conditions

The future without project condition (FWOP) is the projection of the likely future conditions in the study area in the absence of any action resulting from the current study effort documented in this Revised Draft HSGRR/EIS. The FWOP is the baseline for the analysis and comparison of alternatives developed for this study. The FWOP for this study includes the following assumptions.

- Maintenance dredging of the existing federal navigation channels at East Rockaway Inlet and Rockaway Inlet (Jamaica Bay Channel) are expected to continue as authorized.
- The existing federal project from Beach 19th street to Beach 149th, which was repaired to design conditions following Hurricane Sandy, would not be renourished in the future as a federal project, since there is no current approval for renourishment.
- New York City would undertake small-scale sand placement projects if the beach erodes to where existing infrastructure is imminently threatened.

The FWOP was evaluated to identify the expected damages that are likely to occur in the absence of a project. This analysis was undertaken considering an intermediate rate of relative sea level rise in the future (approximately 1 ft. over 50 years, from 2020 to 2070). This analysis shows that there is a potential for significant damages along the Atlantic shorefront and in Jamaica Bay. A summary of these damages is provided in Table ES-1 below.

Table ES-1
Without-Project Condition Equivalent Annual Damages ($)

Atlantic Ocean Shorefront Planning Reach	18,512,000
Jamaica Bay Planning Reach (Cross-Shore Flooding)	27,384,000
Jamaica Bay Planning Reach (Jamaica Bay Flooding)	149,162,000
Total Annual Damages	**195,058,000**

Alternative Plan Development

An array of structural and nonstructural management measures, including NNBFs, were developed to address one or more of the planning objectives. 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.

Since the problems and opportunities vary across the study area, alternatives were formulated for two separate planning reaches in order to identify the most efficient solution for each reach. The two planning reaches are the Atlantic Ocean Shoreline Reach, and the Jamaica Bay Reach.

Atlantic Ocean Shorefront Planning Reach

The Atlantic Ocean Shorefront Planning Reach is subject to inundation, erosion, wave attack, and overtopping along the Rockaway peninsula. Several iterations of plan formulation were undertaken for the shorefront reach, including an initial screening of measures to identify the subset of measures that should be considered in the development of alternatives. Following the initial measures screening, the approach to alternative development was to evaluate features that optimize life-cycle costs in combination with a single beach and dune template in order to select the most cost effective renourishment approach. Once the most efficient lifecycle management plan was selected, different combinations of beach, dune and reinforced dune cross-sections were evaluated to identify the most economically efficient plan, considering the level of risk reduction afforded and the lifecycle costs.

The most cost efficient alternative life-cycle management approach for the Atlantic Ocean Shorefront Planning Reach is beach restoration with renourishment, five groin extensions and the addition of 13 new groins. This alternative would provide the lowest annualized costs over the 50-year project life and the lowest renourishment costs over the project life - renourishment material would be sourced from a borrow area approximately two miles offshore, south of the Rockaway peninsula. Renourishment also provides recreation benefits to beach users, which are included in the economic evaluation of the Atlantic Ocean Shorefront Planning Reach alternatives.

After the most cost-effective life-cycle approach was identified, the dimensions of the Atlantic Shorefront component were optimized to evaluate the level of CSRM provided by a range of dune and berm dimensions and by reinforced dunes. A composite seawall in combination with beachfill and groin features was selected as the most efficient CSRM alternative. This plan reduces risks for erosion and wave attack and also limits storm surge inundation and cross-peninsula flooding. The seawall crest elevation is +17 feet NAVD88 (North American Vertical Datum of 1988), the dune elevation is +18 feet NAVD88, and the design berm width is 60 feet at an elevation of +8 feet NAVD88. Armor stone prescribed for the composite seawall significantly reduces wave breaking pressure, which allows smaller steel sheet pile walls to be used in the design since the face of the wall would be completely protected by armor stone. The composite seawall may be adapted in the future to rising sea levels by adding one layer of armor stone and extending the concrete cap up to the elevation of the armor stone.

Jamaica Bay Planning Reach: Comprehensive Plans

The communities surrounding and within Jamaica Bay are subject to storm surges that amass in Jamaica Bay by entering through Rockaway Inlet and by overtopping and flowing across the Rockaway Peninsula (the Atlantic Ocean Shorefront Planning Reach) and across Coney Island. Preliminary screening of comprehensive alternative plans for the Jamaica Bay Planning Reach in the Draft HSGRR/EIS resulted in a final array of two alternatives: a Jamaica Bay Perimeter Plan and a Storm Surge Barrier Plan. Both plans would tie into the plan features for the Atlantic Ocean Shoreline Planning Reach.

Perimeter Plan. The Perimeter Plan would create a 44 mile contiguous barrier of levees, floodwalls, and closures along the Jamaica Bay interior, with the exception of JFK Airport (JFK Airport already has infrastructure providing CSRM). The community at Broad Channel, which is effectively within Jamaica Bay - as opposed to being a community on the fringe of Jamaica Bay - would not benefit from the Perimeter Plan, as site-specific features for Broad Channel were not cost-effective and eliminated from further consideration in the initial screening. The Jamaica Bay Perimeter Plan would require 13 tributary flood gates, and five roadway flood gates. Additionally a railroad floodgate would be required at 104th Street for the Long Island Railroad.

Storm Surge Barrier Plan. The Storm Surge Barrier Plan would include a hurricane barrier across Rockaway Inlet and tie into CSRM at the Atlantic Ocean Shorefront Planning Reach. Three alternative alignments of the Storm Surge Barrier Plan were evaluated on the basis of construction, real estate, mitigation, and Operation, Maintenance, Repair, Reconstruction, & Replacement (OMRR&R) costs, and net benefits. The Storm Surge Barrier Plan selected for comparison to the Perimeter Plan included an inlet barrier 3,930 feet in length, over 28,000 linear feet of concrete floodwalls, 4,900 linear feet of levee, two sector gates, and elevated promenades.

The Draft HSGRR/EIS evaluation demonstrated that the Perimeter Plan and the Storm Surge Barrier Plan were both economically justified. The evaluation determined that the Storm Surge Barrier Plan would provide more net benefits at a lower total cost, and was selected as an element of the TSP.

As described above (under the heading of Draft HSGRR/EIS), the result of the ADM was to move all further evaluation of the proposed storm surge barrier element of the TSP to the

NYNJHATs Feasibility Study. Going forward, the Recommended Plan documented in this Revised Draft HSGRR/EIS does not represent a comprehensive approach to providing CSRM solutions for the Jamaica Bay Planning Reach – a full comprehensive approach is deferred until completion of the NYNJHATs Feasibility Study.

Jamaica Bay Planning Reach: High Frequency Flooding Risk Reduction Features

Low lying coastal neighborhood areas within Jamaica Bay were identified as areas where High Frequency Flooding Risk Reduction Features (HFFRRFs) could be implemented. The Phase 1 preliminary screening and subsequent feasibility design and analysis was performed only on the areas identified as potentially having large concentrations of vulnerable homes where stand-alone projects which tie into adjacent high ground could be built.

Other parts of the Jamaica Bay shoreline that are subject to flooding were not included; such areas are characterized by natural or undeveloped areas or isolated structures. Inclusion of HFFRRF projects for such locations would garner minimal reduction to the overall flood risk within Jamaica Bay and as such only marginally contribute to the overall objective of the project. Examples of such exclusions, amongst others, are geographically much smaller areas with very few assets at risk, undeveloped urban lots adjacent to Jamaica Bay, isolated developed but privately-owned lots with one single owner, and natural shorelines and parklands.

Areas for study were identified, analyzed, and screened for feasibility. A general grouping of viable low lying coastal neighborhoods was completed, and the following six general areas were identified where HFFRRFs could be implemented:

1. Bayside of the Rockaways, which includes the Hammels, Arverne, and Edgemere neighborhoods,
2. Motts Basin, Norton Basin and the Inwood Marina Area,
3. Head of Bay and the adjoining Nassau County watershed, including Cedarhurst-Lawrence, and Meadowmere,
4. Old Howard Beach,
5. Canarsie, and
6. Broad Channel.

Within the six areas listed above, a total of twenty-three HFFRRFs were delineated and designed for economic screening. Three HFFRRFs passed economic screening and were included in the Recommended Plan. These manage risk from frequent floods along the bayside of the Rockaways in New York City, in the Village of Cedarhurst in Nassau County, and at Motts Basin North in the Town of Hempstead in Nassau County.

Recommended Plan

The Recommended Plan documented in this Revised Draft HSGRR/EIS is comprised of a shorefront component and three separate HFFRRF projects: 1) Mid-Rockaway, 2) Cedarhurst-Lawrence, and 3) Motts Basin North. The Mid-Rockaway HFFRRF is the largest and stretches across three neighborhoods/subreaches - Hammels, Edgemere, and Arverne. An overview of the project locations is provided in Figure ES-2 in order to provide a geographic reference for each of the project components.

Figure ES-2: Recommended Plan Geographic Overview

Recommended Plan: Atlantic Shorefront Component

Analyses support the recommendation for a composite seawall and associated beach restoration with increased renourishment at the Atlantic Ocean shorefront. The structure crest elevation is +17 feet NAVD88, the dune elevation is +18 feet NAVD88, and the design berm width is 60 feet at an elevation of +8 feet NAVD88. The Atlantic Ocean Shorefront component of the Recommended Plan consists of:

- A reinforced dune (composite seawall) with a structure crest elevation of +17 feet NAVD88 and dune elevation of +18 feet NAVD88, and a design berm width of 60 feet extending approximately 35,000 linear feet (LF) from Beach 9th Street to Beach 149th Street. The bottom of dune reinforcement extends up to 15 feet below the dune crest.
- A beach berm elevation of +8 ft. NAVD88 and a depth of closure of -25 ft. NAVD88;
- A total beach fill quantity of approximately 1.6 million cy for the initial placement, including tolerance, overfill and advanced nourishment[6] with a 4-year renourishment cycle of approximately 1,021,000 cy, resulting in an advance berm width[7] of 60 feet;
- Obtaining sand from borrow area located approximately 2 miles south of the Rockaway Peninsula and about 6 miles east of the Rockaway Inlet. It is about 2.6 miles long, and 1.1 miles wide, with depths of 36 to 58 feet and contains approximately 17 million cy of suitable beach fill material, which exceeds the required initial fill and all periodic renourishment fill operations.
- Extension of 5 existing groins; and new construction of 13 new groins.

Economic data for the Atlantic Shorefront component is provided below in Table ES-2. Investment costs include project first costs with contingencies plus interest during construction. Annualized costs include annualized investment costs plus annual operations and maintenance costs. An overview of the Atlantic Shorefront component is shown on Figure ES-3, with additional detail shown on Figures ES-4a through ES-4d.

Table ES-2
Atlantic Shorefront Component – Economic Metrics

Initial Investment ($)	Annualized Cost ($)	Annual Benefits ($)	BCR	Net Benefits ($)
285,064,000	19,544,000	62,828,000	3.2	43,284,000

6 Initial fill quantities were estimated shortly after the USACE placed 3.5 million cubic yards of sand on Rockaway beach from Beach 19th Street to Beach 149th as an emergency repair project after Hurricane Sandy in 2014. The initial estimate was 804,000 cubic yards in 2016, which has been updated for the Revised Draft HSGRR/EIS due to continued erosion of the beach and to include the sand required for the tapers on either end of the Atlantic Shorefront reach. The initial beachfill volumes will be reevaluated at the start of the Pre-Construction Engineering and Design Phase based on new surveys of the condition of the beach

7 Advance berm width is the additional berm width required for advance fill. The advance fill is the expected losses between initial construction and the 1st renourishment operation.

Figure ES-3: Atlantic Shorefront Component of the Recommended Plan - Overview

Figure ES-4a: Atlantic Shorefront Component of Recommended Plan (1 of 4)

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

Figure ES-4c: Atlantic Shorefront Component of Recommended Plan (3 of 4)

Figure ES-4d: Atlantic Shorefront Component of Recommended Plan (4 of 4)

High Frequency Flooding Risk Reduction Measures

The Recommended Plan includes solutions to address high frequency flooding risks for communities vulnerable to high frequency events. A wide range of high frequency flooding risk reduction measures (HFFRRFs) were evaluated, and are included in the project costs, with three separate projects identified for the Recommended Plan:

- Cedarhurst-Lawrence;
- Motts Basin North; and
- Mid-Rockaway.

Economic data for each of the HFFRRF projects is provided below in Table ES-3, followed by a description of each of the projects. Investment costs include project first costs with contingencies plus interest during construction. Annualized costs include annualized investment costs plus annual operations and maintenance costs.

Table ES-3
HFFRRF Projects – Economic Metrics

HFFRRF Project	Investment Cost ($)	Annualized Cost ($)	Annual Benefits ($)	BCR	Net Benefits ($)
Cedarhurst-Lawrence	15,790,000	669,000	5,154,000	7.7	4,485,000
Motts Basin North	3,160,000	134,000	140,000	1.0	6,000
Mid-Rockaway	222,508,000	9,376,000	11,875,000	1.3	2,499,000

Cedarhurst-Lawrence

The Cedarhurst-Lawrence project (Figure ES-5) begins on the east side of the channel near the driveway to Lawrence High School. It consists of approximately 1,000 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, and have been set at an elevation of +10.0 ft NAVD88.

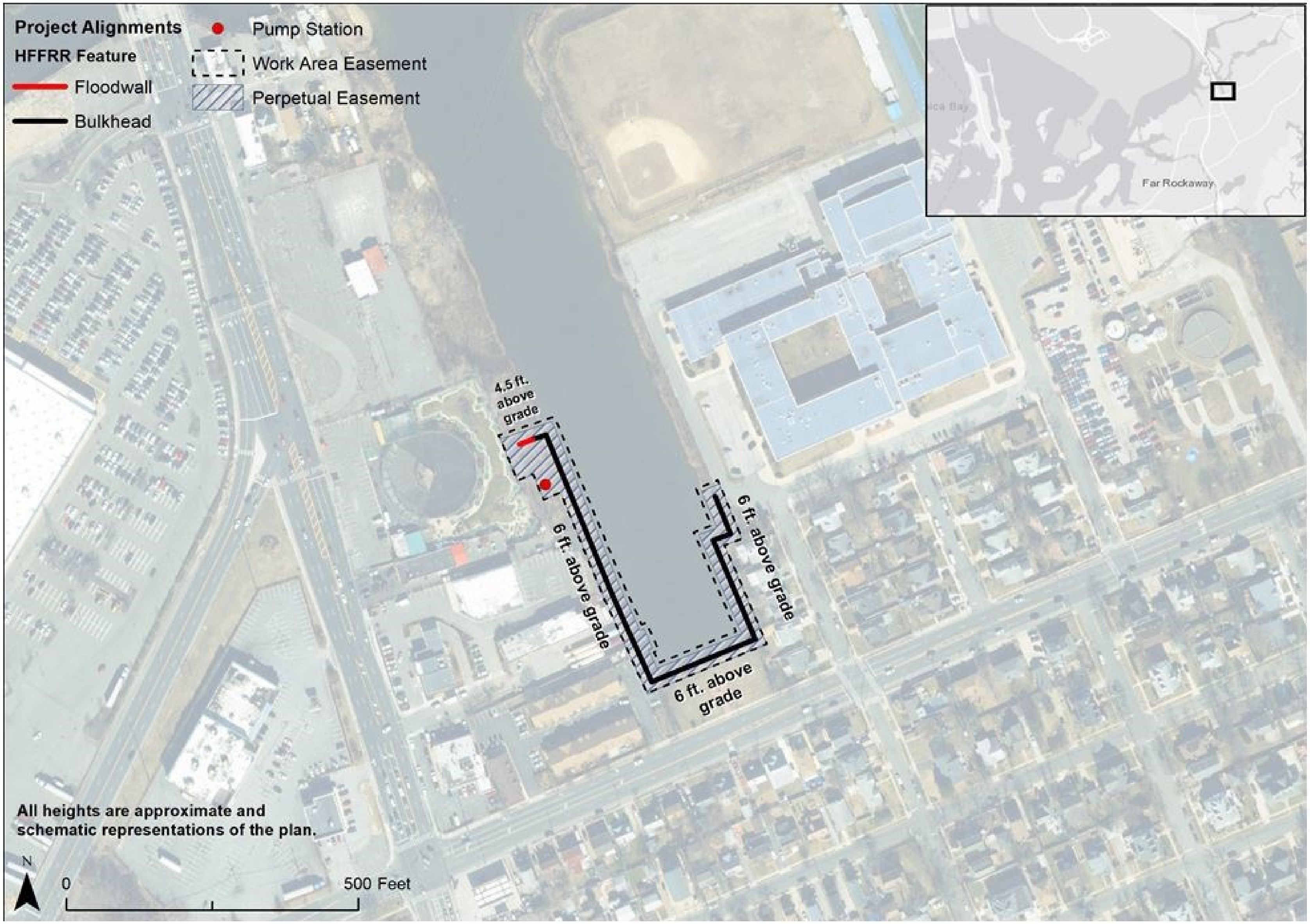

Figure ES-5: Cedarhurst-Lawrence HFFRRF Project Plan

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 cfs, which will be refined during the design phase.

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 ES-6). 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 NAVD88.

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.

Mid-Rockaway - Edgemere Area

The eastern end of the project area (Figure ES-7) begins at high ground near the intersection of Beach Channel Drive and Beach 35th Street. The project alignment proceeds north and then west following and 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 placed as far landward as possible and weaves in and out between properties so as to ensure structural protection is provided to occupied properties while wetland impacts are minimized. The hybrid berm is strategically used at these locations to minimize and avoid impacts to existing healthy wetland habitats.

This area also has been identified as a suitable 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 (smooth cordgrass) 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.

Figure ES-6: Motts Basin North HFFRRF Project Plan

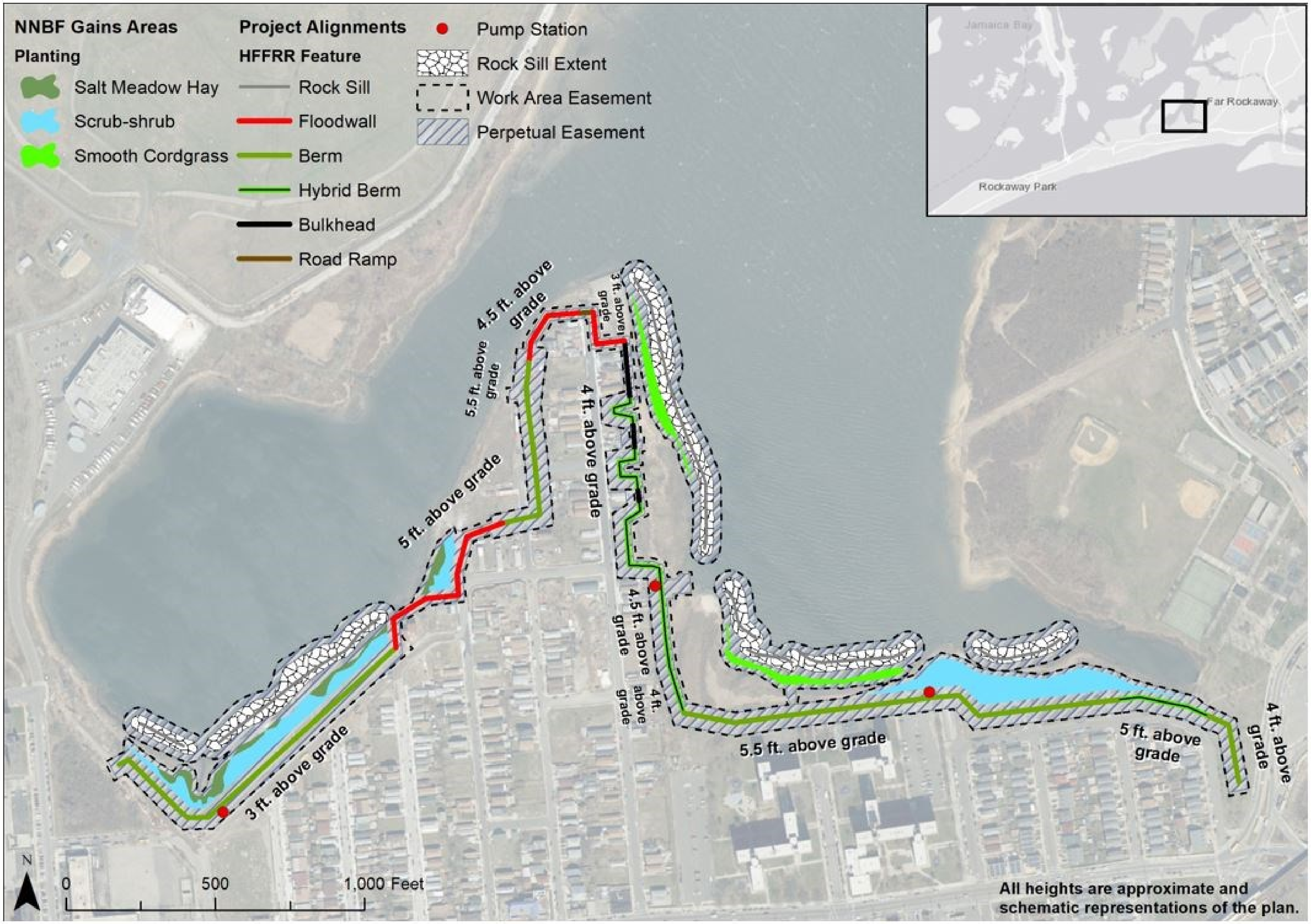

Figure ES-7: Mid-Rockaway - Edgemere Area HFFRRF Project Plan

On the north east of the Edgemere peninsula the project transitions into 200 feet of shallow bulkhead, which continues north along existing water front properties and bulkheads. Approximately 200 feet of medium elevation floodwall then turns 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 suitable 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 +9.5ft 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 nine outlets, which includes two existing outlets. Subbasin E2 was estimated to require six outlets, including one 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. 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 would be required 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 approximately 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.

Mid-Rockaway - Arverne Area

This area of the project (Figure ES-8) 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 alignment of the berm has been placed as far landward as possible to avoid healthy habitat. This segment has been identified as a candidate for the use of NNBFs. Much of

Figure ES-8: Mid-Rockaway - Arverne Area HFFRRF Project Plan

the area is identified as existing quality wetlands, but a portion of fill area has been identified where intermediate marsh (Salt meadow Hay) would 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 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 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 suitable candidate for NNBF. Based on existing elevations and profiles, a combination of either fill or excavation would be used to provide the appropriate elevations shoreward of the rock sills to maximize healthy subtidal habitats, with restoration of a transition area for low to high intertidal marsh. Eroded shorelines would be replaced with low intertidal (smooth cordgrass) habitats, and transition to either intermediate (salt meadow hay) 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 project footprint. The berm section has been positioned close to the roads to minimize impacts on habitat.

The berm section transitions into a high floodwall which runs 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 plantings of 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, and 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 connects 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 NAVD88 and +11.5ft NAVD88.

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 eight outfalls, including five existing outfalls. Subbasin A2 was estimated to require three outlets. Subbasin A3 was estimated to require five outlets, including three 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. 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 Street with an estimated capacity of 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.

Mid-Rockaway – Hammels Area

Two separate segments compose the Hammels area of the Mid-Rockaway project (Figure ES-9). 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 Hamels Wye adjacent to the Rockaway Line. The alignment heads west and

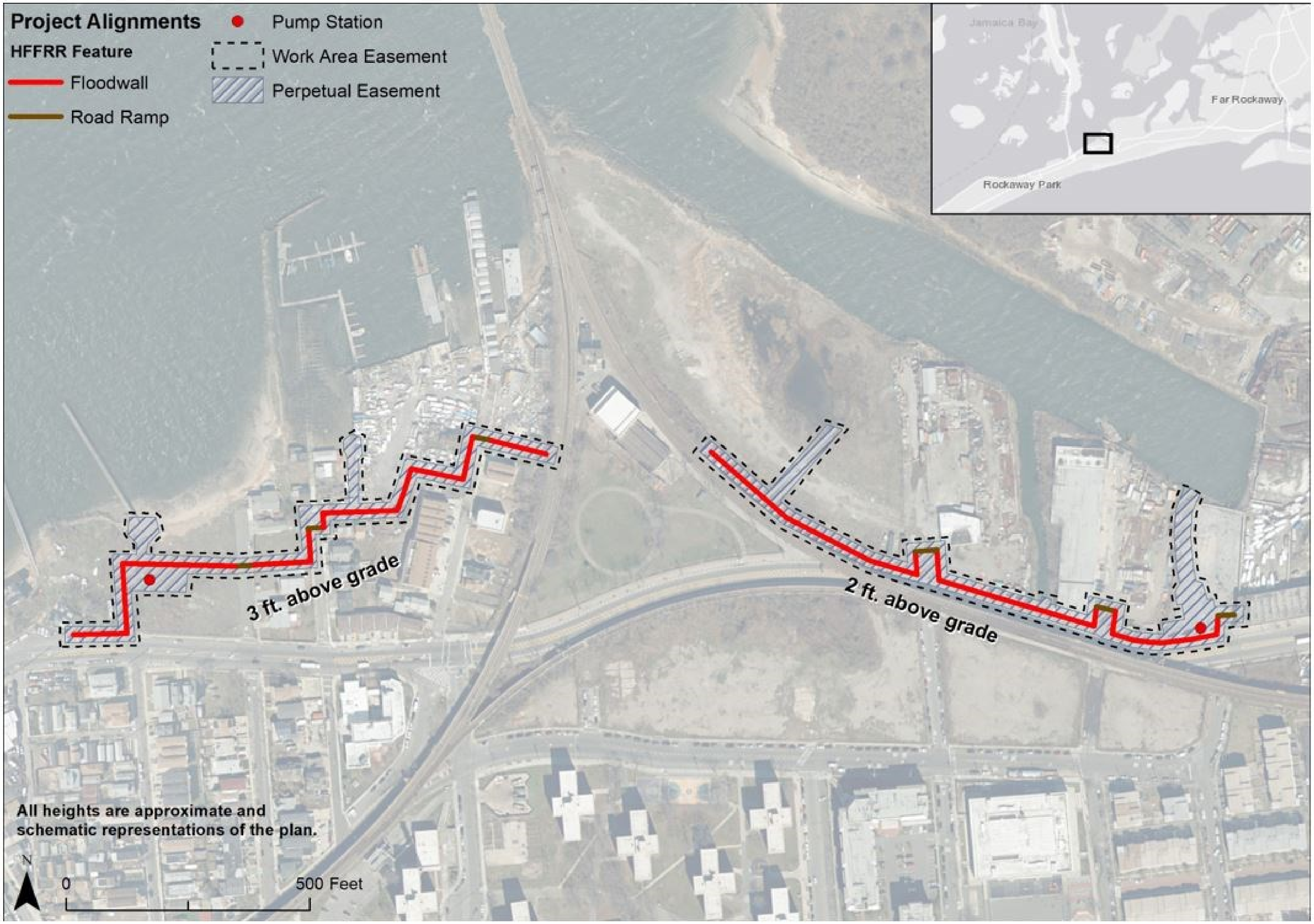

Figure ES-9: Mid-Rockaway - Hammels Area HFFRRF Project Plan

south in a stair-step fashion to avoid impacts to 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 three outlets, which include two 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. 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 estimated at 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.

PERTINENT DATA

DESCRIPTION: The Recommended Plan developed in this report provides CSRM for an Atlantic Shorefront reach and five neighborhoods through high frequency flood risk reduction measures (HFFRRFs)

LOCATION: 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

PROJECT DESIGN DATA

Atlantic Shorefront Element

Length of Composite Seawall	33,550 FT
Volume of Beach and Dune (Design fill only)	1,365,000 CY
Width of Dune at Crest	25 FT
Width of Berm	60 FT
Elevation of Dune (NAVD88)	18 FT
Elevation of Composite Seawall (NAVD88)	17 FT
Elevation of Beach Berm (NAVD88)	8 FT
Groin Extensions (existing groins)	5
Groin Construction (new groins)	13
Dune Slopes	
Landward	1V:3H
Seaward	1V:5H
Beach Berm Slope	1V:15H
Renourishment - every 4 years	1,021,000 CY
Total Initial Fill Beach and Dune (design, advance, overfill and tolerance	1,596,000 CY

Cedarhurst-Lawrence HFFRRFs

		Total Length (linear feet)	Average Elevation (NAVD88)	Height Above Grade (feet)
Bulkheads				
Deep Bulkhead		963	10.0	4.0
Floodwalls				
Medium Floodwall		23	10.0	3.0
Interior Drainage				
Additional outfalls	1			
Pump Station Capacity (cfs)	40			

Motts Basin North HFFRRFs

		Total Length (linear feet)	Average Elevation (NAVD88)	Height Above Grade (feet)
Floodwalls				
Low Floodwall		641	8.0	2.0
Medium Floodwall		47	8.0	2.0
Interior Drainage				
Additional outfalls	0			

Mid-Rockaway HFFRRFs

Edgemere Area

		Total Length (linear feet)	Average Elevation (NAVD88)	Height Above Grade (feet)
Berms				
Low Berm		1,509	8.0	2.5
Medium Berm		2,064	10.0	3.3
High Berm		81	12.5	5.5
Hybrid Berm		1,552	9.3	4.4
Bulkheads				
Shallow Bulkhead Urban[8]		192	9.0	4.0
Shallow Bulkhead		125	9.0	4.0
Floodwalls				
Medium Floodwall		478	8.8	3.8
High Floodwall		664	11.5	6.0
Road Ramps		53	8.0	4.0
Rock Sills		2,900	0.0	0.0
Interior Drainage				
Additional Outfalls	12			
Pump Station 1 Capacity (cfs)	210			
Pump Station 2 Capacity (cfs)	120			
NNBF Gains (acres)	2.0			

[8] Bulkheads with design complications resulting from the urban environment are broken out separately as they have a slightly higher cost associated with them.

Mid-Rockaway HFFRRFs
Arverne Area

HFFRRF Elements		Total Length (linear feet)	Average Elevation (NAVD88)	Height Above Grade (feet)
Berms				
Low Berm		2,494	9.1	2.9
Medium Berm		1,142	12.5	5.0
Hybrid Berm		292	8.0	3.0
Bulkheads				
Shallow Bulkhead Urban		893	10.5	4.0
Shallow Bulkhead		1,939	10.6	4.0
Deep Bulkhead		1,121	11.5	4.0
Floodwalls				
Low Floodwall		3,167	8.8	2.4
Medium Floodwall		365	11.5	5.0
High Floodwall		439	11.5	5.5
Revetments		988	10.5	2.8
Road Ramps		111	8.0	2.3
Vehicular Gates		25	8.0	2.0
Rock Sills		5,177	0.0	0.0
Interior Drainage				
Additional Outfalls	8			
Pump Station 1 Capacity (cfs)	70			
Pump Station 2 Capacity (cfs)	180			
Pump Station 3 Capacity (cfs)	300			
NNBF Gains (acres)	7.0			

Mid-Rockaway HFFRRFs
Hammels Area

		Total Length (linear feet)	Average Elevation (NAVD88)	Height Above Grade (feet)
Floodwalls				
Low Floodwall		2,550	8.0	2.3
Road Ramps		218	8.0	2.8
Interior Drainage				
Additional Outfalls	3			
Pump Station 1 Capacity (cfs)	100			
Pump Station 2 Capacity (cfs)	180			

REAL ESTATE REQUIREMENTS

Atlantic Shorefront Element

Required Interest	Required Acres	Public Parcels	Public Owners
Perpetual Beach Storm Damage Reduction Easement	329.25	15	2
Temporary Construction Easement	65.85	15	2

Cedarhurst-Lawrence HFFRRFs

Required Interest	Required Acres	Private Parcels	Public Parcels
Flood Protection Levee Easement	0.85	8	3
Temporary Construction Easement	0.20	8	3

Motts Basin North HFFRRFs

Required Interest	Required Acres	Private Parcels	Private Owners
Flood Protection Levee Easement	0.55	3	3
Temporary Construction Easement	0.30	3	3

Mid-Rockaway HFFRRFs

Required Interest	Required Acres	Private Parcels	Public Parcels
Flood Protection Levee Easement	26.07	182	61
Bank Protection Easement	32.75		
Temporary Construction Easement	11.76	182	61
Fee excluding minerals	3.98	3	6

ECONOMIC DATA

Atlantic Shorefront Element

Initial Investment Cost ($)	285,064,000
Annual Project Cost ($)	19,544,000
Average Annual Benefits ($)	62,828,000
Net Excess Benefits ($)	43,284,000
Benefit to Cost Ratio	3.2

Cedarhurst-Lawrence HFFRRFs

Initial Investment Cost ($)	15,790,000
Annual Project Cost ($)	669,000
Average Annual Benefits ($)	5,154,000
Net Excess Benefits ($)	4,485,000
Benefit to Cost Ratio	7.7

Motts Basin North HFFRRFs

Initial Investment Cost ($)	3,160,000
Annual Project Cost ($)	134,000
Average Annual Benefits ($)	140,000
Net Excess Benefits ($)	6,000
Benefit to Cost Ratio	1.0

Mid-Rockaway HFFRRFs

Initial Investment Cost ($)	222,508,000
Annual Project Cost ($)	9,376,000
Average Annual Benefits ($)	11,875,000
Net Excess Benefits ($)	2,499,000
Benefit to Cost Ratio	1.3

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East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Reformulation Study

Revised Draft General Reevaluation Report and Environmental Impact Statement

1 INTRODUCTION

This report is a Revised Draft Integrated Hurricane Sandy General Reevaluation Report / Environmental Impact Statement (HSGRR/EIS) examining coastal storm risk management (CSRM) problems and opportunities for the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay study area, which was devastated by the impacts of Hurricane Sandy in 2012. Consistent with current U.S. Army Corps of Engineers (USACE) planning guidance, this reformulation identified and screened alternatives to address CSRM, and is presenting a Recommended Plan. This Revised Draft HSGRR/EIS will undergo public review, policy review, and Agency Technical Review (ATR). The USACE study team will respond to review comments, then present a recommended plan and develop a Final HSGRR/EIS.

1.1 Construction Authority & Reformulation Authority

There is a long history of sediment placement in the study area (see Section 1.7: Prior Reports and Existing Projects). After initial construction in 1977 and subsequent beachfill placement along the Rockaway peninsula, a Reformulation was authorized by Congress in 1997 to ensure that the appropriate long-term solution was recommended.

The Reformulation Effort 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 (29 Jan 13), 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, USACE 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, New York project met the definition in the Act as a constructed project. In accordance with the Act, USACE is proceeding with this HSGRR to address resiliency, efficiency, risks, environmental compliance, and long-term sustainability within the study area (USACE, 2013a). The HSGRR effort is 100% federally funded, and the initial construction of project features is 100% federally funded subject to availability of funds.

1.2 Reformulation Purpose and Scope*

Prior to Hurricane Sandy, CSRM efforts focused on Atlantic Ocean Shoreline features with the State of New York through the New York State Department of Environmental Conservation as the non-federal sponsor. Awareness of the need for an integrated approach to CSRM opportunities for the entire study area including the shorefront, Jamaica Bay and surrounding communities has increased since Hurricane Sandy impacted the area in 2012. As a result of the devastation associated with Hurricane Sandy, the USACE has been tasked to address coastal resiliency and long-term sustainability when undertaking this reformulation effort, in addition to the traditional USACE planning report categories of "economics, risk, and environmental compliance (USACE, 2013a)." The goal of this Revised Draft HSGRR/EIS is to identify solutions that will reduce Atlantic Ocean Shoreline and Jamaica Bay vulnerability to storm damage over time, in a way that is sustainable over the long-term, both for the natural coastal ecosystem and for communities.

The relationships and interactions among the natural and built features (e.g., floodwalls, flood gates, etc.) comprising a coastal risk reduction system are important variables determining coastal vulnerability, reliability, risk, and resilience (USACE, 2013b). Improving resilience, which is a key factor in reducing risk, includes improving the ability to anticipate, prepare for, respond to, and adapt to changing conditions and to recover rapidly from disruptions (USACE, 2013c).

Natural Features (NF) are defined as features that are created and/or evolve over time through the actions of physical, biological, geologic, and chemical processes operating in nature. NF in a coastal ecosystem take a variety of forms, including reefs (e.g., coral and oyster), barrier islands, marsh islands, dunes, beaches, wetlands, and maritime forests. Nature-based features (NBF) are defined as those features that may mimic characteristics of natural features but are created by human design, engineering, and construction to provide specific services such as coastal risk reduction. Examples of NBF include constructed wetlands, or a beach and dune system engineered for coastal storm risk management. Consistent with the North Atlantic Coast Comprehensive Study (USACE, 2013b), these features are referred to jointly throughout this study. NNBFs (natural and nature-based features) are commonly combined to implement the concept of a "living shoreline".

1.3 Non-Federal Sponsor

New York State, through the New York State Department of Environmental Conservation, is the non-federal partner. New York City (NYC), through the NYC Mayor's Office of Recovery and Resiliency, is the local sponsor to New York State. The non-Federal sponsor and the local sponsor support the Recommended Plan and moving forward with Plans & Specifications and

Construction. Other project partners include the NYC Department of Parks and Recreation and NYC Department of Environmental Protection. The National Park Service, Gateway National Recreation Area (NPS) is a consulting party under Section 106 of the National Historic Preservation Act.

1.4 Study Area

The study area consists of the Atlantic Coast of NYC between East Rockaway Inlet and Rockaway Inlet, and the water and lands within and surrounding Jamaica Bay, New York – unchanged from the Draft HSGRR/EIS (Figure 1-1). The study area also includes the low lying Coney Island section of Brooklyn, which can be overtopped by floodwaters that flood the Brooklyn neighborhoods surrounding Jamaica Bay. The coastal area, which is approximately 10 miles in length, is a peninsula located entirely within the Borough of Queens, NYC. This peninsula, generally referred to as the Rockaways, 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, NYC, and a section at the eastern end, known as Head of Bay, lies in Nassau County.

Effective CSRM requires that risk management measures reduce flood risk from inundation at Jamaica Bay and the Rockaway peninsula and also reduce flood risk and the effects of erosion and wave attack along the Atlantic shorefront of the Rockaway peninsula. Reducing flood risk from inundation at Jamaica Bay cannot be fully effective without also reducing flood risk at the Atlantic shorefront on the Rockaway peninsula because flood waters would be able to inundate low lying areas of the Jamaica Bay side of the Rockaway peninsula, if the Atlantic shorefront risk reduction component were not in place. Similarly, risk management measures in Jamaica Bay also require that risk reduction measures address the flood water crossing the Coney Island beach, and flanking the Jamaica Bay risk reduction measures from as far west as Coney Island Creek.

Since the problems and opportunities vary across the study area, alternatives have been formulated considering two planning reaches, to identify the most efficient solution for each reach. The two planning reaches are the Atlantic Ocean Shoreline Reach (Rockaway Peninsula), and the Jamaica Bay Reach. Integrating CSRM alternatives for the two reaches provides the most economically efficient system-wide solution for the vulnerable communities within the study area.

Much of the study area is located within portions of the Gateway National Recreation Area (GNRA), which includes the Jamaica Bay Wildlife Refuge. Both GNRA and the wildlife refuge are operated by the National Park Service (NPS). The portion of any CSRM plan that falls within GNRA boundaries should be mutually acceptable to NPS (U. S. Department of the Interior) and USACE.

Figure 1-1: Study Area Overview - Rockaway Peninsula and Jamaica Bay

1.4.1 Rockaway Peninsula

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 NAVD88[9], except within the existing dune field. Elevations along the Jamaica Bay shoreline side of the peninsula generally range from +5 feet NAVD88, increasing to +10 feet NAVD88 further south toward the Atlantic coast. An estimated 7,900 residential and commercial structures on the peninsula fall within the FEMA regulated 1% Annual Exceedance Probability (AEP)[10] floodplain, commonly referred to as the 100-year floodplain. Nearly the entire peninsula falls within the regulated 100-year floodplain.

The Atlantic Ocean Shorefront Planning Reach along the Rockaway Peninsula is segmented into six reaches for the purpose of this analysis. Each reach is delineated based upon site-specific physical, economic, and institutional differences. Considerations include hydrodynamic differences, coastal features, sediment transport boundaries, shoreline stability, existing projects, and development patterns. Reach designations help characterize the problems, needs, and opportunities and to identify alternatives viable for each reach. It should be noted that segmentation of the Atlantic Ocean Shorefront Planning Reach into reaches does not imply separable projects or construction areas.

The six Atlantic Ocean shorefront reaches (Figure 1-2) include:

- Reach 1: Rockaway Point to Beach 193rd Street;
- Reach 2: Beach 193rd Street to Beach 149th Street;
- Reach 3: Beach 149th Street to Beach 109th Street;
- Reach 4: Beach 109th Street to Beach 86th Street;
- Reach 5: Beach 86th Street to Beach 42nd Street; and
- Reach 6: Beach 42nd Street to Beach 9th Street.

The Rockaway peninsula east of Beach 9th Street along and north of the East Rockaway Inlet is a densely populated neighborhood that experiences flood risk from both Jamaica Bay through East Rockaway Inlet and the wetlands to the north which adjoin Seagirt Avenue, sometimes referred to as Bridge Creek. This creek is part of the Nassau County back bays and these flooding mechanisms are unique to the study area. It is recognized that a solution on the Atlantic Shorefront alone would not provide a comprehensive plan for managing flood risk in this area. Potential projects that could manage flood risk in this area are currently under investigation as part of the ongoing USACE Nassau County Back Bay CSRM Study

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[9] North American Vertical Datum of 1988 (NAVD88).
[10] AEP denotes the probability in any given year that a flood of this magnitude would occur.

Figure 1-2: Atlantic Shorefront Economic Reaches

1.4.1 Jamaica Bay

Jamaica Bay is the largest estuarine waterbody in the NYC metropolitan area covering 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 Jamaica Bay is approximately 13 feet with maximum depths of 60 feet in the deepest historical borrow pits. Federal navigation channels within Jamaica Bay are authorized to a depth of 20 feet. Jamaica Bay has a typical tidal range of five to six feet. The portions of NYC and Nassau County surrounding the waters of Jamaica Bay are urbanized, densely populated, and very susceptible to flooding. Over 46,000 residential and non-residential structures lie within the FEMA regulated 1% AEP Jamaica Bay floodplain.

In order to develop alternative plans and to evaluate the risk reduction provided by those plans, Jamaica Bay was segmented into six economic reaches that are defined by a common inundation elevation and existing community designations (Figure 1-3). For the development and preliminary screening of alternatives, each economic reach was defined as an area (*i.e.,* a GIS polygon) which would be inundated at a stillwater elevation of +11 feet NAVD88. Eleven feet is generally equivalent to the stillwater elevation for a storm event with one percent probability of annual occurrence in 2070 (including the intermediate rate of expected sea level rise).

Six reaches define the Jamaica Bay Planning Reach because much of the shoreline and adjacent uplands that surround Jamaica Bay are low-elevation permeated with numerous basins, tidal creeks, and inlets, which provide little proximate access to areas of high ground. Configuring the reaches defined by a common inundation elevation resulted in six separable reaches. Individual plans were developed for each of the six reaches. Structures within low-lying areas shoreward of the adjacent uplands were assigned to these distinct reaches so that coastal storm damages may be estimated for each reach.

JFK Airport was not included within any of the economic reaches for which stand-alone alternatives were developed. Federal Aviation Administration regulations preclude the construction of barriers (e.g., floodwalls and levees) on airport property, which renders any alternative to directly protect the airport infeasible on an institutional basis. In addition, the airport is on relatively high ground[11], and nonstructural solutions may be a more appropriate solution for any flooding problems. Nevertheless, the Port Authority of New York and New Jersey has been and will continue to be consulted throughout the plan formulation process.

1.5 Project Datum

All elevations referred to in this report, unless specifically noted otherwise, are based on the North American Vertical Datum of 1988 (NAVD88). All depths used in this report are at Mean Lower Low Water (MLLW) datum unless otherwise specified. The difference between MLLW and NAVD88 in Jamaica Bay is approximately 3.0 ft.

11 JFK Airport is located above the FEMA 100-year flood level.

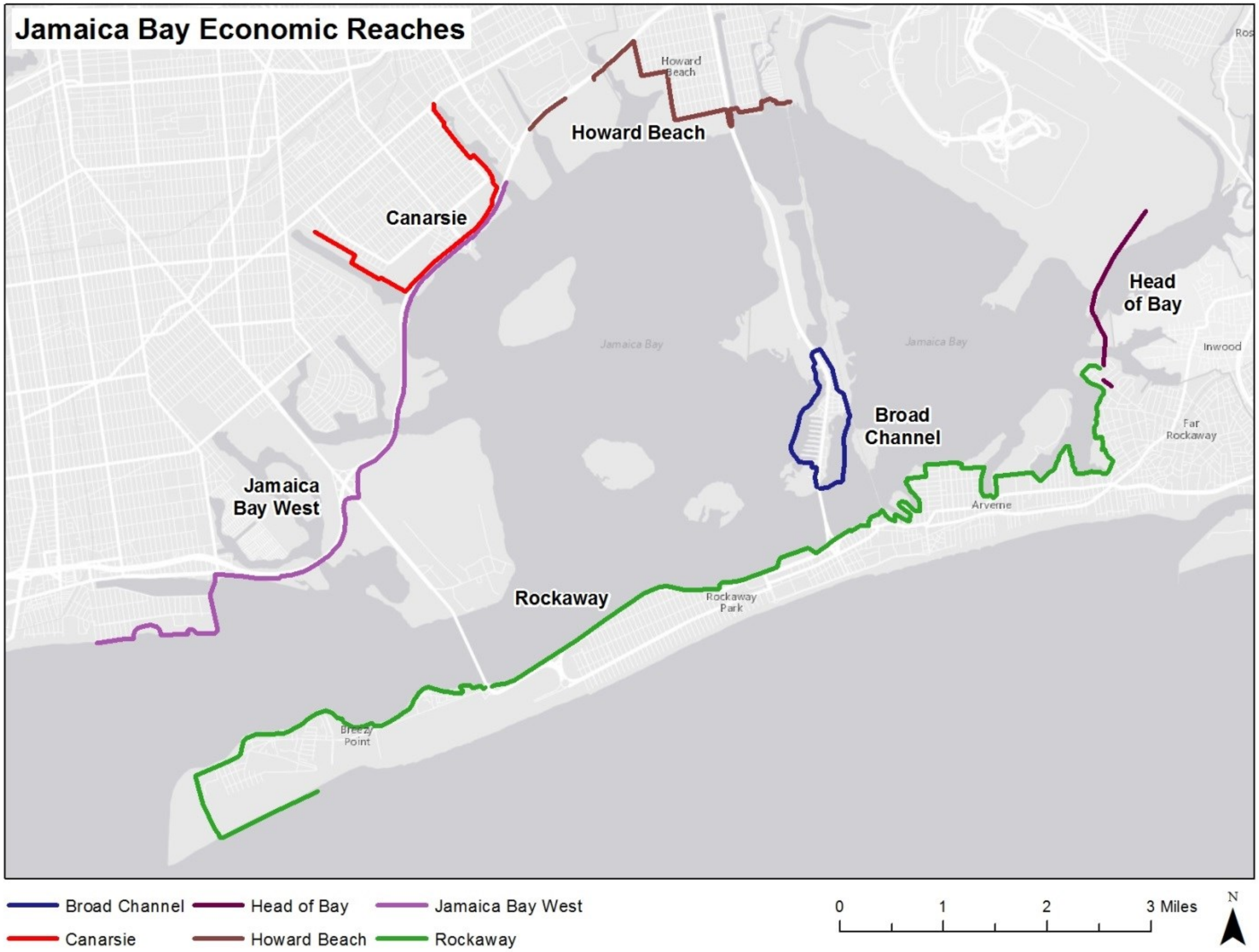


Figure 1-3: Jamaica Bay Economic Reaches

1.6 Major Historical Surge Events in the Study Area

Frequent and severe damage from tidal inundation, erosion, and wave attack at the Atlantic Ocean Shorefront Planning Reach and inundation at the Jamaica Bay Planning Reach has long been identified as a problem for the study area (USACE, 1964). Historical flood impacts include evacuations during times of flood and extensive property damage in communities along the low-lying areas throughout the study area (USACE, 1993). The entire study area, with the exception of JFK Airport, is designated as either Evacuation Zone 1 or Evacuation Zone 2, the most at-risk zones, by NYC Emergency Management (NYCEM, 2014). In response to the long history of storm damage in the study area and a particularly severe storm in 1962, a USACE Cooperative Beach Erosion Control and Hurricane Study recommended construction of a Hurricane Barrier and associated floodwalls and closures to be constructed at Rockaway Inlet (USACE, 1964). Although the Hurricane Barrier was never constructed, erosion control recommendations, consisting of beachfill along the Atlantic Ocean Shorefront Reach were implemented.

Coastal storm surges in the study area occur from hurricanes, tropical storms, and extratropical storms known as "nor'easters". High tide combined with storm surge and wind speed increases flooding (NPS, 2014). There are no long-term historical tide gauge data for the study area, however; 23 major storms have been identified as impacting the NYC region since 1815 with impacts including fatalities, widespread structural damage, and the obliteration and removal of Hog Island from offshore of the Rockaway coast (Weather2000, 2014).

Table 1-1 shows historical extreme tide gauge readings for The Battery on Manhattan Island in New York Harbor. Although there are no data identifying the areas of inundation in the study area associated with most of the storm events identified in Figure 1-4, one reference point is the inundation that occurred during Hurricane Sandy (October 2012), which is associated with a tide gauge reading of 13.986 feet above MLLW at the Battery. Acknowledging that associating tide gauge readings at the Battery with inundation at study area is an approximation at best, Figure 1-5 presents approximate study area inundation based on two foot increments in tide gauge height at the Battery from 6 feet above MLLW (3 ft above NAVD88) to 14.0 feet above MLLW (11 ft above NAVD88).

Table 1-1: Gauge 8518750, The Battery, New York Extreme Tide Gauge Heights

Event	Feet above MLLW
Sep 1938	7.6
Sep 1944	7.9
Nov 1950	8.8
Nov 1953	9.3
Feb 1960	8.0
Sep 1960	10.0
Mar 1962	8.9
Oct 1991	8.7
Dec 1992	9.7
Aug 2010	8.8
Apr 2011	8.1
Aug 2011	9.4
Oct 2012	14.0

Source: http://tidesandcurrents.noaa.gov/est/est_station.shtml?stnid=8518750

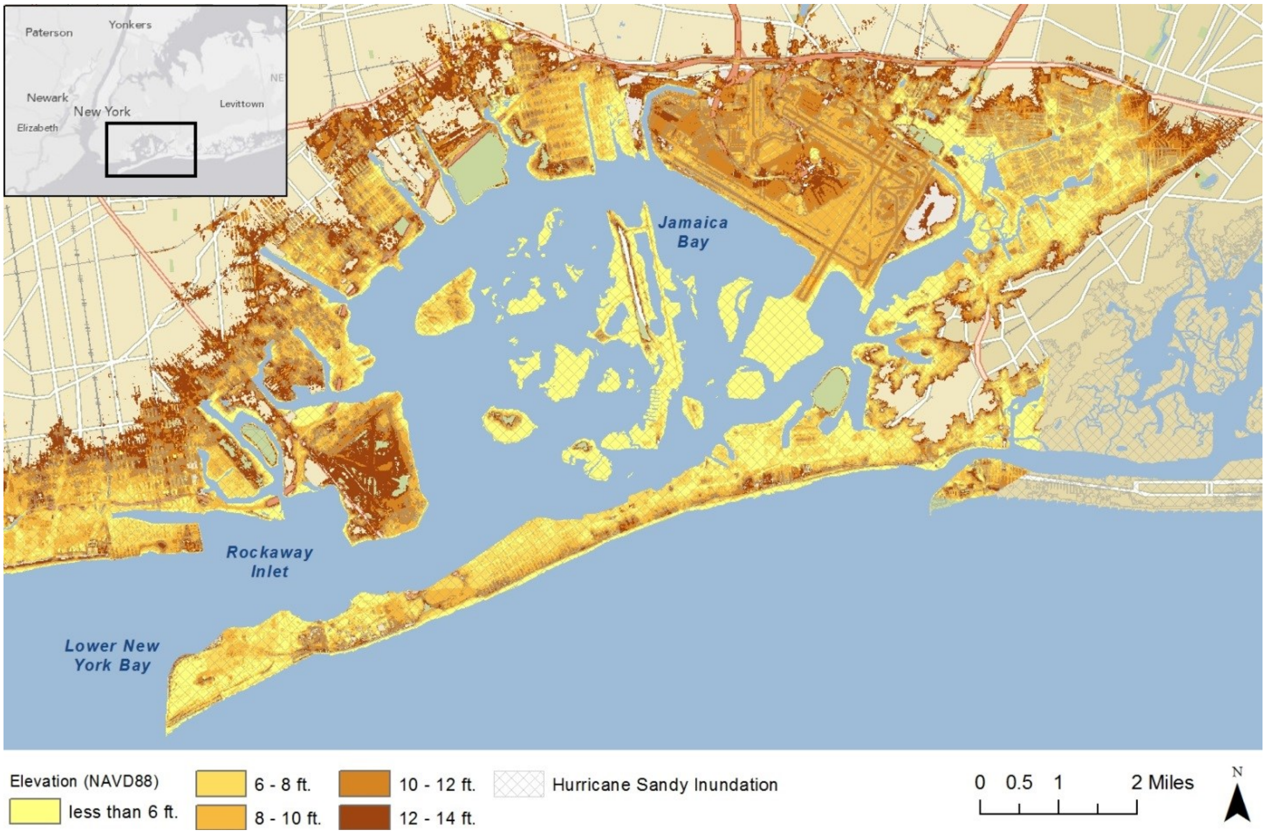


Figure 1-5: Approximate Historical Study Area Inundation at Various Water Elevations

1.7 Prior Reports and Existing Water Projects

1.7.1 1965 Authorization

The Beach Erosion Control and Hurricane Protection Project, recommended by the State of New York and USACE, was authorized by the Flood Control Act of 1965 as prescribed by House Document No. 215, 89th Congress, First Session. The project included a hurricane barrier across the entrance to Jamaica Bay and 4 million cubic yards of beach fill along the ocean front as initial construction, with 10 years of periodic renourishment.

Within the House Document 215 (1965), the District Engineer found that the Rockaway Peninsula and low-lying areas surrounding Jamaica Bay, particularly Howard Beach, were subject to frequent and severe damages from tidal inundation (flooding), and that the ocean front between East Rockaway Inlet and Rockaway Inlet was subject to considerable damage from wave attack. Improvement of the shore and provision of flood control works were needed to provide adequate beach erosion control and hurricane protection.

The problem in the study area, as identified in 1965, was a combination of shore erosion and wave attack along the Atlantic coast of the Rockaways, and storm surge inundation from both the ocean and Jamaica Bay. The inundation problem was further complicated by an inadequate storm sewer system in the Rockaways and an incomplete system in the residential areas on the north side of Jamaica Bay. This resulted in severe hardship to hundreds of families requiring evacuation during times of flood, and extensive property damage. The most severe damages occurred in the Rockaway Peninsula, the Howard Beach area, Broad Channel, and Rosedale sections of Queens.

1.7.2 1974 Authorization

Section 72 of WRDA of 1974 authorized construction of beach erosion control portion of the project separately from the construction of hurricane protection. The beach erosion control aspect of the project provided for the restoration of a protective beach along 6.2 miles of Rockaway Beach, between Beach 149th Street on the west at the boundary with Jacob Riis Park and Beach 19th Street on the east at East Rockaway Inlet. The project authorization also provided for Federal participation in the cost of periodic beach nourishment to stabilize the restored beach for a period not to exceed 10 years after the completion of the initial beach fill.

The initial nourishment construction was completed from 1975 to 1977. The first phase of the initial construction (1975) consisted of placing 3,669,000 cubic yards of sand between Beach 110th Street and Beach 46th Street. In the second phase of construction (1976), 1,490,000 cubic yards of fill were pumped onto the beach between Beach 46th Street and Beach 19th Street. The third phase of initial construction (1977) had 1,205,000 cubic yards placed between Beach 110th Street and Beach 149th Street.

The beach erosion control features of the authorized project on the Rockaway Peninsula consisted only of a 100-foot berm width at an elevation of +10 ft. NGVD (8.9 feet NAVD88) over the peninsula's entire project length (from Beach 19th Street to Beach 149th Street). Additional width sections of 150 feet and 200 feet of the authorized project provided for separable recreation benefits.

Severe storms in 1977 and 1978 eroded areas of the beach. A Post Authorization Change recommending a modification to the authorized Beach Erosion Control Project was approved on 8 June 1979. The modification provided for the construction of a 380-foot long quarry stone groin at the western limit of the project in the vicinity of Beach 149th street. The groin design provided for a structure which would hold the project beach fill and allow for maximum bypassing to the downdrift shore. The construction of the groin was completed in September 1982 and included placement of 163,300 cubic yards of beach fill on both sides of the groin.

Nourishment operations occurred at two-year intervals during the ten years following the completion of the initial fill, with the last operation being in 1988. The authorized hurricane protection aspect of the project was never constructed, and was de-authorized by WRDA of 1986.

1.7.3 Section 934 and Reformulation Study

In response to the authority of Section 934 of WRDA 1986[12], the State of New York requested a reevaluation of the period of renourishment. This resulted in a 1993 report that approved three additional beach nourishments in 1996, 2000, and 2004. The project design was limited to a

[12] Section 934 of WRDA 1986 extended the timeframe for providing periodic beach nourishment from fifteen to fifty years.

100-foot berm, which was determined to be sufficient for hurricane and storm damage protection. The 1993 report also recommended a "reformulation study" to account for the changes to the project in the interest of storm damage reduction, and to identify a more cost-effective approach for addressing renourishment needs, and determine whether federal participation is needed for the project for an additional 50 years. Due to funding limitations, the Reformulation Study started in 2003 when NYSDEC and USACE signed a cost-share agreement.

Historically, maintenance material from the navigation channel at East Rockaway Inlet has been beneficially used periodically along the Rockaway Beach shoreline both between Beach 27th Street and Beach 38th Streets, and in some instances in the areas of Beach 92nd street. This has occurred intermittently over the years with the last placement occurring in 2010.

At the time Hurricane Sandy impacted the area, the project was in an eroded condition. Following Hurricane Sandy, the Corps was authorized to repair the project to pre-storm conditions and under P. L. 113-2 was also authorized to restore the project to its original design conditions. Emergency repair and restoration in response to Hurricane Sandy was performed in 2014. Sand placement on Rockaway Beach from Beach 19th Street to Beach 149th Street consisted of 3.5 million cubic yards of material. In conjunction with this repair and restore operation, the City of New York, and State of New York provided additional funds to also establish a project dune at elevation +16 ft. NAVD88.

1.7.4 Federal Navigation Channels

There are two federal navigation channels in the study area. Federal navigation at Jamaica Bay was authorized by the Rivers and Harbors Act of 1910 and subsequently modified by the Rivers and Harbors Acts of 1945 and 1950, and includes an entrance channel at Rockaway Inlet with an authorized depth of -20 feet MLLW. The channel continues to Barren Island at a depth of -18 feet MLLW. Branch channel depths range from -12 feet to -18 feet MLLW (USACE, WCSC 2014). The Project also includes the rock jetty constructed on the east side of the entrance channel.

Dredging records for the Rockaway channel show initial construction in 1930. No maintenance dredging of the entrance channel occurred until 1976, after which records show regular maintenance of the channel. The lack of maintenance dredging until the 1976 is likely due to the impoundment capacity of the jetty at Rockaway Inlet. Once maintenance dredging began in 1976, dredging intervals varied from one year to five years. Maintenance dredge volumes have gradually increased over time and is likely due to the growth of the fillet and increasing bypassing around east jetty at Breezy Point.

According to the Waterborne Commerce of the United States, domestic commercial vessels made approximately 1,002 upbound (entered Jamaica Bay) and downbound (exited Jamaica Bay) trips in 2013 (USACE, 2013). Based on this report, no trips were made by non-domestic vessels into Jamaica Bay.

Commercial vessels primarily transport bulk fuel to several privately operated bulk fuel storage terminals located in basins at the eastern end of Jamaica Bay. Commercial vessels also transport sand and gravel to several aggregate facilities at the eastern end of Jamaica Bay and north of Coney Island.

The Federal Navigation Channel at East Rockaway Inlet was authorized by the Rivers and Harbors Act of 1930. The project allows navigation to proceed from the Atlantic Ocean into Reynolds Channel and the bays north of the Long Beach. The inlet provides for a channel 12 ft. deep and approximately 250 ft. wide; one jetty constructed on the east side of the channel; one jetty (authorized but not constructed) on the west side of the channel. Dredging records for East Rockaway channel show initial construction in 1935, maintenance dredging from 1938-1985, a channel realignment in 1988, and regular maintenance dredging from 1989 to present.

1.7.5 Jamaica Bay Study

A 1990 Study resolution for Jamaica Bay, Marine Park, and Plumb Beach New York resulted in the completion of a Reconnaissance Study by USACE New York District. The study recommended feasibility investigations for storm damage reduction in areas of areas of Arverne, Plumb Beach, Howard Beach and Broad Channel. The storm damage reduction study never advanced past the reconnaissance phase due to lack of local support at the time. The report also recommended a feasibility study for environmental restoration in Jamaica Bay, which moved forward. Some of the features recommended in the Jamaica Bay Study (now incorporated into the Hudson-Raritan Ecosystem Restoration Feasibility Study) are considered in this reevaluation study for CSRM as NNBFs.

1.8 History of the Investigation

This General Reevaluation is a result of the Section 934 analysis, which recommended project reformulation to identify the appropriate long-term solution for the study area. The Reformulation effort was initiated in 2003, and had focused on developing plans for risk reduction along the Atlantic Ocean Shoreline when Hurricane Sandy impacted the study area.

The size and energy of Hurricane Sandy caused damage not previously experienced along the Atlantic coast and left in its wake degraded coastal features, which increased risks and vulnerability from future storm events. The Disaster Relief Appropriations Act of 2013 was passed by Congress and signed into law by the President on January 29, 2013 as Public Law 113-2 (P.L. 113-2). The legislation provides supplemental appropriations to address damages caused by Hurricane Sandy and 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 addition to repairing the authorized project to the original design, USACE was also directed to undertake a broad, conceptual examination of the best ideas and approaches to reducing the vulnerability to major storms over time, in a way that accounts for current science and engineering, is sustainable over the long-term, both for the natural coastal ecosystem and for communities. Evaluations of project specific measures would addresses resiliency, economics, risks, environmental compliance, and long-term sustainability. Recognizing the vulnerability of the entire study area from Rockaway Inlet to East Rockaway Inlet and Jamaica Bay, the Reformulation effort was re-scoped to consider a greater suite of alternatives along the shorefront, and plans to address Jamaica Bay and its communities following the devastation caused by Hurricane Sandy.

The Alternatives Milestone was held in October 2014, which recommended a final array of alternatives that included 1) a Perimeter Plan for CSRM structures along the shoreline within Jamaica Bay and along the Atlantic Ocean shorefront and a Storm Surge Barrier Plan at

Rockaway Inlet, which also included CSRM features along the Atlantic Ocean shorefront. The tentatively selected plan (TSP) Milestone was held in March of 2016, which approved the release of the Draft HSGRR/EIS in August 2016.

1.8.1 Draft HSGRR/EIS

Consistent with current U.S. Army Corps of Engineers (USACE) planning guidance, the study team identified and screened alternatives to address CSRM, and presented a tentatively selected plan (TSP) in the Draft HSGRR/EIS. The TSP identified overall project features, with the acknowledgement that the specific dimensions of the plan were not finalized in the Draft HSGRR/EIS, which was released to the public in August 2016. The Draft HSGRR/EIS has undergone concurrent public review, policy review, Agency Technical Review (ATR), and Independent External Peer Review (IEPR). As a result of the significance (extent and content) of partner, agency and public comments received on the TSP, as well as the feedback to the District resulting from the concurrent policy and technical review conducted by USACE Headquarters (HQUSACE), the District determined that sufficient revision to the Draft HSGRR/EIS would be required in order to proceed to a final decision document.

The 25 May 2017 USACE Agency Decision Milestone (ADM) resulted in the decision to move all further evaluation of the proposed storm surge barrier measure within Jamaica Bay, a significant component of the TSP, to the ongoing New York and New Jersey Harbor and Tributaries (NYNJHATs) Feasibility Study. The NYNJHATs Feasibility Study was initiated in the Summer of 2016, and is evaluating large-scale regional coastal storm risk management (CSRM) strategies for the New York metropolitan area (which includes Jamaica Bay) extending upstream of the Hudson River to the federal lock and dam at Troy, New York, the Passaic River to the Dundee Dam, and the Hackensack River to the Oradell Dam. The NYNJHATs study is evaluating a suite of storm surge barriers, including one alignment from Breezy Point to Sandy Hook that would obviate the need for the Jamaica Bay barrier proposed as part of the Draft HSGRR/EIS TSP. As such, any further evaluation of a storm surge barrier for Jamaica Bay is a more appropriate fit for the NYNJHATs study.

1.8.2 Revised Draft HSGRR/EIS

USACE has further refined and developed the ‘Residual Risk’ measures in the Back-Bay, now termed high frequency flooding risk reduction features (HFFRRFs), in order to bring them up to full feasibility level of design and environmental analysis, and to include natural and nature-based features, as well as areas outside of New York City in Nassau County. Taper designs to tie in the Atlantic Shorefront at each project end with the adjacent areas have also been added to the design included in this Revised Draft HSGRR/EIS.

In this Revised Draft HSGRR/EIS, documentation of the Recommended Plan is presented, which reflects changes to the TSP as described above.

2 EXISTING CONDITIONS*

The study area is categorized by two distinct planning reaches: the Atlantic Ocean Shorefront Planning Reach and the Jamaica Bay Planning Reach. Where appropriate, descriptions are categorized to identify the different conditions occurring at each reach.

The 11-mile long coastline of the Rockaway peninsula is the only unobstructed coastline of all of NYC (NYC, 2013 South Queens) and is a major recreational resource hosting millions of visitors each year[13]. The Rockaway peninsula is home to more than 110,000 residents spread across neighborhoods all along the peninsula. The Rockaway peninsula also acts as a barrier protecting Jamaica Bay communities. Jamaica Bay includes NYC's largest remaining natural marshland and 10,000 acres of parkland under the coordinated management of NYC and the National Park Service. Jamaica Bay communities cross three New York State counties, including Kings (Brooklyn), Queens, and Nassau counties with a population of more than 185,000 (NYC 2014 South Queens and Brooklyn). Many of the residences in Jamaica Bay communities were built in the 1920s in low lying areas, which are susceptible to flooding.

2.1 Geologic Setting

Both planning reaches lie within the Atlantic Coastal Plain Physiographic Province of the U.S. and includes geological deposits and regional aquifers that are bounded to the south by the Atlantic Ocean and the north by Long Island Sound.

Long Island was formed primarily by Pleistocene-age glaciations including the Wisconsin Ice Age and Laurentide Ice Sheet, which retreated approximately 10,000 years ago. Two advances of the Wisconsin ice sheet during the Upper Pleistocene Epoch of the Quaternary Period caused the island to be blanketed with glacial till, ice-contact stratified drift, outwash deposits, and other deposits composed of clay, silt, sand, gravel, and boulders. The terminal moraines and the north shore of Long Island are composed primarily of stratified glacial drift with some till. The area between the moraines and the south shore of Long Island is primarily covered by outwash deposits. Central and South Long Island are of glaciofluvial origin. These Pleistocene deposits lie atop gently dipping, metamorphic, Paleozoic or Precambrian-age rocks (Misut and Monti 1999; US Dept Interior, NPS, October 2015).

The undifferentiated igneous and metamorphic bedrock of Paleozoic or Precambrian age that underlies the Cretaceous sediments was eroded to a nearly flat or broadly undulating plain before the overlying Cretaceous-age sediments were deposited; the rock surface was later eroded by Pleistocene glaciation in north-northwestern Queens County near the East River and slopes southward at about eighty (80) feet per mile (USEPA 1983a; USEPA 1983b). This dipping bedrock surface and the depositional environment of the overlying sediments resulted in a series of southdipping, unconsolidated, morainal and outwash accumulations associated with the continental glaciers.

The Raritan Formation, consisting of the Lloyd Sand Member and an unnamed clay member, directly overlies the igneous and metamorphic bedrock. Overlying the Raritan Formation is the Magothy Formation and Matawan Group (undifferentiated), the Jameco Gravel, the Gardiners

[13] https://www.nycgovparks.org/parks/rockaway-beach-and-boardwalk

Clay, and upper Pleistocene deposits. Rockaway Peninsula and Coney Island consist of Holocene fluvial deposits. There are four primary water-bearing formations on Long Island: the Upper Glacial, Jameco, Magothy, and Lloyd aquifers.

2.1.1 Soils

The soils on the Rockaway peninsula are formed in a mantle of eolian and marine washed sand (USDA, 2001). These landforms are highly dynamic and can change readily with each coastal storm. Some areas have also been affected by human activities such as hydraulic filling or dredging to control erosion from hurricanes and nor'easters, and to maintain depth in nearby shipping channels. Soils found on the eolian and marine deposits within these portions of the park include Hooksan and Jamaica. On less stable landscapes the miscellaneous land units, Dune land and Beaches, are common. Soils formed in dredge filled areas include Bigapple, Fortress, and Barren. Verrazano soils are found where loamy fill has been placed over sandy materials. Soils within the Atlantic Shoreline Planning Reach are predominantly classified as Urban land-Verrazano and Urban land-Flatbush complexes, with 0-3% slopes and a sandy substratum, Hooksan-Dune land complex, and beaches. Soils along the perimeter of the Rockaway API are typically mucky peats susceptible to subsidence (USDA 2016a).

The Jamaica Bay Planning Reach includes one of the most urbanized estuaries in North America, and has had a long history of anthropogenic disturbances which include extensive dredging, filling, and development in and around the bay (USFWS 1997; USDA 2001; GNRA 2015). In many locations, the topography of the region has been altered by development and cut and fill activities which have created many new, man-made topographic features. Within the bay, many areas within the bay have been used historically as a borrow source for urban development. On land, native soils have primarily been excavated, covered with fill material, compressed, or covered by impervious surfaces. Historically, significant salt marsh areas throughout the Bay project area have been filled to support construction of Floyd Bennett Field, John F. Kennedy (JFK) Airport, and/or the Fountain Avenue and Pennsylvania Avenue former landfills. The New York Soil and Water Conservation District have mapped the soils surrounding the bay as almost entirely categorized anthropogenic fill.

2.1.2 Topography

In 1835, Rockaway Point was located near the present east boundary of Jacob Riis Park (FEMA 2013). East Rockaway Inlet was located 20,000 feet east of its present position, near Long Beach, New York. South of Rockaway Point, a large shoal had formed which was to provide the material for extending this point nearly four miles to the east during the next 100 years. The shoreline generally receded between 1835 and 1878 while, at the same time, Rockaway Point extended two miles westward. Jacob Riis Park acquired its present shoreline during this period. Between 1878 and 1927, the shoreline of the Rockaways advanced a small amount. Rockaway Point grew rapidly until 1902, but from 1902 to 1927, its westward expansion was only half its previous rate. From 1927 to 2007, the shoreline of the Rockaways has been stable. Nearly 12 million cubic yards of sand have been artificially placed east of Rockaway Point since that time (FEMA 2013).

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 ft NAVD88, except within the existing dune field. Elevations along the Jamaica Bay shoreline side of the peninsula generally range from +5 ft NAVD88, increasing to +10 ft NAVD88 further south toward the Atlantic coast (USGS, 2016, based on topographic maps dated 2013).

The topography of the Jamaica Bay varies among the natural and man-made physiographic features, including the numerous basins and creeks that fringe the interior periphery of the bay; several man-made landfills and residential/commercial infilled developments along the interior periphery of the bay; and numerous salt marsh islands and island bars located within the interior of the bay. Accordingly, elevations vary on account of these features. The grades of the salt marsh islands and island bars vary from sea level to as high as +22 ft NAVD88 at Ruffle Bar and Little Egg Marsh. Inland landfills rise rapidly from the shoreline to approximately +40 ft NAVD88, while residential/commercial areas are lower than the landfills, ranging from sea level at their shoreline to approximately +20 ft NAVD88 inland (USGS, 2016, topographic maps dated 2013).

2.2 Bathymetry and Sediments

Jamaica Bay bathymetry and the anthropomorphic changes over time have been well documented (USACE 2010, Nordenson, et. al. 2014; Seavit et al. 2014). The mean depth of Jamaica Bay is approximately 13 feet with dredged channels reaching 30 to 50 feet deep (NYCDEP 2007). Dredging and filling of Jamaica Bay over the past century has significantly altered the bathymetry of Jamaica Bay. Currently, USACE only dredges the federally authorized and maintained Jamaica Bay Federal Channel in Rockaway Inlet approximately every two years. The Federal Channel is at the eastern entrance channel to Jamaica Bay and is dredged to an authorized depth of approximately 20 feet and width of 1000 feet. The interior bay channels have an authorized depth of approximately 12 feet, however many of these channels are significantly deeper and therefore, maintenance dredging is unnecessary. These navigational channels within the Bay are used by the NYCDEP sludge barges serving the municipal waste water treatment plants and dredging is infrequent due to the lack of sediment input from former tributaries and the narrow, modified morphology of the tributaries.

Jamaica Bay also has numerous deep borrow pits. Borrow pits, exceeding forty feet in depth in some locations are located at the bayside margins of both Floyd Bennett Field and JFK Airport. Other borrow pits include the Norton Basin and Little Basin Borrow Pits; as well as offshore borrow areas that include East Rockaway Inlet Rockaway Emergency Contract 1C Borrow Area, and USACE Borrow Areas A-West and A-East.

Historic dredging has increased the overall water volume within Jamaica Bay (NYCDEP 2007) and has had consequences on both the rate of flushing and sediment budget (NYCDEP 2007). The rate of flushing for an urbanized estuary is critical factor to consider as it reduces concentrations of pollutants and raises valuable oxygen levels (NPS 2015). In addition, the historic filling operations, hardening of shorelines, and eradication of natural habitats have also altered historic flow patterns and flushing time within the Bay. The effect of this historic dredging is discussed below.

2.2.1 Sediment Transport

With respect to sediments within the Jamaica Bay Planning Reach, movement is restricted due to the narrow restriction of Rockaway Inlet and little to no sediment input from the watershed (due to the urbanized land uses). At the entrance to Rockaway Inlet, the prevailing currents slow as they enter the mouth of Jamaica Bay and turn to the east to again slow. This continual slowing of water movement reduces sediment transport throughout the Jamaica Bay Planning Reach. Consequently, sediments at the mouth of Jamaica Bay are primarily coarse sands and the remainder of the bay is finer silt sediments.

2.2.2 Sediment Quality

Historically, prior to pollution regulations, large quantities of chemicals, including heavy metals, pesticides, polychlorinated biphenyl (PCB), dichlorodiphenyltrichloroethane (DDT), and dioxin, were discharged into waters of Jamaica Bay. During the last 30 years levels of most of these contaminants have decreased on average by about an order of magnitude (Steinberg et al 2004). This decrease is due mainly to the implementation of a number of control measures required by the Clean Water Act. However, contaminations adhere to organic compounds and settle into sediments and are still found throughout Jamaica Bay (Steinberg et al. 2004). In addition to these "legacy" chemicals, chemicals from modern sources (i.e., WWTP discharges, CSOs, non-point source discharges, chemical and oil spills) are also known to adversely affect Bay sediments.

Many of these chemicals, which are readily absorbed in the fat cells of animals, can accumulate to dangerous levels. Currently, all regions of the HRE, including Jamaica Bay, have consumption advisories in some fish and shellfish species (NYSDOH 2016, NJDEP 2013). Moreover, the recent rates of decline in contaminants will be difficult to match in the future since current non-point sources of these chemicals and metals (e.g., overland runoff, atmospheric deposition) will not be as easy to control as point sources (Steinberg et al. 2004).

2.3 Surface Water

Jamaica Bay's watershed and surface waters are well documented (USACE 2010, NYCDEP 2007), and are dominated by the 36-square mile water body which historically captured water and sediment from a watershed approximately 142 square miles. Eight natural tributaries remain and which discharge directly into Jamaica Bay: Sheepshead Bay, Paerdegat Basin, Fresh Creek, Hendrix Creek, Spring Creek, Shellbank Basin, Bergen Basin, and Thurston Basin.

Jamaica Bay has been greatly influenced by the anthropogenic activities to the extent that tributaries in the traditional sense, now consist of receiving basins, sewersheds, and canals. The sources of water in Jamaica Bay are the WWTPs, CSOs, storm sewers, groundwater, precipitation, and tidal exchange through Rockaway Inlet. The most important hydrologic input to the bay remains the semidiurnal tides. However, contributions from natural tributaries, now mostly filled or diverted by urbanized development, have been replaced in importance through outflows from WWTPs, CSOs, and stormwater runoff and which will be discussed further below.

The mean tidal range along the Atlantic Ocean Shorefront Planning Reach 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 Ocean

Shorefront Planning Reach. With respect to the Jamaica Bay Planning Reach, the MHW level and MLW level relative to NAVD88 are +2.4 ft. and -3.07 ft., respectively.

2.3.1 Coastal Storm Hazards

For the purposes of the preliminary screening described in this document, major storms are identified to be those which produce storm surge and wave conditions similar to the 100-year base flood elevation (BFE), as defined by the Federal Emergency Management Agency (FEMA), with additional consideration of projected sea-level change (SLC). FEMA has released Preliminary Flood Insurance Rate Maps (FIRMs) in the NYC portion of the study area, which includes consideration of stillwater elevations and wave conditions, and illustrate current flood risks in the study area. While these maps will not become effective FIRMs due to NYC's successful 2017 appeal, they are believed to be the best available information for defining the 100-year flood elevations. The City is in the process of developing revised Preliminary Flood Insurance Rate Maps (PFIRMs), but they are not expected to be available until after this study is complete.

The portions of the study area in Nassau County are assessed using the Nassau County 2009 Flood Insurance Study (FIS) 100-year effective Base Flood Elevation (BFE) data. These data were released in 2009 by FEMA (FEMA 2009) and include consideration of still water levels and wave action throughout Nassau County. Figure 2-1 shows the preliminary FIRMs for NYC and the effective BFEs in Nassau County.

Water levels used in the more detailed alternative evaluations were selected from the available USACE North Atlantic Coast Comprehensive Study (NACCS) data (NACCS-Simulation BasePlus96Tides). The NACCS analysis included numerical model simulations of several storms under various tidal conditions to estimate the 100-year water level in Jamaica Bay (Cialone et al. 2015). This study did not report wave conditions for the 100-year event. Instead, this study used wave conditions from the FEMA flood insurance rate map study from 2013 (FEMA 2013). This was deemed reasonable because the water levels from both studies at the 100-year recurrence interval are comparable. This conclusion is corroborated by a USACE study in Raritan Bay (USACE 2015a).

Figure 2-1: Preliminary FEMA Map Elevations (NAVD88) for the Study Area

2.3.1.1 Impacts of Hurricane Sandy

The study area was one of the areas most devastated by Hurricane Sandy. Within the study area, 10 fatalities occurred, and more than 1,000 structures were substantially damaged[14] to restrict re-entry or were destroyed by Hurricane Sandy (NYCEM, 2016). The NYC Department of Buildings post-Hurricane Sandy damage assessment indicates the disproportionate vulnerability of the study area to storm surge damage. Of all buildings city-wide that were identified as unsafe or structurally damaged, 37% were located in the southern Queens portion of the study area, which is far greater than the percentage of all buildings in the Hurricane Sandy inundation zone that are located in southern Queens portion of the study area (24%). In addition to the structural impacts caused by waves and inundation, fires ignited by the storm surge inundation of electrical

[14] Substantial damage to a structure occurs when the total cost of repair is 50 percent or more of the structure's market value prior to a storm event.

systems destroyed 175 homes at the Rockaway Peninsula portion of the study area[15] (SIRR, 2013).

Hurricane Sandy hit the study area at nearly high tide. Waves eroded beaches, breached boardwalks and seawalls, and broke against buildings in the oceanfront communities. Storm water inundation reached as much as 10 feet above ground in some portions of the study area. In addition, more than 1.5 million cubic yards of sand was torn from Rockaway Beach and deposited on oceanfront communities or washed out to sea.

Floodwaters funneled through Rockaway Inlet amassing a storm surge that inundated all the neighborhoods surrounding Jamaica Bay. The low-lying neighborhoods in the central and northern portions of Jamaica Bay, where the narrow creeks and basins provide the marine aesthetic of the neighborhood, were especially devastated by flood waters. Damage to the elevated portion of the subway system in Jamaica Bay and Rockaway (A line) disrupted service for over six months affecting about 35,000 riders daily. In the southern Queens portion of the study area 37 schools were closed for up to two months.

In the Hurricane Sandy Coastal Projects Performance Evaluation Study (HSCPPES), the study area was identified as being within the area of Extreme Exposure during Hurricane Sandy, which is defined as an area exposed to water surface elevations greater than +9 feet mean higher high water (MHHW)[16] onshore and greater than 30 feet offshore significant wave heights (USACE, 2013d). The height of the beach and dunes on the Rockaway Peninsula at the time Hurricane Sandy hit is unknown, but project height was below design dimensions (USACE, 2013d). Although the beach berm on the Rockaway Peninsula had been overtopped, widespread flooding, inundation, and damages were also due to back-bay flooding, which had not been addressed through implementation of coastal flood risk management measures in project construction authorization (USACE, 2013d). Additional information concerning high-water marks with photos is available on the Hurricane Sandy Storm Tide Mapper website, at: http://water.usgs.gov/floods/events/2012/sandy/sandymapper.html.

The Hudson-Raritan Estuary Comprehensive Restoration Plan (HRE CRP) dated June 2016, identified that the Jamaica Bay Planning Region experienced extensive natural resource damages resulting from the storm surge associated with Hurricane Sandy.

> *"Within the interior of Jamaica Bay, coastal wetlands were littered with debris following the storm and wrack deposits were visible in many marsh areas. Initial reports and damage assessments may have underestimated the amount of wrack deposited, especially where obscured by dense reed stands or maritime woody vegetation (ALS 2012). The Jamaica Bay marsh islands, restored prior to Hurricane Sandy by the USACE in partnership with NYSDEC, NYCDEP, PANYNJ, and National Park Service (NPS), accumulated significant amounts of debris, but experienced relatively little damage to existing plantings; repairs to vegetation originally planted at Yellow Bar Island in the*

15 Special Initiative for Rebuilding and Resiliency, City of New York. 2013. Available online at https://www1.nyc.gov/site/sirr/report/report.page

16 Mean Higher High Water is defined as the average of the higher high water height of each tidal day observed over the National Tidal Datum Epoch. For stations with shorter series, comparison of simultaneous observations with a control tide station is made in order to derive the equivalent datum of the National Tidal Datum Epoch.

summer of 2012 were required in the spring of 2014. The sand placed on Rulers Bar and Black Wall islands did not experience any damage as a result of the storm. Black Wall and Rulers Bar were subsequently vegetated through a community based planting effort led by ALS, Jamaica Bay Ecowatchers, and the Jamaica Bay Guardian funded by NYCDEP in July 2013.

The freshwater East and West Ponds of the Jamaica Bay Wildlife Refuge were breached by the storm surge during Hurricane Sandy and were inundated with saltwater. Storm waves washed away portions of the berm that separated the ponds from Jamaica Bay, transforming them into saltwater inlets. The ponds were well known for their abundance of waterfowl and shorebirds, including snow geese (Chen caerulescens), lesser and greater scaup (Aythya affinis and A. marila), ruddy duck (Oxyura jamaicensis), ring-necked duck (Aythya collaris), green winged teal (Anas carolinensis), northern pintail (Anas acuta), American wigeon (Anas americana), and gadwall (Anas strepera). The sudden rise in salinity created an unsuitable environment for brackish water species, which may ultimately alter foraging habitats (ALS 2012). Proposed repairs to the primary and secondary breaches include replacement of the wetlands water control structure and installation of a groundwater well to provide freshwater, which will allow NPS to return West Pond to a more freshwater and resilient condition that supports a diversity of Jamaica Bay habitats and wildlife (NPS 2016).”

2.3.2 Tidal Currents

With respect to the Atlantic Ocean Shorefront Planning Reach, tidal currents are generally weak. Currents at Rockaway Inlet and East Rockaway Inlet have respective 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 into Jamaica Bay with high currents at its narrowest point which is 0.63 miles wide 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 Jamaica Bay and turn to the east and again slow which significantly reduces tidal exchange. Tides in Jamaica Bay are semi-diurnal and average 5 feet. Dredging has deepened the mean depth of Jamaica 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 gauge are generally 1.0 knots or less during neap tide periods and 1.7 knots or less during spring tide periods (Arcadis 2016b).

2.3.3 Wind and Wave Climate

Wind speed/direction data for the Jamaica Bay Planning Reach were available from recorded wind data at the National Oceanic and Atmospheric Administration (NOAA) National Climatic Data Center (NCDC) for JFK Airport. Data are available beginning in the early half of the 20th century to the present. Based on the wind speed-direction occurrence, normal winds are predominantly from south clockwise to northwest quadrant, with stronger winds predominantly from west and northwest. Average monthly wind speeds range from 10 to 14 miles per hour (mph) and the maximum wind gust reached 71 mph and peak wind gusts from 47 to 71 mph with a prevailing direction from south.

The direction of wave approach to the Atlantic Ocean Shorefront Planning Reach is primarily from the south and southeast. For the Atlantic Coast of Long Island Jones Inlet to East Rockaway Inlet Long Beach Island Project, a wave height-frequency curve was developed to obtain storm wave conditions (USACE 1995). Breaking wave heights were calculated for the 10, 25, 50, 100 and 500-year return periods. The results of these calculations indicate that the deep-water wave height for a storm having a 100-year return period would be 21 ft. (USACE 2015).

Due to the length and orientation of Rockaway Inlet, the Jamaica Bay Planning Reach is largely sheltered from ocean waves. The majority of waves in Jamaica Bay are locally generated due to wind/water surface interaction or produced by vessels navigating the interior channels. The wind climate varies from calm and light to potentially dangerous winds of a winter nor'easter or a late summer hurricane. The wind, waves, and currents have significant bearing on the sustainability of the marsh within Jamaica Bay. To varying degrees, the stability of the vegetative cover and the conservation of sediment depend on these coastal processes. The wave climate may be considerably different from year to year, resulting in very different erosion rates from year to year.

2.3.4 Sea Level Change

Local relative sea level change (SLC) was considered in all aspects of the analyses included in this Revised Draft HSLRR/EIS based on the guidance contained in Engineer Technical Letter (ETL) 1100-2-1 and Engineering Regulation (ER) 1100-2-8162 (USACE 2013e) – the successor to Engineering Circular (EC) 1165-2-212 (USACE 2011). This set of guidance requires the consideration of a range of relative SLC including the historic rate of SLC, and projections of increased rates of SLC. The current rate of local SLC, including subsidence, at the Sandy Hook, NJ gauge is 3.99 millimeters/year (.013 feet/year)[17]. A more detailed discussion of the range of SLC and the effects of SLC is discussed in Section 3.8 Sea Level Change.

2.4 Water Quality

For the Atlantic Ocean Shorefront Planning Reach, water quality is influenced by ebbing waters from East Rockaway Inlet to the east and from semi-diurnal tidal fluctuations characteristic of the Atlantic coast. The study area is outside of and to the east of the three miles of the Atlantic coastline along New York State that are subject to shellfish water quality impairments from CFOs (NYSDEC 1998).

Recent water quality data collected from coastal stations at Far Rockaway and Atlantic Beach, as part of the USEPA helicopter-monitoring program, show that overall bacteriological water quality is very good. In addition, the NYC and Nassau County Public Health Departments report good overall water quality in the Atlantic Ocean Shorefront Planning Reach (Jacobs 1999, Luke 1999). However, geometric mean densities (1989 through 1998) of fecal coliform and enterococci are well below acceptable federal guidelines for primary contact recreational uses (USEPA 1999b).

[17] http://marine.rutgers.edu /geomorph/geomorph/pages/slr.html

With respect to the Jamaica Bay Planning Reach, the bay continues to be threatened by poor water quality. Almost the entire watershed is urbanized such that Jamaica Bay receives pollution from point and non-point sources around the bay, such as the CSOs, runoff from the roads and the airport, leachate from landfills, windblown trash, and other sources. Specifically, 240–340 million gallons per day of treated sewage effluent flow into Jamaica Bay from four Wastewater Treatment Plants (WWTP) (GNRA 2013). This continues to be a major source of pollution, including treatment byproducts such as chlorine, and heavy metals and other contaminants that are not eliminated by water treatment facilities (NPCA 2007a). In addition, large rain events can overwhelm the sewer system capacity, resulting in untreated wastewater and raw sewage. Other sources within the Jamaica Bay Planning Reach include landfill leaching, runoff from JFK Airport, as well as atmospheric deposition (NPCA 2007, USACE and PA 2009).

Water quality in Jamaica Bay has been extensively studied and characterized, as it is a critical component to the Jamaica Bay Watershed Protection Plan (NYCDEP 2007). While nitrogen and phosphorus are characteristically limiting nutrients in estuarine ecosystems, their quantities within Jamaica Bay are exaggerated by WWTP inputs. As such, nutrient loading can lead to eutrophication. High nitrogen levels can also decrease root production in salt marsh plants, and in turn decrease their ability to accumulate organic material and hold sediments within tidal marshes. High nitrogen levels also increase microbial decomposition, reducing the accumulation of organic matter and limiting the ability of saltmarshes to maintain an elevation that keeps pace with relative sea level change (SLC) (Rafferty, Castagna, and Adamo 2010).

High nutrient levels are also a major contributor to low DO levels in Jamaica Bay. DO ranges from 3.5 to 18.5 milligrams per liter (mg/L), sometimes falling below the 5.0 mg/L threshold specified by state water quality standards for waters suitable for recreation and fishing. Long periods of low DO can harm or kill larval fish and shellfish, and lead to odor problems from production of H2S gas in oxygen-deficient sediments. High concentrations of DO in the water column can also indicate poor water quality, and typically occur when algal blooms near the surface create very high to supersaturated DO concentrations as a byproduct of photosynthesis. While there is high year-to-year variability in measured DO concentrations, long-term monitoring suggests DO levels are trending toward improvement (NYCDEP 2007).

The NYSDEC assigns classifications to all of the waterbodies within its jurisdiction. These classifications are assigned such that "the discharge of sewage, industrial waste or other wastes shall not cause impairment of the best usages of the receiving water as specified by the water classification at the location of the discharge and at other locations that may be affected by such discharge." Three of the classifications developed by NYSDEC apply to waters within Jamaica Bay: Class SB, Class SC and Class 1.

- Class SB – includes the open waters of Jamaica Bay, Shellbank Creek, Gerritsen Creek, Mills Basin, and East Basin (NYSDEC 2011). The best usages of Class SB waters are primary and secondary contact recreation and fishing. These waters shall be suitable for fish, shellfish and wildlife propagation and survival.
- Class SC – Motts Basin (NYSDEC 2011). The best usage of Class SC waters is fishing. These waters shall be suitable for fish, shellfish and wildlife propagation and survival. The water quality shall be suitable for primary and secondary contact recreation, although other factors may limit the use for these purposes.

- Class 1 - Hendrix Street Canal, Fresh Creek, Hendrix Creek, Spring Creek, Paerdegat Basin, Bergen Basin, Sheepshead Basin, and Thurston Basin (NYCDEC 2011). Impairment is due to nitrogen levels, oxygen demand, and presence of pathogens. The best usages of Class I waters are secondary contact recreation and fishing. These waters shall be suitable for fish, shellfish, and wildlife propagation and survival. In addition, the water quality shall be suitable for primary contact recreation, although other factors may limit the use for this purpose.

2.5 Air Quality

Based on the National Ambient Air Quality Standards (NAAQS), Queens, Kings, and Nassau Counties located in the New York, Northern New Jersey, Long Island, ozone nonattainment area are currently classified as 'moderate' nonattainment for the 2008 8-hour ozone standard and 'maintenance' of the 2006 particulate matter less than 2.5 microns ($PM_{2.5}$) standard and 1971 carbon monoxide standard (40CFR§81.333). These counties are part of the Ozone Transport Region. Ozone is controlled through the regulation of its precursor emissions, which include oxides of nitrogen (NO_x) and volatile organic compounds (VOC). Sulfur dioxide (SO_2) is a precursor for $PM_{2.5}$.

2.6 Shoreline Habitats

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 high water springs (MHHS).

Biological communities were classified into seven 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 seven 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.

2.6.1 Subtidal Bottom

Subtidal bottom includes open water areas below the MLLW line (i.e., -3.1 feet NAVD88). This habitat type represents a significant area throughout Jamaica Bay, as well as a significant variation of water depths (both naturally occurring and anthropogenic). Specific to this habitat type, historic anthropogenic disturbances have commonly altered this habitat and its connection to adjacent intertidal and upland habitats. In addition, managed navigation channels occur throughout Jamaica Bay to support commerce.

2.6.2 Hardened Shoreline

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.

2.6.3 Mudflats

Mudflats are broad, shallow areas which are un-vegetated and exposed twice daily (i.e., semi-diurnal) at or near low tide. This habitat provides a crucial ecological transition between intertidal wetlands and subtidal bottom areas, as well as provides services related to shoreline protection, water quality improvement, fisheries resources, and habitat and food sources for migratory and resident animals. Tidal mudflats support a wide diversity of both terrestrial and aquatic life.

Specific to this habitat, mudflats commonly occur within Jamaica Bay in the historic location of intertidal wetlands. The loss of coastal wetlands has resulted in expansive mudflats along the shorelines edge in many locations throughout Jamaica Bay. While differing from the historical condition, mudflats still provide suitable habitat for a wide assemblage of benthic macroinvertebrates which then provide a critical food resource to fish, birds, as well as crustaceans.

2.6.4 Intertidal Wetlands

Intertidal wetlands are vegetated areas tidally influenced and connected to open waters that are inundated or saturated by surface- or ground-water frequently enough to support vegetation that thrives in wet soil conditions. Intertidal wetlands for purposes of this Revised Draft HSGRR/EIS include both low and native high salt marsh communities. The low salt marsh community generally occurs between mean low and mean high water, and is inundated twice daily by normal high tides. Low marsh communities are typically dominated by saltmarsh cordgrass *(Spartina alterniflora*). The native high marsh community occurs between MHW and the MHHS, which is only occasionally flooded during major storms or during extreme (i.e., spring) high tides. High marsh vegetation is dominated by salt marsh hay (*Spartina patens*) with saltgrass (*Distichlis spicata*) and/or marsh elder (*Iva frutescens*) occasionally mixed throughout.

Unfortunately, much of the native high marsh salt marsh community has been invaded by common reed throughout Jamaica Bay. Given the expansive monotypical stands of common reed, as well as the reduced level of services and functions that this community affords to the Jamaica Bay ecosystem, non-native intertidal wetlands have been defined as a separate habitat type. Common reed can cover many acres, and effectively out-compete native species that historically occurred throughout the high marsh. Through development of these expansive monotypical communities, this species also significantly reduce hydrologic complexity by altering and/or limiting intertidal channels and pools. Finally, these large monotypical stands also raise the elevation of these historic marsh communities by trapping sediment as well as the annual decomposition of the significant above ground biomass produced by this species.

2.6.5 Maritime Coastal Forest and Shrubland

Historically, a mosaic of the maritime forests/shrubland/grassland habitats was a large component of the undisturbed Jamaica Bay complex. They supported and therefore increased the value of the wetland and aquatic habitats by providing cover, alternate food sources and breeding habitats to many of the species that characteristically inhabit adjacent salt marshes, mudflats and shallow water habitats. They additionally act as a buffer area for the salt marsh communities. This benefit is integral to a full functioning integrated estuarine system, adding to the benefits of the adjacent habitats and increasing overall connectivity between and among similar habitats and multiple habitats used by the same species. They provide a critical resource for migratory passerine bird species, as well as other resident and migratory birds, mammals, and sensitive insect species Unfortunately, these maritime forests and grasslands, with beach and dune complexes, are now the rarest habitat type and often the subject of long-term restoration goals throughout Jamaica Bay. When they do exist in both planning reaches, their understory vegetation is commonly dominated by common reed and other invasive species.

2.6.6 Ruderal Uplands

As Jamaica Bay remains one of the most urban estuaries throughout North America, many upland habitats (which are not yet impervious surfaces) have been modified by historic and current anthropogenic disturbances. Ruderal upland habitats found extensively throughout both study area reaches represent upland areas that are (1) dominated by invasive species, (2) managed as lawns or landscape features, and/or (3) disturbed soil and/or rock and gravel.

2.6.7 Urban

A great deal of area within both study area reaches has been paved with impervious surface due to urban development. This urban habitat type is inclusive of the following, and not necessarily limited to: roads; paved trails; recreational courts; commercial and residential buildings; parking lots; and laydown yards. This habitat type is assumed to provide little to no services or functions to the Jamaica Bay ecosystem.

2.7 Invertebrate and Benthic Resources

Terrestrial and marine invertebrates have many important functions as key lower food web components in coastal and marine ecosystems. Terrestrial and benthic invertebrates serve as food resources for birds, mammals, and fish (Waldman 2008). Blue crab (*Callinectes sapidus*) and American lobster (*Homarus americanus*) are food resources for predatory fish and birds (Bain et al 2007; Waldman 2008; USACE 2009), and commonly found in subtidal bottom and shellfish reef habitats. Horseshoe crab (*Limulus polyphemus*), and specifically the large quantities of horseshoe crab eggs produced during spawning, are key food resources for fish, reptiles, and migrating shorebirds like the red knot (Botton et al 2006). Horseshoe crabs utilize multiple habitats along the shoreline from subtidal bottoms, into intertidal mudflats, and along sandy beaches.

Clams (for example softshell, *Mya arenaria*, and quahog, *Mercenaria mercenaria*) are important food resources for other food web components and also perform water quality functions (USFWS 1997a). Blue mussels (*Mytilus edulis*) are found in intertidal shallows along the shorelines attached to hard substrates, while ribbed mussels (*Geukensia demissa*) are found in soft sediments and have an important mutualism with cordgrass species. Both mussel species are important food resources for fish and birds and as filter-feeders they improve water quality (Bain et al. 2007; Waldman 2008; USACE 2009; NYC Department of Environmental Protection 2014). Oysters (*Crassostrea virginica*) filter particulate matter from the water column, enhance subtidal habitats like eelgrass beds, and function as food resources for fish and birds.

With respect to the Atlantic Ocean Shorefront Planning Reach, the primary shellfish with important commercial or recreational value in the near shore portion of the study area are the hardshell clam [Quahog], softshell clam, bay scallop (*Argopencten irradiens*), American lobster, and blue crab (MacKenzie 1990). Surf clam (*Spisula solidissima*), razor clam (*Ensis directus*) and tellin (*Tellina agillis*) occur in the vicinity of the offshore borrow area. Surveys conducted by the USACE in 2003 and by the NYSDEC in 2012 indicate that the borrow area itself contains very small, to no, localized populations of surf clam.

With respect to the Jamaica Bay Planning Reach, horseshoe crabs are known to utilize sandy beach habitats. Ribbed mussels are dominant in certain areas associated with shoreline banks vegetated with smooth cordgrass. As noted above, while oyster reefs no longer exist in the study area, scattered live oysters can be found in localized areas. Specific to the project area, a spat-on shell reef was established off the shoreline of Dubos Point in 2010.

2.8 Finfish

Primary fish species of the Atlantic Ocean Shorefront Planning Reach and borrow area include black sea bass (*Centropristis striata*), summer flounder (*Paralichthys dentatus*), winter flounder (*Pseudopleuronectes americanus*), weakfish (*Cynosion regalis*), bluefish (*Pomatomus saltatrix*), scup (*Stenotomus chrysops*), striped bass (*Morone saxatillis*), and Atlantic mackerel (*Scomber scombrus*). In addition, other common species in near shore waters include tautog (*Tautoga onitis*), northern puffer (*Sphoeroides maculates*), windowpane (*Scophthalmus aquosus*) and American eel (*Anguilla rostrata*). A number of migrant anadromous and catadromous species are found throughout both study area reaches. Common migrant species include the Atlantic sturgeon (*Acipenser oxyhinchus*), blueback herring (*Alosa aestivalis*), alewife (*Alosa pseudoharengus*), American shad (*Alosa sapidissima*), Atlantic silverside (*Menidia menidia*), striped bass, and American eel (Woodhead 1992).

Jamaica Bay habitats are highly productive and support a large number of fish species that serve as key resources for other Jamaica Bay ecosystem components. Forage fish (*Fundulus sp.*) are important middle food web components and function as food resources for birds and predatory fish including resident (e.g., flounder sp.) and anadromous (e.g., shad, herring, Atlantic sturgeon, striped bass) species (USFWS 1997b; Waldman 2008; USACE 2009).

Winter flounder was the most important commercial and recreational fish to use Jamaica Bay in great numbers during all life stages; Jamaica Bay is also believed to be a significant breeding area for this species. Forage fish species with high abundances, including Atlantic silverside (*Menidia menidia*), bay anchovy (*Anchoa mitchilli*), mummichog (*Fundulus heteroclitus*), Atlantic menhaden (*Brevoortia tyrannus*), and striped killifish (*Fundulus majalis*), form a prey base for other fish and birds that use the area. Both the nearshore and offshore waters of the study area support seasonally abundant populations of many recreational and commercial finfish (USFWS 1989, 1995, USACE 1995). Some of the other common species found in surveys and recreational landings include scup, bluefish, windowpane, tautog, weakfish, black sea bass, summer flounder, American eel, and searobin (*Prionotus spp*.). Anadromous species that use the area include blueback herring, Atlantic sturgeon, alewife, American shad, striped bass, and Atlantic mackerel (*Scomber scombrus*).

The Atlantic sturgeon is a federally endangered species that is vulnerable to various impacts because of their wide-ranging use of rivers, estuaries, bays and the ocean throughout the phases of their life. In addition, they have been commercial over-harvesting for years and which likely has contributed to population declines. Further information is discussed in the Protected Species section below.

2.9 Reptiles and Amphibians

The diamondback terrapin (*Malaclemys terrapin*) are medium sized turtle species that inhabits brackish waters of estuaries, tidal creeks, and salt marshes along the northeastern coast of North America. Unfortunately, and its populations are declining throughout their range (Waldman 2008; USACE 2009). Diamondback terrapin use habitats within the Jamaica Bay Planning Reach for nesting and feeding.

Other amphibians and reptiles species that may potentially be present in the study area include Fowler's toad (*Bufo woodhousii fowleri*), spring peeper (*Pseudacris crucifer*), gray treefrog (*Hyla versicolor*), green frog (*Rana clamitans*), spotted salamander, redback salamander (*Plethodon cinereus*), northern brown snake (*Storeria d. dekayi*), smooth green snake (*Opheodrys vernalis*), eastern hognose snake (*Heterodon platirhinos*), eastern milk snake (*Lampropeltis triangulum triangulum*), northern black racer (*Coluber c. constrictor*), snapping turtle (*Chelydra serpentina*), eastern painted turtle (*Chrysemys p. picta*), and eastern box turtle (*Terrapene c. carolina*).

Five species of threatened and endangered marine turtles have habitat ranges that overlap with the near shore coastal waters of the study area during summer and early fall. Species include the federally-listed Kemp's ridley (*Lepidochelys kempii*, endangered), leatherback (*Dermochelys coriacea*, endangered), green (*Chelonia mydas*, threatened), loggerhead (*Caretta caretta*, threatened), and hawksbill (*Eretmochelys imbricata*, endangered). The most common are Kemps ridley that prefer coastal areas, and leatherbacks, which commonly found nearby in offshore Long Island waters (NYS DEC 2016a), while the hawksbill is considered to be the rarest encountered in NY waters (NYS DEC 2016b). Sea turtles may utilize coastal resources in the study area for foraging. However, nesting is unlikely to occur along beaches in the Atlantic

Ocean Shorefront Planning Reach, as breeding grounds for all species are located in warmer waters to the south.

2.10 Birds

Several different groups of bird species use both the Atlantic Ocean Shorefront Planning Reach and the Jamaica Bay Planning Reach. Wading birds (herons, stilts), seabirds (terns, cormorants), waterfowl (ducks, geese), shorebirds (plovers, sandpipers), passerines (terrestrial songbirds) and raptors are dependent upon the different types of coastal and upland habitats found in these areas (Waldman 2008; USACE 2009; NYC Audubon 2015). Both resident and migratory bird species use Jamaica Bay (including Floyd Bennet Field, Gateway National Wildlife Refuge), Rockaway Beaches and Breezy Point.

A wide diversity of bird species is likely to occur within, and in the vicinity of, the study area. The most common species in the study area are habitat generalists that are tolerant of development and that utilize beach habitat along the shoreline and deepwater habitats. Common species include herring gull (*Larus argentatus*), greater black-backed gull (*Larus marinus*), American crow (*Corvus brachyrhynchos*), American robin (*Turdus migratorius*), barn swallow (*Hirundo rustica*), black-bellied plover (*Pluvialis squatarola*), black scoter (*Melanitta nigra*), bufflehead (*Bucephala albeola*), common grackle (*Quiscalus quiscula*), common yellowthroat (*Geothlypis trichas*), double-crested cormorant (*Phalacrocorax auritus*), European starling (*Sturnus vulgaris*), gray catbird (*Dumetella carolinensis*), mourning dove (*Zenaida macroura*), rock dove/pigeon (*Columba livia*), sanderling (*Calidris alba*), song sparrow (*Milospiza melodia*), house sparrow (*Passer domesticus*), house finch (*Carpodacus mexicanus*), and tree swallow (*Iridoprocne bicolor* [USACE 1998, 2003, USFWS 1992]). Permanent avian residents of the surrounding area include various species of gulls, crows, pigeons, and sparrows, which are commonly associated with developed areas and areas of high human activity (USFWS 1992, USACE 1998, 2003). Numerous migratory bird species of conservation concern are likely to be found breeding, foraging or migrating through the study area and are listed in Section 2.9.3.

2.11 Mammals

Although mammals are a less visible component of study area ecosystems, the study area serves as important habitat for many species. Bat species like hoary bat (*Lasiurus cinereus*), red bat (*Lasiurus borealis*), little brown bat, (*Myotis lucifugus*), and silver-haired bat (*Lasionycteris noctivagans*) may be present (Waldman 2008) in upland habitats adjacent to Jamaica Bay. Other terrestrial mammals in the Atlantic Ocean Shorefront Planning Reach and the Jamaica Bay Planning Reach include opossum (*Didelphis virginiana*), black-tailed jackrabbit (*Lepus californicus*) escaped from JFK Airport cargo, eastern cottontail rabbit (*Sylvilagus floridanus*), eastern chipmunk (*Tamias striatus* - introduced), gray squirrel (*Sciurus carolinensis*), white-footed mouse (*Peromyscus leucopus*), meadow vole (*Microtus pennsylvanicus*), muskrat (*Ondatra zibethicus*), and house mouse (*Mus musculus*).

Nearshore coastal and the borrow areas serve as habitat for several marine mammals. Federally-listed cetaceans that may occur in the study area include the endangered North Atlantic right whale (*Eubalaena glacialis*); the endangered humpback whale (*Megaptera novaeangliae*); and the endangered fin whale (*Balaenoptera physalus*) (USACE 2015). Non-listed cetacean species with nearshore coastal New York water habitats include finback (*Balaenoptera physalus*), minke (*B. acutorostrata*), and pilot (*Globicephala melaena*) whales as well as several dolphin species, including common (*Delphinus delphis*), bottle-nosed (*Tursiops truncatus*), white-sided (*Lagenorhynchus acutus*), and striped (*Stenella coerulealba*), and harbor porpoise (*Phocoena phocoena*) (Edinger et. al. 2014). Other marine mammals that are found in coastal waters include seals. Harbor seals, the most abundant seal species found within New York State waters, frequently winter in nearshore waters of the study area and can be found basking on sand bars, rocks, or remote beaches (NYS DEC 2016c). Although not as frequent, grey seal (*Halichoerus grypus*) habitat also overlaps with the study area.

2.12 Threatened and Endangered Species

2.12.1 Federally-Listed Species

The USFWS, through its formal consultation with USACE regarding implementation of the project, identified three threatened and endangered (T&E) species as being present on or near the project area:

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

A formal Biological Assessment pertaining to these three species is included as Attachment D2 within the Environmental Compliance Appendix. In addition, the state-listed threatened common tern (Sterna hirundo) and least tern (*Sterna antillarum*) and the federally and state-listed Endangered roseate tern (*Sterna dougallii*), have been identified as species that may occur in the Project Area ; specifically utilizing beach habitat similar to that of the piping plover and sea beach amaranth (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 through the Biological Assessment (USFWS 1995a).

Seasonal avian surveys are conducted by NYC Parks and Recreation at the Atlantic Ocean Shorefront Planning Reach. In 2014 piping plovers used approximately 2 miles of beach. There are three continuous management zones: Far Rockaway (B9-B35 Street), Arverne (B35-B73 Street) and Rockaway (B73- B149 Street). In most years, including 2014, plovers bred between Beach 56th to Beach 19th Streets. 2014 breeding season netted 12 pairs. 54 eggs, 44 chicks and 25 fledglings (Productivity Rate of 2.08 fledglings/pairs).

Migrating red knot populations use the beach habitat within the Atlantic Ocean Shorefront Planning Reach to forage on horseshoe crab eggs laid on beaches in Jamaica Bay, Breezy Point, and Rockaway Beaches. The red knot is only present in the study area during migration and does not breed there.

More than 90 percent of New York State's population of roseate terns is made up by a single colony on Great Gull Island, off Long Island's eastern end. The remainder occurs in small groups of often just one or two breeding pairs in variable locations along the south shore of eastern Long Island (Mitra 2008). Roseate terns have sporadically nested within the Jamaica Bay estuary in the past (e.g., 2 pairs in 1996; Wells 1996), but during the most recent Breeding Bird Atlas, they were not documented anywhere west of Suffolk County (Mitra 2008). Roseate terns are not among the beach-nesting bird species that nest on Rockaway Beach (Boretti et al.

2007). The Jamaica Bay estuary provides feeding and nesting habitat. The potential for roseate terns to occur in the study area is considered low and limited to migrants moving through the area en route to nesting sites elsewhere in the region or to wintering grounds in the southern hemisphere.

The Atlantic Ocean Shorefront Planning Reach supports one of the largest seabeach amaranth populations in New York State (Young 2000). During field surveys conducted by NYSDEC biologists in 2000, 26 sea beach amaranth plants were identified on the beach between Beach 22nd and Beach 39th Streets (Young 2000). A larger population of approximately 2,000 plants was also identified further west, between Beach 44th and Beach 66th streets. Seabeach amaranth is an annual plant that prefers beach habitats, and is subject to competitive exclusion by beach grass and other vegetation.

In addition, the federally-endangered Atlantic sturgeon (*Acipenser oxyrhynchus oxyrhynchus*, endangered) is listed in the New York Bight. Specifically, adult and subadult can be found within the study area. Numbers of Atlantic sturgeon in the New York Bight distinct-population segment are extremely low compared to historical levels and have remained so for the past 100 years. Currently, the existing spawning population in the Hudson River is estimated to have 870 adults spawning each year (600 males and 270 females). There is no population estimate for the Delaware River, but it is believed to have less than 300 spawning adults per year. The spawning population of this distinct population segment is thought to be one to two orders of magnitude below historical levels. Additionally, the shortnose sturgeon (Acipenser brevirostrum), in the adult and sub-adult life stages, may also be present in these waters. The shortnose sturgeon is endangered throughout its range. Both species may occur in the study area periodically and seasonally.

As noted above, two federally listed whales and four federally listed sea turtles also may occur in the study area, periodically and seasonally.

2.12.2 Critical Habitat

No federally designated critical habitat is found within or near the study 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.

2.12.3 Migratory Birds

Migratory birds are protected by the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act. Any activity that results in the take of migratory birds or eagles is prohibited unless authorized by USFWS. The results of a data search through USFWS' Information for Planning and Consulation (IPaC) which identified 68 migratory birds which could potentially be affected by a project in the study area are shown as Table 2-1.

Table 2-1: Migratory Bird Species with Potential to Occur in or Proximate to the Study Area

Scientific Name	Common Name	Presence	Breading Season
Haematopus palliatus	American Oystercatcher	Year round	Breeds Apr 15 to Aug 31
Sterna paradisaea	Arctic Tern	Seasonal	Breeds May 20 to Aug 15
Haliaeetus leucocephalus	Bald Eagle	Year round	Breeds Oct 15 to Aug 31
Cephhus grylle	Black Guillemot	Seasonal	Breeds May 15 to Sep 10
Melanitta nigra	Black Scoter	Year round	Breeds elsewhere
Rynchops niger	Black Skimmer	Seasonal	Breeds May 20 to Sept 15
Coccyzus erythropthalmus	Black-billed Cuckoo	Seasonal	Breeds May 15 to Oct 10
Rissa tridactyla	Black-legged Kittiwake	Seasonal	Breeds elsewhere
Dolichonyx oryzivorus	Bobolink	Seasonal	Breeds may 20 to Jul 31
Chroicocephalus philadephia	Bonaparte's Gull	Year round	Breeds elsewhere
Onychoprion anaethetus	Bridled Tern	Seasonal	Breeds Apr 15 to Sep 20
Pelecanus occidentalis	Brown Pelican	Seasonal	Breeds Jan 15 to Sep 30
Calidris subruficollis	Buff-breasted Sandpiper	Seasonal	Breeds elsewhere
Cardellina canadensis	Canada Warbler	Seasonal	Breeds May 20 to Aug 10
Dendroica cerulea	Cerulean Warbler	Seasonal	Breeds Apr 29 to Jul 20
Rallus crepitans	Clapper Rail	Seasonal	Breeds Apr 10 to Oct 31
Somateria mollisima	Common Elder	Seasonal	Breeds Jun 1 to Sep 30
Gavia immer	Common Loon	Year round	Breeds Apr 15 to Oct 31
Sterna hirundo	Common Tern	Seasonal	Breeds May 10 to Sep 10
Calonectris diomedea	Cory's Shearwater	Seasonal	Breeds elsewhere
Phalacrocorax auritus	Double-crested Cormorant	Year round	Breeds Apr 20 to Aug 31
Alle alle	Dovekie	Seasonal	Breeds elsewhere
Calidris alpine arcticola	Dunlin	Year round	Breeds elsewhere
Coccothraustes vespertinus	Evening Grosbeak	Seasonal	Breeds elsewehere
Aquila chrysaetos	Golden Eagle	Seasonal	Breeds elsewhere
Vermivora chrysoptera	Golden-winged Warbler	Seasonal	Breeds May 1 to Jul 20
Larus marinus	Great Black-backed Gull	Year round	Breeds Apr 15 to Aug 20
Puffinus gravis	Great Shearwater	Seasonal	Breeds elsewhere
Gelochelidon nilotica	Gull-billed Tern	Seasonal	Breeds May 1 to Jul 31
Larus argentatus	Herring Gull	Year round	Breeds Apr 20 to Aug 31
Limosa haemastica	Hudsonian Godwit	Seasonal	Breeds elsewhere
Oporornis formosus	Kentucky Warbler	Seasonal	Breeds Apr 20 to Aug 20
Oceanodroma leucorhoa	Leach's Storm-petrel	Seasonal	Breeds May 15 to Nov 20
Sterna antillarum	Least Tern	Seasonal	Breeds Apr 20 to Sep 10
Tringa flavipes	Lesser Yellowlegs	Seasonal	Breeds elsewhere
Asio otus	Long-eared Owl	Seasonal	Breeds elsewhere
Clangula hyemalis	Long-tailed Duck	Seasonal	Breeds elsewhere
Puffinus puffinus	Manx Shearwater	Seasonal	Breeds Apr 15 to Oct 31
Ammodramus nelson	Nelson's Sparrow	Seasonal	Breeds May 15 to Sep 5
Morus bassanus	Northern Gannet	Seasonal	Breeds elsewhere
Stercorarius parasiticus	Parasitic Jaeger	Seasonal	Breeds elsewhere
Dendroica discolor	Prairie Warbler	Seasonal	Breeds May 1 to Jul 31
Protonotaria citrea	Prothonotary Warbler	Seasonal	Breeds Apr 1 to Jul 31
Calidris maritima	Purple Sandpiper	Seasonal	Breeds elsewhere
Alca torda	Razorbill	Seasonal	Breeds Jun 15 to Sep 10
Phalaropus fulicarius	Red Phalarope	Seasonal	Breeds elsewhere
Mergus serrator	Red-breasted Merganser	Year round	Breeds elsewhere
Melanerpes erythrocephalus	Red-headed Woodpecker	Seasonal	Breeds May 10 to Sep 10
Phalaropus lobatus	Red-necked Phalarope	Seasonal	Breeds elsewhere

Scientific Name	Common Name	Presence	Breading Season
Gavia stellata	Red-throated Loon	Seasonal	Breeds elsewhere
Larus delawarensis	Ring-billed Gull	Year round	Breeds elsewhere
Sterna dougallii	Roseate Tern	Seasonal	Breeds May 10 to Aug 10
Thatlasseus maxiumus	Royal Tern	Seasonal	Breeds Apr 15 to Aug 31
Arenaria interpres morinella	Ruddy Turnstone	Seasonal	Breeds elsewhere
Euphagus carolinus	Rusty Blackbird	Seasonal	Breeds elsewhere
Ammodramus caudacutus	Saltmarsh Sparrow	Seasonal	Breeds May 15 to Aug 20
Ammodramus mritimus	Seaside Sparrow	Seasonal	Breeds May 10 to Aug 20
Calidris pusilla	Semipalmated Sandpiper	Seasonal	Breeds elsewhere
Limnodromus griseus	Short-billed Dowitcher	Seasonal	Breeds elsewhere
Bubo scandiacus	Snowy Owl	Seasonal	Breeds elsewhere
Onychoprion fuscatus	Sooty Tern	Seasonal	Breeds Mar 10 to Jul 31
Melanitta perspicillata	Surf Scoter	Seasonal	Breeds elsewhere
Uria lomvia	Thick-billed Murre	Seasonal	Breeds Apr 15 to Aug 15
Numenius phaeopus	Whimbrel	Seasonal	Breeds elsewhere
Melanitta fusca	White-winged Scoter	Seasonal	Breeds elsewhere
Tringa semipalmata	Willet	Seasonal	Breeds Aug 20 to Aug 5
Oceanites oceanicus	Wilson's Storm-petrel	Seasonal	Breeds elsewhere
Hylocichla mustelina	Wood Thrush	Seasonal	Breeds May 10 to Aug 31

2.12.4 State-Listed Species of Concern

A review of New York State-listed threatened, endangered, and rare species and species of concern in Nassau, Queens, and Kings Counties was conducted using the NYDEC website (http://www.dec.ny.gov/animals/7494.html, accessed April 6, 2016), and are summarized in Table 2-2.

The state-listed endangered least tern (*Sterna antillerum*) is known to occur in the same type of habitat as the piping plover and roseate tern (see Section 2.3.9 Threatened and Endangered Species) (USACE 1993). Least terns are known to nest in areas in the vicinity of Beach 45th Street and westward along the beach (USFWS 1999). Other state-listed threatened species that occur in the general area include the northern harrier (*Circus cyaneus*), osprey (*Pandion haliaetus*), and common tern (*Sterna hirundo*).

In addition, the piping plover (state endangered), peregrine falcon (state endangered), roseate tern (state endangered), and the bald eagle (state threatened) are present in the study area.

Two species of state-listed plants are known to occur in the vicinity of the study area (Young 2000). Seabeach knotweed (*Polygonum glaucum*, state status: rare) and dune sandspur (*Cenchrus tribuliodes*, state status: threatened) have been observed by NYSDEC biologists in the same type of habitat along the East Rockaway beaches as the federally-listed sea beach amaranth (Young 2000).

Table 2-2: New York State Protected Species with Potential to Occur in or Proximate to the Study Area

Scientific Name	Common Name	NY-listed (county)
Gavia immer	Common Loon	SC
Podilymbus podiceps	Pied-billed Grebe	T
Botaurus lentiginosus	American Bittern	SC
Ixobrychus exilis	Least Bittern	T
Haliaeetus leucocephalus	Bald Eagle	T
Accipiter cooperii	Cooper's Hawk	SC
Accipter striatus	Sharp-shinned hawk	SC
Buteo lineatus	Red-shouldered Hawk	SC
Circus cyaneus	Northern harrier	T
Falco peregrinus	Peregrine Falcon	E
Pandion haliaetus	Osprey	SC
Bartramia longicauda	Upland sandpiper	T
Rynchops niger	Black skimmer	SC
Sterna antillarum	Least tern	T
Sterna hirundo	Common tern	T
Asio flammeus	Short-eared owl	E
Eremophila alpestris	Horned lark	SC
Ammodramus maritimus	Seaside sparrow	SC
Ammodramus savannarum	Grasshopper sparrow	SC
Charadrius melodus	Piping Plover	E
Sterna dougallii dougallii	Roseate Tern	E

SC – Species of Concern; T – Threatened; E - Endangered

2.13 Special Management Areas

2.13.1 Gateway National Recreation Area

The following sections identify the individual Gateway National Recreation Area parks that fall within either the Jamaica Bay Planning Reach or the Atlantic Ocean Shorefront Planning Reach.

2.13.1.1 Atlantic Ocean Shorefront Planning Reach

The Gateway National Recreation Area parks located within the Rockaway Atlantic Ocean Shorefront Planning Reach include Fort Tilden, Jacob Riis Park, and Breezy Point Tip (Figure 2-2).

2.13.1.2 Jamaica Bay Planning Reach

The Gateway National Recreation Area parks located within the Jamaica Bay Planning Reach include Jamaica Bay Wildlife Refuge, Floyd Bennett Field, Plumb Beach, Bergen Beach, Canarsie Pier, and the Frank Charles Memorial Park (Figure 2-2). In addition to these specific park lands, Figure 2-2 also shows that the northern perimeter of Jamaica Bay and the majority of the waters of Jamaica Bay fall within the jurisdictional boundaries of the GNRA.

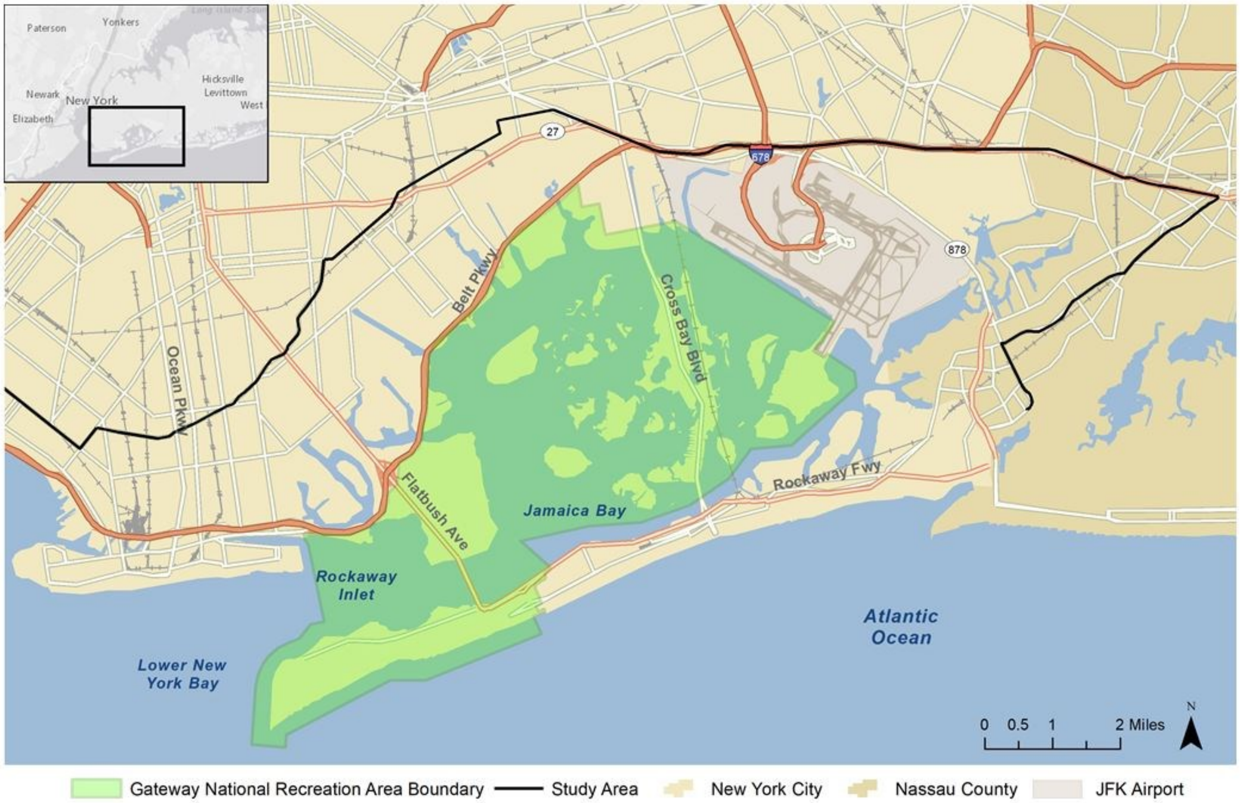


Figure 2-2: Gateway National Recreation Area Boundary

2.13.2 NYC Waterfront Revitalization Program

This Discussion incorporates both Planning Reaches. The NYC Waterfront Revitalization Program (WRP) is the city's principal coastal zone management tool. It establishes the City's policies for development and use of the waterfront. Most city, state and federal discretionary actions in the Coastal Zone must be reviewed for consistency with these policies.

On February 3, 2016, the NYS Secretary of State approved the revisions to the NYC Waterfront Revitalization Program. This set of policies and maps should be used for consistency review of all local and state actions. However, until the revisions to the Waterfront Revitalization Program (WRP) are approved by the US Secretary of Commerce, the 2002 WRP should be used for all federal actions that require consistency review.

Although the NYC WRP policies are intended to be used to evaluate proposed actions to promote activities appropriate to various waterfront locations, evaluating the consistency of existing land use with those policies can be used to anticipate future waterfront conditions. Ten policies are included in the Program: (1) residential and commercial redevelopment; (2) water-dependent and industrial uses; (3) commercial and recreational boating; (4) coastal ecological systems; (5) water quality; (6) flooding and erosion; (7) solid waste and hazardous substances; (8) public access; (9) scenic resources; and (10) historical and cultural resources.

As originally mapped and adopted in 1982, the coastal zone boundary defines the geographic scope of the WRP (Figure 2-3).

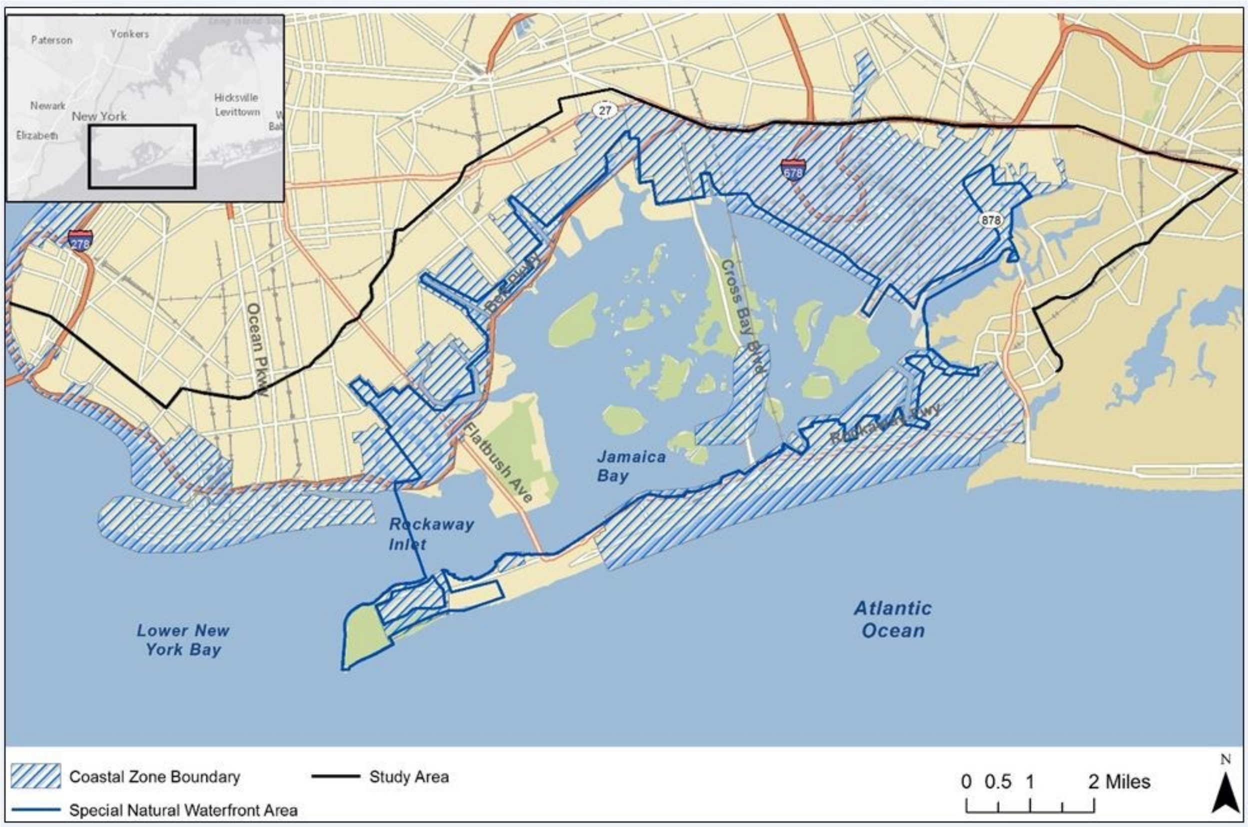


Figure 2-3: NYC Waterfront Revitalization Program, Coastal Zone Boundary, and Special Natural Waterfront Areas

2.13.3 Coastal Zone Boundary

This discussion incorporates both Planning Reaches. As originally mapped and adopted in 1982, the coastal zone boundary defines the geographic scope of the WRP. Pursuant to federal statute, the boundary encompasses all land and water of direct and significant impact on coastal waters.

The coastal zone boundary extends from the Westchester and Nassau County and New Jersey boundaries seaward to the three-mile territorial limit in the Atlantic. The boundary extends landward to encompass the following coastal features:

- Significant Maritime and Industrial Areas
- Significant Coastal Fish and Wildlife Habitats
- Special Natural Waterfront Areas (e.g. Jamaica Bay)
- Staten Island Bluebelts
- Intertidal and Freshwater Wetlands
- Coastal Floodplains and Flood Hazard Areas
- Erosion Hazard Areas
- Coastal Barrier Resources Act Areas
- Steep Slopes

- Parks and Beaches
- Visual Access and Views of Coastal Waters and the Harbor
- Historic, Archaeological, and Cultural Sites Closely Associated with the Coast
- Special Zoning Districts.

In developed areas devoid of these features, the coastal zone boundary is generally defined as the nearest legally mapped street at least 300 feet landward of the Mean High Tide Line. In undeveloped areas devoid of these features, the landward boundary is delineated at the legally mapped street nearest to the first major man-made physical barrier. Exceptions to these guidelines include City Island, Broad Channel Island, and the Rockaway Peninsula which are included within the coastal zone in their entirety. Federal lands and facilities are excluded from the coastal zone and consistency review in accordance with federal legislation. However, should the federal government dispose of any coastal property, it would be included in the coastal zone.

2.13.4 NYC Special Natural Waterfront Area

This discussion incorporates both Planning Reaches. Jamaica Bay, including the Rockaway peninsula, is a NYC-designated Special Natural Waterfront Area (SNWA). A SNWA is a large area with concentrations of important coastal ecosystem features such as intertidal wetlands, habitats and buffer areas, many of which are regulated under other programs. The New Waterfront Revitalization Program (NYC Department of City Planning [NYCDCP] 1999b) defines SNWAs as coastal areas with special characteristics identified in NYC's Comprehensive Waterfront Plan that "have particular natural habitat features that should be considered in connection with any waterfront activity." It further directs that "activities that protect and restore these features would be consistent with waterfront policy for these areas." Accordingly, the WRP encourages public investment within the SNWA to focus on habitat protection and improvement and discourages activities that interfere with the habitat functions of the area. Acquisition of sites for habitat protection is presumed consistent with the goals of this policy. Similarly, fragmentation or loss of habitat areas within an SNWA should be avoided.

2.13.5 Coastal Barrier Resources Act Areas

This discussion incorporates both planning reaches. In the 1970s and 1980s, Congress recognized that certain actions and programs of the federal government have historically subsidized and encouraged development on coastal barriers, resulting in the loss of natural resources; threats to human life, health, and property; and the expenditure of millions of tax dollars each year (USFWS, 2016). To remove the federal incentive to develop these areas, the Coastal Barrier Resources Act (CBRA) of 1982 designated relatively undeveloped coastal barriers along the Atlantic and Gulf coasts as part of the John H. Chafee Coastal Barrier Resources System (CBRS), and made these areas ineligible for most new federal expenditures and financial assistance. CBRA encourages the conservation of hurricane prone, biologically rich coastal barriers by restricting federal expenditures that encourage development, such as federal flood insurance. Areas within the CBRS can be developed provided that private developers or other non-federal parties bear the full cost.

The CBRA was amended by the Coastal Barrier Improvement Act of 1990 which added a new category of coastal barriers called Otherwise Protected Areas (OPAs). OPAs are undeveloped coastal barriers that are within the boundaries of an area established under federal, state, or local law, or held by a qualified organization, primarily for wildlife refuge, sanctuary, recreational, or natural resource conservation purposes.

Federal expenditures are allowable within the CBRS, if it meets any of the following exceptions (16 U.S.C. § 3505(a)(6)) and is also consistent with the three purposes of the CBRA (e.g. to minimize [1] the loss of human life, [2] wasteful expenditure of federal revenues, and [3] the damage to fish, wildlife, and other natural resources associated with coastal barriers) :

- Projects for the study, management, protection, and enhancement of fish and wildlife resources and habitats, including acquisition of fish and wildlife habitats, and related lands, stabilization projects for fish and wildlife habitats, and recreational projects.
- Establishment, operation, and maintenance of air and water navigation aids and devices, and for access thereto.
- Projects under the Land and Water Conservation Fund Act of 1965 (16 U.S.C. § 460l-4 through 11) and the Coastal Zone Management Act of 1972 (16 U.S.C. § 1451 et seq.).
- Scientific research, including aeronautical, atmospheric, space, geologic, marine, fish and wildlife, and other research, development, and applications.
- Assistance for emergency actions essential to the saving of lives and the protection of property and the public health and safety, if such actions are performed pursuant to sections 5170a, 5170b, and 5192 of title 42 and section 1362 of the National Flood Insurance Act of 1968 (42 U.S.C. § 4103) and are limited to actions that are necessary to alleviate the emergency.
- Maintenance, replacement, reconstruction, or repair, but not the expansion (except with respect to U.S. route 1 in the Florida Keys), of publicly owned or publicly operated roads, structures, and facilities.
- Nonstructural projects for shoreline stabilization that are designed to mimic, enhance, or restore a natural stabilization system.

The western portion of the Rockaway peninsula and all of Jamaica Bay are located within the designated CBRA (Unit NY-60P) (Figure 2-4). Since this area is designated as an Otherwise Protected Area (OPA), the restrictions on federal expenditures are far less. The only restriction in OPAs is in issuance of Federal Flood Insurance. There is no requirement to demonstrate that the project meet the above exemptions when the work is within an OPA, and CBRA does not impact alternative development or plan selection.

Figure 2-4: Coastal Barrier Resource System Area

2.13.6 New York State Natural Heritage Program

This discussion incorporates both Planning Reaches. The New York State Natural Heritage Program, in conjunction with The Nature Conservancy, recognizes two Priority Sites for Biodiversity within the Jamaica Bay and Breezy Point habitat complex: Breezy Point Tip (B2 - very high biodiversity significance) and Fountain Avenue Landfill (B3 - high biodiversity significance). The Breezy Point Tip is located in the Atlantic Ocean Shorefront Planning reach and the Fountain Avenue Landfill is located in the Jamaica Bay Planning Reach.

2.13.7 New York State Department of State Significant Coastal Fish and Wildlife Habitats

This discussion incorporates both planning reaches. Jamaica Bay and Breezy Point Tip have been designated as Significant Coastal Fish and Wildlife Habitats by the New York State Department of State (NY Department of State, Planning and Development, 2016) (Figure 2-5).

Figure 2-5: NYS Dept. State Significant Coastal Fish and Wildlife Habitats

Note: Green shaded area indicates Significant Coastal Fish and Wildlife Habitats
Source: NY Department of State, Planning and Development, 2016.

2.13.8 NYC Planning Special Purpose Districts

In addition to standard zoning, the NYC Department of City Planning (DCP) has designated special zoning districts to achieve specific planning and urban design objectives in defined areas with unique characteristics[18]. Special districts respond to specific conditions; each special district designated by the Commission stipulates zoning requirements and/or zoning incentives tailored to distinctive qualities that may not lend themselves to generalized zoning and standard development. Any CSRM measures developed within a special purpose district would require consultation with the NYC Planning Commission.

2.13.8.1 Atlantic Ocean Shorefront Planning Reach

No NYC-designated special purpose districts were identified within the Rockaway Area of Potential Effect (APE) (NYC Planning, 2016).

2.13.8.2 Jamaica Bay Planning Reach

Within the Jamaica Bay APE, the NYC Planning-designated special purpose districts are located to the west of Marine Parkway Bridge, and include the following areas:

- Sheepshead Bay District. The Sheepshead Bay district was identified to protect and strengthen that neighborhood's waterfront recreation and commercial character. New

[18] NYC Planning, 2016, http://www1.nyc.gov/site/planning/zoning/districts-tools/special-purpose-districts.page

commercial projects and residential development must meet conditions that will support the tourist-related activities along the waterfront. Provision for widened sidewalks, landscaping, useable open space, height limitations, and additional parking.

- Ocean Parkway District. The Ocean Parkway Special District encompasses a band of streets east and west of the parkway extending from Prospect Park in the north to Brighton Beach on the south. The purpose of the Special District is to enhance the character and quality of this broad landscaped parkway, a designated Scenic Landmark.
- Coney Island District. The Special Coney Island District was created as part of a comprehensive, long-range plan to re-establish famed Coney Island as a year-round, open entertainment and amusement destination. Outside of the entertainment area, the district fosters neighborhood amenities and new housing opportunities, including affordable housing through the Inclusionary Housing designated areas Program.
- Coney Island Mixed Use District. The Special Coney Island Mixed Use District was established to stabilize existing residential development and protect the industries within an area, zoned M1-2, north of Neptune Avenue. The district allows existing residential buildings to be improved and enlarged, and new residential infill housing to be developed if adjacent to an existing residence or community facility. Certain manufacturing uses and most commercial uses are allowed as-of-right on lots adjacent to existing commercial and manufacturing uses, and along certain streets that allow commercial uses.
- Bay Ridge District. The Special Bay Ridge District maintains the neighborhood's existing scale in conjunction with contextual and lower-density zoning districts mapped throughout the district. Beyond the underlying district controls, the neighborhood streetscape is preserved by limitations on the maximum permitted floor area ratio and the height of community facilities, which is limited to 32 feet in contextual zoning districts.
- Special Coastal Risk District. DCP designated two special coastal risk districts in the study area in 2017: Hamilton Beach and Broad Channel. The Special Coastal Risk District was created to address coastal areas that are currently at exceptional risk from flooding and may face greater risk in the future. The Special District places limits on new development in these vulnerable areas and, in certain instances, to protect sensitive natural areas and ensure that new development is consistent with open space and infrastructure plans.

2.13.9 NYSDEC Critical Environmental Area

This discussion incorporates both Planning Reaches. Jamaica Bay, including the Rockaway peninsula, is recognized by the NYSDEC under the State Environmental Quality Review Act as a Critical Environmental Area (CEA) (NYSDEC, 1990). The NYSDEC states that Jamaica Bay and its tributaries, tidal wetlands, and regulated adjacent areas are considered to be a CEA. The tributaries leading into Jamaica Bay (e.g., Gerritsen Creek) and their tidal wetlands and regulated adjacent areas are considered as part of this CEA. The NYSDEC defines a CEA as having "exceptional or unique character." The distinct characteristics associated with Jamaica Bay are: 1) a natural setting (e.g., fish and wildlife habitat, forest and vegetation, open space and areas of important aesthetic or scenic quality) and 2) an inherent ecological, geological or hydrological sensitivity to change that may be adversely affected by any change.

2.13.10 New York/New Jersey Harbor Estuary Program

This discussion incorporates both Planning Reaches. The New York/New Jersey Harbor Estuary Program (HEP) has also recognized the importance of the Jamaica Bay watershed, which includes the Rockaway Peninsula as one of the three watershed areas "of primary concern and ecological importance". HEP has adopted the HRECRP as the restoration strategy for the Program with the Jamaica Bay identified as one of the eight Planning Regions within the HRECRP study area.

2.14 Recreation

Major parks on the Rockaway Peninsula include Rockaway Beach as well as parts of the Gateway National Recreation Area. Rockaway Beach, along the southern edge of the peninsula, is operated or under the authority of NYC Parks. Located along the last stops of the A-line, the beach stretches from Beach 9th Street in Far Rockaway, to Beach 149th Street in Neponsit. It is open year round, but peak beach usage is between Memorial Day and Labor Day. During beach season, lifeguards are employed from 10 AM to 6 PM. Amenities include concessions stands, mobile charging stations, a street hockey rink, a skate park, several play grounds, handball courts a boardwalk, and surf beaches. The City's only legal surfing beaches are on Rockaway Peninsula, between 67-69 Streets and 87-92 Streets.

Beach attendance data provided by the Department of Parks and Recreation (DPR), City of New York, indicates that approximately 7,738,500 beach visits per year occur on the Rockaway Peninsula at Rockaway Beach. Additional details on recreation use and valuation are located in the Economics Appendix.

Several parks on the western portion of Rockaway Peninsula are within the Jamaica Bay unit of GNRA. These are Fort Tilden, Jacob Riis Park, and Breezy Point Tip.

The major recreational areas in Jamaica Bay include Gateway National Recreation Area parks and New York City parks. The Jamaica Bay Unit of the Gateway National Recreation Area includes the following areas: Jamaica Bay Wildlife Refuge, Floyd Bennett Field, Plumb Beach, Bergen Beach, Canarsie Pier, and the Frank Charles Memorial Park. Summary information about these parks is provided below, followed by additional recreation resources in the Jamaica Bay area.

Jamaica Bay Wildlife Refuge encompasses approximately 9,000 acres that include a portion of the bay itself, several islands, two brackish ponds (East Pond and West Pond –now breached), trails, and a visitor center. The refuge is composed of saltmarsh, natural inlets, grassy hassocks, sand dunes, small beaches, and upland habitats. The Jamaica Bay Wildlife Refuge is located along the Atlantic flyway and is a significant bird sanctuary with sightings of over 300 species of songbirds, shorebirds, and waterfowl over the last 30 years. Shoals, bars, and mud flats provide habitat for a number of small mammals, reptiles, and amphibians. The Jamaica Bay Wildlife Refuge is the only wildlife refuge in the National Park System, and is also home to an impressive array of native reptiles, amphibians, small mammals, over 60 species of butterflies and one of the largest populations of horseshoe crabs in the Northeast. The refuge provides opportunities for recreation, scenic vistas, birding, visitor orientation, environmental education, national recreation area maintenance, and ranger operations.

Floyd Bennett Field has a variety of nature programs that include urban camping, ecology walks, astronomy and gardening events and kayak trips, which launch from the Seaplane Ramp into Jamaica Bay. Ranger-led walks through the wild North Forty highlight the site's unique, sensitive ecology and give visitors the opportunity to get as close as possible to amazing flora and fauna without causing harm. Bird lovers especially appreciate the wild grassland areas; these uncut sections provide a variety of rare species with essential native habitat. Additionally, the Floyd Bennett Field Garden Association runs Brooklyn's largest community garden, where members plant and tend their own plots. Other park recreational activities include horseback riding at Jamaica Bay Riding Academy, golf and mini golf, archery, biking, softball, and fishing. Visitors also make use of the Jamaica Bay Greenway, a multi-use pathway adjacent to Floyd Bennett Field for walking, jogging, or biking.

Plum Beach is located at the mouth of Jamaica Bay, along the north shore of Rockaway Inlet, in the New York City borough of Brooklyn. It is a stretch of shoreline, tidal mudflats, low saltmarsh areas, a tidal lagoon, a dune system, and woodland thickets at the entrance to Gerritsen Creek adjacent to the Belt Parkway.

Canarsie Pier offers several recreational opportunities. There is a kayak launch from which many ranger-led Canarsie Pol paddle trips embark and the sheltered coast next to the pier offers a safe space for the park's summer kayak tryouts. Seasonal kite flying activities, youth group paddling, fishing and a summer concert series also take place.

Bergen Beach is located on the north shore of Jamaica Bay (not to be confused with the bordering neighborhood of the same name) is also nearby and within the unit's boundary, supporting the Jamaica Bay Riding Academy concession (horses). Bergen Beach was originally an island later connected to the Brooklyn mainland by landfill.

Frank Charles Memorial Park and Hamilton Beach were originally created as municipal parks and include playgrounds and ball fields along with shoreline access for fishing, as well as some sensitive marshlands.

The Jamaica Bay API also includes many parks owned by New York City and managed by the NYC Department of Parks and Recreation, including, but not limited to:

- Idlewild Park Preserve, including Hook Creek park
- Coney Island Boat Basin
- Calvert Vaux Park
- Bensonhurst Park
- Belt Parkway/Shore Parkway
- Sheepshead Bay Piers/Shore Boulevard
- Manhattan Beach Park
- Marine Park
- Four Sparrow Marsh
- Joseph T. McGuire Park
- Paerdegat Basin Park
- Fresh Creek Park
- Spring Creek Park and Addition
- Broad Channel American Park
- Hook Creek Park/Wildlife Sanctuary
- Tucker Place
- John J. Carty Park
- Dyker Beach Park

- Bensonhurst Park

2.15 Navigation

Rockaway Inlet connects Jamaica Bay to the New York Harbor at the southwest corner of the bay. Rockaway Inlet is the only entrance into the bay from the Atlantic Ocean/New York Harbor. Most of Jamaica Bay is a shallow body of water, primarily navigable only by shallow draft vessels. Over the last century, the various entities, including USACE dredged a number of channels through Jamaica Bay. At the mouth of Jamaica Bay, Rockaway Inlet branches into four channels that vary in depth from 20 to 40 feet. On the west side of the bay, the larger channels fork into smaller channels that run through and around the various marsh islands that are typically 10 to 16 feet deep.

According to USACE data, domestic commercial vessels made approximately 1,002 upbound (entered Jamaica Bay) and downbound (exited Jamaica Bay) trips in 2013. Based on these data, no trips were made by non-domestic vessels into Jamaica Bay. Commercial vessels primarily transport bulk fuel to several privately operated bulk fuel storage terminals located in basins at the eastern end of Jamaica Bay. Commercial vessels also transport sand and gravel to several aggregate facilities at the eastern end of Jamaica Bay and north of Coney Island.

Recreational navigation includes motor, sail, and paddle boats. Recreational traffic includes vessels traveling to and from many private and one municipally-owned marinas offering permanent storage (slips or moorings), as well as transient (temporary) storage associated with restaurants located along the shoreline of Jamaica Bay and Rockaway peninsula.

2.16 Infrastructure

2.16.1 Atlantic Ocean Shorefront Planning Reach

2.16.1.1 Roads

The Rockaway peninsula is accessible from roadways on the eastern end of the peninsula and two bridges crossing over Jamaica Bay from the north. From the north, the primary roadways leading to and from the Rockaway Peninsula include Flatbush Avenue, which crosses over the Marine Parkway Memorial Bridge (Gil Hodges Bridge), and Cross Bay Boulevard, which crosses over the Cross Bay Veterans Memorial Bridge. Marine Parkway-Gil Hodges Bridge is a vertical-lift bridge connecting Rockaway Peninsula to Flatbush Avenue, Floyd Bennett Field, Belt Parkway, and Marine Park. The Cross Bay Veterans Memorial Bridge is a high-level fixed bridge connecting Cross Bay Boulevard from Broad Channel in Jamaica Bay to the Rockaway Peninsula.

From the east, the primary roadway is Rockaway Beach Boulevard, which extends west through the central portion of the peninsula to Jacob Riis Park. Beach Channel Drive on the southern side of the peninsula extends west terminating at Breezy Point Tip. Shore Front Parkway (State Route 908L) is a 1.5-mile roadway that provides access to portions of Rockaway Beach on the northern side of the peninsula.

2.16.1.2 Trains

The Rockaway Park Shuttle is a shuttle service of the New York City Subway operating in Queens. From the Cross Bay Veterans Memorial Bridge, it connects with the A train at Broad

Channel station and is the latest iteration of the Rockaway Shuttle services that have been running in the Rockaway peninsula since 1956. This shuttle train provides service to the western part of the peninsula, with a terminus at Rockaway Park – Beach 116th Street, and to the eastern part with a terminus at Far Rockaway-Mott Avenue. The Long Island Rail Road extends into the eastern portion of the Rockaway peninsula at Far Rockaway, but this train does not connect with the New York City Subway stop at Far Rockaway-Mott Avenue.

2.16.2 Jamaica Bay Planning Reach

2.16.2.1 Airports

John F. Kennedy (JFK) International Airport is a 5,000-acre major international airport located in Queens, New York City. The airport is 12 miles southeast of lower Manhattan and is located within the Jamaica Bay API. Over 70 airlines operate from the airport and have destinations in all six inhabited continents. JFK International Airport is accessible via Route 678 by car, or via the MTA subway and buses and the Long Island Railroad which connect to the JFK AirTrain system, which makes several stops throughout the airport and is operated by the Port Authority of NY & NJ.

2.16.2.2 Roads

The Jamaica Bay API is located in Kings, Queens, and Nassau Counties. Vehicles travel through this area via several key routes and bridges. Within the Jamaica Bay Unit of the Gateway National Recreation Area, the Belt Parkway and Flatbush Avenue provide access to Canarsie Pier and Floyd Bennett Field districts from the north, east, and west (NPS, 2013). Continuing across the Marine Parkway Bridge allows access to the Rockaway Peninsula. Belt Parkway and Woodhaven Boulevard provide access to the Jamaica Bay Wildlife Refuge from the north, east, and west. These routes connect to Cross Bay Boulevard, which extends across the Joseph Addabbo-North Channel Bridge into the Jamaica Bay Wildlife Refuge. The primary roadways to and from Coney Island include Cropsey Avenue and Ocean Parkway.

2.16.2.3 Trains

The New York City Subway provides transit services throughout Kings and Queens Counties. Within the Jamaica Bay API, the L line provides access to Canarsie Park. The New York City Subway also provides access from northern areas to Coney Island, including the Broadway Local N line, Broadway Express Q Line, the 6 Avenue Express D Line, the 6 Avenue Local F Line, and the B line.

2.17 Hazardous, Toxic, and Radioactive Wastes (HTRW)

A review was conducted of publically available databases for selected federal- and state-regulated sites with hazardous, toxic, and radioactive waste (HTRW) for both planning reaches. USEPA's Superfund Information System contains several databases with information on existing Superfund sites, including the Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS), the National Priorities List (NPL), Resource Conservation and Recovery Act Information (RCRAinfo), and the Brownfields Management System. In addition, the NYSDEC has records of RCRA sites. In summary, RCRA sites were investigated with the EPA Clip N Ship Application. The NYSDEC Remediation Site Boundary layer was used to investigate Superfund, Brownfields and Voluntary Cleanup sites within the study area. The Department of Energy database was reviewed for radioactive waste sites (http://energy.gov/em/cleanup-sites).

Summary findings of the review are provided below.

The following entries were found for the Atlantic Ocean Shorefront Planning Reach:

- 47 inactive RCRA sites and 49 active sites (EPA 2016). The generation and disposal of hazardous waste should not have an effect on the environment if in compliance with RCRA.
- 3 Brownfield Cleanup Sites (NYSDEC 2016). Of those sites, two sites are active, none are closed and one is No Further Action Taken.
- 5 State Superfund Sites (NYSDEC, 2016). Three of those sites are "Registry" Sites and the remaining two are Non-Registry Sites.
- Three Voluntary Cleanup Sites (NYSDEC 2016). One is active and the remaining two are closed.
- No radioactive waste sites were identified.

The following entries were found for the Jamaica Bay Planning Reach:

- Nearly 1,000 inactive RCRA sites and nearly 700 active sites were found (EPA 2016). The generation and disposal of hazardous waste should not have an effect on the environment if in compliance with RCRA.
- Ten Brownfield Cleanup Sites (NYSDEC, 2016). Of those sites, six sites are active, three are closed and one is no further action taken.
- Twenty four State Superfund Sites (NYSDEC 2016). Nine of those sites are "Registry" Sites and the remaining 15 are Non-Registry Sites.
- Twelve Voluntary Cleanup Sites (NYSDEC 2016). Just one site is no further action at this time, six are active and the remaining five are closed.
- No radioactive waste sites were identified.

Additionally, during preparation of the Federal Energy Regulatory Commission (FERC) EIS for the M&R facility, FERC received a comment from the NPS that a tar-like substance associated with an "old factory site" was located on the south shore of Floyd Bennett Field east of the Marine Parkway Bridge (FERC, 2013). No additional information about this site or actions taken was available in the file material.

2.18 Cultural Resources

"Cultural resources" is an umbrella term for many heritage-related resources, including prehistoric and historic archaeological sites, buildings, structures, districts, or certain objects. Cultural resources are discussed in terms of archaeological resources, architectural resources, or resources of traditional cultural significance.

Federal laws applicable to this project include the National Historic Preservation Act of 1966, as amended, the American Indian Religious Freedom Act (1978), the Abandoned Shipwreck Act

(1987), Native American Graves Protection and Repatriation Act (1990), Presidential Memorandum "Government to Government Relations with Native American Tribal Government (1994), and Executive Order 13175 "Consultation and Coordination with Tribal Governments" (2000).

The National Register of Historic Places (National Register) is the official list of the properties in the United States that are significant in terms of prehistory, history, architecture, or engineering. The National Register is administered by the National Park Service.

Generally, resources must be more than 50 years old to be considered eligible for the National Register. To meet the evaluation criteria for eligibility to the National Register, a property needs to be significant under one or more National Register evaluation criteria (36 CFR Part 60.4), and retain historic integrity expressive of the significance. More recent structures might be eligible for listing in the National Register if they are of exceptional importance or if they have the potential to gain significance in the future per special National Register considerations.

The New York City landmarks law gives the New York City Landmarks Preservation Commission (NYCLPC) authority to designate City landmarks, Interior landmarks, Scenic landmarks, and Historic Districts, and to regulate any construction, reconstruction, alteration, or demolition of them. Projects that might physically affect City landmarks or are within landmark Historic Districts require review by NYCLPC. Archaeological resources also are considered by the NYCLPC. Criteria for City landmarks are different from National Register evaluation criteria, and consider properties 30 years of age or older that meet certain criteria, compared to the National Register evaluation of properties of at least 50 years of age or older.

Section 106 of the National Historic Preservation Act requires a federal agency official to take into account the effects of its undertaking on historic properties, and afford the Advisory Council on Historic Preservation (Advisory Council), an independent federal agency, an opportunity to comment. This is done in accordance with the regulations of the Advisory Council implementing Section 106 process, 36 CFR Part 800, "Protection of Historic Properties". Additionally, consultation with the New York State Historic Preservation Office (SHPO) and consulting parties including local governments is required regarding the identification and evaluation of potentially affected historic properties, determination of potential effects of an undertaking on historic properties, and resolution of any adverse effects. Under the Section 106 process, the City of New York would also be a consulting party for the proposed project.

The Section 106 review requires an assessment of the potential impact of an undertaking on historic properties that are within the proposed project's Area of Potential Effect (APE). The APE is defined as the geographic area(s) "within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist."

The APEs are based on location of each proposed project element (represented in Section 6 below as Figures 6-1, and 6-5 through 6-11) and the areal extent over which construction and operation of the element would reasonably be expected to occur. In general, the APEs for each project element are considered to be within or immediately adjacent to the element, because construction and operation of each element is not anticipated to require disturbing the ground surface beyond the immediate "footprint" of the element. A description of the APEs are provided in the following sections.

2.18.1 Historical Context

The following information for the Cultural Resources sections were excerpted from Hunter, Richard and Tvaryanas, Damon. 2002 Phase 1A Cultural Resource Documentary Study For Gerritsen's Creek Ecosystem Restoration, Borough of Brooklyn, Kings County, New York. Report on file with the U.S. Army Corps of Engineers, New York, New York. This information was reported in the USACE Gerritsen's Creek EA.

The following information pertains to the area encompassing both the Rockaway and Jamaica Bay project areas.

2.18.1.1 Native American and Early European History

Roughly 5,000 to 6,000 years ago (circa 3,000 to 4,000 B.C.), the Atlantic shoreline lay some 25 miles to the east; by around A.D. 500 to 1000, less than 1,500 years ago, the coastline began to roughly resemble that of the present day, and Jamaica Bay and its neighboring drainages will have been largely tidal (Hunter and Damon, 2002).

Native American occupation of the Lower Hudson Valley and Long Island is likely to have followed on soon after the retreat of the last glacier, although clear cut evidence of such activity during the Paleo-Indian (circa 10,000-8,000 B.C) and Archaic (circa 8,000-2,000 B.C.) periods is generally sparse (Hunter and Damon, 2002).

Throughout the Late Woodland period, circa AD 1000-1600, camp sites and shell middens were a common feature within the tidal landscape of southern Long Island and evidence of Native American occupation of this period has been recorded all around the periphery of Jamaica Bay (Hunter and Damon, 2002). Further inland on Long Island, a few larger sites, probably permanent base camps, have also been identified, including one locus in Flatlands with an Iroquois style longhouse considered to be a ceremonial center and meeting house. Both longhouses and smaller round houses have been noted on Late Woodland period sites on Long Island. The majority of the documented sites were noted in the late nineteenth and early twentieth centuries, in particular as a result of the work of Reginald Bolton (1920, 1922, 1934), with several subsequent studies confirming their existence (Hunter and Damon, 2002).

Towards the end of the Late Woodland period, continuing into the seventh century when contact with Europeans was occurring on a regular basis, the Native American population of Long Island began to come more clearly into focus as a part of recorded history (Hunter and Damon, 2002). The Brooklyn area was inhabited by a group known as the Canarsie (or Canarsee), a branch of the Algonquian-speaking Lenape, a series of loose-knit and semi-sedentary tribes spread across much of the area between the Delaware and Lower Hudson Rivers and extending east into Long Island (Hunter and Damon, 2002).

The Jamaica Bay area supported villages of Canarsie and Rockaway American Indians, who engaged in cultivation, fishing, gathering shellfish, and possibly the manufacture of wampum from the seashells (Hunter and Damon, 2002). In the seventh century, the Canarsie participated in a complex of web of trading relationships involving the Lenape, other Native American peoples further to the west and north, the Dutch and eventually the English. The two key commodities traded by the Canarsie for European goods were furs and wampum (polished shell beads used for jewelry and as currency), the latter being of particular importance in view of the abundance of shellfish in and around Jamaica Bay. The general area (southern Long Island) was settled by the Dutch in the 1630s and 1640s (Hunter and Damon, 2002). In the 1630s and 1640s, however, the Canarsie began to lose their hold over land in southern Long Island, ceding property to Dutch farmer-settlers. By century's end, their numbers, probably never more than a few thousand, were severely reduced as a result of disease, conflict (notably Kieft's War of 1643-46) and the general dislocation visited upon them by Europeans. Over the course of the eighteenth century, the surviving Canarsie moved west and out of the Hudson Valley altogether.

A detailed and more expansive history of the transition from American Indians to European occupancy is available in *Jamaica Bay: A History, Gateway National Recreation Area, New York--New Jersey* (Black, 1981), as well as the *Cultural Resources Baseline Study, Jamaica Bay Ecosystems Restoration Project, Kings, Queens and Nassau Counties, New York* (Panamerican, 2003a).

2.18.1.2 19th and 20th Century History

The section provides a summary of development in the Rockaway and Jamaica Bay areas during the 19th and early 20th centuries.

Rockaway

Although a part of Queens, Rockaway was settled by Europeans separately and earlier than other areas around Jamaica Bay (NYCDEP, 2011). In 1833, the Rockaway Association purchased most of the oceanfront property on the Richard Cornell homestead to construct an oceanfront resort called the Marine Hotel in Far Rockaway. Transportation to and from Rockaway originally consisted of horses and horse-drawn carriages, but by the mid-1880s, railroad access was provided, terminating at the present Far Rockaway station of the Long Island Railroad. Land values increased and business expanded rapidly as a consequence, and the population of Far Rockaway was large enough to apply for incorporation in 1888. On July 1, 1897, the Village of Rockaway Park was incorporated into the City of Greater New York. Streets were graded and sections of Rockaway Park, Belle Harbor, and Neponsit began to be developed. Completion of the Cross Bay Bridge in 1925, further development of the beach and boardwalk in 1930, the opening of the Marine Parkway Bridge in 1937, and improvements to the railroad services in 1941 all made Rockaway more accessible, encouraging population growth, development, and urbanization (NYCDEP, 2011).

In the second half of the nineteenth century, the Rockaway Peninsula developed as a popular seaside resort for the growing middle-class New Yorkers, who filled its seaside bungalows and amusement parks (Structures of Coastal Resilience [SRC], 2014). Transportation access to the oceanfront beaches became an issue. Ferry service and deepened navigational channels were established by the Canarsie Railroad Line, and by 1887 a cross-bay train trestle was constructed by the New York, Woodhaven, and Rockaway Railroad. This line was sold in 1886 to the Long Island Railroad, which renamed it the New York and Rockaway Beach Railway. It was purchased in 1955 by the City of New York, reconstructed, and incorporated into the city's subway service as the IND Rockaway Line; it now carries the Metropolitan Transportation Authority's A and S trains across Jamaica Bay. The trestle pilings caused some obstruction of the bay's creeks and waterways, as did the development of the Flynn Cross-Bay Roadway (now the Cross Bay Boulevard) traversing the bay. Yet the Canarsie Line, the train trestle, and the Cross Bay Boulevard led to the transformed perception of the bay itself as an enjoyable place of recreation. Many believed that the waters of the bay were healthier and safer for swimming than the Atlantic beachfront of the Rockaway Peninsula (SCR 2014).

Fort Tilden was established in 1917 and provided a coastal location from which to defend New York City and the harbor from sea and air attacks during World War I through the Cold War era, when a Nike Missile Launch Site was installed. Fort Tilden was decommissioned in 1967 and in 1974 was transferred to the National Park Service and became part of the Gateway National Recreation Area (NPS 2014).

Jamaica Bay

A review of historical maps shows that the area of Brooklyn adjacent to Jamaica Bay was largely undeveloped marshland until the turn of the 20th century (NYCDEP 2011). The neighborhoods of East New York and Flatbush were the closest developed areas of Brooklyn to Jamaica Bay, although limited development had occurred in Canarsie Landing and Bergen Beach on high ground that extended into the marshes of Jamaica Bay. Brooklyn was originally inhabited by the Lenape, American Indians who planted corn and tobacco and fished in the rivers. The Dutch settled in Manhattan in the early 1600s, and subsequently founded five villages on Long Island: Bushwick, Brooklyn, Flatbush, Flatlands, and New Utrecht. A sixth village, Gravesend, was founded in 1643 by an Englishwoman. The British captured the Dutch territory in 1674, and incorporated the six villages into Kings County, which is now part of New York City. A 1698 census counted 2,017 people in Kings County, about half of whom were Dutch (NYCDEP 2011).

Brooklyn quickly became an important commercial port, in part due to the supply of foods grown on Long Island to New York City (NYCDEP 2011). The Navy opened a shipyard on Wallabout Bay in 1801, and Robert Fulton began a steam-ferry service across the East River in 1814. The Village of Brooklyn was incorporated in 1816, roughly encompassing what is now known as Brooklyn Heights. By 1860, 40 percent of Brooklyn’s wage earners worked in Manhattan, and ferries carried more than 32 million passengers a year. The intense pressure on ferry service led to the construction of the Brooklyn Bridge, which opened in 1883, spawning a surge in population and development. The City of Brooklyn, created in 1834, expanded to accommodate the new population, eventually encompassing all of Kings County. Brooklyn was incorporated into the City of New York in 1898 (NYCDEP 2011).

The early 20th century saw a vast expansion in the population and urbanization of Brooklyn (NYCDEP 2011). New bridges, trolley lines, elevated railroads, and subway lines went further into the borough. Each expansion opened new settlement and development areas. The rural character of Brooklyn quickly vanished. By the 1930s, the tributary waterbodies had been dredged, straightened, and armored, and by about 1960, most of the shoreline area was developed and expanded around Jamaica Bay (NYCDEP 2011).

In Queens, as in Brooklyn, expansion of mass transportation system influenced growth and urbanization in Queens dramatically (NYCDEP 2011). By 1915, most of Queens came within reach of the New York City subway. The Interborough Rapid Transit service opened to Long Island City (1915), Astoria (1917), and Queensboro Plaza (1916). Another branch extended along Queens Boulevard and Roosevelt Avenue, reaching Corona (1917) and Flushing (1928). In southern Queens, the Brooklyn Rapid Transit Company built an elevated line along Liberty Avenue through Ozone Park and Woodhaven to Richmond Hill in 1915 and along Jamaica Avenue from the Brooklyn border through Woodhaven and Richmond Hill to Jamaica during 1917-1918 (NYCDEP 2011).

These improvements in transportation promoted rapid growth (NYCDEP 2011). During the 1920s, the population of Queens more than doubled, from 469,042 to 1,079,129. Farms and open areas were replaced with urban street grids aligned without regard to streams, marshes, and other waterbodies that would have to be buried or filled. While the Great Depression of the 1930s ended this boom, transportation improvements continued with new bridges (the Triborough Bridge in 1936 and the Bronx-Whitestone in 1939), roadways (the Interboro Parkway in 1935 and the Grand Central Parkway in 1936), and airports (LaGuardia Airport in 1939 and Idlewild in 1948) (NYCDEP 2011).

Floyd Bennett Field was constructed in 1928-1931 on Barren Island and served as New York City's first municipal airport. It was sold by the City to the US Navy in 1941, and became the most active Naval Air Station in the US during World War II. In 1972, it was transferred to the National Park Service and became part of the Gateway National Recreation Area (http://www.nyharborparks.org/visit/flbe.html).

Plumb Beach is located along the north shore of Rockaway Inlet in Brooklyn. It is a stretch of shoreline, tidal mudflats, low saltmarsh areas, a tidal lagoon, a dune system, and woodland thickets at the entrance to Gerritsen Creek adjacent to the Belt Parkway. Originally an island, the creek separating it from the land was filled in the 1930s. In 1924, New York City acquired the property for use as a park, but instead leased it to a contracting company, which parceled and rented the land. In 1972 it became part of Gateway National Recreation Area, though the parking lot and greenway that provide primary access to the shore are the responsibility of the New York City Department of Parks and Recreation and the New York City Department of Transportation.

The Marine Parkway-Gil Hodges Memorial Bridge was opened by the Marine Parkway Authority in 1937 to provide access to the Rockaway Peninsula, which previously could be reached only by ferry or by a circuitous route around the eastern end of Jamaica Bay (NYC MTA 2016). The bridge is approximately 3,985 feet long, and is designed with a vertical lift-through truss. The land at both ends of the bridge is part of the Gateway National Recreation Area. In 1978, Gil Hodges' name was added to the bridge in honor of the Brooklyn Dodgers' great first baseman and Mets manager. Average daily traffic is approximately 20,000 vehicles.

2.18.2 Areas of Potential Effect

2.18.2.1 Rockaway

The APE for Rockaway consists of the ocean-side (Atlantic shorefront) onshore and immediate near shore areas. It also includes the proposed off-shore borrow area located in the Atlantic Ocean approximately two miles south of the Rockaway peninsula. The shorefront extends from Beach 19th Street to Beach 169th Street and includes the beach and existing groins, as well as the near shore sand placement area. Based on the current proposed alignment, the APE is limited to a relatively narrow strip within the Rockaway peninsula. However, the APE for the offshore borrow area includes the entire borrow area.

2.18.2.2 Jamaica Bay

The APE for the high-frequency flood risk reduction features within Jamaica Bay include the footprint of the measures recommended for Lawrence, Motts Basin north, and Mid-Rockaway Arverne and Hammels (represented in Section 6 below as Figures 6-7 through 6-11.

2.18.3 Previous Research

This section summarizes the findings of previous research investigations for cultural resources within or in close proximity to the APEs for Rockaway and Jamaica Bay, with a primary emphasis on historic properties—those that are listed or eligible for listing on the National Register, followed by a secondary focus on NYCLPC landmarks not on the National Register. This section also describes research findings for archaeological resources (pre-contact sites) and submerged sites within the APEs.

Large portions of both APEs are located within the Jamaica Bay Unit of the Gateway National Recreation Area. The NPS has reported that evidence of Paleo-Indian use in Gateway is sparse. Although manifestations of Paleo-Indian use of the general region are evident, no Paleo-Indian sites have been recorded (NPS, 2014). The NPS also reported that although manifestations of human occupation of northern New Jersey and the New York Harbor during the Archaic period have been recorded, no archeological sites dating definitively to this period have been recorded in Gateway. Several sites dating to the Woodland period have been identified within Gateway and are characterized by the presence of ceramic sherds (fragments), lithic artifacts, and shell middens indicative of the period. Several Contact period sites are known to have existed in the area around Gateway, but none have been recorded within Gateway (NPS, 2014). Contact period settlements typically include small amounts of European goods (metal kettles, glass beads, bottles, etc.) intermixed with larger amounts of indigenous-material cultural items.

2.18.3.1 Rockaway

Prior cultural resource assessments have been conducted for beach nourishment projects along sections of Rockaway (e.g. between Beach 19th Street and Beach 149th Street; Kopper 1979) (USACE 1979; USACE 1993; Kopper 1979). These prior studies concluded that no existing prehistoric or historic sites and no archaeological sites were present, and that, "…cultural resources reconnaissance surveys were deemed unnecessary considering the great erosive forces…" in those specific project areas (USACE 1979; Kopper 1979). The USACE has also determined for similar nourishment projects that sand placement should not have an adverse effect as long as it does not interfere with any features in historic districts.

Historic Districts Listed on the National Register

Fort Tilden, the Fort Tilden Wharf, the US Coast Guard Far Rockaway, the Breezy Point Surf Club, the Silver Gull Beach Club, Jacob Riis Park, and the Far Rockaway Beach Bungalow Historic District (Beach 24th, 25th, and 26th Streets) are historic districts on the Rockaway Peninsula. These districts are listed on the New York State Register of Historic Places (State Register) and the National Register.

Historic districts are defined by NPS as resources that possess a significant concentration, linkage, or continuity of sites, buildings, structures, or objects united historically or aesthetically by plan or physical development.

Fort Tilden, Breezy Point Surf Club, the Silver Gull Beach Club, the US Coast Guard Far Rockaway, and Jacob Riis Park are located within the Gateway National Recreation Area and are managed by the National Park Service. Only the Jacob Riis Park and the US Coast Guard Far Rockaway Historic Districts are located within the Rockaway APE. The Gil Hodges Bridge, which has been determined by the SHPO to be eligible for the National Register is located adjacent to the Rockaway APE.

Jacob Riis Park Historic District. The Jacob Riis Park Historic District, listed in 1981, is considered an "excellent, though greatly deteriorated, example of … municipal recreational planning the 1930s" (NPS, 2014). Its historical significance derives from its association with New York City's Commissioner of Parks, Robert Moses, as well as it being a notable work of landscape architecture. The park was completed through the WPA (Works Progress Administration) and is associated with this important social and government program (NPS 1979b). The park landscape has lost much of its integrity and has not been well maintained (Olmsted Center for Landscape Preservation, 2002). In 2012, Hurricane Sandy resulted in heavy wind and water damage to Jacob Riis Park facilities, including flooding; broken windows; blown out walls, sand deposition in the bathhouse; missing ceramic tiles in the bathhouse; and sand and other debris deposited in structures and across the landscape. The brick courtyard wall was destroyed and heavy erosion is evident along the boardwalk (IMT 2012a).

The 220-acre Jacob Riis Park occupies a mile-long section of the Rockaway Peninsula and provides a variety of recreational activities. The park's three significant recreational buildings were constructed between 1932 and 1937.

The original bathing pavilion—commonly known as the bathhouse—is the dominant feature of the park. The T-shaped, one-story brick masonry structure was completed in 1932. In 1936–37, it was enlarged by a long, two-story addition on the south side of the structure. The entrance to the bathhouse is located on the north wall. The front of the bathhouse is faced with a long arcade supported by pillars and topped with two octagonal turrets (NPS 1979b).

The mall focuses on a crescent-shaped extension of the boardwalk. The twin central mall buildings—constructed of brick and tile masonry—face each other at the southern end of the mall. Constructed in 1936–1937, both are two-story, square buildings, flanked by one- story wings, and connected to a rectangular, single-story wing to the south by a single- story, semicircular wing. Both have flat concrete roofs, concrete cornices, and concrete floors (NPS 1979b).

In addition, a broad promenade plaza adjacent to the original bathhouse was opened in 1932. During an expansion of the original park in 1936–1937, a continuous walkway (the length of the beach) was created, connecting all areas of the park. Both the promenade and boardwalk are considered integral elements of the park and contribute to its historic significance (Lane, Frenchman, and Associates 1992). Another striking feature of the park is the 72-acre parking lot located north of the bathhouse. With a 12,000–14,000 car capacity, it was believed to be the largest in the world at that time (NPS 1979b). The parking lot still retains its original integrity and is a contributing element to the district. (Please refer to NPS 1979b; Lane, Frenchman, and Associates 1992; and the Olmsted Center for Landscape Preservation 2002 for greater detail on the Jacob Riis Park Historic District).

Far Rockaway Beach Bungalow Historic District. The Far Rockaway Beach Bungalow Historic District is located along Beach 24th, 25th, and 26th Streets in Far Rockaway in Queens County. It was listed on the National Register of Historic Places in 2013 (NPS 2013). It includes summer beach bungalows near the oceanfront of Far Rockaway. They are smaller than the usual domestic bungalows of the 1920s. They were built in 1921 using pattern book designs incorporating uniform facades, compact interiors, integrated porches and exposed rafters. Their architect, Henry Hohauser, became better known in the 1930s as a designer of Art Deco hotels in Miami Beach. The district was hit by Hurricane Sandy in 2012, but survived without major damage.

Landmark Structures

Landmark structures include buildings and sites and may be eligible for or listed on the National Register by the NPS and the NYC Landmark Preservation Commission. These landmark structures and sites include the Richard Cornell Burial Ground (1457 Greenport Road, Far Rockaway) (listed by the NYC Landmark Preservation Commission, http://www.neighborhoodpreservationcenter.org/db/bb_files/richard-cornell-graveyard.pdf), and NPS-designated structures including the Rockaway Courthouse (90-01 Beach Channel Drive), the Temple of Israel Synagogue (1-88 Beach 84th Street), US Post Office-Far Rockaway (1836 Mott Avenue), Trinity Chapel (1847 Mott Avenue), and the Russell Sage Memorial Church (1324 Beach 12th Street).

Local landmarks (not formally listed) include the Waterfront Tribute Park (9/11 memorial) at the corner of Beach 116th Street and Beach Channel Drive and American Airline Flight 587 Memorial (southern end of Beach 116th Street near the beachfront).

2.18.3.2 Jamaica Bay

Prior cultural resource assessments have been conducted in the area of the Jamaica Bay APE (FERC, 2013; NPS, 2014; Bernstein, 2009). Documented sites include the Equendito Native American village site and the nineteenth century Rendering Plant on Dead Horse Bay. Bernstein indicated that the area around Barren Island had an “overall low sensitivity for intact prehistoric and historic period archaeological deposits…” but “The area of highest sensitivity for archaeological sites is near the southern end (the west side of Flat Bush Avenue near the entrance to Floyd Bennett Field), where historic maps indicate that former Barren Island was dry land and fill may not be as deep as elsewhere in the APE” (Bernstein, 2009). Bernstein also reported that undisturbed portions Barren Island, if they exist, would have a moderate to high sensitivity for the presence of prehistoric resources. However, it is likely that any prehistoric deposits are now very deeply buried beneath landfill (greater than six feet below sediment surface). Excavation about six feet was anticipated to have relatively low potential for impact to any prehistoric resources (Bernstein 2009).

No historic districts are within the Jamaica Bay APE. Floyd Bennett Field and other locations within the NPS Jamaica Bay unit are located in the vicinity of the Jamaica Bay APE. The Gil Hodges Bridge, which has been determined by the SHPO to be eligible for the National Register is located outside of the Jamaica Bay APE.

Landmark Structures

Landmark structures include buildings and sites and may be eligible for or listed on the National Register by the NPS and the NYC Landmark Preservation Commission. These landmark structures and districts are listed below by county. These properties are located adjacent to or nearby the Jamaica Bay APE.

Kings County

- Landmark Buildings and Sites

- All Saints' Memorial Church Complex
    - Beth El Jewish Center of Flatbush
    - Casemate Fort, Whiting Quadrangle
    - Hubbard House
    - Lott, Hendrick I., House
    - New Lots Reformed Church and Cemetery
    - Old Gravesend Cemetery (Site)
    - On Coney Island - Coney Island Fire Station Pumping Station
    - On Coney Island – The Jewish Center of Coney Island
    - On Coney Island – Manhattan Beach Jewish Center
    - Stoothoff-Baxter-Kouwenhaven House
    - West Bank Light Station
    - Wyckoff-Bennett Homestead
- Landmark Structures
    - Avenue U Station (Dual System BRT)
    - Bay Parkway Station (Dual System BRT)
    - Coney Island Yard Electric Motor Repair Shop
    - Coney Island Yard Gatehouse
    - On Coney Island - Cyclone Roller Coaster
    - On Coney Island - Ocean Parkway Station (Dual System BRT)
    - On Coney Island - Parachute Jump
    - Romer Shoal Light Station (located in Lower Bay approximately 4 miles south of Coney Island and 4 miles west of Breezy Point Tip)

Queens County

- Landmark Structures
    - Trans World Airlines Flight Center at JFK International Airport

Nassau County

- Landmark Buildings and Sites
    - Rock Hall

2.18.4 Archeological Resources – Rockaway and Jamaica Bay

The NPS has reported that archeological resources in the Jamaica Bay Unit of the Gateway National Recreation Area date primarily to later pre-contact (Woodland period) and historical periods (NPS 2014). Cultural manifestations include both surface and subsurface materials. However, many of the archeological resources identified in earlier studies can no longer be located, due to a combination of inaccurate data records, natural processes (e.g., erosion), and landfilling throughout the region in the late 19th and 20th centuries (NPS 2014).

2.18.4.1 Pre-Contact Archeological Sites

Most of the recorded pre-contact sites in Gateway were described as lithic scatters, lithic/ceramic scatters, campsites, or shell middens (NPS, 2014). Most of these remain undated or are believed to date to the Woodland period. Isolated finds believed to date to the Paleo-Indian period have also been recovered. The NPS has stated that the potential for encountering pre-contact archeological resources in the future is dependent on the original sensitivity and later historical use of the area (NPS 2014).

Although the APEs for Rockaway and Jamaica Bay are relatively narrow, the APEs extend for several linear miles through Gateway. Accordingly, it is possible that pre-contact archeological sites are present in the APE.

2.18.4.2 Historical Archaeological Sites

The potential for the discovery of additional in situ archeological resources in Gateway is influenced by a variety of natural and human factors (NPS 2014). These include ancient and historical sea-level fluctuations, erosion and sediment transport due to tidal/wave action, and land filling/land-modification activities in the 19th and 20th centuries. All these factors affect the potential for the discovery of buried archeological resources, and their influence varies by geographic location. Although many natural coastal park areas have been buried beneath deep fill deposits, there are also areas where intact soils and archeological deposits have been recorded. For these reasons, the potential for the identification of intact archeological deposits in the park is strongly dependent on the types and effects of past and ongoing natural and human processes. The potential for discovery of archeological resources in each specific area of the park should be evaluated based on each area's unique set of circumstances.

Recent and comprehensive archeological assessments that considered the issue of the potential for archeological resources in Gateway included area-specific analyses of the sensitivity for such resources (NPS 2014). These studies have included consideration of both natural and human impacts on specific park areas, and they have speculated on where the areas of highest potential for archeological resources may be (NPS 2014).

2.18.4.1 Submerged Archeological Resources (Shipwrecks and Submerged Sites)

Rockaway

The Rockaway beach nourishment and reformulation proposed action may obtain sediment from one or more off-shore borrow locations, as well as from onshore sources shipped overwater via barge to the site by one or more commercial aggregate suppliers (USACE 2016). Accordingly, and pursuant to guidelines established by the NHPA and the National Environmental Policy Act of 1969, potential impacts to any significant cultural resources in a proposed borrow area must be addressed.

Based on a borrow source investigation, USACE identified three suitable offshore borrow areas approximately three miles south of the Rockaway peninsula. The borrows are identified as Borrow Area A West, Borrow Area A East, and Borrow Area B West. The average dredging depth would be approximately 18 feet below the seafloor.

The area for Borrow Area A-West is roughly rectangular in shape approximately 4,800 feet from east to west, and 4,000 feet from north to south. Borrow Area A-East is roughly rectangular (5,000 feet in the alongshore direction by 4,000 feet in the on-offshore direction), and is approximately 1 mile east from Borrow Area A West. Borrow Area B-West is roughly a 1,200 by 1,200 feet box, and is approximately 4 miles west of Borrow Area A West (USACE 2016).

Panamerican conducted a remote sensing survey at Borrow Area A-West and A-East in 2005 (Panamerican, 2005). Sixty-seven magnetic anomalies were recorded within the project area. Based on signal characteristics, three anomalies have the potential to represent significant cultural resources. Panamerican recommended avoidance of all three targets. If avoidance is not an option, additional archaeological investigations are recommended to identify the source of the magnetic anomalies. Additional work should consist of remote-sensing target refinement and diver assessment of the refined target location. Diver assessment should consist of a visual and tactile investigation of the ocean bed at the center of highest gamma deviation for each. In the event that there is no source of magnetic deflection located directly on the ocean bed, sub-ocean bed investigations should be conducted with a probe or hydroprobe to a depth sufficient to either meet proposed project requirements or to locate and delineate the anomaly source. All targets should be assessed as to historical significance, relative to NRHP criteria. The remaining anomalies represent debris deposited for fish havens along and in the western edge of the project area, as well as a pipeline that parallels the southern project area boundary (Panamerican 2005).

A remote sensing survey has not been conducted at Borrow Area B-West. If USACE plans to use this borrow area, a remote sensing survey will be conducted prior to dredging any material. USACE will share the results with the SHPO and provide recommendations for avoidance or additional investigation, as warranted.

Previous reports suggest there is the potential for shipwrecks in the general area off of the Rockaway peninsula (e.g. Engebretsen's shipwreck inventory on the Greater New York Harbor; Engebretsen, 1982, as referenced in Panamerican Consultants, 2003a and 2003b; Panamerican Consultants, 2006). Based on an analysis of shipwrecks compiled by Riess and Pickman, Panamerican concluded, "Considering the amount of vessels wrecked off of Coney Island/Ambrose Channel (west of Borrow Area 2) and the number of vessels wrecked to the east of [Borrow Area 2], it can be inferred that the potential for wrecks off of Rockaway Beach remains high" (Panamerican Consultants, 2003). Additionally, Panamerican reported that a diver's guide to shipwrecks within the general area of Rockaway Beach lists seven wreck sites, including: *Princess Anne, Robert A. Snow, Cornelia Soule, Rascal, Black Warrior, Mistletoe,* and *Margaret* (in Daniel Berg's Wreck Valley Vol. II, 1990) (Panamerican Consultants, 2003a and 2003b). USACE has previously stated that "*twenty-three vessels were known to have been wrecked or stranded off Rockaway and Rockaway Beach. No wrecks have been located in the East Rockaway channel inlet itself. Because this inlet has been dredged in the past [prior to 1993], no resources will be impacted* (Kopper 1979*)*" (referenced in Appendix F in USACE, 1993).

The Rockaway APE also includes creation of groins and lengthening of existing groins along the Atlantic Ocean shoreline, on the eastern portion of the Rockaway peninsula. Based on the preliminary construction design, constructing new or extending groins will require deepening of the seafloor up to 10-12 feet below existing grade, over a width of approximately 50 feet.

Jamaica Bay

A recent survey within the waters of Jamaica Bay, including waters under the jurisdiction of Gateway, found no significant magnetic anomalies or sonar targets that might indicate the presence of buried/submerged cultural resources (PBS&J, 2009, in NPS, 2014). However, the authors provided information on several shipwrecks that are known to be present in waters adjacent to lands managed by the NPS. These include the *Mistletoe*, the *Black Warrior*, the

Ajace, and the *Cornelia Soule*, all of which sank, burned, or were grounded between 1859 and 1924. New York State also maintains a list of shipwrecks in Jamaica Bay. These submerged historic resources are also subject to disturbance from weather, development (construction of undersea utility lines, structures, etc.), and dredging activities (NPS 2014).

2.18.1 Native American Tribal Consultation

USACE will consult with Native American Tribes to solicit input regarding the Recommended Plan and for information about historical properties and archaeological resources within the Rockaway and Jamaica Bay APEs. The Native American Tribes to be consulted include the federally-recognized Shinecock Indian Nation, Delaware Tribe of Indians, and Delaware Nation, as well as the NY State-recognized Ukecheug Indian Nation. Although the Montauk Indian Nation is not federally- or state-recognized, they will be consulted as an interested stakeholder.

2.19 Socioeconomic Considerations

The NYSDEC identifies "Potential Environmental Justice Areas (PEJAs)" as census block groups meeting one or more of the following NYSDEC criteria in the 2000 U.S. Census (NYSDEC, 2016):

- 51.1% or more of the population are members of minority groups in an urban area;
- 33.8% or more of the population are members of minority groups in a rural area, or;
- 23.59% or more of the population in an urban or rural area have incomes below the federal poverty level.

The NYSDEC publishes county maps identifying PEJAs, including Kings, Queens, and Nassau counties (NYSDEC 2016). The following section discusses the NYSDEC PEJAs for the Atlantic Ocean Shorefront Planning Reach and the Jamaica Bay Planning Reach. Figure 2-6 identifies the proportion of persons below the poverty level for census blocks within study area communities.

The Atlantic Ocean Shorefront Planning Reach contains several PEJAs identified by the NYSDEC (NYSDEC 2016). Almost the entire area between the eastern end of the reach and Beach 116th Street near the central portion of the peninsula is identified as a PEJA (see Section 7). There are no communities identified as a PEJA by the NYSDEC to the west of Beach 116th Street.

The Jamaica Bay Planning Reach contains several PEJAs identified by the NYSDEC (NYSDEC 2016). In Nassau County, a small PEJA is present the municipality of Hempstead, west of the Valley Stream neighborhood; however, the area south of Route 27 within the Jamaica Bay Planning Reach appears to contain few if any residences. In Queens County, the majority of the Jamaica Bay Planning Reach north and east of JFK airport is identified as a PEJA, while the neighborhoods west of JFK airport are not (Howard Beach, Lindenwood, Hamilton Beach). Likewise, the majority of the Jamaica Bay Planning Reach within Kings County is identified as a PEJA, including the communities surrounding the Gateway National Recreation Area, a large portion of Coney Island, and in and around the Fort Hamilton municipality.

Map created by the Science and Resilience Institute

Figure 2-6: Percent of Persons Below Poverty Level

3 FUTURE WITHOUT-PROJECT CONDITIONS*

The USACE is required to consider the Future Without-Project (FWOP) alternative (called the "No Action Alternative") during the planning process and assessment of impacts to comply with USACE regulation and guidance for planning as well as NEPA. With the FWOP, it is assumed that no project would be implemented by the federal government or by local interests to achieve the planning objective. The FWOP forms the basis against which all other alternative plans are measured.

The FWOP condition assumes the continuation of existing conditions for the resources listed in the preceding section; no comprehensive intervention to reduce the impacts of storm surge on vulnerable populations (such as the elderly, low income, and public transportation dependent populations) and infrastructure of the study area; and no large-scale ecosystem restoration efforts to improve the sustainability of fragile coastal systems and attenuate storm surge.

It should be noted though that planned community resilience and wetland restoration efforts conducted under other authorities in in Jamaica Bay, such as restoration projects constructed by non-federal entities outlined in this section, are projected to be implemented in the FWOP. Along the Atlantic Ocean Shorefront Planning Reach, it is assumed that maintenance dredging of the existing federal navigation channels at East Rockaway Inlet and Rockaway Inlet (Jamaica Bay Channel) continue as authorized. The existing, authorized, and constructed project from Beach 19th street to beach 149th will not be renourished in the future as a federal Project. In the absence of federal renourishment, it is expected that New York City would undertake small-scale emergency sand placement projects if the beach erodes to a point that the existing infrastructure along the shorefront is imminently threatened.

3.1 Study Area

The study area has a resident population of 850,000 persons based on the 2010 census, and is expected to grow. Projected population growth (2010 – 2040) for the study area is based on projections for the boroughs of Brooklyn and Queens (Kings County and Queens County, respectively) developed by the NYC Department of City Planning. The total resident population of Brooklyn is projected to increase by 11.3% and the population of Queens is projected to increase by 7.2%. The school age population for each of the two boroughs is project to increase by 7.1%. The population 65 years and older is projected to increase by 45.6% in Brooklyn and by 30.8% in Queens (NYC 2013).

3.2 Coastal Storm Risk Resiliency Efforts by Non-Federal Entities

Numerous coastal storm risk resiliency efforts by non-federal entities are expected to be completed in the FWOP conditions. The Governor's Office of Storm Recovery (GOSR) and the Dormitory Authority of the State of New York (DASNY) have implemented projects within the study area to make the Rockaway Peninsula more resilient to coastal storm risks. The state of New York sustained major damages in the years of 2011 and 2012 with three consecutive hurricanes: Irene, Lee, and Sandy. Federal agencies have committed to funding recovery in New York, and GOSR is managing this effort.

Within Queens County, the GOSR is tracking a total of over $2.3 billion of committed funds for recovery investments. The majority of these investments (80.6%) are for infrastructure and environmental projects. The remaining projects cover housing, community reconstruction, economic development, and human services. There are two major programs contributing to infrastructure and environment projects: FEMA Public Assistance (over $1.8 billion), and the CDBG-DR Non-Federal Match Program (approximately $262 million).

3.2.1 Nassau Expressway Project

The New York State Department of Transportation (NYSDOT) is proposing a project along a 0.57-mile section of the interim Nassau Expressway (NY878) between Burnside Avenue and Rockaway Turnpike in the Town of Hempstead, Nassau County. The Nassau County Expressway is a key evacuation route for surrounding areas and this project will reduce the flood risk to the evacuation route and improve overall resiliency in the area. The project is on time to be completed by November 20, 2019. The current construction contract cost is $93,500,000. This project will function together with the Cedarhurst-Lawrence HFFRRF to manage the risk of frequent flooding in the Village of Cedarhurst and parts of the Town of Hempstead.

The objective of the project is safety and operational improvements for coastal flood evacuation, improved drainage, shared use path, signal improvements, and pavement improvements. The project will be a retaining wall on the western side of the Nassau Expressway with a centerline elevation ranging from 11 ft NAVD88 to 12.5 feet NAVD88. This project would prevent water from crossing over the expressway into the Lawrence neighborhood.

3.2.2 NY Rising Community Reconstruction Program

The Dormitory Authority of the State of New York provides construction, financing, and allied services to serve the public good of New York. The NY Rising Community Reconstruction (NYRCR) Program was established to provide additional re-building and revitalization assistance to communities severely damaged during the 2011-2012 hurricanes. This program has received Community Development Block Grant Disaster Recovery funding from the U.S. Department of Housing and Urban Development. Of this grant, NY State has allotted up to $11.9 million to fund project developed to improve the resiliency of the Canarsie neighborhood in the project area, which was heavily damaged during Hurricane Sandy. Many of projects have been developed by NYRCR to help Canarsie become more resilient to sea level rise. These include: Fresh Creek Coastal Protection, Fresh Creek Long-Term Restoration and Resiliency, Canarsie Pier Access Improvements, Canarsie Pier and Beach Community Enhancements, Canarsie Youth and Environmental Education Program, Canarsie and Southeast Brooklyn Waterfront Stormwater Study and Pilot Projects, Recovery Community Center, Critical Facility Upgrades Program, Canarsie Corps Program, Homeowner Audit and Grant Program, Resiliency Workforce Development, and Resilient Streetscaping.

3.2.3 Fresh Creek Project

The Fresh Creek project is very similar in objective to the HFFRRF developed by the USACE, which was screened out of the Recommended Plan because it was not considered to be economically justified based on the federal level USACE authority and policy. However, DASNY's Fresh Creek project, developed with slightly different modeling and planning criteria, is moving forward. The DASNY project focuses on nature-based flood risk management measures including living shorelines, bioswales, and berms to improve community resiliency and improve ecological systems. Flood protection measures are recommended for the entire western shore of Fresh Creek extending to the Creek mouth, further downstream of the HFRRF project limits. The project is expected to be completed by 2022.

3.2.4 New York City Projects

3.2.4.1 Broad Channel Road Raising Project

New York City expects to invest approximately $60 million in two phases of road raising projects in Broad Channel, Queens. Phase 1 of the project, expected to be complete in 2018, includes the elevation of West 11th St, West 12th St, and West 13th St as well as utility relocation and bulkhead reconstruction and raising. Phase 2 of the project is currently in design and includes similar road raisings and bulkhead work for West 14th St, West 15th St, West 16th St, West 17th St and West 18th St.

3.2.4.2 Build it Back Program

The NYC Mayor's Office of Housing Recovery Operations and the Build It Back Program are dedicated to helping New Yorkers living in communities affected by Hurricane Sandy. Through the repair, rebuilding, and elevation of homes, the Build It Back program is working to enhance resiliency in New York City’s waterfront neighborhoods. Funded by the US Department of Housing and Urban Development (HUD) Community Development Block Grant disaster recovery funds (CDBG-DR), Build It Back aids homeowners after all other forms of disaster assistance have been exhausted. Build It Back’s single-family program is helping 8,300 homeowners and landlords of 1 to 4 unit homes, including the elevation or reconstruction of about 1,300 homes and the acquisition of about 250 properties. Within the HSGRR/EIS study area, the Build It Back program is in the process of elevating or rebuilding approximately 850 residential structures.

3.2.4.3 Breezy Point Hazard Mitigation Grant Program

The City is working with the Breezy Point Cooperative to implement an approximately $60M flood risk reduction project for the communities of Breezy Point and Roxbury. The project, which is funded through a combination of FEMA Hazard Mitigation Grant Program and HUD CDBG-DR funds, will include a combination of dunes, berms, and floodwalls as well as potential erosion control measures.

3.2.4.4 New York City Parks

Bayswater Park Reconstruction: NYC Parks, with funding from FEMA, will reconstruct Bayswater Park implementing resilient design features.

Rockaway Community Park Reconstruction: NYC Parks, with funding from FEMA, will reconstruct the shoreline of Rockaway Community Park implementing resilient design.

Beach 88th Street Park Construction: NYC Parks, with funding from FEMA, will construct a new park that will implement resilient design features aimed to protect the nearby community against frequent flooding from Jamaica Bay due to storm surge and sea level rise. The new park features will manage stormwater runoff, provide ecological diversity, and provide recreational amenities.

Thursby Basin Park Construction: NYC Parks, with funding from FEMA, will construct a new park that will implement resilient design features aimed to protect the nearby community against frequent flooding from the Somerville Basin due to storm surge and sea level rise. The new park features will manage stormwater runoff, provide ecological diversity, and provide recreational amenities.

3.2.4.5 Spring Creek Hazard Mitigation Grant Proposal

The Department of Environmental Conservation (DEC) is the sub-recipient of $3,334,610 in Federal Emergency Management Agency (FEMA) Hazard Mitigation Grant Program (HMGP) funding for engineering, design and permitting to reduce flooding and coastal storm risk for the community of Howard Beach, which was heavily damaged by Hurricane Sandy in 2012. The Spring Creek South Storm Resilience and Ecosystem Restoration project incorporates natural and nature-based features such as an earthen berm to a maximum elevation of 19’ NAVD88, expansion of tidal marsh from 20 to 40 acres, restoration of native vegetation, the creation of three freshwater wetland forest areas that will provide stormwater runoff storage, and the stabilization of shoreline with a vegetated rip-rap revetment. Currently, the 237-acre site is dominated by the common reed *Phragmites australis*, which poses a fire risk due to its quick growth and dense biomass. The nature-based resilience strategy will improve the environmental quality of this former landfill site and facilitate enhanced public use and safety as part of Gateway National Recreation Area. Design is slated for completion in December 2018. At the time of this report, the estimated $65 million in construction funds have not been authorized. Phase 1, Engineering & Design, was funded 100% by FEMA at $3,334,610. Deliverables are due December, 31, 2018.

3.3 Ecosystem Restoration Efforts by Non-Federal Entities

Numerous ecosystem restoration efforts by non-federal entities are expected to be completed in the FWOP conditions, as outlined below.

3.3.1 Idlewild Park

NYC Parks, with funding from the Port Authority, will be performing comprehensive ecosystem restoration in the upland and coastal forest areas of Idlewild Park with the primary goal of establishing low growing plant communities that are compatible with FAA height restrictions associated with JFK runways. Timeline: 2016 - 2026

3.3.2 Salt Marsh Restoration

NYC Parks, with funding from the Department of State, will pilot a salt marsh restoration technique aimed at counteracting salt marsh loss. This project aims to restore approximately 1 acre of salt marsh through placement of clean sediment to raise the elevation of the drowning marsh plane and planting of native salt marsh grasses. Timeline: 2017-2020

3.3.3 Marine Park

Natural Areas Conservancy, in partnership with NYC Parks and the Nature Conservancy, embarked on a project to restore coastal upland ecosystems and improve existing trail networks within the western portion of Marine Park along Gerritsen Creek. Through this project, over

6,000 native trees and shrubs were installed and local youth performed trail improvement work through a partnership with the Student Conservation Association. Timeline: 2015-2017

3.3.4 Rockaway Community Park

A major upland habitat restoration project in this park culminated in the planting of 20,000 native trees and shrubs with volunteers in fall of 2013, one year after Hurricane Sandy. Subsequent to that, an additional 5,000 trees and shrubs were planted one year later. This site continues to be a focus of community engagement efforts and has hosted several stewardship events to care for these trees and shrubs and remove invasive species. Timeline: 2011 – 2017

3.3.5 Jamaica Bay Park

Over two acres of coastal maritime forest have been restored at this small community park since spring of 2014, including the planting of 6,000 native trees and shrubs. NYC Parks staff continue to expand from this prior investment, with the next planting at this park scheduled for fall of 2018. NYC Parks, in conjunction with the Natural Areas Conservancy, has also been seeking funding to expand this work to the entirety of the park and establish a nature trail. Timeline: 2013 – 2018 (ongoing)

3.3.6 Spring Creek

NYC Parks, with funding from the Department of the Interior-National Fish and Wildlife Foundation, will restore six acres of coastal forest and transitional salt marsh habitat along Spring Creek in areas that have been severely degraded by dumping and invasive vegetation and construct two bio-retention basins along the street edge to reduce inland flooding and a low-elevation vegetated berm along the Belt Parkway. Each of these components are designed to be complementary to future work completed by the Army Corps of Engineers and provide added resiliency benefits to the ecosystem and surrounding communities. Timeline: 2014-2018 (ongoing).

3.3.7 Sunset Cove

NYC Parks, with funding from the Department of the Interior-National Fish and Wildlife Foundation, will remove hazardous and contaminated fill material, construction debris, and concrete from Sunset Cove - a former marina shuttered for illegal dumping - to restore 7 acres of salt marsh and transitional wetland and 5 acres of coastal maritime forest, scrub shrub, and grassland; rehabilitate approximately 100 feet of hardened shoreline; and construct a perimeter berm to provide resiliency benefits and pedestrian access to the site. Timeline: 2013-2019

3.3.8 Bayswater

Natural Areas Conservancy, in partnership with NYC Parks, will restore 0.5 acres of salt marsh in Bayswater Park with funding from the Jamaica Bay-Rockaway Parks Conservancy. This project will remove concrete and construction debris from the site, place clean soil, and grade the site to an elevation that will allow native salt marsh plantings to thrive. Timeline: 2017-2019

3.3.9 Fresh Creek

Partner Projects on Parkland Two projects, one for flood mitigation managed by the Dormitory Authority of the State of New York (DASNY) to implement the New York Rising plan for

Canarsie, Brooklyn, and a salt marsh mitigation project by NYC Dept. of Environmental Protection are planned in Fresh Creek. The DASNY project focuses on nature-based flood risk management measures including living shorelines, bioswales, and berms to improve community resiliency and improve ecological systems. Flood protection measures are recommended for the entire western shore of Fresh Creek extending to the Creek mouth, further downstream of the HFRRF project limits. The project is expected to be completed by 2022.

3.4 Economic Conditions

The FWOP economic conditions are based on the assumption that system wide CSRM will not be implemented in the study area. Comprehensive measures to provide CSRM to vulnerable communities and populations with the study area are not included in the FWOP economic conditions. Because CSRM measures would not be in place, projected FWOP damages create a baseline against which alternative plans can be evaluated. The number and type of structures in the study area (Table 3-1) is projected to be the same under FWOP conditions and with alternative plans in place. Table 3-2 presents the expected annual damages for the 1% storm in the study area.

Table 3-1: Structures Within FEMA 1 Percent Annual Chance Flood Area

Structure Type	Atlantic Ocean Shorefront Planning Reach	Jamaica Bay Planning Reach	Total
Banks / Professional Services	39	231	270
Church/Non-Profit	54	108	162
Colleges/Universities	54	1	55
Dormitories, Nursing Homes, Temp Lodging	17	20	37
Entertainment & Recreation	4	36	40
Gov Emergency Response & Offices	11	11	22
Grade Schools	25	60	85
Hospitals, Clinics	5	12	17
Industrial	27	108	135
Parking (Garages)	9	19	28
Repair Services (Service Station / Shop)	9	46	55
Residential: Single Family	3,307	22,106	25,413
Residential: Multi-Family (Duplex)	3,364	11,931	15,295
Residential: Multi-Family (3-4 Units)	729	2,470	3,199
Residential: Multi-Family (5-49 Units)	125	128	253
Residential: Multi-Family (over 50 Units)	44	123	167
Retail Trade	168	790	958
Wholesale Trade (Warehouses)	6	85	91
Total Structures	**7,997**	**38,285**	**46,282**

Table 3-2: Without-Project Condition Damages (AAEQ)

Atlantic Ocean Shorefront Planning Reach	18,512,000
Jamaica Bay Planning Reach (Cross-Shore Flooding)	27,384,000
Jamaica Bay Planning Reach (Jamaica Bay Flooding)	70,505,000
Jamaica Bay Planning Reach (HFFRRF Areas)	78,657,000
Total Annual Damages	**195,058,000**

3.5 Physical Conditions

Under without-project conditions natural processes will continue to be impacted by anthropomorphic conditions, which will result in net loss of beach at the Atlantic Ocean Shorefront Planning Reach and net loss of wetlands in the Jamaica Bay Planning Reach, as discussed below.

Identifying the FWOP at the Atlantic Ocean Shorefront Planning Reach is particularly challenging because the historical conditions include a federal project with a history of renourishment. Therefore, historical data alone may not be used to describe the shoreline and beach conditions if no actions are taken in the study area. Instead, a shoreline change model (GENESIS-T) is used to simulate longshore sediment transport and shoreline changes that are likely to occur in the FWOP.

In defining the FWOP, the following assumptions are made to establish the framework of what is likely to occur:

- Beachfill Placement (P): As defined by existing federal or state navigation authorities, the existing inlets (Rockaway Inlet and East Rockaway Inlet) and their corresponding approach and back-bay navigation channels will be maintained near the present widths depths, and locations. Approximately 230,000 cubic yards of material will be dredged from East Rockaway Inlet every 2 years and placed in Reach 6a.
- Natural Inlet Bypassing (BP) A natural inlet bypassing rate of 100,000 cy/year at East Rockaway Inlet is used to characterize the FWOP. This bypassing rate provided the best calibration in GENESIS-T and is within the range of previous estimates (OCTI 2011; USACE NYD 2012).

GENESIS-T is designed to simulate long-term shoreline change based on spatial and temporal differences in longshore sediment transport induced primarily by wave action while accounting for coastal structures and beach fills. The GENESIS-T model was calibrated to historical conditions from 1996-2010.

A 16-year GENESIS-T simulation was performed to characterize the FWOP. Wave conditions for the 16-year period are based on the wave conditions from 1996 to 2012. The predicted net annual longshore sediment transport from GENESIS-T is used in the FWOP sediment budget. The FWOP simulations include both natural inlet bypassing and inlet maintenance dredging, both of which reduce the shoreline erosion in Reach 6a. The GENESIS-T simulations do not include the impact of relative sea level change or any other cross-shore coastal processes.

The FWOP sediment budget was developed based on modeled shoreline changes, modeled net annual longshore sediment transport rates, relative sea level rise, and inlet bypassing and inlet maintenance dredging assumptions.

Cross-shore sediment losses due to relative sea level rise (RSLR) are incorporated in the sediment budget after Bruun (1962). The FWOP sediment budget uses the historic rate of RSLR at the NOAA Tide Gage at Sandy Hook, NJ. The sensitivity of the FWOP to higher rates of sea level rise is shown based on current USACE guidance (ER 1100-2-8162). Future RSLR rates were evaluated for a 50-year period from 2018-2068. Table 3-3 provides an overview of the impact of sea level rise.

Table 3-3: Relative Sea Level Rise Impacts on Shoreline Changes and Sediment Budget

RSLR Scenario	RSLR over 50 years (ft)	Shoreline Change (ft/yr)	Volumetric Loss (cy/yr)
USACE Low (Historical)	.064	-0.78	53,000
USACE Intermediate	1.09	-1.32	90,000
USACE High	2.80	-3.07	209,000

The seven-cell FWOP sediment budget provides a detailed look at the sediment budget and identifies erosional hotspots along the Atlantic Ocean Shorefront Planning Reach. The net annual longshore sediment transport rates are similar to the Historical Conditions, and increase from east to west along Rockaway Beach peaking in Reach 3. The steady increase in net annual longshore transport rate creates a sediment deficit in Reaches 3, 4, 5, and 6a. The overall trend in longshore sediment transport is driven by the alongshore variability in the wave conditions. Figure 3-1 shows the alongshore variability in the net annual longshore sediment transport problems.

The primary difference between the FWOP and Historical Conditions sediment budgets is that there is no beachfill in the FWOP to offset the sediment deficit created by the overarching trend longshore sediment transport. Table 3-4 shows the corresponding shoreline change rates based on the FWOP sediment budget. The most striking cell is sub-reach 4, which is predicted to erode by 17.5 ft/yr. This erosion hotspot is caused by 1) overarching trend in longshore sediment transport along eastern Rockaway Beach, and 2) sediment impoundment of updrift groin field in sub-reach 5. Note also that shoreline change in sub-reach 6a would be much greater without beachfill from inlet maintenance dredging.

Table 3-4: Future Without Project Shoreline Changes

Atlantic Shorefront Sub-reach	Shoreline change (ft/yr)
1	+9.0
2	+4.4
3	-3.2
4	-17.5
5	-3.8
6a	-5.3
6b	+9.4

Figure 3-1: Future Without Project Sediment Transport Pathways at the Atlantic Ocean Shorefront Planning Reach

Wetland loss at Jamaica Bay has been occurring for decades, with a measured loss of vegetated marsh islands of 63% (1,471 acres) from 1951 to 2003 (2,347 acres to 876 acres). During this time of wetland loss, the rate of marsh loss has increased from 17 acres lost per year from 1951 - 1974 to 33 acres lost per year from 1989 – 2003 (NPS 2007). An alternative measure of marsh island loss indicates that during the five years from 1994 to 1999, an estimated 220 acres of marsh were lost at a rate of 47 acres per year (USACE 2016). At that rate of loss USACE projects that marsh islands would vanish from the Jamaica Bay Planning Reach by 2025.

Numerous initiatives, including beneficial use of dredged material from the NYNJ Harbor Deepening Project have been implemented to restore Jamaica Bay's marsh islands. To date more than 155 acres of marsh island have been restored (USACE 2016), however the potential for long term net loss vegetated wetlands in the Jamaica Bay Planning Reach is likely.

3.6 Life Safety

Hurricane Sandy caused 10 fatalities in the study area. The overall resident population at risk in the study area is 850,000 based on the 2010 census blocks that intersect the damageable properties in the study area. Among the most vulnerable of the population at risk include the population over age 65 (Table 3-5). This population was based on the 2010 census blocks that intersect NYC Community Board boundaries in the study areas and on the 2010 census population for Inwood, Census-Designated Place (CDP) (Figure 3-2). This demonstration of those at risk does not include transportation routes for population evacuating or those at work in commercial or industrial areas.

Table 3-5: At Risk Population Over Age 65

Atlantic Ocean Shorefront Planning Reach	
Community Board	Population
QC 14	15,319
Atlantic Ocean Shorefront Planning Reach Total	**15,319**
Jamaica Bay Planning Reach	
Community Board	Population
QC 10	15,044
BK 13	22,547
BK 15	26,319
BK 18	22,908
Inwood CDP	1,155
Jamaica Bay Planning Reach Total	**87,973**
Study Area Total	**103,292**

Other considerations include high-risk areas that have populations/residents with special needs, hospitals, nursing homes, and schools. These types of populations were not fully defined in this study; however, the existing structures (hospitals, nursing homes, and schools) were inventoried in the study area. These structures are listed in Table 3-1 are within the FEMA 1% Annual Chance Flood Area.

3.7 Critical Infrastructure

Figure 3-3 presents critical infrastructure within the study area and critical infrastructure within the Hurricane Sandy area of impact.

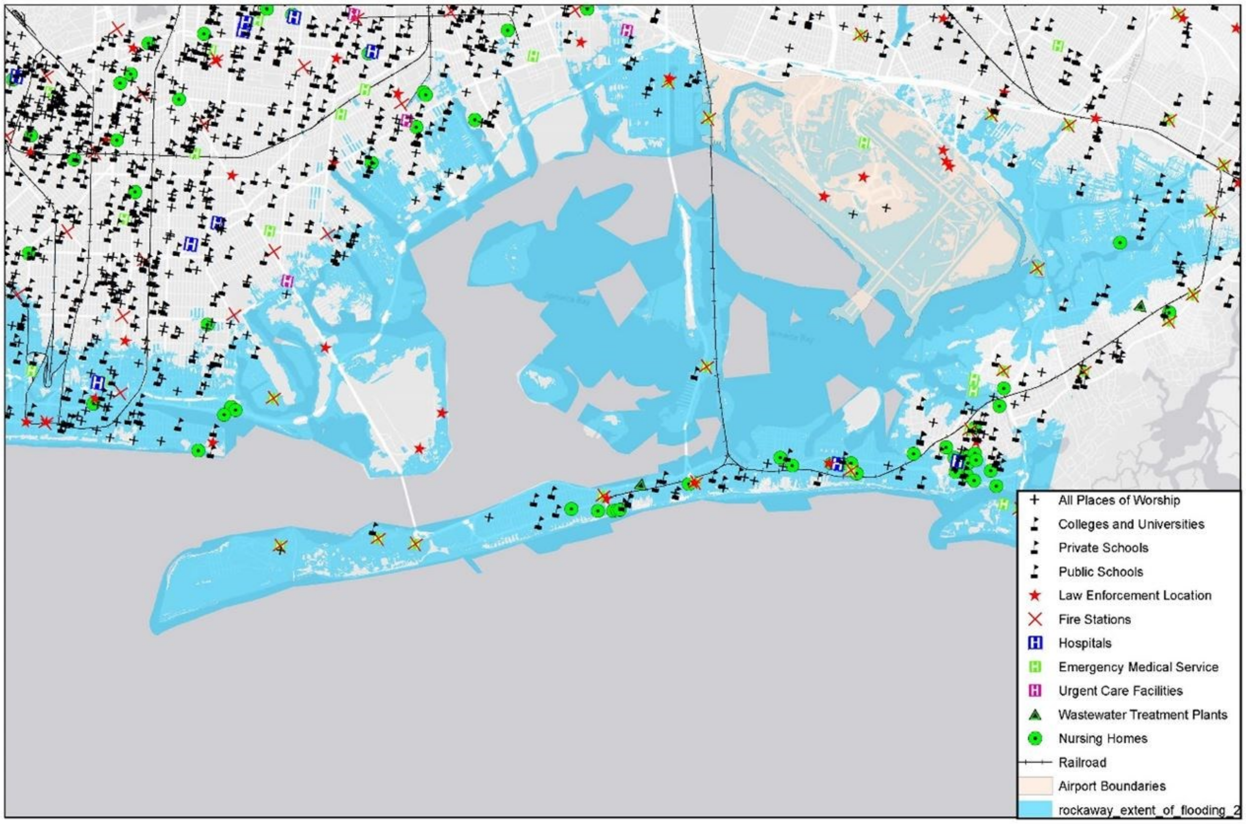


Figure 3-3: Study Area Critical Infrastructure and Hurricane Sandy Impact Area

3.8 Sea Level Change

Local relative sea level change (SLC) was considered in the screening of measures based on the guidance contained in ETL 1100-2-1 and ER 1100-2-8162 (USACE 2013e). Per ER 1100-2-8162:

> Planning studies and engineering designs over the project life cycle, for both existing and proposed projects, will consider alternatives that are formulated and evaluated for the entire range of possible future rates of SLC, represented here by three scenarios of "low," "intermediate," and "high" SLC. These alternatives will include structural, nonstructural, nature based or natural solutions, or combinations of these solutions. Alternatives should be evaluated using "low," "intermediate," and "high" rates of future SLC for both "with" and "without" project conditions.

ER 1100-2-8162 considers the historic rate of SLC as the low rate. The intermediate and high rates are computed from the modified National Research Council (NRC) Curve I and III respectively, considering both the most recent Intergovernmental Panel on Climate Change (IPCC) projections and modified NRC projections with the local rate of vertical land movement added.

For the purposes of this study, the first year of construction is assumed to be 2020, with a design life of 50 years. Table 3-6 shows the USACE SLC data for 2010 to 2100 at The Battery, NY based on ER 1100-2-8162. The intermediate SLC rate is used to calculate equivalent annual flood damages. The sensitivity of the project to the historic rate of RSLC and the high rate of RSLC will be developed at a future phase of study. Hence, a SLC of 1.3 feet in 2070, as compared to the 1992 sea level values, or slightly greater than one foot as compared to the 2014 sea level value, is added to the 1% AEP storm elevations to identify future risk levels.

Table 3-6: USACE SLC Projections (feet) at The Battery, NY (Gauge: 8518750)

Year	Low	Intermediate	High
2010	0.17	0.20	0.29
2015	0.22	0.27	0.42
2020	0.27	0.34	0.56
2025	0.32	0.41	0.72
2030	0.36	0.49	0.90
2035	0.41	0.58	1.10
2040	0.46	0.66	1.31
2045	0.51	0.76	1.55
2050	0.56	0.85	1.80
2055	0.60	0.96	2.07
2060	0.65	1.06	2.37
2065	0.70	1.17	2.67
2070	0.75	1.29	3.00
2075	0.80	1.41	3.35
2080	0.84	1.53	3.71
2085	0.89	1.66	4.10
2090	0.94	1.79	4.50
2095	0.99	1.93	4.92
2100	1.03	2.07	5.36

Values shown to hundredth of foot per direct calculations from EC 1165-2-212, Equation 2: $E(t) = 0.0017t + bt^2$ and illustrate the incremental increase of sea level change over time.

With the addition of SLC to the current floodplain, the floodplain for the region expands in area and depth. Regions currently in the floodplain are at risk of higher flood depths during storm events. Similarly, the floodplain will extend further inland, increasing the number of assets at risk of flooding. Figure 3-5 depicts the current and projected future area of inundation, which would occur during a 1% annual chance flood hazard event (also referred to as the 100-year event) in the study area.[19]

[19] Water levels were established using FEMA stage frequency curves (2013), which were adopted and used to define the Atlantic Shorefront and Back-bay stage frequency curves in the study area (see Appendix A1, Section 4.3 for more information).

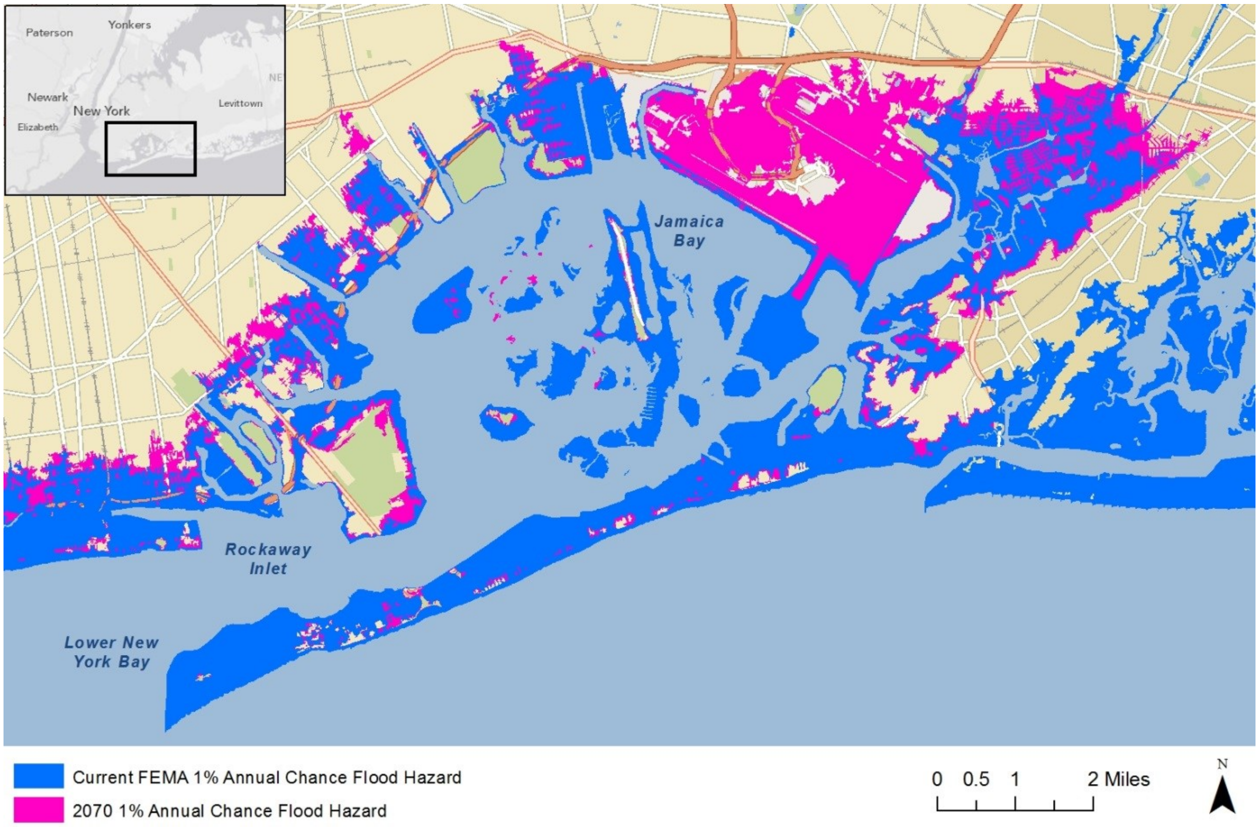


Figure 3-5: One Percent Annual Chance (100-year) Flood Hazard with Intermediate SLC

3.9 Future Without-Project Conditions Summary

Based on the evaluation of the FWOP conditions, there is the potential for significant economic damages in the Atlantic Ocean Shorefront and Jamaica Bay Planning Reaches. There are also concerns for life-safety, damages to critical infrastructure, sea level changes, and impacts on significant environmental resources. These can be further characterized as problems and opportunities for the federal government or local interests to implement projects. The FWOP forms the basis against which all potential projects are measured.

The FWOP conditions in the study area do not provide system-wide CSRM to communities devastated by Hurricane Sandy. Within the study area, 10 fatalities and more than 1,000 structures were substantially damaged to restrict re-entry or were destroyed by Hurricane Sandy. The NYC Department of Buildings post-Hurricane Sandy damage assessment indicates the disproportionate vulnerability of the study area to storm surge damage. In addition to the structural impacts caused by waves and inundation, fires ignited by the storm surge inundation of electrical systems destroyed 175 homes at the Atlantic Ocean Shorefront Planning Reach. Damage to the elevated portion of the subway system which connects the Atlantic Ocean Shorefront Planning Reach with the Jamaica Bay Planning Reach (A line) disrupted service for over six months affecting about 35,000 riders daily. In the Atlantic Ocean Shorefront Planning Reach and in part of the Jamaica Bay Planning Reach 37 schools were closed for up to two months. Nothing in the FWOP condition prevents this level of devastation from recurring.

4 PROBLEMS AND OPPORTUNITIES

This section presents results of the first step of the planning process: the specification of water and related land resources problems and opportunities in the study area. Problems are the undesirable conditions that effective plans avoid, reduce/minimize, or mitigate. Opportunities are occasions to beneficially influence future conditions.

4.1 Background

The project area consists of naturally low-lying topography that is densely populated, including extensive low-lying infrastructure. The coastal ecosystems which historically provided some natural flood risk management by buffering inland communities, reducing wave action, and more, have been degraded by development, hardening shorelines, erosion, and other impacts to coastal processes.

The combination of degraded coastal ecosystems around the densely developed low-lying areas means that communities in the project area are vulnerable to extensive inundation from storm surges during coastal storms and experience high levels of risk to human life, infrastructure, and property from coastal flooding. In some areas, the problem is so bad that high tides can cause flooding which cannot drain because the interior drainage is below the high tide, which relies on gravity to drain rainwater out of streets and neighborhoods. Figure 4-1[20] illustrates this problem and shows a storm drain in Hamilton Beach (at the end of 161st Avenue) completely flooded by the high spring[21] tide. This type of problem is only worsening with sea level rise in this area.

Figure 4-1: Spring High Tide Flooding of Storm Drain

[20] Source: Curbed New York, "In Queens, chronic flooding and sea-level rise go hand in hand," October 12, 2017, Nathan Kensinger.

[21] Spring tides occur twice a month, during full and new moons when the Earth, sun, and moon are nearly in alignment. When this occurs the gravitational pull of the sun combines with the gravitational pull of the moon on the earth and high tides become higher and low tides become lower. In areas that experience tidal flooding, the spring tide is also the time when the flooding, irrespective of rainfall, would be worst.

Coastal storm damages can include storm water overtopping of storm risk management features, flooding, wave attack, and erosion. In addition, projected future climate changes are expected to exacerbate existing problems. Projected future climate changes, including sea level rise, will increase coastal storm flooding, erosion and wetland loss (NPS 2014). In the communities surrounding Jamaica Bay, an intermediate USACE sea level change estimate shows the frequency of lower level inundation flooding to more or less double as the sea level would rise roughly 1.1 feet in this scenario.

Table 4-1 shows how the water levels measured in Jamaica Bay have increased roughly .34 feet since 1992. The last column projects a potential future water level for Jamaica Bay, based on the USACE intermediate sea level rise curve. The chance of a flood elevation of roughly seven feet occurring is projected to double in 50 years and go from a 10 percent annual chance of exceedance to a 20 percent chance in a given year. Section 2 of the Engineering and Design Appendix A2 discusses this issue in more detail.

Table 4-1: Changed and Projected Water Levels in Jamaica Bay

Annual Exceedance Probability	Water Level based on 1992 MSL (Feet, NAVD88)	Water Level based on 2018 sea levels (Feet, NAVD88)	Water Level based on 2068 sea levels (Feet, NAVD88)
33%	4.3 ft	4.64 ft	5.74 ft
20%	5.5 ft	5.84 ft	6.94 ft
10%	6.6 ft	6.94 ft	8.04 ft
5%	7.6 ft	7.94 ft	9.04 ft

With the problem of coastal flood risk and the likelihood that this risk will only increase with time, there also comes the opportunity for federal and local governments to work together to help manage this risk. In addition, there is an overall opportunity to complement ongoing system recovery and efforts by state and local agencies to manage coastal storm risk, as well as bolster the natural resiliency of coastal ecosystems.

Figures 4-2[22] and 4-3[23] show flooding Rockaway Park and Far Rockaway after the winter storm of 2016, which had an AEP of 25%. This level flood event is a frequent occurrence. High tides and storm waters resulted in prolonged inundation that took over 24 hours to subside. The federal government does not have a mission to work on interior drainage problems like those pictured in Figure 4-1, since stormwater infrastructure is managed by local governments. However, where smaller storms produce significant damages that stand to worsen with sea level

[22] Source: Source: ABC7NY news story, “High tide brings significant flooding to parts of Queens, New Jersey” dated February 8, 2016. Photo credit: Angelia Roggie.
[23] Source: The Yeshiva World News, “More Coastal Flooding Hits NYC –Parts of Far Rockaway Under Water Tuesday Morning, February 9, 2016.

rise, there is also significant life safety risks, which is a priority mission area of the USACE. Areas that suffer from nuisance flooding have increased risk during large storms due to their lower elevation and poor interior drainage. Similarly, low lying areas with tidal inundation experience significant damages at higher AEP storms (i.e. smaller level storms that occur more frequently) and have an opportunity for an economically justified CSRM plan that addresses frequent flooding. For a plan to be economically justified the National Economic Development (NED) benefits of the project must exceed the costs over the 50-year life of the project.

Figure 4-2: Newport Avenue in Rockaway Park During 25% AEP – February 2016

Figure 4-3: Far Rockaway During 25% AEP at High Tide– February 2016

4.2 Problem 1 – Impacts to Human Health and Safety

- Hurricane Sandy storm surge resulted in ten deaths in the Rockaway study area and 43 deaths in New York City; many victims drowned in their homes during the Hurricane Sandy storm surge (New York Times, 17 November 2012);
- Service disruptions due to the Hurricane Sandy storm surge and inundation, included critical electricity, water, heat, transportation, and health services (SIRR, 2013);
    - Power outages lasted more than 20 days
    - More than 37 schools closed for two months
    - Subway system damages required months of repairs, impacting 35,000 riders daily
- Coney Island Hospital was evacuated due to the Hurricane Sandy storm surge and inundation (SIRR 2013).

4.2.1 Opportunity to Address Problem 1

Enhance human health and safety by improving the performance of critical infrastructure and natural features during and after storm surge events.

4.3 Problem 2 - Projected Future Coastal Storm Impacts

- The Hurricane Sandy water levels peaked at nearly +13 NAVD88, which is as much as 10 feet above ground in some places, and waves resulted in extensive shorefront damages and inundation of neighborhoods in Brooklyn and Queens, and hamlets in Nassau County (SIRR 2013); and
- Storm-related flooding and wave damages also occur with more frequent storms of less intensity than Hurricane Sandy.

4.3.1 Opportunity to Address Problem 2

Prevent or reduce future coastal storm impacts and related damages. Reduce the risk of coastal storm damage to buildings and infrastructure, which are subject to damages due to storm surge, waves and erosion from the ocean and storm surge in Jamaica Bay.

4.4 Problem 3 - Insufficient Resiliency in Natural and Man-made Systems

- Recovery from the damage caused by the Hurricane Sandy storm surge and inundation was inconsistent across the region, with some systems taking an unacceptable time to recover (SIRR 2013); and
- Long lasting service disruptions (healthcare, transportation, telecommunications, electricity, liquid fuels, water supply, wastewater treatment) due to the Hurricane Sandy storm surge impacted communities within and outside of the storm surge inundation area (SIRR 2013).

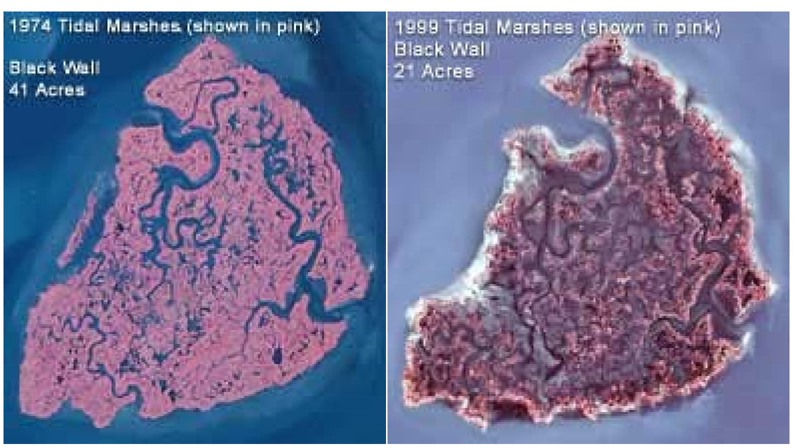
4.4.1 Opportunity to Address Problem 3

Improve the community's ability to recover from damages caused by storm surges by reducing the duration of interruption in services provided by man-made and natural systems.

4.5 Problem 4 – Erosion, Loss and Degradation of the System's Living Shorelines Protective Capacity

- Between 1951 and 2003 Jamaica Bay lost 63-percent of its vegetated wetlands and salt marshes, which provide a natural storm surge buffer (USACE, 2009); These protective wetlands continue to diminish at a high rate threatening their long term stability (DOI, 2013) and further exacerbating coastal flood risk in the process; DEC has observed significant losses of vegetated tidal wetlands dating back even further, principally *Spartina alterniflora* (Intertidal Marsh), in marsh islands of Jamaica Bay. Examination of historic maps reveals that between 1857 and 1924, the intertidal marsh islands area varied in size without trend, with average changes of up to 10 acres per year. During periods of significant storms, there were losses of marsh islands. But during quiescent years, the marsh islands were able to rebuild (DEC 2018)[24].
- Accelerating rates of wetland erosion—DEC summarizes the accelerating rates of wetland loss:

  From 1924 to 1974, 780 acres of marsh islands were lost due to direct dredging and filling (which were unregulated activities up to 1974) and 510 acres were lost (approximately 10 acres per year) due to other reasons. This information was obtained through analysis of aerial photography. Since 1974, the study shows that the rate of loss of intertidal marsh islands is accelerating. Between 1974 and 1994, 526 acres of marsh islands were lost at an average rate of 26 acres per year. Between 1994 and 1999, 220 acres were lost at an average rate of 44 acres per year. The vegetated intertidal marsh is being converted to nonvegetated underwater lands. Photographs illustrating this conversion are shown below.



[24] This information was obtained by scanning into a computer tidal wetland boundaries on historic US Coast and Geodetic Survey Maps and aerial photography. Source: New York State DEC, available at http://www.dec.ny.gov/lands/5489.html, accessed on 19 June 2018.

These photographs show the twenty acres of tidal marshes lost between 1974 and 1999 on Black Wall Marsh in Jamaica Bay.

- Maritime and coastal forests within Jamaica Bay, which provide a natural storm surge buffer while also protecting adjacent coastal wetland habitats (DOI 2013) have also become increasingly rare;
- Projected FWOP erosion will substantially impact communities along the Atlantic Ocean Shorefront Planning Reach, can be costly to address, and contribute to increased risk from coastal storms. Evidence of scarping along existing natural shoreline, the increasing rates of erosion as documented by DEC, and the lack of living reefs and structures to break up wave action on marshes indicate that without intervention, shorelines will continue to erode, further reducing natural coastal storm risk management and resiliency from coastal storms.

4.5.1 Opportunity to Address Problem 4

Manage coastal storm risk and erosion problems with *natural and nature-based features* (NNBFs) such as wetlands, oyster and/or ribbed mussel reefs, vegetated dunes, beaches, maritime or coastal forests, where appropriate. NNBFs can manage flood risk by breaking up wave action, slowing and storing would be flood waters and even providing elevated protective features that help to keep water out of communities. Figure 4-4[25] below illustrates how a marsh and rock sill NNBF concept, one of the many types considered in this study, can reduce erosion and help in the management of coastal storm risk.

[25] Source: New York Department of Environmental Conservation and New York State Department of State, 2018

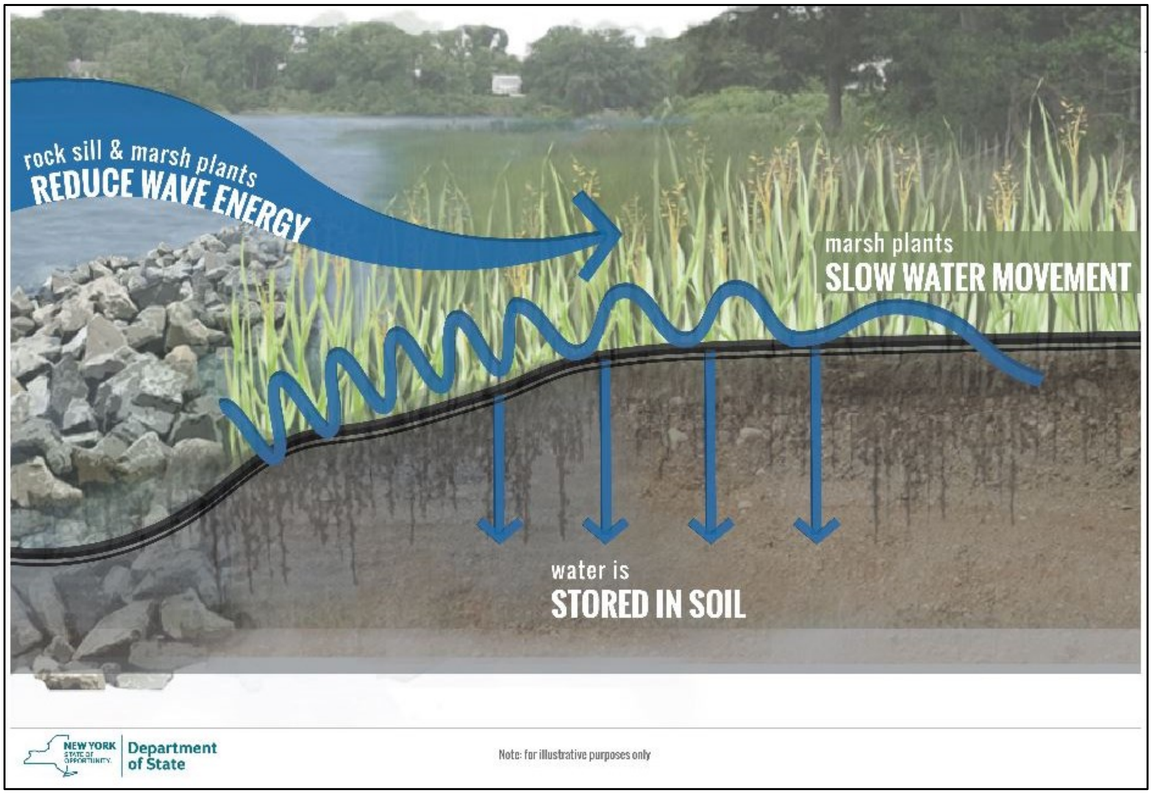


Figure 4-4: Marsh and Rock Sill NNBF Concept Illustration

4.6 Planning Goals, Objectives, and Constraints

4.6.1 Planning Goals

The main goals of this project are to reduce the risk to lives and property associated with coastal storms within the project area. Achievement of these goals includes the formulation of alternative plans for water resource problems to maximize contributions to NED. Contributions to NED are increases in the net value of the national output of goods and services expressed in monetary units. Contributions to NED are the direct net economic benefits that accrue in the planning area and in the rest of the nation. NED benefits for CSRM projects are the reduction in projected future coastal flooding-related damages (USACE 2000). Not all project benefits and costs are quantified in monetary units, and some are only captured qualitatively. Because of this, the NED benefits for some of the CSRM measures likely understate the benefit to the nation of a proposed plan. For example, NNBFs help manage coastal storm risk and increase the system's resiliency after a storm—they also have other 'incidental benefits' to the environment, such as ecosystem services like improving water quality, ecosystem restoration, aesthetic improvements, and more. Additionally, some of the CSRM benefits of NNBFs are infeasible to measure at this time. The USACE planning paradigm is to develop sufficient level of detail and analysis to make a decision. Therefore if a measure can be shown to be economically justified and cost effective, it is not necessary to expend additional time and money to try and capture all of the benefits in their entirety. Since the additional benefits from NNBFs are not factored into the NED benefits in the benefit-to-cost ratio, it would be possible for the most efficient alternative not to be the plan with the greatest monetary net benefits. Planning objectives; therefore, were not limited to monetary contributions to NED. Similarly, the plan formulation analysis includes descriptions of the additional benefits that are either infeasible to measure or not captured in the NED benefits yet may still prove valuable to decision makers (USACE 2013e).

4.6.2 Public Concerns

Public scoping meetings were held in April 2015 following the Alternatives milestone, to obtain feedback on the alternatives under consideration. Common concerns expressed during public scoping meetings included the sense of urgency to construct a coastal flood risk management feature as quickly as possible. Some expressed concerns about the coordination among multiple agencies addressing CSRM issues. Other concerns included maintaining access to the water, preserving views, and balancing risk management with environmental impacts. Public concerns identified during scoping were used to scope the study.

4.6.3 Planning Objectives

Objectives are the measurable outcomes of effective plans to avoid, reduce, or mitigate the problems; planning objectives must address the identified problems. In addition, planning objectives must be measurable so that alternative plans may be evaluated on their effectiveness and efficiency in meeting planning objectives over the 50-year period of analysis for the project, from 2020 to 2070.

In the aftermath of Hurricane Sandy, the study team held numerous meetings with communities and other stakeholders and conducted a thorough review of the published literature to support the development of planning objectives to guide the study. Five principal planning objectives were identified and include:

- Reduce vulnerability to coastal storm impacts;
- Reduce future coastal storm risk in ways that will support the long-term sustainability of the coastal ecosystem and communities;
- Reduce the economic costs and risks associated with large-scale flood and storm events;
- Improve community resiliency, including infrastructure and service recovery from storm effects; and
- Improve coastal resilience by reducing erosion and risk caused frequent flooding through the enhancement of natural storm surge buffers, also known as natural and nature-based features (NNBFs).

Each of these objectives has the potential to address at least two of the identified problems. All of the problems may be addressed if multiple objectives are achieved. Table 4-1 depicts the problems addressed by each objective.

Table 4-1: Problems and Objectives Matrix

Objectives	Problem 1: Human Health & Safety Impacts	Problem 2: Storm Damages	Problem 3: Insufficient Resiliency	Problem 4: Erosion of system's living shorelines protective capacity
Reduce Vulnerability	X	X	-	-
Reduce Flood Risk while Supporting Sustainability	X	X	-	X
Reduce Economic Costs and Risks	-	X	X	-
Improve Community Resiliency	X	X	X	X
Enhance Natural Buffers and Ecosystem Resiliency	-	X	X	X

The Disaster Relief Appropriations Act of 2013, which this Reformulation Study is authorized and funded under, directs the USACE to support 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 order to accomplish this directive, the study team integrated measures for reducing coastal risks along with measures that would increase human and ecosystem community resilience. Structural traditional CSRM measures were combined with natural and nature-based measures, as well as non-structural measures like buy-outs and home relocations, house raisings, and flood proofing. Various combinations of measures were developed into an array of alternatives to be analyzed, evaluated and screened in order to arrive at a recommended plan. These measures are fully defined in Section 5.5 Management Measures.

Alternative plans are developed to achieve the planning objectives. In order to measure the effectiveness and efficiency with which alternative plans achieve these objectives, the study team develops metrics for the evaluation. For a CSRM study like this one, reductions in vulnerability are evaluated by measuring projected reductions in coastal storm risk and associated reductions in projected monetary damages.

Improvements to resiliency also are evaluated, in part, by measuring projected reductions in coastal storm risk and associated reductions in projected monetary damages. Improvements to resiliency are often a function of reducing the time-to-recovery and can be influenced by bringing the more important systems back on-line before other services.

4.6.4 Planning Constraints

Unlike planning objectives that represent desired positive changes, planning constraints represent restrictions that limit what could be done and are recognized as constraints because they should not be violated in the planning process. The planning constraints identified in this study are as follows:

- Do not negatively impact ongoing recovery, ecosystem restoration, and risk management efforts by others;
    - There are multiple agencies, which are planning and constructing infrastructure, ecosystem, and risk management improvements within the project area. Some of this work is in response to Hurricane Sandy, other efforts are part of other ongoing programs (e.g., National Park Service's Gateway National Recreation Area General Management Plan (NPS, 2014), NYC Department of Environmental Protection's Jamaica Bay Watershed Protection Plan (NYCDEP, 2007);
- CSRM plans affecting the Gateway National Recreation Area must be mutually acceptable to the Department of the Interior and the Department of the Army[26];
- Do not negatively impact navigation access through Rockaway Inlet;
    - The federal navigation channel serves navigation interests including commercial cargo transport, charter fishing fleets, and recreational boaters, which use marinas within Jamaica Bay as their homeport;
- Do not induce flooding in areas not currently vulnerable to flooding and do not induce additional flooding in flood-prone areas;
- Do not reduce community access and egress during emergencies;
    - Island and peninsular communities within the study area currently have limited access, egress, and emergency evacuation routes;
- Do not impact operations at John F. Kennedy International Airport.
- Do not negatively affect plants, animals, or critical habitat of species that are listed under the Federal Endangered Species Act or a New York State Endangered Species Act.

[26] The authorizing legislation (P.L. 92-592, 1972) for GNRA recognized the potential need for water resource development projects within the Corps mission to be undertaken within its boundaries by establishing that that there must be agreement between the two agencies.

The authorizing language states that "The authority of the Secretary of the Army to undertake or contribute to water resource developments, including shore erosion control, beach protection, and navigation improvements (including the deepening of the shipping channel from the Atlantic Ocean to the New York harbor) on land and/or waters within the recreation area shall be exercised in accordance with plans which are mutually acceptable to the Secretary of the Interior and the Secretary of the Army."

5 FORMULATION AND EVALUATION OF ALTERNATIVE PLANS*

This section describes the plan formulation process for this study, which was conducted in accordance with the national objectives as stated in the USACE Planning Guidance Notebook (Engineer Regulation 1105-2-100, 22 April 2000). The planning process consists of six major steps: (1) Specification of water and related land resources problems and opportunities; (2) Inventory, forecast and analysis of water and related land resources conditions within the study area; (3) Formulation of alternative plans; (4) Evaluation of the effects of the alternative plans; (5) Comparison of the alternative plans; and (6) Selection of the recommended plan based upon the comparison of the alternative plans. Water resources project planning is an iterative process, such that any of the six major steps may be revisited as additional information comes to light during the performance of a subsequent step. Once the problems and opportunities had been assessed and study objectives established, the conditions and existing information inventoried, forecasted and analyzed for the study area.

The iterative planning process is combined with risk-informed decision making, as depicted in Figure 5-1, in order to balance the needs for data and analysis with swift progress sound investment of resources. Figure 5-2 below captures the risk-informed planning process as the decision makers gather evidence to support risk-informed decision making in order to progress through the study process.

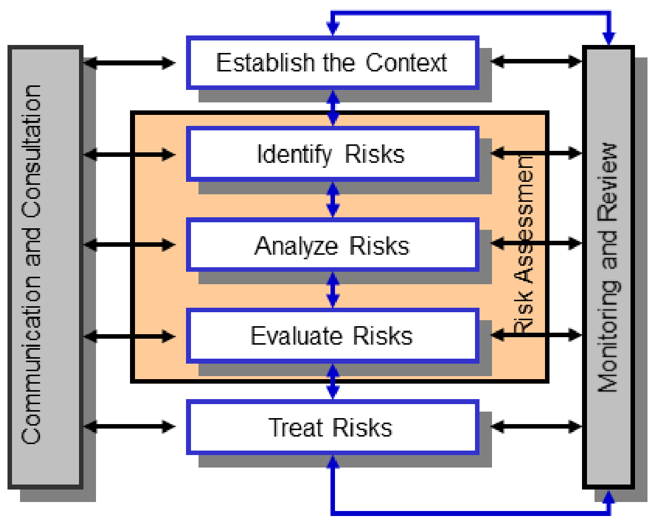


Figure 5-1: Risk-Informed Decision Making Process

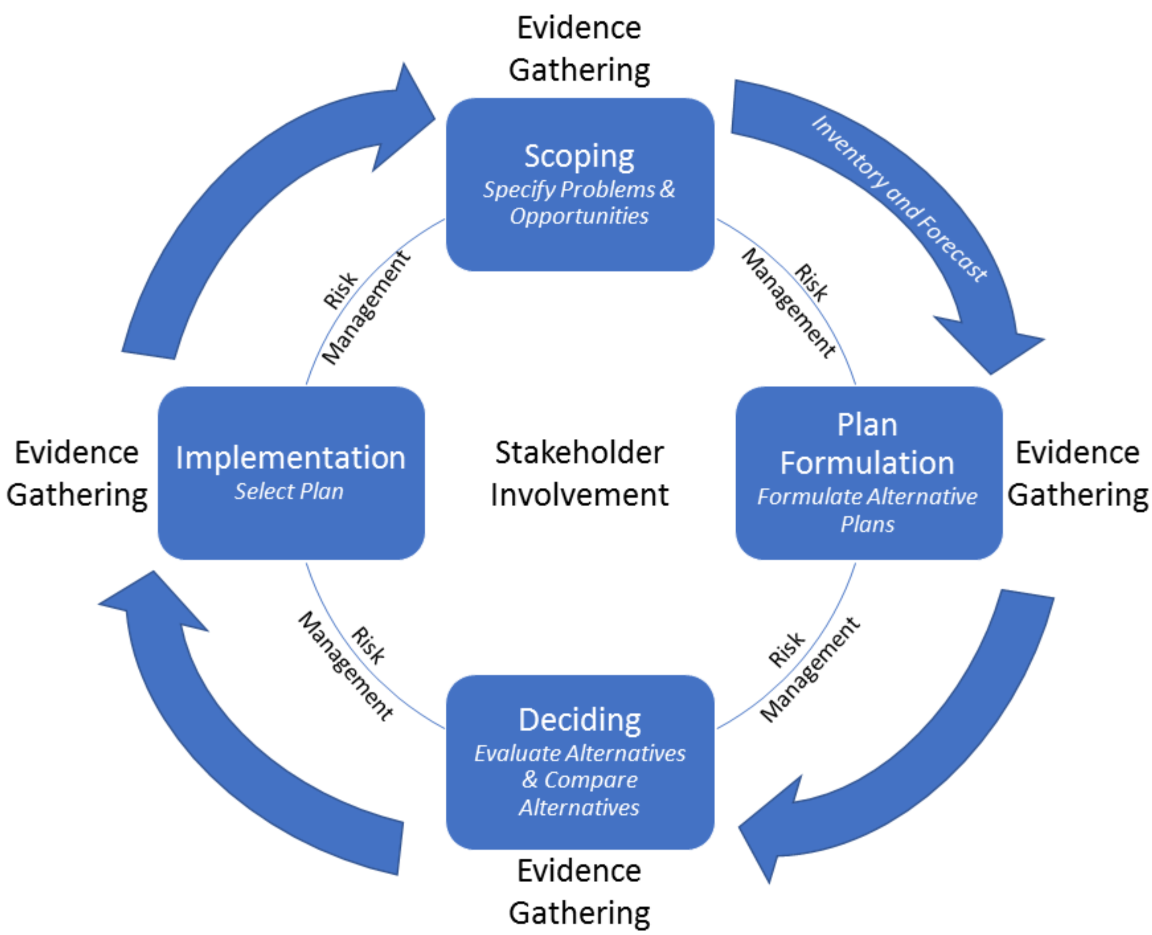


Figure 5-2: Risk-Informed Planning Process

5.1 Development of the Array of Alternatives

In consultation with the non-federal sponsor (NYSDEC), the City of New York, state and local agencies, and non-governmental entities, structural and non-structural management measures, including NNBFs, were developed to address one or more of the planning objectives. 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 distinct planning 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 project area. 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 most economically efficient solution for the Atlantic Ocean Shorefront Planning Reach was included as a component of the alternative plans for the Jamaica Bay Planning Reach.

The array of alternative plans, which resulted from the Alternatives Milestone Meeting, included alternative alignments for the Storm Surge Barrier Plan and a Jamaica Bay Perimeter Plan. Design details for the array of alternative plans were refined to address key uncertainties prior to plan evaluation. Evaluation of the array of alternative plans was based on criteria developed for the Alternatives Milestone, including CSRM effectiveness and efficiency, environmental impacts, and real estate impacts.

5.2 Identification of the Tentatively Selected Plan

The evaluation of the array of alternatives resulted in the identification of a Tentatively Selected Plan (TSP) and included:

1. A reinforced vegetated dune and beachfill for the Atlantic Shorefront of the Rockaway peninsula from Beach 9th Street to Beach 149th Street to manage risk from coastal flooding using a nature-based feature. The vegetation on the dune will help stabilize it and reduce erosion, as well as trap sand for natural accretion. The dune and widened beach have additional recreation and environmental benefits of providing both space to recreate and habitat. The proposed dune would be reinforced with a composite seawall core, which provides resiliency to the system.
2. Groin construction and extensions are proposed to help keep sand in place and reduce the frequency of beach renourishment required to maintain the beach berm at design width and grade to protect the dune from erosion.
3. A storm surge barrier across Rockaway Inlet, with tie-ins was proposed as part of the TSP to keep storm surge from large storms and hurricanes from entering the Rockaway Inlet and flooding the densely populated communities surrounding Jamaica Bay.
4. Finally, residual risk features are proposed to protect against the residual flood risk that would persist even with a barrier in place as the barrier would only be operated at or beyond a certain threshold of storms.

5.3 Inviting and Incorporating Public and Agency Comments into the Agency Decision on a Recommended Plan

The TSP was described in the Draft HSGRR/EIS which was released for agency and public review in August 2016 and followed by a series of public meetings. The project delivery team received copious and significant comments from the public and agencies on the TSP. Comments strongly voiced the need for additional study and analysis of the proposed storm surge barrier. Conversely, comments strongly urged the need for urgency and haste in constructing coastal storm risk management features in the study area.

Around the same time that the Draft HSGRR/EIS was released, a new study was kicked off, the New York/New Jersey Harbor and Tributaries Study, or NYNJHATS, looking at reducing regional coastal storm risk. One of the proposed alternatives for this study, the NY/NJ Outer Harbor Barrier, is a giant storm surge barrier that would stretch from Sandy Hook, New Jersey to Breezy Point on the Rockaway peninsula and obviate the need for a storm surge barrier across Rockaway Inlet. Therefore it makes more sense from an agency perspective to analyze the proposed Rockaway storm surge barrier in comparison to other regional solutions being studied in the New York/New Jersey Harbor and Tributaries Study. Furthermore, the Rockaway Reformulation and 16 other USACE studies and projects are 100% federally funded by the Sandy Recovery Improvement Act of 2013 (Public Law 113-2), yet the proposed Rockaway storm surge barrier cost would exceed the entire appropriation of that Act and would therefore require additional authority and appropriations from Congress to be built. It is unlikely that

Congress would appropriate the roughly three billion dollars estimated for construction of this storm surge barrier until the NYNJHAT study had at the minimum screened out the alternative that would make the Rockaway barrier redundant and duplicative. Therefore, as an outcome of the Agency Decision Milestone (ADM) the proposed storm surge barrier across Rockaway Inlet is not going to be further analyzed nor recommended under the Rockaway Reformulation Study, but instead under the separate ongoing NYNJHAT Study.

5.4 Refinement of the Recommended Plan

Once the decision was made to move the storm surge barrier feature out of the Rockaway Reformulation recommended plan, the project delivery team (PDT) sought to identify stand-alone incrementally justified features to manage coastal flood risk for the communities of Jamaica Bay, who remain at substantial risk without a storm surge barrier in place, even with the proposed Atlantic Shorefront features. The communities in and around Jamaica Bay are low-lying communities who experience frequent flooding. Jamaica Bay is an erosive environment, as evidenced by the high rates of wetland loss and shoreline erosion. Causes include anthropogenic changes to the system over time, sea level change, and local natural conditions, but the bottom line is that the resiliency of the system has been compromised over time and is now densely populated and subject to frequent flooding and high risk for residents.

High frequency flooding risk reduction features (HFFRRFs) were developed using the residual risk concepts of the TSP and expanding upon them to 1) include areas in Nassau County, 2) to evaluate for three different high frequency flood extents, and 3) to develop and include in the screening NNBFs as CSRM features to be considered as required[27]. The HFFRRFs were designed to be stand-alone features that are incrementally justified from an economic standpoint yet would complement a potential future storm surge barrier. The rationale is that if and when a proposed storm surge barrier is built, it would still not be closed for every storm event. Barrier closures incur economic impacts to transportation and are directly linked to increased maintenance costs. The development and screening of the HFFRRFs begins in Section 5.11.

The revised Recommended Plan includes:

1) A reinforced vegetated dune and beachfill for the Atlantic Shorefront of the Rockaway peninsula from Beach 9th Street to Beach 149th Street to manage risk from coastal flooding using a nature-based feature.
2) Groin construction and extensions are proposed to help keep sand in place and reduce the frequency of beach renourishment required.
3) HFFRRFs to manage the risk of frequent flooding from smaller storms and high tide. HFFRRF locations include 1) the mid-Rockaway peninsula bay-side, including NNBFs, floodwalls, bulkheads and stormwater drainage pump stations, 2) bulkheads and a stormwater drainage pump station at Cedarhurst-Lawrence in Nassau County, and 3) a low floodwall and stormwater pond storage at Motts Basin North. All

[27] CECW-CE Memorandum for Commanders, Major Subordinate Commands dated 28 September 2017, Subject: Implementation Guidance for Section 1184 of the Water Resources Development Act of 2016 (WRDA 2016), Consideration of Measures

HFFRRFs also include measures to manage the interior drainage, such as added or extended stormwater outfalls.

The following sections describe the plan formulation steps in detail, which have been summarized above.

5.5 Management Measures

5.5.1 Atlantic Ocean Shorefront Planning Reach

The following measures were identified for consideration as CSRM features along the Atlantic Ocean Shorefront Planning Reach.

1. No Action (FWOP)
2. Sand Bypassing / Inlet Management
3. Vegetated Dune with Beach Fill
4. Breakwaters
5. Groins
6. Removal or Modification of Groins
7. Bulkhead under/near the boardwalk
8. Seawalls / Reinforced Dunes
9. Non-structural Measures (i.e. floodproofing, structure raising, relocations)
10. Boardwalk Relocation

A preliminary screening was undertaken based upon the specific problems and opportunities in each reach, to identify those measures that are applicable to the specific needs. Table 5-1 provides a summary of the measures that were identified for consideration in each reach during the initial formulation process. Each measure marked with an "X" was recommended for further consideration within that Reach.

Table 5-1: Summary of Measures

Measures for consideration	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach 6
Shorefront measures						
No Action	X	X	X	X	X	X
Inlet Management	X					X
Vegetated Dune with Beach Fill	X	X	X	X	X	X
Breakwaters						
Groins		X		X		X
Groin Modification		X	X	X	X	X
Bulkhead under/near the boardwalk			X	X	X	X
Seawalls / Reinforced dunes			X	X	X	X
Non-structural (Boardwalk Relocation)						X

5.5.2 Jamaica Bay Planning Reach

The USACE Project Delivery Team used previous USACE investigations, Rockefeller Foundation analyses supporting the Science and Resiliency Institute at Jamaica Bay's "Towards a Master Plan for Jamaica Bay" initiative, and meetings with local stakeholders to identify the universe of potential measures that may be applicable to the Jamaica Bay planning reach. A comprehensive inventory of proposals compiled as part of the stakeholder outreach facilitated by the Science and Resiliency Institute at Jamaica Bay was reviewed to identify the breadth of measures to be considered for the reformulation effort. The measures evaluated in this analysis are listed in Table 5-2.

Table 5-2: Comprehensive Inventory of Measures

Non-structural Measures	**NNBF Measures**
Acquisition	Living shoreline
Managed Retreat	Wetland
Floodplain zoning	Maritime forest
Floodproofing	Reef
Flood warning system	Dunes[1] and Beaches
Structural Measures	Swale/Channel
Flood gate	**Other Measures**
Hurricane barrier	Bay shallowing
Levee	Storm water improvement
Floodwall	Wastewater treatment
Bulkhead/Seawall	Park access and recreation
Breakwater	Evacuation routes
Sediment management	No action
Groins	
Beach nourishment	

[1]Includes reinforced dunes

Preliminary screening criteria were developed from the planning objectives, including:

- Can the measure provide CSRM benefits in accordance with USACE Civil Works missions and authorities?
- Is the measure effective in providing CSRM benefits (reduce vulnerability, flood risk, and economic costs associated with coastal storms) either as a stand-alone measure or as a part of a larger system when joined with other measures?
- Can the measure provide improvements in resiliency sustainability which include reductions of the time-to-recovery for the natural coastal ecosystem and for communities?
- Are there areas where NNBF measures for CSRM are feasible, and could minimize overall project impacts to the environment, reduce potential mitigation requirements, or reduce the long-term O&M costs of the project?

Figure 5-3 presents a summary of the measures screened for the Jamaica Bay Planning Reach. For measures that achieved the particular screening criterion, a solid, blue marker was placed in the appropriate row and column and that measure was retained for further evaluation. If a measure likely achieves the particular screening criterion only during high frequency storm events, a blue and yellow marker used to indicate this detail and the measure also is retained for further evaluation. Measures identified by a grey box are not carried forward for further evaluation, including swale/channel, bay shallowing, storm water improvement, wastewater treatment, park access and recreation, and evacuation routes. The authority for this General Reevaluation is a CSRM authority so the USACE restoration mission benefits cannot be used to justify measures, though the benefits to ecosystems and other social effects are described in order to support decision makers with full information to include incidental benefits.

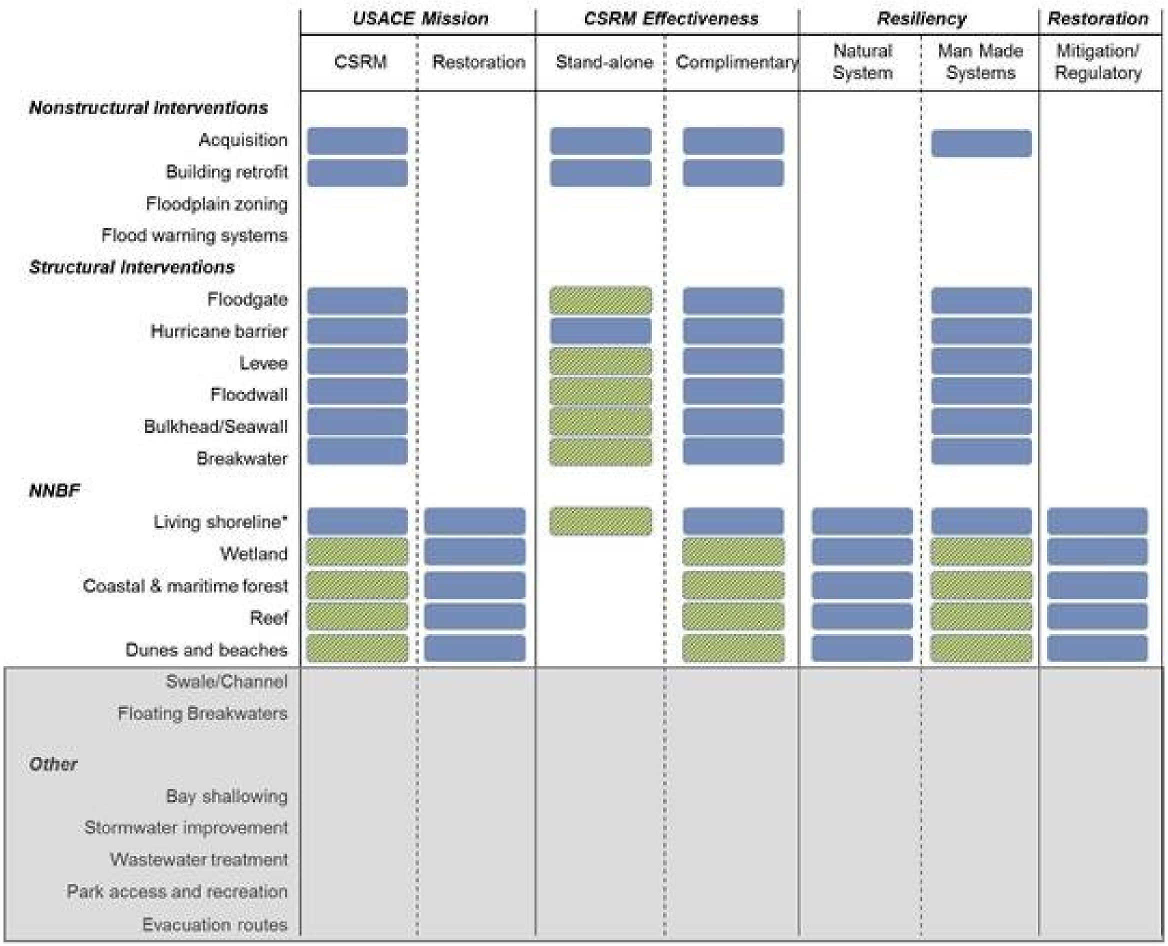


Figure 5-3: Summary of Preliminary Screening of Jamaica Bay Measures

5.6 Alternative Plan Formulation

This section describes the development of alternative plans based on combinations and refinements of screened measures. Measures were combined to create CSRM alternatives for two distinct reaches: the Atlantic Ocean shorefront and Jamaica Bay. A 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; therefore, the first step was to formulate efficient CSRM solutions specifically to address conditions at the Atlantic Ocean Shorefront Planning Reach. The best solution for the Atlantic Ocean Shorefront

Planning Reach was then included as a component of the alternative plans for the Jamaica Bay Planning Reach.

5.6.1 Atlantic Ocean Shorefront Planning Reach

The general approach to developing CSRM alternatives along this reach was to evaluate features that optimize life-cycle costs in combination with a single beach and dune template to select the most cost effective renourishment approach. From the measures described above, this includes beachfill, groins, groin modifications, and boardwalk relocation. Once the most efficient lifecycle management plan was selected, different combinations of beach, dune and reinforced dune cross-sections were evaluated to identify the most economically efficient plan for the planning reach, considering both the level of risk reduction afforded and the lifecycle costs.

5.6.1.1 Life-Cycle Cost Optimization: Beachfill

Three lifecycle management alternatives were short-listed by the PDT and selected to be evaluated in detail. These alternatives included the following:

- Beachfill Alternative 1: Beach Restoration; consisting of a beach and dune with renourishment.
- Beachfill Alternative 2: Beach Restoration, Groin Modifications, and Boardwalk Relocation; consisting of a beach and dune with renourishment, shortening of existing groins, and relocation of the boardwalk.
- Beachfill Alternative 3: Beach Restoration, Groin Modifications, and Construction of New Groins; consisting of a beach and dune with renourishment, extension of existing groins, and construction of new groins.

The screening level design was used to optimize life-cycle costs, which consisted of developing layouts, cross-sections, quantities, and costs. The objective of the design was to develop enough detail regarding the designs to be able to reliably estimate the life-cycle costs. The life-cycle cost optimization (Table 5-3) does not consider storm damage reduction benefits since all of the alternatives are based on the same design profile, and all provide a comparable level of risk reduction.

Based upon this comparison of costs, the optimal life-cycle cost feature is Beachfill Alternative 3, which includes beach restoration with renourishment, extension of existing groins, and the construction of new groins (Figure 5-4). This feature had the lowest annualized costs over the 50-year project life and the lowest renourishment costs over the project life (Beachfill Alternative 3 in Table 5-3). The Beachfill Alternative without groins has higher annualized costs over the life cycle of the project due to the additional beachfill that would be needed to maintain the project without groins (see Engineering Appendix, Section 7.2.8 for more detail). Renourishment material would be sourced from a borrow area approximately two miles offshore (south) of the Rockaway peninsula.

Table 5-3: Optimal Beachfill Life Cycle Cost Screening for Atlantic Shorefront

		Beachfill Alternative 1	Beachfill Alternative 2	Beachfill Alternative 3
Initial Cost	Initial Construction	$24,016,000	$128,177,000	$60,801,000
	IDC	$125,000	$2,204,000	$1,273,000
	Investment Cost	**$24,141,000**	**$130,381,000**	**$62,074,000**
Annualized Cost	Initial Construction	$1,006,000	$5,434,000	$2,587,000
	Renourishment (Planned/Emergency)	$7,708,000	$5,936,000	$5,740,000
	O&M	$403,000	$403,000	$573,000
	Major Rehab	$332,000	$332,000	$332,000
	SLR Adaptation	$0	$0	$0
	Total Annual Cost	**$9,449,000**	**$12,105,000**	**$9,232,000 (lowest lifecycle cost)**

Figure 5-4: Beach Restoration with Beachfill, Groin Extensions, and New Groins

Beachfill quantities required for initial construction of the selected alternative were estimated based on the expected future shoreline positions. It is impossible to predict exact shoreline positions since the wave conditions vary from year to year and affect shoreline change rates. The future shoreline position was estimated based on a two and a half year GENESIS-T simulation representative of typical wave conditions. Beachfill quantities are based on the difference in the design shoreline position (including advance fill) and the predicted future shoreline. For every foot that the projected shoreline needs to be translated seaward 1.22 cubic yards per foot (cy/ft) of fill would be required. This is based on a berm elevation of +8 ft NAVD88 and a depth of closure of -25 ft NAVD88. Beachfill quantities (Table 5-4) include an overfill factor of 11% based on the compatibility analysis for the borrow areas (see the Engineering Appendix for more detail). Namely, as finer materials wash out more readily back into the ocean after placement, larger losses of initial fill are incurred with finer grain sizes. Therefore, the initial fill quantities will overfill a certain percentage to make up for the amount that is estimated to be lost based on the grain size of the material to be placed.

A renourishment interval of four years was developed, which is projected to result in minimum berm widths of approximately 60 feet along the placement area. Renourishment in Reach 6a is not included as a part of the project because of annual East Rockaway Inlet dredging, which is projected to place 115,000 cubic yards of material on this reach annually. Renourishment for this reach, and Reaches 3, 4, and 5, once authorized, are subject to O&M funding of authorized O&M activities. Reach 6b appears to accrete naturally based on site-specific natural morphological processes and was not identified as having erosion issues warranting renourishment. The 'major rehab' is a projected cost to repair damage to the project due to large events that may occur over the life of the project.

Table 5-4: Beachfill and Renourishment Quantities (cubic yards)

Reach	Beachfill	Renourishment per Cycle
West Taper	306,000	0
Reach 3	356,000	444,000
Reach 4	294,000	133,000
Reach 5	321,000	444,000
Reach 6a	250,000	0
Reach 6b	20,000	0
East Taper	49,000	0
Totals	**1,596,000**	**1,021,000**

Note: Renourishment would occur on a four-year cycle

5.6.1.2 Life-Cycle Cost Optimization: Groins

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. Table 5-5 presents the location and length of groin sections depicted in Figure 5-4 (above).

Table 5-5: Groin Locations and Lengths (feet)

Street	HSS	ISS	OS	Total	Description
34th	90	108	328	526	New 526’
37th	90	108	328	526	Extension 175’
40th	90	108	328	526	Extension 200’
43rd	90	108	228	426	Extension 75’
46th	90	108	228	426	Extension 150’
49th	90	108	228	426	Extension 200’
92nd	90	108	128	326	New 326’
95th	90	108	128	326	New 326’
98th	90	108	128	326	New 326’
101st	90	108	128	326	New 326’
104th	90	108	128	326	New 326’
106th	90	108	128	326	New 326’
108th	90	108	128	326	New 326’
110th	90	108	153	351	New 351’
113th	90	108	178	376	New 376’
115th	90	108	178	376	New 376’
118th	90	108	178	376	New 376’
121st	90	108	128	326	New 326’

5.6.1.3 Atlantic Ocean Reach Optimization

Optimization was performed by evaluating the level of overall CSRM provided by a range of dune and berm dimensions and by reinforced dunes, which would be combined with Beachfill Alternative 3 (Beach Restoration with Groin Rehabilitation and Construction of New Groins) to optimize CSRM at the Atlantic Ocean Shorefront Planning Reach.

Five shorefront coastal storm risk management alternatives were considered:

1. Beach Restoration, 16 ft NAVD88 sand-only dune, 60 foot berm
2. Beach Restoration, +18 ft NAVD88 sand-only dune, 80 foot berm, with boardwalk relocation to extend the available beach area landward and reduce the amount of beach renourishment needed
3. Beach Restoration, +20 ft NAVD88 sand-only dune, 100 foot berm
4. Beach Restoration, +18 ft NAVD88 reinforced dune – buried seawall, 60 foot berm
5. Beach Restoration, +18 ft NAVD88 reinforced dune – composite seawall, 60 foot berm

All of the alternatives include the most cost effective beach fill and groin features described in Sections 5.1.2.1 and 5.1.2.2 (Beachfill Alternative 3).

Three sand-only beach restoration alternatives were considered initially in order to assess the most efficient way to maintain a design beach profile. The smallest design beach fill profiles alternatives under consideration is slightly narrower than the Flood Control and Coastal Emergencies (FCCE) project but wider than the prior WRDA 1974 and Section 934 projects, with a dune height of +16 ft NAVD88 and a berm width of 60 feet. The two additional design beach fill profiles under consideration have wider berms and higher dunes (Figure 5-5). The dimensions of the three design beach profiles and associated level of protection is provided in Table 5-6.

Table 5-6: Recommended Design and Beachfill Profiles for Sand-only Dunes (Shorefront Alternatives 1-3)

Shorefront Alternative	Dune Size	Dune Height (feet, NAVD88)	Design Berm Width (feet)	LORR[1] (years)	Annual Exceedance Probability (AEP)
Shorefront Alternative 1 (sand-only dune)	Medium	+16 ft	60 ft	44	2.2%
Shorefront Alternative 2 (sand-only dune)	Large	+18 ft	80 ft	70	1.4%
Shorefront Alternative 3 (sand-only dune and boardwalk relocated landward)	XL	+20 ft	100 ft	100	1%

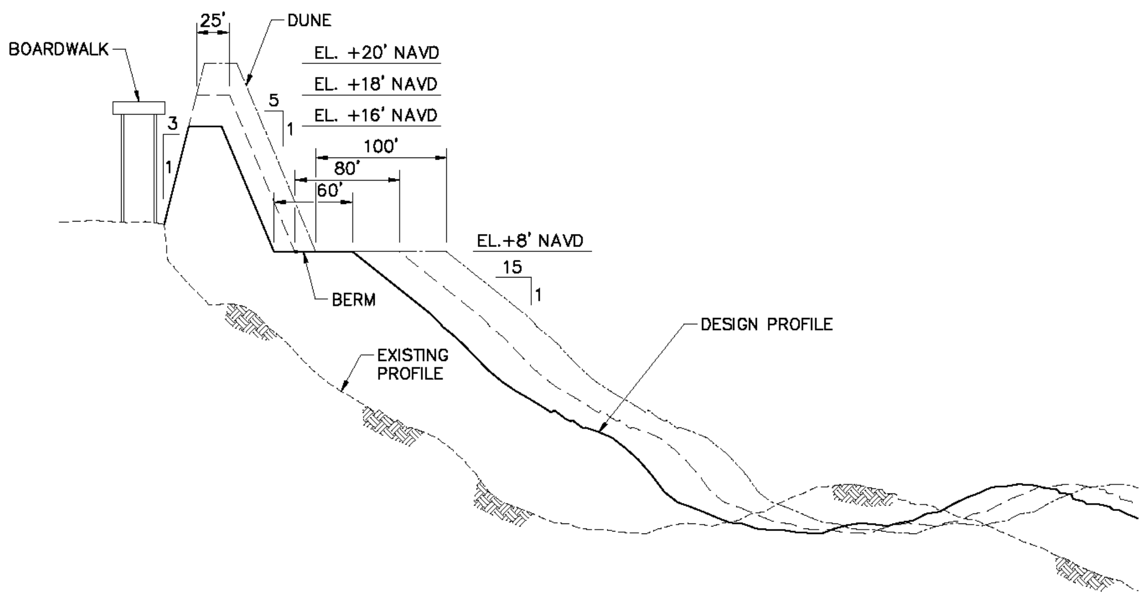


Figure 5-5: Profile of Beach Restoration and Dune Alternatives

Two reinforced dune concepts were proposed and considered for Rockaway Beach as part of the effort to optimize the design in order to maximize net benefits. The first type is a buried seawall the second type is a buried composite seawall. Both designs increase the resiliency of the dune as a CSRM feature if back-to-back storms by reinforcing the dune with non-erodible material.

Buried seawalls are essentially dunes with a reinforced rubble mound core and were developed as an alternative to larger standalone seawalls. Buried seawalls are designed to function in conjunction with beach restoration projects and dunes and are a more natural nature-based alternative to a standalone seawall. The primary advantage of buried seawalls over traditional dunes is the additional protection against erosion and wave attack provided by the stone core. Since the purpose of the buried seawall is wave protection, it may be constructed intermittingly along the shoreline in the most vulnerable areas. By vegetating the dune, erosion is further limited and the vegetation has a stabilizing effect on the dune, as well as increasing the dune's natural ability to trap sand and accrete. The vegetated dune also provides incidental benefits to the coastal habitat and aesthetics of the beach, though they do have a larger footprint which limits space for beach recreation on the flatter berm portion of the beach. The buried seawall, however, is permeable and will not stop cross-island flooding nor storm surge inundation.

The second reinforced dune concept considered is a composite seawall with an impermeable core (i.e. steel sheet pile). The purpose of the composite seawall is to not only protect against erosion and wave attack but also to limit storm surge inundation and cross-island flooding. The composite seawall provides a high level of protection that may not be practical to achieve with a sand-only dune because of the necessary height and footprint of such a dune. In addition, the composite seawall is compatible with a comprehensive storm surge barrier for Jamaica Bay.

Table 5-7: Seawall Design Alternatives Considered

Shorefront Alternative	Structure Type	Structure Crest Elevation (feet, NAVD)	Dune Elevation	Design Berm Width (feet)	LORR[1] (years)	AEP
Shorefront Alternative 4	Buried Seawall	+16	+18	60	70	1.4%
Shorefront Alternative 5 *(Recommended)*	Composite Seawall	+17	+18	60	150	.67%

The cost and benefits for each of the alternatives were evaluated. Among the beach restoration and dune alternatives, the highest net benefits are provided by the largest alternative considered. The results of the comparison are presented in Table 5-8 under a low sea level rise scenario and Table 5-9 under an intermediate sea level rise scenario. The results showed that all of the alternative plans are cost effective and that the highest net benefits are provided by Shorefront Alternative 5, the composite seawall, under both sea level rise scenarios.

The buried seawall design in Shorefront Alternative 4 was intended to help optimize the plan. However, analysis of the cross-island flooding benefits showed that this factor was an important damage driver and since the Shorefront Alternative 4 design did not reduce cross shore flood damage compared to the sand-only dune of the same height (because it is permeable), it did not increase net benefits. Alternatively, the composite seawall design in Shorefront Alternative 5, though it is a more expensive design, is very effective at reducing cross-shore flood damages because it is impermeable, and this difference helped to maximize the net benefits of this alternative.

Table 5-8: Rockaway Beach Dune and Berm Formulation Summary - Low Sea Level Rise Scenario

		Without-Project (No Action)	16 Foot Dune Shorefront Alt 1	18 Foot Dune Shorefront Alt 2	20 Foot Dune Shorefront Alt 3	Buried Seawall Shorefront Alt 4	Composite Seawall Shorefront Alt 5 NED Plan
Initial Cost	Initial Construction	$0	$71,017,000	$95,497,000	$147,199,000	$155,483,000	$220,988,000
	Interest During Construction (IDC)	$0	$1,307,000	$2,129,000	$3,462,000	$3,752,000	$6,760,000
	Investment Cost	**$0**	**$72,324,000**	**$97,626,000**	**$150,661,000**	**$159,235,000**	**$227,748,000**
Annual Costs	Initial Construction (annualized)	$0	$2,679,000	$3,616,000	$5,581,000	$5,898,000	$8,436,000
	Renourishment (Planned/ Emergency)	$867,000	$5,950,000	$6,392,000	$6,829,000	$5,950,000	$5,950,000
	O&M	$0	$579,000	$598,000	$621,000	$727,000	$836,000
	Major Rehab	$0	$332,000	$332,000	$332,000	$332,000	$332,000
	SLR Adaptation	$0	$0	$0	$0	$0	$0
	Total Annual Cost	**$867,000**	**$9,540,000**	**$10,938,000**	**$13,363,000**	**$12,907,000**	**$15,554,000**
Damages	Damages (Shorefront)	$17,502,000	$8,389,000	$5,180,000	$2,752,000	$5,097,000	$1,986,000
	Damages (Cross-Shore Flood Damages)	$28,757,000	$26,393,000	$19,350,000	$15,413,000	$19,350,000	$11,360,000
	Back-bay Damages	$65,548,000	$65,548,000	$65,548,000	$65,548,000	$65,548,000	$65,548,000
	Total Damages	**$111,807,000**	**$100,330,000**	**$90,078,000**	**$83,713,000**	**$89,995,000**	**$78,894,000**
CSRM Benefits	Total Benefits (Reduced Damages)	-	$9,113,000	$12,322,000	$14,750,000	$12,405,000	$15,516,000
	Cost Avoided (Emergency Nourishment)	-	$867,000	$867,000	$867,000	$867,000	$867,000
	Shorefront Benefit (Reduced Damage Plus Cost Avoided)	-	$9,980,000	$13,189,000	$15,617,000	$13,272,000	$16,383,000
	Cross-Shore Flood Damage Reduced	-	$2,364,000	$9,407,000	$13,344,000	$9,407,000	$17,397,000
	Total Storm Damage Reduction Benefits	-	$12,344,000	$22,596,000	$28,961,000	$22,679,000	$33,780,000
Recreation Benefits		-	$29,430,000	$29,430,000	$29,430,000	$29,430,000	$29,430,000
Total Benefits		-	**$41,774,000**	**$52,026,000**	**$58,391,000**	**$52,109,000**	**$63,210,000**
Net Benefits (Damage Reduction Only)		-	**$2,804,000**	**$11,658,000**	**$15,598,000**	**$9,772,000**	**$18,226,000**
BCR		-	**4.4**	**4.8**	**4.4**	**4.0**	**4.1**
BCR (CSRM Damage Reduction Only)		-	**1.3**	**2.1**	**2.2**	**1.8**	**2.2**

Table 5-9: Rockaway Beach Dune and Berm Formulation Summary - Intermediate Sea Level Rise Scenario

		Without-Project (No Action)	16 Foot Dune Shorefront Alt 1	18 Foot Dune Shorefront Alt 2	20 Foot Dune Shorefront Alt 3	Buried Seawall Shorefront Alt 4	Composite Seawall Shorefront Alt 5 NED Plan
Initial Cost	Initial Construction	$0	$71,017,000	$95,497,000	$147,199,000	$155,483,000	$220,988,000
	Interest During Construction (IDC)	$0	$1,307,000	$2,129,000	$3,462,000	$3,752,000	$6,760,000
	Investment Cost	**$0**	**$72,324,000**	**$97,626,000**	**$150,661,000**	**$159,235,000**	**$227,748,000**
Annual Costs	Initial Construction (annualized)	$0	$2,679,000	$3,616,000	$5,581,000	$5,898,000	$8,436,000
	Renourishment (Planned/ Emergency)	$943,000	$6,364,000	$6,801,000	$7,243,000	$6,364,000	$6,364,000
	O&M	$0	$579,000	$598,000	$621,000	$728,000	$836,000
	Major Rehab	$0	$332,000	$332,000	$332,000	$332,000	$332,000
	SLR Adaptation	$0	$210,000	$373,000	$377,000	$1,020,000	$1,453,000
	Total Annual Cost	**$943,000**	**$10,164,000**	**$11,720,000**	**$14,154,000**	**$14,342,000**	**$17,421,000**
Damages	Damages (Shorefront)	$18,512,000	$8,644,000	$5,405,000	$2,916,000	$5,296,000	$2,494,000
	Damages (Cross-Shore Flood Damages)	$27,384,000	$25,191,000	$18,515,000	$14,794,000	$18,515,000	$10,947,000
	Back-bay Damages	$70,505,000	$70,505,000	$70,505,000	$70,505,000	$70,505,000	$70,505,000
	Total Damages	**$116,401,000**	**$104,340,000**	**$94,425,000**	**$88,215,000**	**$94,316,000**	**$83,946,000**
CSRM Benefits	Total Benefits (Reduced Damages)	-	$9,868,000	$13,107,000	$15,596,000	$13,216,000	$16,018,000
	Cost Avoided (Emergency Nourishment)	-	$943,000	$943,000	$943,000	$943,000	$943,000
	Shorefront Benefit (Reduced Damage Plus Cost Avoided)	-	$10,811,000	$14,050,000	$16,539,000	$14,159,000	$16,961,000
	Cross-Shore Flood Damage Reduced	-	$2,193,000	$8,869,000	$12,590,000	$8,869,000	$16,437,000
	Total Storm Damage Reduction Benefits	-	$13,004,000	$22,919,000	$29,129,000	$23,028,000	$33,398,000
Recreation Benefits		-	$29,430,000	$29,430,000	$29,430,000	$29,430,000	$29,430,000
Total Benefits		-	**$42,434,000**	**$52,349,000**	**$58,559,000**	**$52,458,000**	**$62,828,000**
Net Benefits (Damage Reduction Only)		-	**$2,840,000**	**$11,199,000**	**$14,975,000**	**$8,686,000**	**$15,977,000**
BCR		-	**4.4**	**4.5**	**4.1**	**3.7**	**3.6**
BCR (CSRM Damage Reduction Only)		-	**1.3**	**2.0**	**2.1**	**1.6**	**1.9**

CSRM at the Atlantic Ocean Shorefront Planning Reach consists of optimized beach fill with groins plus a composite seawall, which provides the highest net benefits of all Atlantic Ocean shorefront alternatives considered for all three sea level rise scenarios analyzed, which included low, intermediate, and high USACE curves (Table 5-8 and 5-9, see Engineering Appendix, Section 7.2.8 and Table 7-8 of this appendix for more detail, as well as the Benefits Appendix Tables 8-1 through 8-3). Shorefront Alternative 5 with the composite seawall is the NED alternative for the shorefront because it has the lowest life cycle costs of the alternatives considered. The armor stone in horizontally composite structures, as included in Shorefront Alternative 5, 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 one layer of armor stone and extending the concrete cap up to the elevation of the armor stone.

A sand-only dune design with equivalent or greater level of risk reduction was considered in beach reaches with a very wide beach berm of roughly 200 feet versus the more typical minimum berm width of 60 feet in many parts of the Atlantic shorefront. However, this design would be less resilient in the face of back-to-back overtopping events due to the erodability of sand, and would need to be modified to the buried composite seawall dune design if and when the proposed storm surge barrier is authorized for construction under the New York and New Jersey Harbor and Tributaries Study. The modification cost would exceed the relatively minimal cost savings for initial construction of the sand-only design therefore this design approach was not carried forward (see Engineering Appendix for more detail). The 'major rehab' is a projected cost to repair damage to the project due to large events that may occur over the life of the project[28].

The composite seawall protects against erosion and wave attack and also limits storm surge inundation and cross-island flooding. The structure crest elevation is +17 feet NAVD88, the dune elevation is +18 feet NAVD88, and the design berm width is 60 feet. The composite seawall alternative provides effective and efficient CSRM at the Atlantic Ocean Shorefront Planning Reach and is a necessary component of comprehensive CSRM in the project area.

5.6.2 Jamaica Bay Planning Reach

The alternative plans for the Jamaica Bay Planning Reach include the best solution for the Atlantic Ocean Shorefront Planning Reach, which would substantially reduce overtopping of the Rockaway peninsula as a source of flood waters into Jamaica Bay. However, in order to identify a comprehensive solution, the team also developed plans to keep water from Jamaica Bay from flooding Back-bay communities. Four plans were initially developed (A – D) to manage flood risk for the communities in and around Jamaica Bay, also referred to as the Back-bay:

1. Plan A is the no Action Alternative.
2. Plan B consists of non-structural alternatives such as buy-out, flood-proofing, home raising, etc.

[28] This was calculated as an annual probability weight cost. More information on this can be found in the Engineering and Design Appendix.

3. Plan C is a storm surge barrier at Rockaway Inlet with complementary CSRM features to address residual flood risk that would remain during smaller rainfall events or high tide when a storm surge barrier would likely remain open.
4. Plan D is a perimeter barrier along the Jamaica Bay shoreline.

Plan B was screened out due to the high density of development and structure types not being conducive to non-structural measures in many areas. The final array of alternatives for the Jamaica Bay Planning Reach that resulted from the Alternatives Milestone included the Perimeter Plan, the Storm Surge Barrier Plan (Plan C), and the No Action Alternative (Plan A).

5.6.2.1 Perimeter Plan (Plan D) and the Storm Surge Barrier Plan (Plan C)

Figure 5-6 gives a summary of the first and second screenings as well as further changes to the Recommended Plan that occurred subsequent to the ADM, after the TSP was identified and received public comments. The public and agency comments received on the TSP resulted in the agency decision to move the storm surge barrier component of Plan C into a different, new and ongoing study for further analysis while moving forward with the implementation for the Jamaica Bay features that address frequent flooding from smaller events.

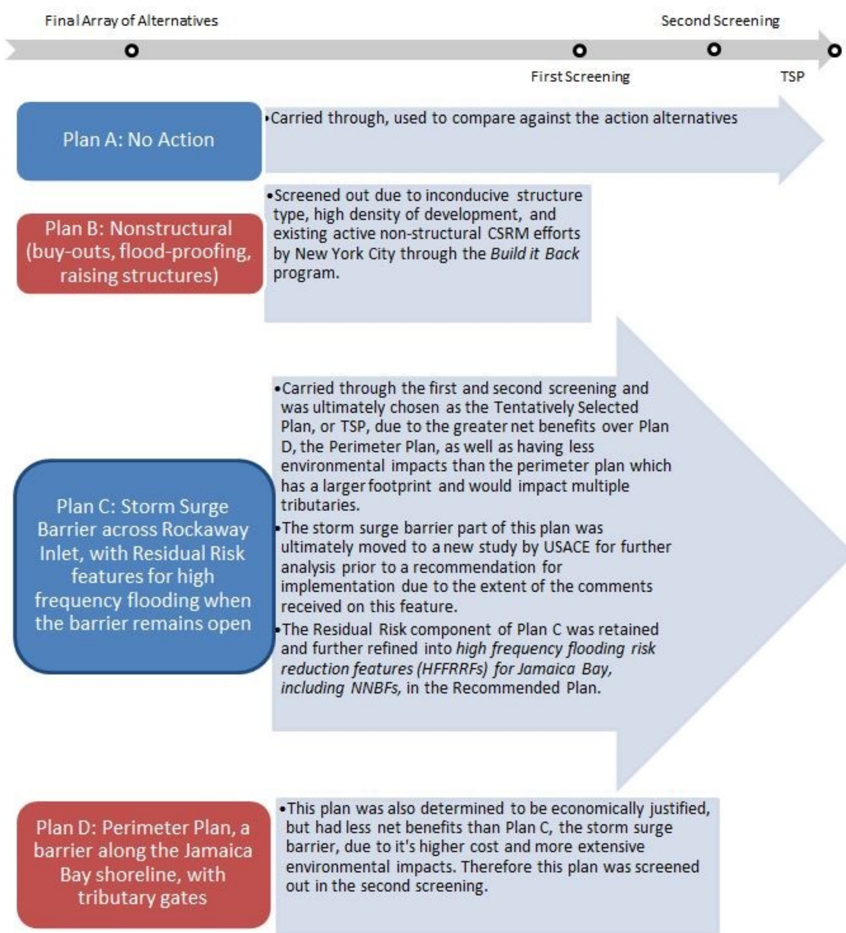


Figure 5-6: First and Second Screening Rounds of Jamaica Bay Plans

Storm Surge Barrier Alternative (Plan C)

The storm surge barrier alternative includes 1) a barrier which would have both permanent in-water features that tie-in to the land, as well as gates which would remain open most of the time, and close during a "triggering event" in order to keep storm surge from passing beyond the barrier and flooding coastal communities, and 2) Residual Risk measures to address high frequency flooding that would still occur when the proposed barrier would remain open.

Two alternative alignments of the Storm Surge Barrier Plan (C-1, and C-2) were assessed prior to the ADM when the storm surge barrier was moved to the NYNJHAT study. Each alternative alignment consisted of the optimized plan for the Atlantic Ocean Shorefront Planning Reach, two tie-ins (Coney Island tie-in and the Rockaway shorefront eastern and western tie-in) and alignment-specific variations of the Jamaica Bay Northwest CSRM unit (CSRMU) and the Rockaway Bayside CSRM unit.

The C-3 alignment was screened out from the more detailed analysis conducted for alignments C-1 and C-2 because alignment C-3 proved to have higher construction costs and OMRR&R costs due to its longer in-water footprint, while providing the same level of benefits as alignments C-1 and C-2.

Alignment C-2 and two alternative alignments for C-1 (C-1E and C-1W) were analyzed using the ADCIRC numerical model to aid in the design of the storm surge barriers and consider the number of openings, evaluate changes in tidal amplitude and velocities in Jamaica Bay for various gate configurations and Storm Surge Barrier alignments (Figure 5-8). Storm Surge Barrier alignment C-1E is preferred over alignment C-1W because alignment C-1E:

- would likely result in less impact to the Gil Hodges Memorial Bridge;
- would result in less real estate and aesthetic impacts to the Roxbury Community where alignment C-1W would tie in;
- is located in a more stable channel location; and
- avoids potential impacts to submerged cables.

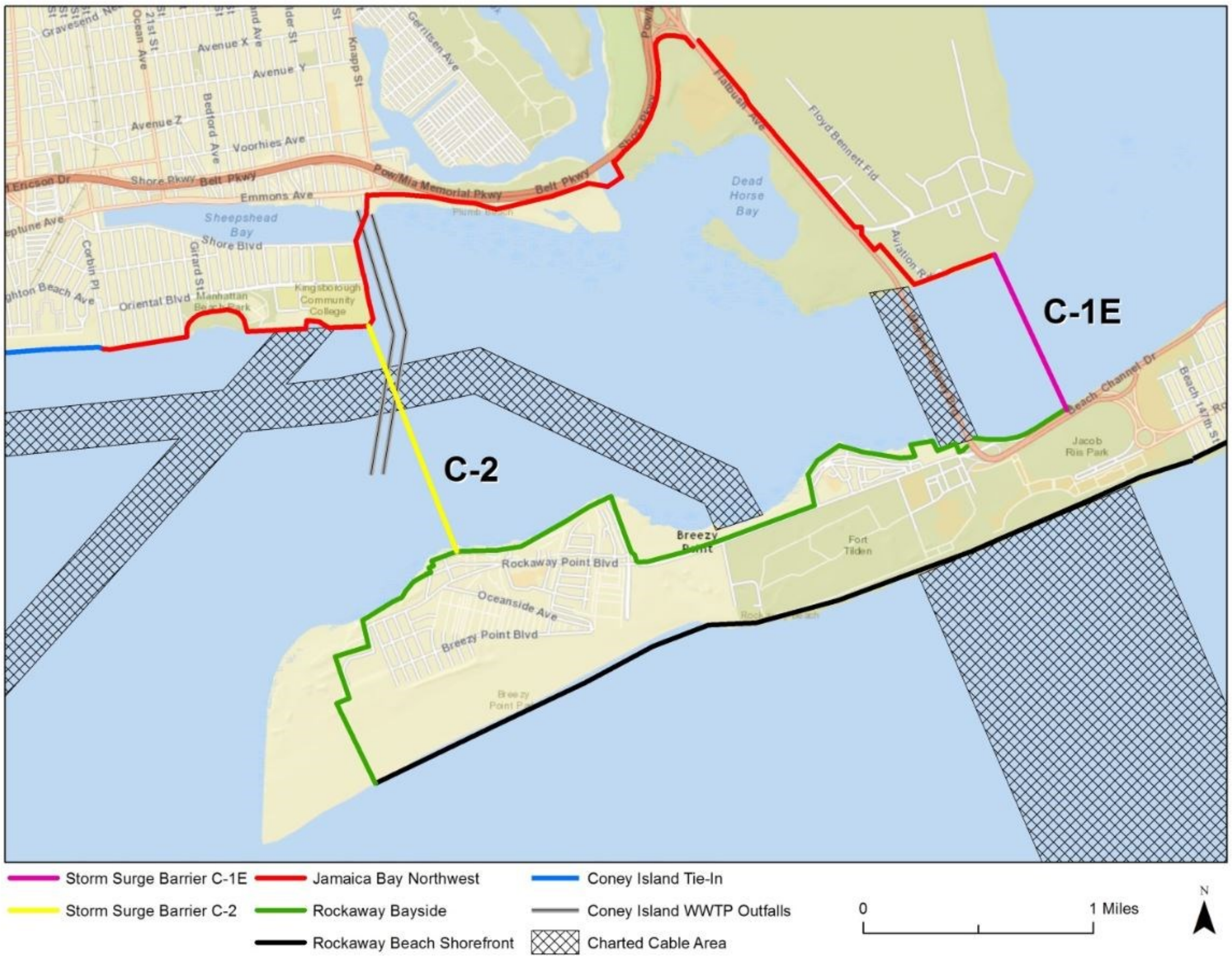


Figure 5-7: Alignments C-1 and C-2

Hydrodynamic modeling was conducted on multiple alignment and opening configurations to determine the alignment configuration pairs with the least impacts to tidal amplitude. The ADCIRC hydrodynamic modeling identified alignment C-1E with 1,100 linear feet of gate opening and alignment C-2 with 1,700 linear feet of gate opening as having the least hydrodynamic impacts to Jamaica Bay as compared to all other potential alignment and opening configurations. Both alignments C-1E and C-2 result in a maximum tidal amplitude change of 0.2 feet, which occurs only during the highest tides of a tidal cycle. This small impact to tidal amplitude indicates that there would not be any major changes in the water column throughout Jamaica Bay. Limited changes to the water column indicates that the natural environment driven by water circulation would be undisturbed and water chemistry, including the benthic layer, would be consistent with and without a Storm Surge Barrier. In addition, flow speeds and directions for both alignments are similar to without-project conditions, which imply that circulation within Jamaica Bay would be minimally impacted. This modeling effort was consistent with SMART planning guidelines as an initial step to identify and mitigate risks, and was intended to identify any significant impacts of a barrier before it was further refined and considered at the TSP Milestone. Additional water quality modeling has been undertaken and analyzed since the TSP Milestone (NYCDEP, 2016 and USACE 2018) and will be included in the NYNJHAT study prior to implementation of a Rockaway Inlet barrier to ensure that any barrier design avoids water quality impacts while the barrier is open or closed. Comments pertaining to alignment and potential impacts of the storm surge barrier will be addressed under the NYNJHAT study.

Jamaica Bay Perimeter Plan Alternative (Plan D)

The Jamaica Bay Perimeter Plan consists of the optimized plan for the Atlantic Ocean Shorefront Planning Reach, two tie-ins (Coney Island tie-in and the Rockaway shorefront eastern and western tie-in) and three distinct CSRM units (Jamaica Bay Northwest, Head of Bay, and Rockaway Bayside).

The Jamaica Bay Perimeter Plan (Figure 5-9) creates a contiguous barrier along the Jamaica Bay interior, with the exception of JFK Airport, which chooses to manage risk from coastal storms independently. The Jamaica Bay Perimeter Plan would avert inundation at a stillwater elevation of 11 feet for communities surrounding the bay. Eleven feet is generally equivalent to the stillwater elevation for a storm event with 1% probability of annual occurrence in 2070 including intermediate sea level rise. The community at Broad Channel, which is effectively within Jamaica Bay—as opposed to being a community on the fringe of Jamaica Bay—would not benefit from the Jamaica Bay Perimeter Plan.

After the Alternatives Milestone, additional analyses were conducted to reduced uncertainties associated with the final array of alternatives. A major objective of the additional analyses was to refine alignments to minimize costs, impacts to private property, and habitat disturbances associated with the Jamaica Bay Perimeter Plan.

Figure 5-8: Plan D Jamaica Bay Perimeter Plan

5.7 Alternative Plan Evaluation and Comparison

The Jamaica Bay Perimeter Plan (Plan D) and the Storm Surge Barrier (Plan C alignments C-1E and C-2) were evaluated for habitat impacts, real estate impacts, costs (construction, mitigation, real estate, under water utility relocation, and OMRR&R), and net benefits. Both plans include the same project features along the Atlantic Ocean shoreline Planning Reach.

5.7.1 Screening Criteria

- Is the plan economically justified where the benefits to the nation exceed the cost?
- Does the plan reasonably maximize benefits to the nation?
- Is there a significant impact to the environment? What would it take to mitigate the environmental impact?
- What are the impacts to real estate if this plan is built? I.e. how many structures would need to be acquired or would have their views impacted?
- How do cost factors for construction, mitigation, and real estate vary?

- Would there be a need for significant underwater utility relocation which has significant risk involved both to project schedule, cost, and potential disruption in services or impacts to the water body?
- What would the long-term operation and maintenance of the project entail?

5.7.2 Habitat Impacts and Mitigation Requirements

Environmental impacts associated with structural alternatives were addressed by complimentary evaluations:

1. Permanent and temporary impacts using an acreage metric. This provides a traditional measure of mitigation needs, and does not account for the level of ecological service and/or functions provided by the habitat types; and
2. Evaluation for Planned Wetlands (EPW) was used to evaluate impacts to ecological functioning within coastal wetlands in in-water habitats[29].

Table 5-10 presents permanent and temporary habitat impacts using an acreage metric. The metric used during preliminary screening provided a traditional measure of impacts and mitigation needs, but did not account for the level of ecological service and/or functions provided by the habitats. Since the storm surge barrier component of Plan C is no longer part of the Recommended Plan for the Rockaway Reformulation, the functional habitat assessment and associated mitigation from potential impacts due to the barrier will not be discussed in this EIS, but will be further addressed in the NYNJHAT study instead.

Table 5-10: Permanent and Temporary Habitat Impacts (acres)

Habitat Type	Permanent			Temporary		
	C-2	C-1E	D	C-2	C-1E	D
Subtidal Bottom	37.7	34.6	45.1	0.1	1.2	13
Intertidal Mudflat	3.3	7.5	25.1	3.8	8.8	24.2
Intertidal Wetlands	0	0	9.4	0	0.1	7
Non-Native Wetlands	0	0.4	3.5	0	0.4	0.3
Beach	0	13	17	61	69.9	69.6
Dune	3.1	4	6.8	10.4	11.3	10.3
Maritime Forest/Shrub	6.71	20.6	31.5	3.9	11.4	30.3
Total	**50.81**	**80.1**	**138.4**	**79.2**	**103.1**	**154.7**

[29] EPW has been certified by USACE for use in studies.

The acreage of habitat impacts was used to provide a rough estimate of mitigation costs for the screening of the final array of alternatives to arrive at the TSP. Future functional habitat modeling can facilitate refinement of any mitigation costs for any Rockaway barrier if one is ultimately recommended by the NYNJHAT study. All further analysis would be conducted under the NYNJHAT study. However, the work done in the Rockaway Reformulation to determine that the storm surge barrier is preferable to a perimeter plan for Jamaica Bay would remain unchanged and would not be revisited. Public and agency comments raised no objection to the conclusion that the storm surge barrier was environmentally preferable to the perimeter plan. Comments on the storm surge barrier were focused more on the alignment, design, and operation considerations for the storm surge barrier, with many commenters expressing a desire to ensure that impacts to the environment and viewscape aesthetics are minimized. Furthermore, comments included calls for further analysis on sediment transport, and potential impacts to Gil Hodges Bridge, etc., based on the alignment of the storm surge barrier to ensure no negative scour impacts to the bridge would occur.

5.7.3 Atlantic Ocean Shorefront Planning Reach

The benefit estimates for Atlantic Ocean shorefront coastal storm risk reduction include reduced damages for the Atlantic Ocean shoreline, reduced damages from cross island flooding, and reduced future maintenance costs (Table 5-11). For the Atlantic Ocean shoreline areas the Beach-fx models incorporate each design profile and were adjusted for future profiles to reflect the planned renourishment, which maintains the design profile into the future. The reduced damage due to cross shore flooding was estimated by using the HEC-FDA levee function to truncate/eliminate damages for storm events that would not generate significant overtopping volumes (1.0 cfs). Because the project will maintain the design profile there will be no need for non-federal actions to repair the design profile after major storm events. These future costs avoided are estimated to add $812,000 in average annual benefits to each plan. The composite seawall was selected as a common element of each alternative plan because it provides the highest net benefits of the alternative shorefront elements.

Table 5-11: Atlantic Ocean Shorefront Planning Reach Equivalent Annual Damage Reduction

	Composite Seawall
Total Benefits (Reduced Damages)	$13,896,000
Cost Avoided (Emergency Nourishment)	$812,000
Shorefront Benefit (Reduced Damage Plus Cost Avoided)	$14,708,000
Cross Shore Flood Damage Reduced	$17,309,000
Total Storm Damage Reduction Benefits	$32,017,000
Net Benefits (Damage Reduction Only)	**$16,222,000**

5.7.4 Recreation Benefits

Implementation of the shorefront component of the project will maintain the beaches within the study area that were restored and renourished after Hurricane Sandy in 2012. Maintaining the width of existing beaches will create an enhanced recreation experience (relative to the future condition of the beach without maintenance) which is reflected in an increase in willingness to pay (WTP) for the recreation experience and an increase in visitation.

In the future without-project condition Rockaway beaches would not be maintained at presently renourished beach widths since future renourishment has not been approved. Without renourishment, the beach will experience erosion and will eventually be half the width of the existing beach. The shorefront element of each alternative plan will maintain the beaches in the study area against erosion, to a minimum width of 60 feet of beach.

The Travel Cost Method (TCM) is used to estimate economic use values associated with sites that are used for recreation. The basic premise of the TCM is that the time and travel cost expenses that people incur to visit a site represent the 'price' of access to the site. An individual TCM approach was used, based on survey data from individual users at Rockaway Beach. Data was gathered on the location of the visitor's home ZIP Code, how far they traveled to the site, how many times they visited the site during the season, the length of the trip, travel expenses, the method of travel to the site, the person's income and other socioeconomic characteristics.

Beach attendance data was provided by the Department of Parks and Recreation (DPR), City of New York. Based on the total Rockaway Beach visitation provided by DPR, and information from the survey (corrected for trip bias), 2015 beach attendance was estimated by method of travel to the beach. The without project condition of not maintaining Rockaway Beach against erosion results in a substantial number of existing beach goers not willing to visit. Those willing to visit under the without project condition slightly reduce their number of beach visits compared with their existing beach visits. The number of visits not taking place under the without project condition at Rockaway Beach is 4,512,512. The average value per visit is estimated through the TCM as $6.23.

The without-project future condition assumes the lack of beach maintenance against erosion. Rockaway Beach would continue to experience erosion at a rate of about 10 feet per year. Based on responses to beach surveys completed in the summer of 2015, it is estimated that a 50 percent reduction in beach width would reduce the annual number of visits to Rockaway Beach by 4,512,512 visits. Beach visits per year were interpolated between these two points based on survey responses. The reduced beach width would, in turn, reduce the user willingness to pay for the remaining 3,225,988 visits to a substantially lower $3.24 per visit. The average annual equivalent value of the recreation component of NED benefits is $32,998,000 (see the Recreation Appendix for benefits estimation method and calculations).

5.8 Identification of the Tentatively Selected Plan

Table 5-12 presents the average annual costs, benefits, net benefits, and benefit-to-cost ratio for each of the alternative plans considered for the Jamaica Bay planning reach prior to the TSP milestone. Though the storm surge barrier will now be further evaluated under the NYNJHAT study, the analysis that made it part of the previous TSP is presented in Table 5-12.

Table 5-12: Jamaica Bay Alternative Plan Average Annual Net Benefits (AAEQ)

Plan Name	Total Cost	Benefits	Net Benefits	BCR
Barrier C-1E	$163,638,000	$509,233,000	$345,595,000	3.1
Barrier C-2	$163,710,000	$509,233,000	$345,523,000	3.1
Perimeter-D	$227,416,000	$497,582,000	$270,166,000	2.2

The Storm Surge Barrier Plan has $75.4 million more net benefits than the Perimeter Plan and is a significantly more efficient plan for comprehensively managing risk from coastal flooding for the study area. However, both the Perimeter Plan and the Storm Surge Barrier Plan are economically justified with the benefit to the national economy exceeding the cost to the nation. The Storm Surge Barrier Plan, regardless of alignment, has less of an environmental impact and has less of a real estate impact than the Jamaica Bay Perimeter Plan. Storm Surge Barrier Plan alignment C-1E provides the greatest net benefits of the final set of alternative plans, but is very close when compared to alignment C-2. There were three additional compelling factors that made Storm Surge Barrier Plan alignment C-1E the TSP:

- The costs for C-1E include far less uncertainty that the costs for C-2. There is no need for submerged cable relocations for alignment C-1E.
- Although the real estate costs for alignment C-2 are lower than real estate costs for C-1E, real estate costs do not account for the severe impact to water views that would be imposed on the Breezy Point neighborhood by alignment C-2. Storm Surge Barrier Plan alignment C-1E is nearly one-half mile away from residential structures on the Rockaway peninsula with proximity to the existing in-water infrastructure—the Gil Hodges Bridge.
- Alignment C-1E provides flexibility in the determination of whether to include and to what extent to include Breezy Point and Jacob Riis Park into the project. The Rockaway peninsula terminus of alignment C-2 cannot be removed from Breezy Point in a cost effective manner. In other words, alignment C-2 requires the inclusion of and impacts to Breezy Point, particularly to the viewshed. The Rockaway terminus of alignment C-1E is approximately one-half mile from Breezy Point. There are numerous potential configurations of the Rockaway Bayside and the Rockaway Shorefront CSRM units that can provide alternative levels of CSRM at Breezy Point.

Additionally, Storm Surge Barrier alignment C-1E may be constructed with alternative tie-in locations, which provide flexibility for the final design. Therefore the Storm Surge Barrier Alignment C-1E, which includes CSRM at the Atlantic Ocean Shorefront Planning Reach, was chosen as the TSP.

Table 5-13 presents a summary of comparisons among the three final alternatives, which supported selection of Storm Surge Barrier Plan C-1E as the TSP.

Table 5-13: Jamaica Bay Reach Alternative Plan Comparison Summary

<table>
<tr><th>Category</th><th colspan="2">Alternative C-1E (TSP)</th><th colspan="2">Alternative C2</th><th colspan="2">Alternative D</th></tr>
<tr><td>Construction Cost</td><td colspan="2">$3,328,135,000 (least cost)</td><td colspan="2">$3,361,337,000</td><td colspan="2">$4,467,352,000</td></tr>
<tr><td>Net Benefits</td><td colspan="2">$345,595,000 (greatest net benefits)</td><td colspan="2">$345,523,000</td><td colspan="2">$270,166,000</td></tr>
<tr><td>Benefit-to-Cost Ratio</td><td colspan="2">3.1 (economically justified)</td><td colspan="2">3.1 (economically justified)</td><td colspan="2">2.2 (economically justified)</td></tr>
<tr><td>On-land structures (linear feet)</td><td colspan="2">44,000</td><td colspan="2">15,000 (smallest on-land footprint)</td><td colspan="2">125,000 (largest structural footprint)</td></tr>
<tr><td>In-water structures (linear feet)</td><td colspan="2">4,900 (smallest in-water structural footprint)</td><td colspan="2">7,900</td><td colspan="2">11,000 (largest in-water structural footprint)</td></tr>
<tr><td>Number of tributary gates</td><td colspan="2">3</td><td colspan="2">N/A</td><td colspan="2">16 (most tributary gates)</td></tr>
<tr><td>Number of barrier gates</td><td colspan="2">9</td><td colspan="2">14</td><td colspan="2">N/A</td></tr>
<tr><td rowspan="2">Geomorphology</td><td>Pro</td><td>Con</td><td>Pro</td><td>Con</td><td>Pro</td><td>Con</td></tr>
<tr><td>Hardened shoreline makes longshore sedimentation a smaller risk than C-2</td><td>Marine Parkway - Gil Hodges Memorial Bridge may require scour protection</td><td>Bridge foundation scour not likely</td><td>Longshore sedimentation a greater risk than C-1E</td><td></td><td></td></tr>
</table>

Category	Alternative C-1E (TSP)		Alternative C2		Alternative D	
Utilities	**Pro**	**Con**	**Pro**	**Con**	**Pro**	**Con**
	No conflict with charted submarine cable area	Potential Coney Island WWTP effluent line conflict near Sheepshead Bay – some realignment required		**Conflicts with charted submarine cable area** **Current alignment, which has smallest in-water footprint, conflicts with Coney Island WWTP effluent line; substantial realignment required to avoid conflict**	**No conflict with charted submarine cable area**	Potential Coney Island WWTP effluent line conflict near Sheepshead Bay – some realignment required
Environmental Impact (Permanent Impact to Habitat Acres)	**Pro**	**Con**	**Pro**	**Con**	**Pro**	**Con**
		Moderate level of environmental impact (130 acres)		**Lowest level of environmental impact** **(62 acres)**	**Facilitated incorporation of 8 living shoreline projects within alignment.**	**Highest level of environmental impact** **(247 acres)**

Category	Alternative C-1E (TSP)		Alternative C2		Alternative D	
	Pro	Con	Pro	Con	Pro	Con
Mitigation	Moderate Level Mitigation Costs. $90,833,000. (Includes carrying forward Floyd Bennett Field Wetlands Creation and Elders Island as examples.)	Potential impacts to tidal amplitude in most up-gradient reaches of tidal inlet channels. Unlikely but potential impact to dissolved oxygen /water quality with prolonged closure exceeding 48 hours. Further analysis will be done to assess the potential impacts and required mitigation in the NYNJHAT study.	Lowest required mitigation costs. $75,538,000. (Includes carrying forward Dead Horse Bay and Duck Point as examples.)	Potential impacts to tidal amplitude in most up-gradient reaches of tidal inlet channels. Unlikely but potential impact to dissolved oxygen /water quality with prolonged closure exceeding 48 hours.		Highest required mitigation costs. $123,383,000. (Includes carrying forward Dead Horse Bay and Floyd Bennett Field Wetlands Creation as examples.) Unknown, potential impacts to water quality and tidal amplitude in most up-gradient reaches of tidal inlet channels. Excess mitigation recommended to account for this. unknown.
Annual OMRR&R Costs	$7,424,000		$7,124,000		$14,954,000 (worst)	

5.9 Progression from the TSP to the Recommended Plan

The TSP was selected and presented in the Draft Report which underwent a series of reviews by the public, local, state and federal agencies, including the non-federal sponsors, USACE policy reviewers, an interdisciplinary technical review team within USACE which was not involved in the study called the Agency Technical Review (ATR) team, and an Independent External Peer Review (IEPR) panel which consist of reviewers outside of USACE. The comments received during review are an integral part of the decision making process at the Agency Decision Milestone, or ADM, where a USACE Senior Leader Panel decides on a Recommended Plan to be further refined with detailed feasibility-level design and shared in the Final Report.

USACE guidance requires selection of the TSP as the Recommended Plan unless there are other federal, state, local, or international concerns that make another alternative viable to recommend at full cost sharing. In addition, there is an opportunity for the local sponsor to request implementation of a locally preferred plan (LPP) in which they would fully fund the cost above the NED plan if it were higher, or the plan would be reduced in cost if they preferred a smaller plan. Any plan other than the NED Plan would require a waiver from the Assistant Secretary of the Army for Civil Works.

5.9.1 Outcome of the Agency Decision Milestone

The Agency Decision Milestone, or ADM, is the checkpoint at which the USACE reviews the breadth and content of the comments received during the review period and uses that input to either verify for modify the TSP. The ADM results in an agency decision on a *Recommended Plan*, which is then further refined and developed to the full feasibility level of design. This includes the additional design of the recommended plan that is necessary to reduce risk and uncertainty with cost data, engineering effectiveness, environmental impacts, and economic benefits.

For this study, the outcome of the ADM was to move the further study and potential recommendation of the storm surge barrier feature across the inlet to Jamaica Bay, along with the necessary tie-ins to high ground, into the New York and New Jersey Harbor and Tributaries Study (NYNJHATs) that had been initiated in the late Summer of 2016. The NYNJHATs is considering, among other alternative plans, a storm surge barrier alignment from Breezy Point in the Rockaways to Sandy Hook, New Jersey. This alignment would obviate the need for the Jamaica Bay / Rockaway Inlet storm surge barrier. Additionally, the estimated $3 billion cost to construct the proposed Rockaway Inlet storm surge barrier exceeds full amount of the existing Sandy Bill appropriation, which is being used to fund multiple projects and studies. Therefore the proposed barrier component of the Rockaway TSP would have needed additional funding and authority in order to be implemented. However, prior to being considered implementable, the proposed storm surge barrier would need to be designed to the full feasibility level of design with enough detail to sufficiently analyze all of the potential impacts and to address the copious comments received. This would have added significant time to complete the Rockaway Reformulation.

Since the NYNJHAT study is considering an alignment that would make the Rockaway Inlet barrier redundant, and is considering multiple barrier alignments it is more appropriate to consider these large infrastructure investments within the same study. These factors informed the agency decision to move all further consideration of the proposed Rockaway Inlet storm surge barrier to the NYNJHAT study.

Nonetheless, without the Jamaica Bay storm surge barrier, there would be significant residual risk to residents living in and around Jamaica Bay that could gain significant flood risk reduction from the construction of the barrier. Therefore, the study team sought to identify and refine Back-Bay measures that could still be constructed under the Rockaway Reformulation and reduce this residual risk. The concept of the Residual Risk measures from the TSP were expanded upon and refined to the Feasibility level design so that they could be implemented under the Rockaway Reformulation. Since they are being recommended in advance of the agency decision on whether or not to construct a storm surge barrier, any Back-Bay features would need to be stand alone. They would also need to be able to complement the potential storm surge barrier if it is recommended and built through the NYNJHATs study. Because the storm surge barrier was already determined to be more economically efficient way of addressing system-wide coastal flood risk than the Perimeter Plan, the Back-Bay measures would not be optimized to maximize net benefits. This is because optimization of the Back-Bay measures would result in the Perimeter Plan that was analyzed for a comprehensive CSRM Back-Bay plan, and which was economically justified but less cost effective than the Storm Surge Barrier Plan. The design levels of the Back-Bay measures needed to be based on an assumption of when a barrier would be operated. The Back-Bay measures would be designed to complement the future barrier by addressing the flooding that would still occur when the barrier would remain open, i.e. the high frequency regular flooding that some Back-Bay communities experience. The *high frequency flooding risk reduction features,* or HFFRRFs, were thus developed along this rationale. In addition to being able to function independent of future and uncertain infrastructure investments, each HFFRRF must also be shown to be economically justified.

5.9.2 Public Review Warranted to Finalize the Recommended Plan

Due to the significance of the changes to Recommended Plan since the public last had a chance to comment, the New York District has re-released this Revised Draft HSGRR/EIS for a second public comment period prior to finalization of the Recommended Plan. This revised draft report will undergo public, agency, policy, and ATR reviews, and the study team will address comments from these reviews in the Final HSGRR/EIS.

5.10 Objectives, Planning Considerations, and Screening Criteria for HFFRRF Development

<u>Objectives</u>

1. Reduce the risk of high frequency flooding that occurs in the project area and would not be addressed by the storm surge barrier currently being studied and potentially recommended under the NYNJHAT study.
2. Formulate and include NNBFs in the HFFRRF design, where feasible and cost effective, in order to reduce the risk of high frequency flooding while also improving the systems natural resiliency.

It is important to note that the HFFRRFs will reduce the frequency of inundation that residents of these neighborhoods experience; however, unless a storm surge barrier is built to reduce risk from more extreme events, these features are expected to overtop frequently and residents will still be faced with serious flood risk during larger flood events.

Planning Considerations

Feature type and placement considers existing shoreline and structural features.

In determining what feature type is most appropriate for a given location, the study team first looked at the existing condition of the shoreline. Where the existing shoreline was natural, contained parks or wetlands, and had not been ‘hardened’ by man-made structures, the study team targeted NNBF feature types. Where the shoreline was already hardened and there are existing dilapidated, non-functioning or poorly functioning CSRM structures (such as bulkheads or revetments), the team included new CSRM features to appropriately match the slope and bathymetry of the area (see Table 5-14, HFFRR Feature Placement Considerations).

Table 5-14: HFFRR Feature Placement Considerations

	HFFRR-Feature										
Existing Shoreline and Structural Features	Low Flood Wall	Medium Flood Wall	High Flood Wall	Shallow Bulkhead	Deep Bulkhead	Revetment	Natural and Nature Based Feature (NNBF): Berm & Limited Seaward Marsh Extension (Type A)	NNBF: Berm & Limited Landward Marsh Extension (Type B)	NNBF: Berm & Full Seaward marsh extension (Type A)	NNBF: Berm & Full Landward Marsh Extension (Type B)	Non-Structural (house raisings, buyouts, and/or flood-proofing)
Natural Shoreline	√	√	√				√	√	√	√	
Revetment						√					
Bulkhead				√	√						
Parks or Wetlands	√						√	√	√	√	
Street End	√	√	√	√	√						
Urban Waterfront Development	√	√	√	√	√						
Industrial Waterfront Development	√	√	√	√	√						
Separate Single Family Homes Not Densely Configured											√

Non-structural measures reduce risk not by stopping or redirecting floodwaters, but rather by changing the condition on the ground such that damages from flooding are reduced. Non-structural measures include (but are not limited to) raising homes, buyouts to move people out of the floodplain, and/or flood-proofing measures like raising generators and other infrastructure above the flood elevations. The study area is not very conducive to non-structural measure implementation in general as a means to reducing flood risk. Given the type and high density of development in this area it is often infeasible to raise or flood-proof all of the structures. For example, connected row houses with multiple homeowners, homes on lot sizes not big enough to stage construction (i.e. to fit the cranes or other construction equipment needed to raise a home), and large apartment buildings are all difficult, if not infeasible to raise. Also, in densely populated areas it is usually not cost effective to use non-structural measures compared with building a shoreline measure to protect the development behind it. However, in areas that pose difficulties for structural measures, such as Broad Channel which is situated in the middle of Jamaica Bay at very low elevations and is not as densely developed, non-structural was also considered.

HFFRRFs are intended to complement a potential future storm surge barrier and must establish what level of flood event is an appropriate compliment for this area.

In determining an appropriate size or elevation of the HFFRRFs, the study team analyzed the flood extents of various high frequency AEP flooding events to see which type of event triggered significant flooding in concentrated pockets of developed areas (Figure 5-9). Analyzing these flood extents shows that the future 33% AEP / current 20% AEP %[30] flood incurs some flooding, but not extensive (shown in yellow in Figure 5-9), and much of the flooding is in natural areas such as the wetlands off of JFK airport, with the exception of Broad Channel which floods broadly even at this lowest level event. Whereas the future 20% AEP (5 year RP in 2068), which amounts to a 10% AEP in 2018, or a 10 year RP incurs more significant and widespread flooding. This is shown in blue in Figure 5-9 and also encompasses the yellow areas. The future 10% AEP (10 year RP) / current 5% AEP (20 year RP) flood is the largest high frequency flood event analyzed and is shown in red in Figure 5-9, but also encompasses the blue and the yellow shaded areas. The future 10% AEP event causes extensive flooding throughout the coastal areas, but especially into Old Howard Beach/Hamilton Beach area, parts of Nassau County, the entire Rockaway Peninsula, and Broad Channel. This level of flooding would require a more comprehensive CSRM perimeter plan to address it.

Since the study team's analysis has already shown that the more extensive flooding (which includes the red, but also the blue and yellow shaded areas of Figure 5-9) is more efficiently addressed with a storm surge barrier, the future 20% AEP flood event was chosen as the level of flood at which the HFFRRFs would be designed, based on the assumption that more extensive flooding is better addressed by closing a proposed storm surge barrier to be further studied and potentially recommended in the NYNJHAT Study. However, closing a proposed storm surge barrier for the future 20% AEP event would not address the widespread inundation during smaller more frequent flood events that occurs on Broad Channel. Since Broad Channel has a lower density of structures than other areas, which are largely single-family dwellings that can be raised, non-structural measures were also considered here, namely home raising.

[30] Table 4-1 summarizes the probability of a certain flood occurring now versus in the future given the intermediate USACE projection of sea level rise in this area. In short, the likelihood of a given high frequency flood in this area is expected to roughly double over a fifty year period.

Figure 5-9: Flood Extents for High Frequency Flood Events in the Study Area

Site NNBFs as CSRM measures, where feasible

NNBFs, or living shorelines, can help reduce the risk of smaller, more frequent coastal storms. They have the added benefit of being inherently resilient, and can fare better and recover on their own more than traditional hard structures in many instances (Gittman et al. 2014). For this reason they are an excellent measure for managing risk from high frequency flooding, if they can be sited appropriately. To meet the objective of improving the system's natural resiliency to storms, the PDT used the following criteria to site NNBFs:

- Addresses identified clusters of high frequency flooding—because this project has the objective of managing coastal storm risk, not ecosystem restoration, the NNBFs were sited in the areas where they would help manage risk for communities. Traditional restoration projects will restore wetlands and site those efforts based on the ability to maximize the functional habitat values per dollar invested, which can result in restoration being targeted in less developed areas. For NNBFs, the placement is made with consideration for how to best manage risk from coastal storms.
- Existing bathymetry and lateral space—a desktop analysis was performed to assess whether there was enough space and appropriate underwater bathymetry offshore to fit an NNBF. If the depths dropped off quickly once offshore, then the bathymetry was not considered to be suitable for the NNBF concept envisioned (see Figure 5-10 and 5-11)
- Site suitability—consideration was also given to whether the site conditions lent themselves to the appropriate NNBF type being able to persist. If the site has a heavy presence of anthropogenic infrastructure along shoreline (e.g. docks, piers), then that was

also not considered a suitable site since it is not feasible to maintain a wetland in conjunction with docks and piers and the heavy traffic that they typically produce.

- Wave attenuation and erosion control—NNBFs were particularly considered as a cost effective means for attenuating wave action and thus reducing erosion on a proposed berm. Since the HFFRRFs are designed to be overtopped frequently unless the proposed storm surge barrier is built, they must be designed to withstand the wave action and overtopping they will encounter. Earthen berms, which are made of erodible material, particularly benefit from a wetland and rock sill complex in front of them to help reduce erosion and the required maintenance over time. The NNBF design shown in Figure 5-10 was demonstrated to be more cost effective than a comparably sized floodwall, which is less erodible (Table 5-29). The NNBF design has additional incidental benefits when compared to floodwalls in that they provide habitat, improve local aesthetics, and even improve water quality since wetlands help to filter water. Where berms are the proposed measure, the wetland and rock sill components are integral design features of the overall HFFRRF.

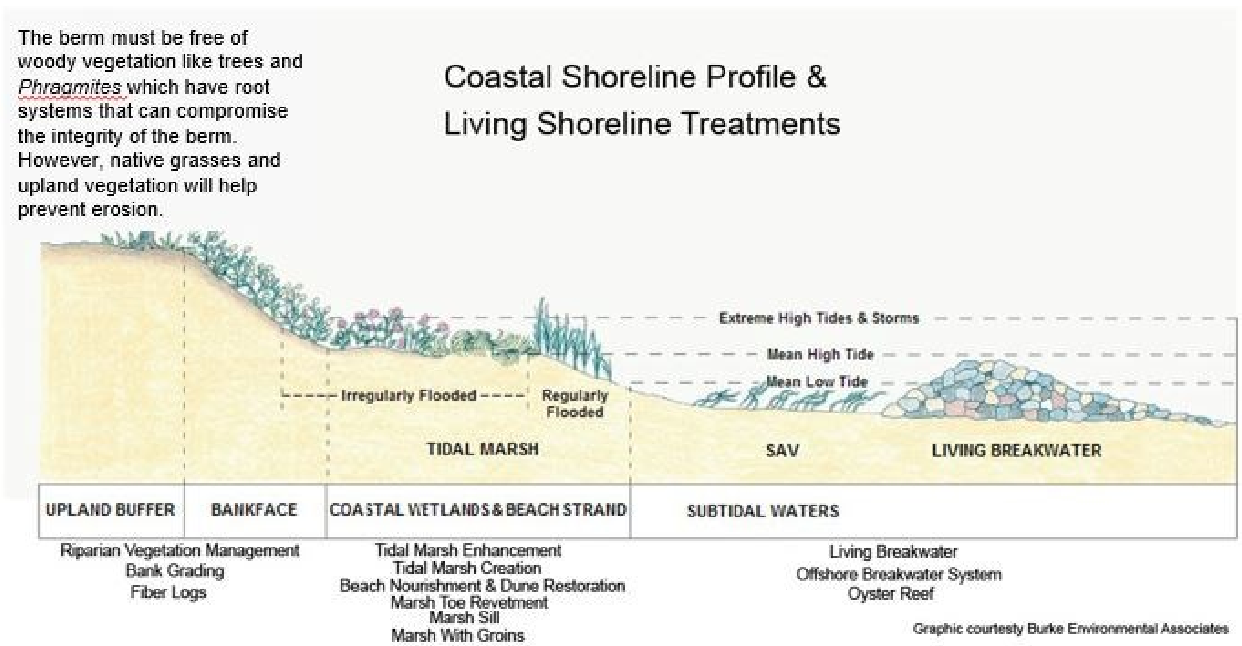


Figure 5-10: Profile drawing of an NNBF, or living shoreline, concept

Source: Burke Environmental Associates

Given these considerations in siting NNBFs, the PDT identified eight potential areas for NNBFs (see Figure 5-11). These were evaluated and screened in conjunction with the other HFFRRFs identified. Three sites in Arverne, one site in Edgemere, one in Norton Basin, and one in Bayswater were identified, as well as one in Motts Basin North and one in Motts Basin South.

Figure 5-11: NNBFs Identified for Evaluation and Screening

Constraints

Do not create redundant federal CSRM investments.

HFFRRFs should complement, but not replicate the function of the storm surge barrier currently being considered under NYNJHAT Study. The Perimeter Plan considered in this study, though economically justified, was shown to be less cost effective and more environmentally damaging than a storm surge barrier across Rockaway Inlet. HFFRRF measures that were considered included shoreline, or perimeter-based features, but the size and level of risk reduction of these features was constrained such that the larger floods would still be addressed by the proposed barrier, which was already shown to be the more efficient means of addressing this type of flooding.

Do not increase risk of wildlife hazards to JFK airport.

Jamaica Bay is home to JFK International Airport, one of the most important economic travel hubs for the nation. Flights coming in and out of JFK International Airport already have a risk to avian collisions which can damage or down a plane. This risk is actively managed by JFK airport. The Rockaway HFFRRFs must be designed such that they do not increase risk of wildlife hazard to airport traffic. In order to not increase the risk of a bird hitting a plane, any NNBFs designed in this area must limit vegetation types to those suitable for foraging, but not nesting.

Do not site NNBFs in environmentally sensitive areas where a habitat transfer to an NNBF habitat site would negatively impact an existing valuable ecosystem.

If the existing habitat at a coastal edge is high functioning and valuable habitat, then NNBFs will either be screened or their design adjusted to avoid negatively impacting high quality habitats. Furthermore, existing high functioning habitat are likely to already provide CSRM services and can be expected to enhance the function of a co-located CSRM project and reduce the risk of erosion to a proposed project.

5.11 Initial HFFRRF Screening

Thirteen sites were identified for HFFRRFs based on the current 10% AEP flood extent (shown in blue in Figure 5-12). Feature types were chosen and aligned in order to develop rough cost and benefit numbers for a preliminary screening to see which sites were economically justified.

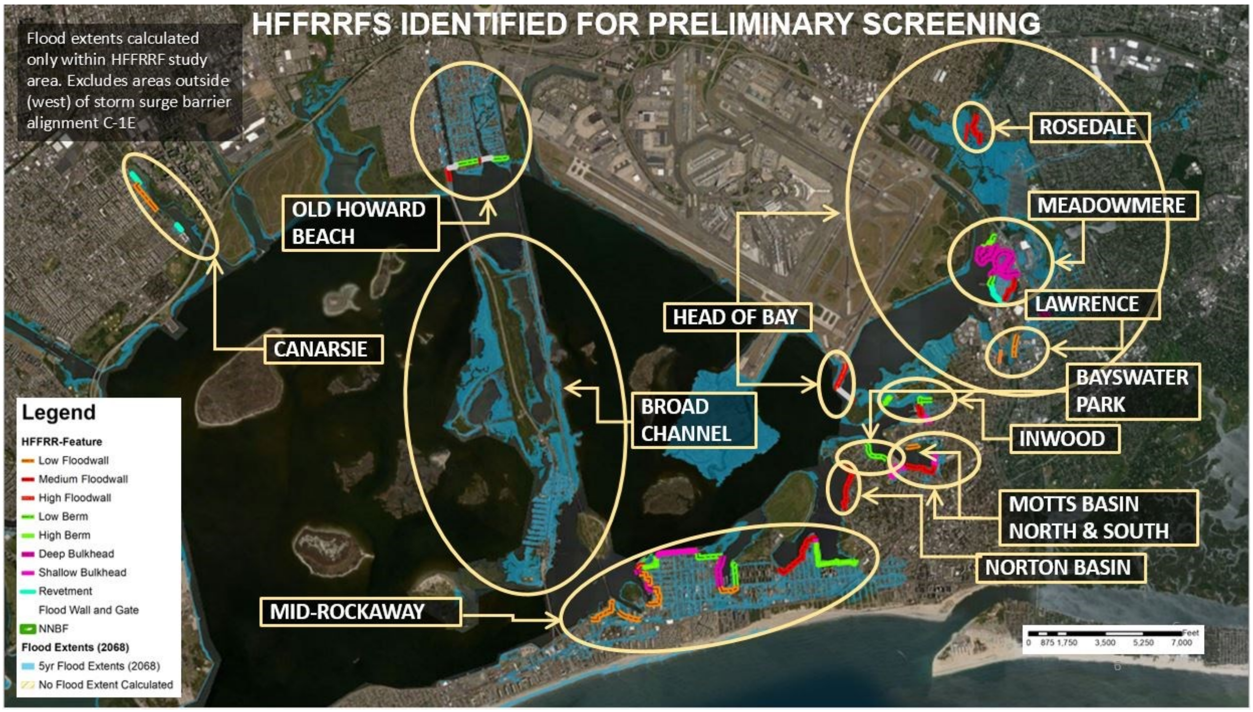


Figure 5-12: Thirteen Potential HFFRRFs Projects identified

In the initial screening, the study team identified the following thirteen HFFRRFs (shown in gold circles on Figure 5-12).

1. Canarsie
2. Old Howard Beach (which includes Hamilton Beach)
3. Broad Channel
4. Mid-Rockaway (including Hammels, Arverne, and Edgemere neighborhoods)
5. Norton Basin
6. Motts Basin South
7. Motts Basin North (shown in one circle above with Motts Basin South)
8. Inwood
9. Bayswater Park
10. Cedarhurst-Lawrence
11. Meadowmere (three parts of Meadowmere were designed and screened)

12. Rosedale
13. Head of Bay

Various feature types were developed which mostly focused on smaller, targeted perimeter measures, to include NNBFs. The Head of Bay HFFRRF included a large in-water gate to block storm surge and tidal flooding for smaller events, which would reduce flood risk for the entire area behind the gate. However, smaller HFFRRFs were also developed and analyzed for neighborhoods in Nassau County that would be covered by the Head of Bay gate should that not pass the initial screening (which it did not).

The Old Howard Beach HFFRRF also included in-water gates to block surge from entering the canals and inundating the communities that live along and adjacent to the canals. A rough estimate of the cost to construct bulkheads along the shorelines in this community instead was also prepared, but it was determined to be more expensive than the gate measure and was therefore not developed further.

The elevations of the top of features to reduce risk for a current 10% AEP flood vary based on the ground elevation and local topography of the various HFFRRF sites as well as expected wave exposure. For example, a very low-lying area with high wave exposure would need a higher feature to provide the same level of risk reduction as a feature on higher ground with low wave exposure. The features are all designed to the same flood event to avoid a “weak” point in the alignment where overtopping would occur first.

5.11.1 Prototypical Designs, HFFRRF Placements and Cost Estimates

In order to evaluate and screen the HFFRRFs, prototypical designs as well as cost per linear foot estimates were developed for each type of HFFFRF (low floodwall, medium floodwall, low bulkhead, etc.). The features were aligned based on the existing space and elevations in order to reduce risk for the most amount of people and infrastructure, while avoiding adverse impacts to existing habitats. The linear feet and thus costs were then calculated for each proposed HFFRRF (See Engineering Appendix).

These initial costs did not include real estate or interior drainage costs since it is time consuming and can be complicated to estimate these costs. The rationale was that the cost to obtain all necessary LRRDDS and to drain any interior stormwater resulting from the project would be assessed for the HFFRRFs that made it through the initial screening. If a project is not economically viable without those costs included, then it certainly would not be viable with them included and doing the screening in two phases was more efficient.

5.11.2 HFFRRF CSRM Benefits

In support of the first round of screening of the HFFRRF projects the economic benefits were analyzed. The without-project annual and equivalent annual damage for areas initially identified as potential HFFRRF locations were calculated in HEC-FDA assuming the intermediate sea level change scenario. For Phase 1 screening purposes, the Coastal Storm Risk Management (CSRM) benefits were estimated based on truncation all damages below the design still water level and there was no analysis of residual interior flooding. Benefits modeling is detailed in the Economic Benefits Appendix (Appendix B).

5.11.3 Preliminary HFFRRF Screening Results

Four sites passed the preliminary screening, which is summarized in Table 5-15. The sites that passed the preliminary screening are:

1. Mid-Rockaway—this is the largest of the HFFRRF sites considered and includes a total of 1,505 structures in Hammels, Arverne, and Edgemere neighborhoods. The Mid-Rockaway design includes multiple NNBF locations and passed the initial screening with a BCR of 1.8.
2. Canarsie—this HFFRRF location in Brooklyn was designed to reduce flood risk for 222 structures and passed the initial screening with a BCR of 3.4.
3. Cedarhurst-Lawrence—located in Nassau County in the Village of Cedarhurst and the Town of Hempstead, adjacent to Lawrence High School. This HFFRRF would manage risk to 128 structures and had an initial BCR of 8.3.
4. Motts Basin North—The Motts Basin North HFFRRF would help manage risk for frequent flooding for 18 structures and had an initial BCR of 1.8. This site originally included an NNBF as part of the design, but upon closer consideration the existing habitat was considered to be high functioning mudflats, which provide some NNBF habitat and function already and would be adversely impacted if this habitat were converted to intertidal marsh. Therefore, the NNBF part of the design was removed.

Ten sites were screened out because their preliminary BCRs were less than one, meaning it would cost more to build and maintain the HFFRFF than the benefit to the national economy from the coastal damage reduction that the HFFRRF would provide. The sites that were screened out in the preliminary screening as not economically justified included Bayswater, Norton Basin, Motts Basin South, Inwood Marina, Head of Bay, three sites in Meadowmere, Rosedale, and Broad Channel. Finally, the Old Howard Beach project had a BCR of 1.0, which is technically positive. However, this did not include real estate and interior drainage costs. Once those costs were added, the BCR is very like to decrease below unity.

Additionally, for the Howard Beach (inclusive of Hamilton Beach) area, the total project cost is estimated to exceed $259 million (without real estate and interior drainage costs). Part of the rationale for formulating and building HFFRRFs in the first place was that they would complement a storm surge barrier solution and would reduce the frequency with which the proposed storm surge barrier across Rockaway Inlet would need to be closed. Frequent closure of storm surge barriers has been shown to greatly increase the cost to both operate and maintain them, given the increased wear and tear of operation (personal communication with barrier operators, 2018). It thereby follows that a sizable civil works investment for Old Howard Beach that would incur expensive operations and maintenance itself is at odds with the objective of constructing HFFRRFs to reduce the frequency with which a barrier would need to be operated and the associated costs (and potential environmental impacts) of frequent operation.

However, if the NYNJHAT Study does not recommend an alternative that addresses risk from large storms and storm surge entering Jamaica Bay, then this Old Howard Beach alternative would warrant further investigation. A CSRM alternative for Old Howard Beach with a more comprehensive objective to manage coastal storm risk for a full suite of storms—both large and small—is likely to result in a larger plan that would optimize the net benefits for this area. Namely, the in-water gates that were considered to keep surge out of the canals at Old Howard

Beach and Hamilton Beach could be sized up, which would increase the benefits of such a plan. This analysis has been deferred to the NYNJHAT Study.

Table 5-15: HFFRRF Preliminary Screening Results ($000)

Project	Annual Benefits	Annual Costs	Net Benefits	BCR	Passed (Y/N)	Number Structures
Canarsie	1,244	367	877	3.4	YES	222
Mid-Rockaway +	9,086	5,040	4,046	1.8	YES	1,505
Motts Basin North	137	77	60	1.8	YES	18
Old Howard Beach	10,892	10,719	173	1.0	NO++	986
Bayswater +	16	225	-209	0.1	NO	9
Norton Basin +	29	828	-799	0.0	NO	19
Motts Basin South +	281	1,055	-774	0.3	NO	118
Inwood Marina	343	553	-210	0.6	NO	60
Head of Bay Gate	14,422	32,423	-18,001	0.4	NO	1,368
Cedarhurst- Lawrence	2,936	352	2,584	8.3	YES	128
Meadowmere	523	1,814	-1,291	0.3	NO	99
Meadowmere North	579	1,399	-820	0.4	NO	38
Meadowmere East	324	565	-241	0.6	NO	25
Rosedale	348	423	-75	0.8	NO	104
Broad Channel	3,237	10,622	-7,385	0.3	NO	764

+ NNBF included in potential project evaluation

5.12 HFFRRF Interior Drainage Analysis

Additional analyses were completed in the next phase to progressively converge to higher level of detail after completion of the preliminary screening. The second phase of the screening included:

- *An analysis of existing drainage infrastructure and an analysis of impacts to the existing drainage system as a result of the construction of HFFRRF Projects.*

  The reason this is needed is that a CSRM alignment keeps water from the bay from entering the adjoining neighborhoods, but it also can have the unintended effect of keeping stormwater from within the neighborhood from draining back out into the bay after it rains or the alignment overtops. Therefore the project must assess whether the existing drainage system can accommodate any changes to the interior drainage that would result from the project. If not, the project design must include a *Minimum Facility* improvement to deal with any increases in stormwater. See Section 6 of the HFFRRF Interior Drainage Appendix for more detail on the interior drainage analysis, which is summarized in this section (Section 5). Interior drainage analyses were conducted in accordance with USACE Policy Guidance Letter No. 37, which clarifies the proper classification of interior drainage facilities as either project components or betterments.

- *A cost estimate to account for modifications to the existing drainage infrastructure and/or construction of new drainage infrastructure as part of the HFFRRF projects*

  An explanation of how these cost estimates were developed can be found in the Interior Drainage Sub-Appendix E to the Engineering and Design Appendix A.

- *Analysis of wave height for the project areas and establishing the required freeboard for the features and the height of the rock sills for the NNBFs*

  Part of the wave analysis was to provide guidance on the elevation of the rock sill such that it is capable of protecting existing and newly established marsh during normal operational events and to minimize the cumulative impact of storms for a 1-2 year period. Following the guidance in Miller et al, 2016, the Sub-Appendix A2-D describes sill height estimates using wave modeling analysis to protect the habitat during normal operational periods, keeping the transmitted wave height at 0.5 feet or less except during extreme storms. Freeboard heights were also calculated using the wave modeling and freeboards were reduced based on the wave attenuation provided by the rock sills.

- *A more detailed analysis of the potential impacts to wetland habitat and a more detailed analysis of the NNBF designs that are part of the screened HFFRRF Projects*

  Site visits were conducted at each HFFRRF site that passed the preliminary screening and the HFFRRFs were adjusted to minimize any potential impacts to wetlands from the footprint of the CSRM alignments. The NNBF designs were further analyzed and refined to help inform the environmental impact analysis described in Sections 6 and 7 of this Revised Draft HSGRR/EIS.

- *Rough costs to acquire all necessary LRRDDS for the HFFRRFs were developed and included in the final screening.*

  The Real Estate Appendix details the analysis that was done pertaining to real estate for this project.

- *Non-structural (buyouts, relocations, home raising) measure evaluation for Broad Channel*

  When the structural measure for Broad Channel did not pass the preliminary screening, the PDT also investigated the feasibility of implementing non-structural measures on Broad Channel since the *Build it Back* program has had a high success rate there and raised approximately half of the homes on Broad Channel. Also, Broad Channel has the worst risk of high frequency flooding in the study area, as it becomes almost completely inundated at the current 20% AEP, while most of the other areas are inundated during the current 10% AEP flood. The non-structural plan was ultimately screened out and the rationale is described in Section 5.17.

5.12.1 Minimum Facility Concept

As stated in U.S. Army Corps of Engineers EM 1110-2-1413, "Hydrologic Analysis of Interior Areas", the design *Minimum Facility* should provide interior flood relief such that during low exterior stages (at gravity conditions for normal astronomic tide) the local storm drainage system (typical 10-year design storm) functions essentially as it would without the Coastal Storm Risk Management System in place.

The Minimum Facility is intended to ensure that the existing drainage system performs the same with and without the project put in place as to avoid induced flood damages. This is the starting point from which all additional interior drainage alternatives can be evaluated. Additional interior drainage measures may be designed to further reduce interior water levels beyond the Minimum Facility. These additional interior facilities must be incrementally justified.

5.12.2 National Economic Development for Interior Drainage Facilities

The benefits accrued from interior drainage alternatives are attributable to the reduction in the residual flood damages that may have remained under the Minimum Facility condition. Finally, a preferred drainage alternative is selected based on meeting National Economic Development (NED) objectives.

Interior Drainage Plan Formulation

The formulation of interior plans was an iterative process that considered a full range of measures for each drainage area. Only measures that are reasonably likely to meet the Minimum Facility or NED criteria discussed above were considered at any location. In areas with relatively low damage, the construction of expensive pump stations or large excavated ponds were not considered. Given the relatively low-lying elevations in the Back-Bay, the relatively high water table, and very limited space for natural ponding/stormwater surface storage, green infrastructure measures such as rain gardens, bioswales were not deemed to have sufficient capacity to meet the Minimum Facility in this area. Each minimum facility plan for the HFFRRFs includes modification of existing gravity outlets 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 pipe will be replaced if the design phase indicates it is necessary due to the condition of the pipe or a need for additional capacity.

5.12.3 Mid-Rockaway HFFRRF Project

The Mid-Rockaway project area covers approximately 1,135 acres and includes three drainage basins: Hammels, Arverne, and Edgemere. The following sections describe the process of the interior drainage plan formulation.

5.12.3.1 Hammels Area

The Hammels drainage basin is almost fully developed, except for a few scattered grassy areas and is predominantly residential, with some commercial development. Two pump stations are proposed to handle the interior drainage in this area. The Minimum Facility plan for the Hammels drainage basin consists of six gravity outlets (including three existing outlets) through the line of flood protection that will drain the system when the pump stations are not being operated. Each of the existing outlets will be modified to prevent high tides or storm surge from flooding through the drainage system. The proposed pump station for Subbasin H1 has the capacity to drain approximately 100 cubic feet per second (cfs) and would be located at the southern end of Hammels near Beach 87th Street. The proposed pump station for subbasin H2 would have approximately 180 cfs capacity and would be located at the northern end of Hammels near Beach Channel Drive. Table 5-16 shows the evaluation of the pump alternatives considered for the Hammels portion of Mid-Rockaway.

Table 5-16: Summary of Alternatives for Hammels Drainage Basin of the Mid-Rockaway HFFRRF

Items	Subbasin H1	Subbasin H2	
	Pump Alternative 1*	Pump Alternative 1	Pump Alternative2*
Damage ($)	209,280	333,290	249,500
Benefits ($)	674,320	384,920	468,710
Pump Size (cfs)	100	160	180
Pump Cost ($)	4,688,500	5,561,900	6,200,666
Annualized Pump Cost ($)	173,670	206,020	229,680
Annual O&M Cost ($)	93,800	111,200	124,000
Total Annual Pump Cost ($)	267,470	317,220	353,680
Net Benefits ($)	406,850	67,700	115,030
Benefit to Cost Ratio	2.5	1.2	1.3

* denotes the Preferred Plan

Table 5-17 shows the proposed location of the gravity outlets for Hammels.

Table 5-17: Preferred Plan Gravity Outlets for Hammels

Hammels Subbasin	Gravity Outlets Description
H1	Existing Outlet ROC-656
H1	Proposed Outlet H1-1, approximately 70 feet east of Beach 85th Street
H1	Existing Outlet ROC-657
H2	Proposed Outlet H2-1, approximately 350 feet west of Beach 80th Street
H2	Proposed Outlet H2-2, approximately 100 feet west of Beach 79th Street
H2	Existing Outlet ROC-653

Note: Size and location of gravity outlets will be refined during the project design phase

The Equivalent Annual Damages (EAD) for the Hammels drainage basin with the Preferred Plan in place is estimated to be approximately $460,000, which is a roughly $1.1 million reduction in annual damages compared to the Minimum Facility condition.

5.12.3.2 Arverne Area

The Arverne drainage basin has three subbasins A1, A2, and A3, covering approximately 76 acres, 139 acres, and 209 acres, respectively. The Arverne drainage basin is almost fully developed and predominantly residential, with a few scattered and undeveloped areas.

The Minimum Facility plan for the Arverne drainage basin consists of 16 gravity outlets through the line of flood protection (including eight existing). Each of the existing outlets will be modified to prevent high tides or storm surge from flooding through the drainage system. Three pump stations are also proposed which would drain the system when the outlets become overwhelmed. Table 5-18 summarizes the analysis of the pump alternatives in Arverne at Mid-Rockaway. Pump Alternative 1, with an estimated pump capacity of 70 cfs, is the Preferred Plan for Subbasin A1. The proposed pump station for Subbasin A1 would be located adjacent to DE Costa Avenue, near Beach 72nd Street. Pump Alternative 2, with an estimated pump capacity of 180 cfs, is the Preferred Plan for Subbasin A2. The proposed pump station for Subbasin A2 would be located on DE Costa Avenue, near Beach 63rd Street. Pump Alternative 2, with an estimated pump capacity of 300 cfs, is the Preferred Plan for Subbasin A3. The proposed pump station for Subbasin A3 would be located south of Thursby Avenue.

Table 5-18: Summary of Interior Drainage Alternatives Considered for Arverne

Items	Subbasin A1	Subbasin A2		Subbasin A3	
	Pump Alternative 1*	Pump Alternative 1	Pump Alternative 2*	Pump Alternative 1	Pump Alternative 2*
Damage ($)	103,810	491,420	213,570	952,840	566,400
Benefits ($)	192,810	752,610	1,030,460	1,122,830	1,509,270
Pump Size (cfs)	70	120	180	200	300
Pump Cost ($)	2,532,200	4,246,700	6,200,666	6,200,700	9,769,642
Annualized Pump Cost ($)	93,800	157,300	229,680	229,680	361,880
Annual O&M Cost ($)	50,600	84,900	124,000	124,000	195,400
Total Annual Pump Cost ($)	144,400	242,200	353,680	353,680	557,280
Net Benefits ($)	48,410	510,410	676,780	769,150	951,990
Benefit to Cost Ratio	1.3	3.1	2.9	3.2	2.7

* denotes the Preferred Plan

Table 5-19 shows the proposed gravity outlets for the Arverne area of Mid-Rockaway.

Table 5-19: Preferred Plan Gravity Outlets for Arverne

Arverne Subbasin	Gravity Outlets Description
A1	Existing Outlet ROC-633
A1	Existing Outlet ROC-634
A1	Existing Outlet TEMP40062
A1	Proposed Outlet A1-1, located at the end of Hillmyer Avenue
A1	Proposed Outlet A1-2, located adjacent to Hillmyer Avenue and Barbadoes Avenue
A1	Existing Outlet ROC-658
A1	Proposed Outlet A1-3, located 250 feet west of Beach 69th Street
A1	Existing Outlet ROC-659
A2	Proposed Outlet A2-1, located on Bayfield Avenue 150 feet west of Beach 65th Street
A2	Proposed Outlet A2-2, located at the east end of DE Costa Avenue
A2	Proposed Outlet A2-3, located at the east end of Burchell Road
A3	Existing Outlet, located at the east end of Thursby Avenue
A3	Existing Outlet ROC-636
A3	Proposed Outlet A3-1, located 250 north of Beach Channel Drive on 58th Street
A3	Existing Outlet ROC-635
A3	Proposed Outlet A3-2, located 50 feet south of Beach Channel Drive on 58th Street

Note: Size and location of gravity outlets will be refined during the project design phase

The Equivalent Annual Damages (EAD) for the Arverne drainage basin with the Preferred Plan in place is estimated to be approximately $885,000, which is a roughly $2.7 million reduction in annual damages compared to the Minimum Facility condition.

5.12.3.3 Edgemere Area

The Edgemere 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.

The Minimum Facility plan for the Edgemere drainage basin consists of 15 gravity outlets through the line of flood protection, including three existing. Each of the existing outlets will be modified to prevent high tides or storm surge from flooding through the drainage system. In addition to the gravity outlets, three pump stations are proposed for Edgemere. Due to the length of the subbasin along the line of protection and the difficulty in draining all of runoff to a single location, two pump stations are proposed for Subbasin E1, with a combined capacity of about 210 cfs. One pump station would be located near Norton Avenue and Beach 49th Street and the other near Beach 43rd Street and Hough Place. Pump Alternative 2, with an estimated pump capacity of 120 cfs, is the Preferred Plan for Subbasin E2. The proposed pump station for Subbasin E2 would be located near Beach 38th Street. Table 5-20 summarizes the pump alternatives evaluated for Edgemere.

Table 5-20: Summary of Interior Drainage Alternatives Considered for Edgemere

Items	Subbasin E1		Subbasin E2	
	Pump Alternative 1	Pump Alternative 2 (split between two stations)*	Pump Alternative 1	Pump Alternative 2*
Damage ($)	462,550	263,520	137,050	238,420
Benefits ($)	1,018,700	1,217,730	400,060	298,690
Pump Size (cfs)	140	210	180	120
Pump Cost ($)	4,910,600	7,135,270	6,200,700	4,246,738
Annualized Pump Cost ($)	181,890	264,300	229,680	157,300
Annual O&M Cost ($)	98,200	142,700	124,000	84,900
Total Annual Pump Cost ($)	280,090	407,000	353,680	242,200
Net Benefits ($)	738,610	810,730	46,380	56,490
Benefit to Cost Ratio	3.6	3.0	1.1	1.2

* denotes the Preferred Plan

Table 5-21 lists the gravity outlets proposed for Edgemere.

Table 5-21: Preferred Plan Gravity Outlets for Edgemere

Edgemere Subbasin	Gravity Outlets Description
E1	Existing Outlet ROC-648
E1	Proposed Outlet E1-1, located on Norton Avenue between Beach 47th and 48th Streets
E1	Proposed Outlet E1-2, located on Norton Avenue between Beach 46th and 45th Streets
E1	Proposed Outlet E1-3, located on Beach 45th Street north of Hough Place
E1	Proposed Outlet E1-4, located on the north end of Beach 45th Street
E1	Proposed Outlet E1-5, located adjacent to Beach 43rd Street, 550 feet north of Hough Place
E1	Proposed Outlet E1-6, located adjacent to Beach 43rd Street, 500 feet north of Hough Place
E1	Existing Outlet ROC-637
E1	Proposed Outlet E1-7, located 700 feet north of Beach 40th Street
E2	Existing Outlet ROC-638
E2	Proposed Outlet E2-1, located 50 feet east of Beach 37th Street
E2	Proposed Outlet E2-2, located 50 feet east of Beach 37th Street
E2	Proposed Outlet E2-3, located 50 feet east of Beach 36th Street
E2	Proposed Outlet E2-4, located 50 feet east of Beach 36th Street
E2	Proposed Outlet E2-5, located between Beach 36th Street and Beach 35th Street

Note: Size and location of gravity outlets will be refined during the project design phase

The Equivalent Annual Damages (EAD) for the Edgemere drainage basin with the Preferred Plan in place is estimated to be approximately half a million dollars, which is a roughly $1.5 million reduction in annual damages compared to the Minimum Facility condition.

5.12.4 Canarsie HFFRRF Project

The Canarsie drainage basin has three subbasins C1, C2, and C3, covering approximately 120 acres, 69 acres, and 84 acres, respectively. The Canarsie drainage basin is completely developed and predominantly residential, with some commercial development.

The Minimum Facility plan for the Canarsie drainage basin consists of gravity outlets through the line of flood protection. Subbasin C1 was estimated to require 4 gravity outlets, Subbasin C2 was estimated to require 2 gravity outlets, and Subbasin C3 was estimated to require 5 gravity outlets. Each existing outlet would be modified to prevent high tides or storm surge from flooding through the drainage system. Pump Alternatives 1 and 2 for Subbasin C1 consist of pump stations with a total capacity of about 70 cfs and 150 cfs, respectively along with 4 gravity outlets. Pump Alternative 1 for Subbasin C2 consists of 2 gravity outlets and a pump station with a total capacity of about 56 cfs. Pump Alternative 1 for Subbasin C3 consists of 5 gravity outlets and a pump station with a total capacity of about 84 cfs.

Table 5-22: Summary of Interior Drainage Alternatives Considered for Canarsie

Items	Subbasin C1		Subbasin C2	Subbasin C3
	Pump Alternative 1	Pump Alternative 2	Pump Alternative 1	Pump Alternative 2
Damage ($)	976,550	360,580	108,760	222,760
Benefits ($)	583,440	1,199,410	98,460	361,800
Pump Size (cfs)	70	150	56	84
Pump Cost ($)	3,314,900	3,851,340	2,664,200	3,959,400
Annualized Pump Cost ($)	122,790	142,660	98,680	146,660
Annual O&M Cost ($)	66,300	77,000	53,300	79,200
Total Annual Pump Cost ($)	189,090	219,660	151,980	225,860
Net Benefits ($)	394,350	979,750	-53,520	135,940
Benefit to Cost Ratio	3.1	5.5	0.65	1.6

Based on the evaluation of the interior water surface elevation and net benefits, no interior drainage plan that would result in a HFFRRF with a BCR above 1.0 was identified. Accordingly there is not a Preferred Drainage Plan identified for the Canarsie drainage basin. Even with the pumps and improved gravity outlet drainage system, flood elevations for a 50% AEP rainfall occurring with the design storm tide are only reduced between .1 and .2 feet. More information on the interior drainage analysis for Canarsie can be found in the HFFRRF Interior Drainage Appendix. Since residual flooding remains high for the Canarsie HFFRRF, NED benefits from the plan are not high enough to justify the federal investment, and the BCR for the whole HFFRRF drops below one despite individual pump stations at Canarsie having a positive BCR.

The Equivalent Annual Damages (EAD) for the Canarsie project area, with Minimum Facility measures in place, is estimated to be approximately 2.35 million dollars.

5.12.5 Cedarhurst-Lawrence HFFRRF Project

The Cedarhurst-Lawrence drainage basin covers approximately 64 acres. The Cedarhurst-Lawrence drainage basin is fully developed and predominantly residential, with some commercial development.

The Minimum Facility plan for the Cedarhurst-Lawrence drainage basin consists of four gravity outlets through the line of flood protection, including three existing outlets in the area where the bulkhead will be raised. Each of the existing outlets will be modified to prevent high tides or storm surge from flooding through the drainage system. Based on the evaluation of the interior water surface elevations and net benefits, Pump Alternative 1, with an estimated pump capacity of 90 cfs, is the Preferred Plan for the Cedarhurst-Lawrence drainage basin (Table 5-23). The proposed pump station for E1 would be located approximately 260 feet north of Plaza Road.

Table 5-23: Summary of Interior Drainage Alternative Considered for Cedarhurst-Lawrence

Items	Pump Alternative 1*
Damage ($)	49,250
Benefits ($)	536,860
Pump Size (cfs)	90
Pump Cost ($)	4,233,800
Annualized Pump Cost ($)	156,820
Annual O&M Cost ($)	84,700
Total Annual Pump Cost ($)	241,520
Net Benefits ($)	295,340
Benefit to Cost Ratio	2.2

* denotes the Preferred Plan

The proposed gravity outlets are listed in Table 5-24.

Table 5-24: Preferred Plan Gravity Outlets for Cedarhurst-Lawrence

Cedarhurst-Lawrence Subbasin	Gravity Outlet Description
L1	Existing Outlet
L1	Existing (recently constructed) culvert, located approximately 100 feet north of Peninsula Boulevard and 150 feet west of Oxford Road
L1	Existing (recently constructed) culvert, located approximately 100 feet north of Peninsula Boulevard and 200 feet west of Oxford Road
L1	Proposed Outlet L-1, located approximately 250 feet from Peninsula Boulevard

Note: Size and location of gravity outlets will be refined during the project design phase

The Equivalent Annual Damages (EAD) for the Cedarhurst-Lawrence drainage basin with the Preferred Plan in place is estimated to be approximately $50,000, which is a roughly $540,000 reduction in annual damages compared to the Minimum Facility condition.

5.12.6 Motts Basin North HFFRRF Project

The Motts Basin North project area has a single subbasin covering approximately 28 acres. The Motts Basin North drainage basin is almost fully developed and predominantly residential, with some commercial development and a wooded area in the southeastern part of the subbasin. The Minimum Facility plan for the Motts Basin North drainage basin consists of retrofitting one existing gravity outlet which will be modified to prevent high tides or storm surge from flooding through the drainage system.

A pump station for Motts Basin North was evaluated. However, based on the analysis of the interior water surface elevations and net benefits, the pump alternative was found to have a negative net benefit and hence was eliminated from further consideration. The Preferred Plan for the Motts Basin North project (which is the Minimum Facility) consists of one retrofitting the existing gravity outfall as discussed above.

The Equivalent Annual Damages (EAD) for Motts Basin North project area with the Preferred Plan in place (i.e., the Minimum Facility condition) is estimated to be approximately $85,000.

5.13 Summary of Interior Drainage Economics for the Recommended Plan

Table 5-25 summarizes the twelve interior drainage alternatives that were considered for the HFFRRFs.

Table 5-25: Interior Drainage Alternatives Evaluated

Drainage Subbasin	Minimum Facility	Pump Alternative 1	Pump Alternative 2
Hammels H1	Gravity Outlets	Gravity Outlets + 100 cfs Pump Station	N/A
Hammels H2	Gravity Outlets	Gravity Outlets + 160 cfs Pump Station	Gravity Outlets + 180 cfs Pump Station
Arverne A1	Gravity Outlets	Gravity Outlets + 70 cfs Pump Station	N/A
Arverne A2	Gravity Outlets	Gravity Outlets + 120 cfs Pump Station	Gravity Outlets + 180 cfs Pump Station
Arverne A3	Gravity Outlets	Gravity Outlets + 200 cfs Pump Station	Gravity Outlets + 300 cfs Pump Station
Edgemere E1	Gravity Outlets	Gravity Outlets + 140 cfs Pump Station	Gravity Outlets + 210 cfs Pump Station
Edgemere E2	Gravity Outlets	Gravity Outlets + 180 cfs Pump Station	Gravity Outlets + 120 cfs Pump Station
Canarsie C1	Gravity Outlets	Gravity Outlets + 70 cfs Pump Station	Gravity Outlets + 150 cfs Pump Station
Canarsie C2	Gravity Outlets	Gravity Outlets + 56 cfs Pump Station	N/A
Canarsie C3	Gravity Outlets	Gravity Outlets + 84 cfs Pump Station	N/A
Cedarhurst-Lawrence L1	Gravity Outlets	Gravity Outlets + 90 cfs Pump Station	N/A
Motts Basin North M1	Gravity Outlets	Gravity Outlets + 26 cfs Pump Station	N/A

The effect on residual flooding for each alternative was modeled in order to assess how the interior drainage would perform under various with-project scenarios based on the alternatives presented in 5-28. Then the cost-to-benefit analysis was performed in order to help identify the preferred plan for interior drainage at each HFFRRF site. Table 5-28 summarizes the economics of the interior drainage plans for the HFFRRFs included in the Recommended Plan. All sites but Motts Basin North need pump stations in order to for the project to function as intended. The Canarsie HFFRRF had very high residual flooding, even with the interior drainage plans in place, which ultimately contributed to Canarsie being screened out of the Recommended Plan. The pump stations included in the Recommended Plan to address high frequency flooding will need to be operated and maintained by the local sponsor, which in these cases has been identified as New York City for Mid-Rockaway and the Village of Cedarhurst for the Cedarhurst-Lawrence HFFRRF.

Table 5-26: Summary of Preferred Plans for the Project Areas

Project Area	Preferred Plans[1]	First Cost	O&M Cost[2]	Total Annual Cost[3]	Annual Benefits	Net Benefits
Mid-Rockaway (Hammels, Arverne, and Edgemere Drainage Basins)						
Hammels	H1 - 100 cfs pump H2 - 180 cfs pump	$10,889,000	$218,000	$621,200	$1,143,000	$521,800
Arverne	A1 - 70 cfs pump A2 - 180 cfs pump A3 - 300 cfs pump	$18,503,000	$370,000	$1,055,400	$2,732,600	$1,677,200
Edgemere	E1 - 210 cfs pump E2 - 120 cfs pump	$11,382,000	$227,600	$649,200	$1,516,400	$867,200
Cedarhurst -Lawrence	L1 - 90 cfs pump	$4,233,800	$84,700	$241,500	$536,900	$295,400
Motts Basin North	M1 - Minimum Facility	N/A	N/A	N/A	N/A	N/A
Totals		**$45,007,800**	**$900,300**	**$2,567,300**	**$5,928,900**	**$3,361,600**

50-year period-of-analysis, 2.75% Federal Discount Rate, October 2017 price level
[1]Preferred Plans with a pump station also include gravity outlets
[2]Includes IDC and O&M Costs
[3]Includes Annualized Replacement Costs (See Cost Appendix)

5.14 Wave Height Analysis for HFFRRFs

Wave-height statistics were derived from the USACE (2015) North Atlantic Comprehensive Coastal Study (NACCS) database. As part of the NACCS, estimates of nearshore winds, waves, and water-levels, as well as the associated marginal and joint probabilities were evaluated. This was achieved by simulating a selected suite of tropical and extra-tropical storms to characterize the regional storm hazard. The modeling suite consisted of an offshore wave model (WAM) for simulation of deep-water waves, which were subsequently used to generate boundary conditions for a near-shore steady state wave model STWAVE. The STWAVE model for near-shore waves also allowed for simulation of local wind-generated waves, and was paired with the hydrodynamic circulation model ADCIRC to allow for dynamic interaction between surge and waves. While the ADCIRC model mesh extends across the western North Atlantic with approximately 3.1 million nodes, the nearshore wave model STWAVE is applied over ten domains from coastal Virginia to Maine, including one in the upper New York Bight area. A suite of 1,150 storms including 100 extratropical events, and 1,050 synthetic tropical events were simulated for the NACCS production.

The design wave-height at each HFFRRF alignment was updated subsequent to the preliminary screening using the simulated wave-height at the feature from wave modeling that was performed.

The Simulation of Waves Nearshore (SWAN) model (Booij et al, 1996) was used to simulate the transformation of waves along 1-D transects from boundary points within the Bay to the corresponding project alignment features. The bathymetric data for the modeling was derived from high-resolution (1/9 arc seconds or 10 feet) resolution topo-bathy Digital Elevation Models (DEMs) developed by NOAA, post- Hurricane Sandy in 2012.

A map of the features denoting the updated wave-heights is shown in Figure 5-13. Wave heights range from zero to three feet. The corresponding required freeboards for the HFFRRFs were set using the overtopping criterion of one liter per second per meter.

In addition, the wave model was also applied to optimize the design of the Natural and Nature-Based Features (NNBFs), which are proposed to accompany select project features. Specifically, the wave model was further applied to optimize the elevation of rock-sills that are part of the Natural and Nature Base Features with the goal of minimizing wave impacts on the wetland vegetation and the berm. Following the guidance in Miller et al, 2016, a target transmitted wave-height across the feature sills of half a foot or less under operational conditions was deemed necessary to protect the habitat on the leeward side of the sill. The higher the sill, the greater the protection, however, higher sills translate into greater costs and could increase visual nuisance. It should be stressed that the rock sill in combination with a healthy wetland habitat on the landward side will provide wave protection (wave height reduction) during the design conditions (5 year Return Period water level and waves) for the berm feature. I.e. the rock sill allows for a reduction in freeboard and lower crest elevation for the upland situated berm feature. Compared to the “without rock sill scenario” the freeboard reduction is approximately 1.5 feet for a rock sill with a 4.5 foot crest elevation.

The Feasibility-level design of the rock sill is positioned at a base elevation of -2’ NAVD88, a sill slope of 1 in 3, and a crest width of 6’. The NNBF area behind the sill was set at a 1 in 40 slope. Although it is recognized that the actual configuration of the NNBF rock sill and leeward wetlands and berm will vary once preliminary designs are completed, the focus of this analysis was on the transmitted wave height. The transmitted wave height is mainly a function of the incoming wave height, the bay-side bathymetric profile and the crest geometry of the rock sill. As such the schematic representation of the landward profile was deemed acceptable for the feasibility study.

The analyses documented in Sub-Appendix A2-D demonstrates a 4.5 to 5.5 foot sill will be sufficient to achieve the target wave conditions for the NNBFs, which may only be expected to be exceeded at an acceptable average rate of once in two years. This design will be further refined in the PED Phase.

Figure 5-13: Calculated Wave-heights at HFFRRF Alignments

5.15 Real Estate Considerations

The HFFRRFs were aligned, wherever possible, to avoid impacting structures, particularly occupied structures, such that homes would not need to be condemned involuntarily. Since New York City is engaged in a robust program called *Build it Back* to help with storm recovery and improve the resiliency of structures, they have been actively offering both buyouts, relocations, and house raisings throughout the project area and thus the assumption was made that if a resident had not opted in to this program for a buyout or relocation, they would be unlikely to do so for a USACE relocation. However, where *Build it Back* has already purchased and removed homes from the floodplain, the HFFRF alignments were configured to enable these areas to be restored to active floodplain, and in many cases for Mid-Rockaway become part of the NNBF designs.

In order to build the recommended HFFRRF plans, 193 construction and maintenance easements on private parcels and 64 on public parcels would need to be acquired. Additionally, three private commercial structures and six public parcels would need to be acquired in fee.

5.16 Cost Effectiveness of NNBFs

The NNBF is an integral design feature to control erosion. However, it is also a cost effective design when compared to alternative gray features that could have been included in this area. Table 5-27 demonstrates the cost effectiveness of the NNBF approach when compared to a floodwall in the same area for those NNBF sites considered. However, even these numbers underestimate the cost of the gray features, or floodwalls, because they do not include the cost to mitigate these less environmentally friendly designs. The inclusion of marshes in our NNBF designs has allowed our HFFRRFs to be self-mitigating, since the marshes added exceed the impacts to marshes from the construction of the HFFRRFs (this is discussed in detail in Chapter 7). Furthermore, the benefits for the NNBFs are underestimated because though researchers have demonstrated the myriad benefits of NNBFs, such as wave attenuation and reduced operations and maintenance (O&M) costs, these CSRM benefits remain difficult to quantify. If the NNBFs as currently evaluated were not shown to be economically justified, the study team could attempt to quantify the additional benefits provided by wave attenuation and reduced long-term O&M. However, since this design is already economically justified and cost effective when compared to alternative designs, there is no need to perform additional analysis at this time.

Table 5-27: NNBF Cost Effectiveness When Compared to Gray Feature Alternatives

Proposed Natural and Nature-Based Feature	Cost	Alternative Gray Feature	Cost Gray Feature (Difference)
Arverne 1: High Berm + Limited Seaward Marsh Extension	$ 2,907/LF	High Floodwall	$ 4,564/LF **excludes cost of mitigation*
Arverne 2: Low Berm + Limited Landward Marsh Extension	$ 1,935/LF	Medium Floodwall	$ 3,058/LF **excludes cost of mitigation*
Arverne 3: Low Berm + Full Seaward Marsh Extension	$ 2,288/LF	Low to Medium Floodwall	$ 1,589 - $ 3,058 **excludes cost of mitigation*
Edgemere: High Berm + Full Landward Marsh Extension	$ 3,055/LF	High Floodwall	$ 4,564/LF **excludes cost of mitigation*

Furthermore, NNBFs provide incidental benefits of improving ecosystems, filtering water, improving aesthetics, and more, which are not taken into account in the economic analysis for this study, but are important and relevant to communities, agencies, and decision makers nonetheless.

5.17 Non-Structural Screening for Broad Channel

In assessing whether a non-structural plan is feasible for Broad Channel, the USACE considered data from Build it Back work on Broad Channel. Roughly 50% of the homes on Broad Channel have been raised out of the 1% AEP floodplain through Build it Back. This information was used as input into the non-structural design, and in the evaluation of the plans. NYC indicated that the nature of the development on Broad Channel was such that many homes did not have sufficient structural integrity to be elevated without significant retrofits. NYC indicated that it was found to be more cost-effective to tear-down and rebuild, using modular structures. NYC also indicated that a challenge in elevating homes was the requirement to obtain a valid certificate of occupancy, and that this contributed to the rate of participation in the program.

Given this understanding of the conditions in Broad Channel, the non-structural plan was eliminated from consideration. The USACE does not support non-structural plans that consist of a tear-down and rebuild, without additional cost-sharing from the homeowner. The USACE also requires that the homeowner is responsible for any costs necessary for a structure to obtain a valid certificate of occupancy, unless directly related to the elevation. Given that the Build it Back program was offered to a large percentage of the Broad Channel Community, and given that the costs that would be borne by the homeowner are greater in the Corps Project than in the NYC program, the PDT determined that a USACE non-structural alternative for Broad Channel would be unlikely to garner sufficient voluntary participation to recommend it for inclusion in the Recommended Plan, given its likely added cost to homeowners. If the full costs for retrofits were considered in the evaluation, it is also likely that this would eliminate the plan from consideration.

5.18 Final HFFRRF Screening Results

The second phase of the screening included an analysis of existing drainage infrastructure and an analysis of the Minimum Facility, which is intended to ensure that the existing drainage system performs the same with and without the project put in place as to avoid induced flood damages. Project Cost was calculated and included estimates to account for modifications to the existing drainage infrastructure and construction of new drainage infrastructure as part of the HFFRRF projects. In addition a more detailed analysis of the potential impacts to wetland habitat was completed and the project NNBF designs were further refined and planned in co-location with the flood risk reduction features in order to take advantage of their capacity to improve the function and resilience of the structural features. Along with the refinement of the project designs, the benefits modeling was updated and refined to accurately capture the changes in the project design. The inclusion of interior drainage features and pump stations resulted in changes in residual damages and thus changes in project benefits.

After completion of the benefits modeling and interior drainage optimization (see Sub-Appendix E) the Benefit Cost Ratio (BCR) was calculated. Screening results for the Phase 2 projects are presented in Table 5-28.

The results of the Phase 2 screening results, based on BCR, presented in Table 5-28 indicate that three (3) out of the four (4) projects are cost effective. Benefit estimates include the reduced damages as result of coastal flooding as well as a reduction in damages as a result of all interior flooding. The Canarsie project has a BCR below unity and is not selected to move forward. The other three project alternatives will be included in the Recommended Plan.

Cedarhurst-Lawrence passed the final screening with the highest BCR: 8.5. Mid-Rockaway is the largest plan in terms of the extent of risk reduction and also the cost, with an estimated cost of approximately $194 million. Cedarhurst-Lawrence is expected to cost approximately $13.6 million, while Motts Basin, the smallest of the HFFRRFs, is estimated to cost roughly $2.6 million.

Table 5-28: Phase 2 Economic Screening Results of the Jamaica Bay HFFRRFs

		Mid-Rockaway Backbay with NNBFs	Canarsie	Cedarhurst - Lawrence	Motts Basin North (no Pumps)
Damages					
Without Project					
Annual Damage		$44,304,000	$4,424,000	$12,655,000	$710,000
With Project					
	Line of Risk Reduction Damages	$30,585,000	$3,557,000	$6,858,000	$484,000
	Interior Drainage Damages	$1,845,000	$692,000	$643,000	$86,000
Annual Damages		$32,430,000	$4,249,000	$7,501,000	$570,000
Benefits					
Annual Benefits		$11,874,000	$175,000	$5,154,000	$140,000
Costs					
	Total with Project Cost	$194,009,000	$27,675,000	$13,573,000	$ 2,596,000
Annual Cost		$8,507,000	$1,262,000	$607,000	$111,000
Net Benefits					
Net Annual Benefits		$3,367,080	($1,087,000)	$4,547,000	$29,000
BCR		1.4	0.1	8.5	1.3

5.19 Consideration of Planning Objectives & Constraints

This section analyzes whether or not the Recommended Plan makes significant contributions to the planning objectives and sufficiently avoids planning constraints. Table 5-29 shows a summary of to what degree each alternative meets the planning objectives and avoids planning constraints on a subjective scale of Low-Medium-High. Those alternatives that met objectives and avoided constraints very well were rated "high." Because of this, the coloring scheme for objectives and constraints is "opposite" to best reflect these ratings.

Table 5-29: Consideration of Planning Objectives and Constraints

Evaluation Factor	Ranking	Discussion
Objective 1: Reduce vulnerability to coastal storm impacts	Medium	The Recommended Plan significantly reduces vulnerability to shorefront communities and reduces vulnerability to smaller coastal storms for Arverne, Hammels, Edgemere, the Village of Cedarhurst, and parts of the Town of Hempstead
Objective 2: Reduce future coastal storm risk in ways that will support the long-term sustainability of the coastal ecosystem and communities	High	Risk management is managed in a way that supports the long-term sustainability of the coastal ecosystem and communities by enhancing or restoring natural resiliency to the shorelines in four areas along the Back-Bay and by recommending a plan which is self-mitigating for its impacts to the environment and does not negatively impact communities.
Objective 3: Reduce the economic costs and risks associated with large-scale flood and storm events	Medium	While the Recommended Plan significantly reduces the economic costs and risk associated with large-scale flood and storm events for the Atlantic Shorefront communities, communities along the Back-Bay remain vulnerable to large-scale flood and storm events without a storm surge barrier to protect the communities in and around Jamaica Bay. The feasibility of constructing a storm surge barrier is currently being studied and potentially recommended under the New York and New Jersey Harbor and Tributaries Study which is looking at regional coastal storm risk.
Objective 4: Improve community resiliency, including infrastructure and service recovery from storm effects	Medium	The interior drainage improvements and NNBFs included in the HFFRRFs and the risk reduction provided by the Shorefront plan will greatly improve community resiliency. Efforts by others to raise evacuation routes above the floodplain, storm proof the NYC subway system and raise and/or relocate homes have also significantly contributed to this objective since Hurricane Sandy hit this region.
Objective 5 1. Improve coastal resilience by reducing erosion and risk caused frequent flooding through the enhancement of natural storm surge buffers, also known as natural and nature-based features (NNBFs).	High	This study is recommending multiple NNBFs, wherever feasible and justified, to help improve coastal resilience and enhance natural storm surge buffers.
Constraint 1: Do not negatively impact ongoing recovery, ecosystem restoration, and risk management efforts by others	Low	Coordination with other local, state, and federal agencies is ongoing to ensure that this project does not negatively impact efforts by others.
Constraint 2: Mutual Acceptability to DOI	Low	USACE has been coordinating with DOI and expects to achieve Mutual Acceptability.
Constraint 3: Do not negatively impact navigation	Low	The plan is not expected to negatively impact navigation.

Evaluation Factor	Ranking	Discussion
Constraint 4: Do not induce flooding	Low	Analysis shows that the Recommended Plan will not induce any flooding.
Constraint 5: Do not reduce community access and egress during emergencies	Low	The plan is not expected to impact access nor evacuation, but may improve egress if streets are able to drain quicker when pump stations are utilized.
Constraint 6: Do not impact operations at John F. Kennedy International Airport	Low	NNBFs will be designed such that they will only provide foraging habitat to avian species which pose a flight hazard to planes traveling in and out of JFK Airport.
Constraint 7: Do not negatively affect plants, animals, or critical habitat of species that are listed under the Federal Endangered Species Act or a New York State Endangered Species Act.	Low	As discussed in the EIS and Environmental Compliance Appendix, this project is not expected to adversely affect any plants, animals, or critical habitat of listed species.
Constraint 8: Avoid impacts to occupied residences	Low	The Recommended Plan avoids aligning CSRM features where they would require use of eminent domain.

5.20 Consideration of the P&G Criteria

The 1983 P&G requires that alternative plans are formulated and compared in consideration of four criteria: completeness, effectiveness, efficiency, and acceptability. Plans that require substantial activity by others, that is not likely to be forthcoming, in order to reach a "go" appraisal for critical objectives are not complete. Plans that are not appraised as a "go" for planning objectives are not effective. Plans that achieve contributions to objectives at higher costs, whether objectively or subjectively measured, are not efficient. Plans with effects that result in infeasibility are not acceptable. Minimum standards for these four criteria must be established in order to determine whether a plan is worthy of additional consideration.

Completeness is the extent to which the alternative plans provide and account for all necessary investments or other actions to ensure the realization of the planned efforts, including actions by other federal and non-federal entities.

In order to fully address large-scale storm and flood risk, the storm surge barrier which was included in the TSP, would need to be constructed. The agency decision was made to study this component of the Rockaway TSP under a separate study analyzing a suite of storm surge barriers across the region, including one which would obviate the need for the Rockaway Inlet Barrier. However, this action does not need to be taken in order for the Recommended Plan to function independently and address many of the problems and objectives of this study, even if it is not to the full extent that would be achieved if the barrier were built.

Effectiveness is the extent to which the alternative plans alleviate the specified problems and achieves the opportunities. The Recommended Plan achieves the study opportunities to:

- Enhance human health and safety by improving the performance of critical infrastructure and natural features during and after storm surge events.

- Prevent or reduce many future coastal storm impacts and related damages. Reduce the risk of coastal storm damage to buildings and infrastructure, which are subject to damages due to storm surge, waves and erosion from the ocean and storm surge in Jamaica Bay.
- Improve the community's ability to recover from damages caused by storm surges.
- Manage coastal storm risk and erosion problems with *natural and nature-based features* (NNBFs) such as wetlands, oyster and/or ribbed mussel reefs, vegetated dunes, beaches, maritime and coastal forests, where appropriate

Efficiency is the extent to which an alternative plan is the most cost effective means of achieving the objectives. Efficiency was measured through a comparison of benefit-to-cost ratios, reduced damages, and benefits from the project. This comparison showed that of the HFFRRF alternatives, only Mid-Rockaway, Cedarhurst-Lawrence, and Motts Basin North sites provide positive net benefits and thus were deemed economically efficient. The Shorefront Plan is also economically efficient with maximized net benefits.

Acceptability is the extent to which the alternative plans are acceptable in terms of applicable laws, regulations, and public policies. The alternatives were formulated in accordance with applicable laws and regulations. The recommended plan meets applicable laws, regulations and public policies and is considered to be implementable.

Table 5-30: Summary of Contribution of Alternatives to the P&G Criteria

	Completeness	Effectiveness	Efficiency	Acceptability
Recommended Plan	High	Medium	High	High

The Recommended Plan meets three of the four P&G criteria very well. The effectiveness could be greatly improved with the construction of the storm surge barrier if recommended under the NYNJHAT Study.

5.20.1 Consideration of P&G Accounts

The 1983 P&G requires that alternative plans are formulated and compared in consideration of four accounts:

- NED (National Economic Development): changes in the economic value of the National output of goods and services
- EQ (Environmental Quality): non-monetary effects on significant natural and cultural resources
- RED (Regional Economic Development): changes in the distribution of regional economic activity that result from each alternative plan
- OSE (Other Social Effects): effects from perspectives that are relevant to the planning process, but are not reflected in the other three accounts

The accounts were the basis for the plan formulation strategy, as described in Chapter 4. Table 5-31 shows a summary of to what degree each alternative meets the P&G accounts on a subjective scale of Low-Medium-High, which is also discussed in Section 6.7.

Table 5-31: Recommended Plan Performance on P&G Accounts

	NED	RED	OSE	EQ
Recommended Plan	High	High	High	High

The Recommended Plan will contribute the NED as described in the Economic Appendix. It will also contribute positively to RED, OSE and EQ as summarized in Section 6.7.

5.21 Decision to be Made

A Tentatively Selected Plan (TSP) was identified in the Summer of 2016 and presented in the August 2016 Draft HSGRR/EIS which was released for agency and public comment. As a result of the significant input received during this comment period, the USACE, along with the non-federal sponsors, decided to defer the recommendation of a key component of the TSP—namely the proposed storm surge barrier— in order to allow for further consideration. This decision was an outcome of the Agency Decision Milestone (ADM). Since the ADM, the study team has refined the Recommended Plan and updated the HSGRR/EIS to this Revised Draft in order to incorporate the changes coming out of the ADM and fully analyze any potential impacts. Once all comments are received on the Recommended Plan, the decision to be made is whether or not to move forward to finalize the Recommended Plan in the Final HSGRR/EIS, or whether additional analysis is required prior to preparing the Final HSGRR/EIS based on inputs for public, policy, and technical reviews of this Revised Draft HSGRR/EIS.

6 RECOMMENDED PLAN

The Recommended Plan integrates CSRM structures for the two planning reaches that provide system-wide benefits to the vulnerable communities within the study area. The major components of the Recommended Plan include:

- Beach restoration with renourishment, groin extension, construction of new groins, and a composite seawall along the Atlantic Ocean Shorefront Planning Reach;
- Three separate high frequency flooding risk reduction features (HFFRRFs) within the Jamaica Bay Planning Reach. The HFFRRFs are small scale CSRM features to reduce risks for communities vulnerable to high frequency events and to provide CSRM in the short-term prior to construction of a comprehensive solution developed as part of the NYNJHATs feasibility study. Each HFFRRF ties into adjacent high ground (see the HFFRRF Engineering Appendix, Sub-Appendix B for maps of inundation extents and elevation information). HFFRRFs would be located at the following locations:
    - Cedarhurst-Lawrence;
    - Motts Basin North; and
    - Mid-Rockaway.

An overview of the project locations is provided in Figure 6-1 in order to provide a geographic reference for each of the project components.

6.1 Atlantic Shorefront Component

The Atlantic Shorefront component of the Recommended Plan calls for the following features:

- A composite seawall with a structure crest elevation of +17 feet NAVD88, the dune elevation is +18 feet NAVD88[31], and the design berm width is 60 feet;
- A beach berm elevation of +8 ft NAVD88 and a depth of closure of -25 ft NAVD88;
- A total beach fill quantity of 804,000 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 general approach to developing CSRM along Rockaway Beach (between Beach 9th Street and Beach 169th Street) 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

[31] As described in Section 1.9.3, emergency repair and restoration of Rockaway Beach in response to Hurricane Sandy was performed in 2014. Repair and restoration consisted of 3.5 million cubic yards of sand placement from Beach 19th Street to Beach 149th Street, and a dune at elevation +16 ft. NAVD88.

Figure 6-1: Recommended Plan Geographic Overview

control alternative is beach restoration with increased erosion control. This constitutes a beach berm width of 60 ft at an elevation of +8ft NAVD88 constructed by a beach fill quantity of 804,000 CY for the initial placement and with a 4-year 1,021,000 renourishment cycle. In addition, a screening analysis was performed to evaluate the level of protection 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 for the Atlantic Ocean Shorefront Planning Reach. 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, which are described below.

The east beachfill taper is approximately 3,000 ft in shorefront length from Beach 19th Street east to Beach 9th Street. The taper comprises 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 NAVD88 at 19th Street down to approximately +12 ft NAVD88 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 rock groins is included for this section.

Additional details on the reinforced dune with composite seawall, the shorefront beach restoration and the groins are provided below.

6.1.1 Reinforced Dune – Composite Seawall

A composite Seawall is proposed for Rockaway Beach from Beach 149th Street up to Beach 20th Street. The composite seawall alignment follows the existing boardwalk alignment. The composite seawall would consist of an impermeable core (i.e. sheet pile wall with concrete cap) and rubble mound structure on the seaward side of the wall. The composite seawall is covered with sand and only the top and concrete cap are exposed on the land side of the dune (see Figure 6-2). The structure crest elevation is +17 feet NAVD88, the dune elevation is +18 feet NAVD88, and the design berm width is 60 feet at an elevation of +8 feet NAVD88. The armor stone feature of the composite seawall design 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. Due to spatial constraints within Reach 3 between Beach 149th Street and Beach 126th Street, a modified version of the composite seawall that includes a splash apron on the leeward side of the sheet pile wall is proposed for this section (see Figure 6-3). Detailed plans and sections are provided in the Engineering Appendix.

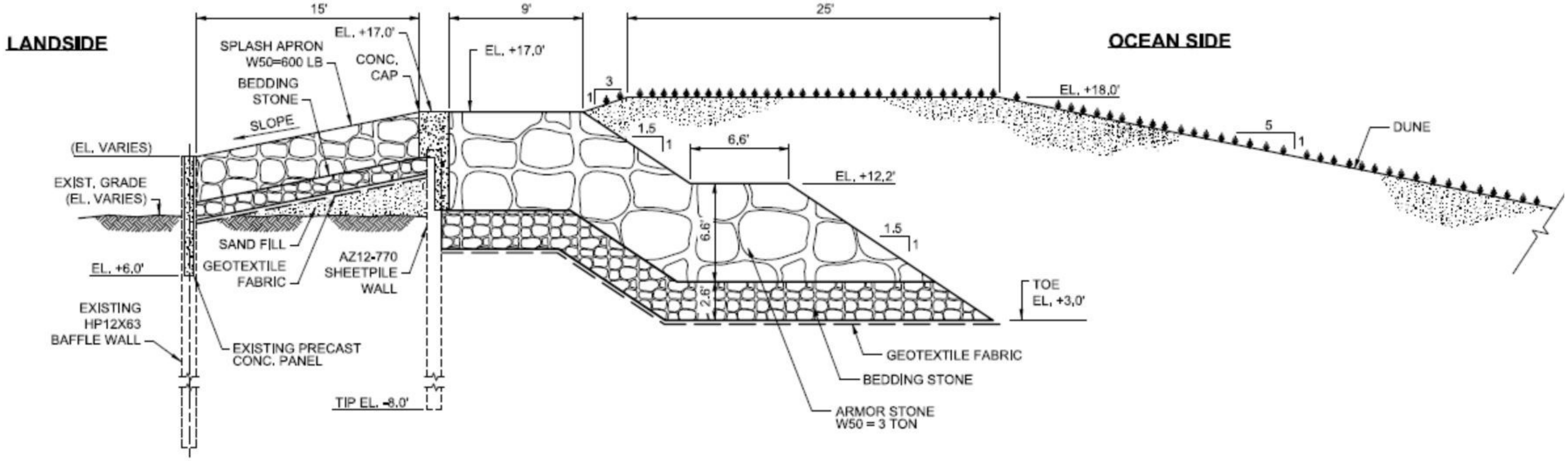


Figure 6-2: Atlantic Shorefront – Composite Seawall

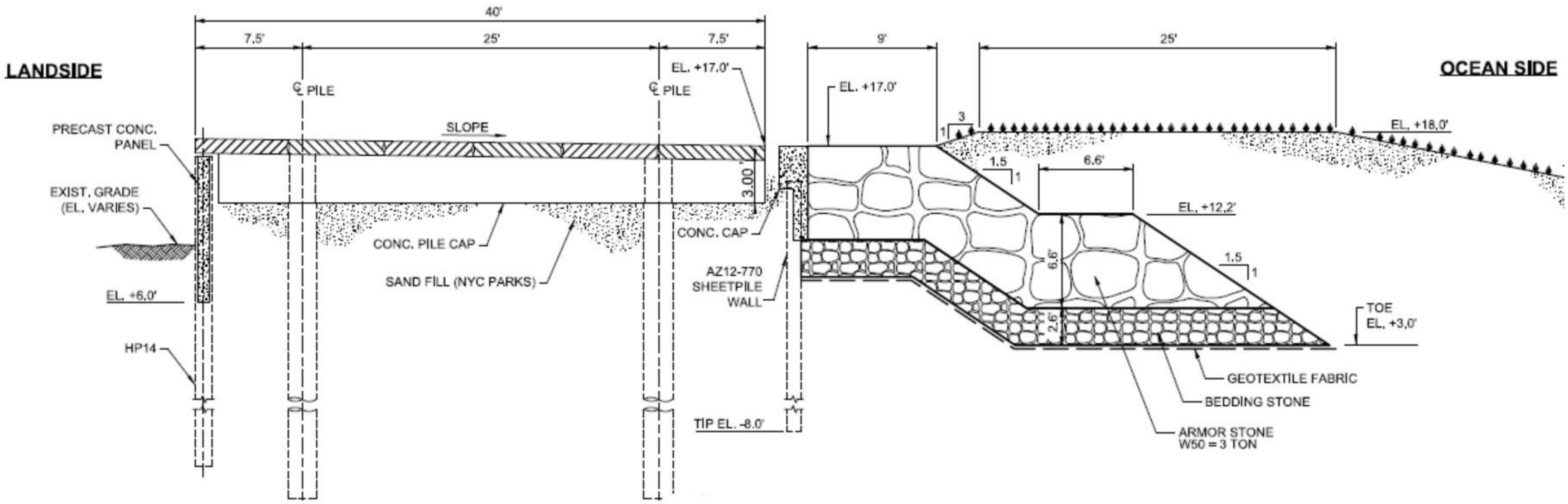


Figure 6-3: Atlantic Shorefront – Composite Seawall (Beach 126th St to Beach 149th St)

6.1.2 Beach Restoration

Beach restoration for the Atlantic Shorefront component consists of beach restoration for Reaches 3 through 6. A design profile is proposed that includes a dune with a 25 ft wide crest at elevation +18 ft NAVD88 and a back slope of 1V:3H and a front slope of 1V:5H. The design includes a berm with a minimum width of 60 ft at an elevation of +8 ft NAVD88. The width of the design berm is controlled by the alignment of the baseline. The baseline is aligned with the natural shoreline and the distance from the baseline to the design shoreline is always 243 ft. The alignment of the dune follows the unnatural alignment of the boardwalk and as a result the distance between the toe of the dune and the seaward crest of the berm varies (Figure 6-4). Detailed plans and sections are provided in the Engineering Appendix. Initial beachfill and renourishment quantities are provided in Table 6-1 below.

Table 6-1: Beachfill and Renourishment Quantities (cubic yards)

Sub-Reach	Beachfill	Renourishment per Cycle
West Taper	306,000	
Sub-Reach 3	356,000	444,000
Sub-Reach 4	294,000	133,000
Sub-Reach 5	321,000	444,000
Sub-Reach 6a	250,000	0
Sub-Reach 6b	20,000	0
East Taper	49,000	0
Totals	**1,596,000**	**1,021,000**

Note: Renourishment would occur on a four-year cycle

6.1.3 Groins

New groins are proposed for the Recommended Plan and include new groin construction and existing groin extension. Existing groins are extended in Reaches 5 and 6 and one new groin is constructed in Reach 6. In Reach 4 seven new groins are to be constructed, and in Reach 3 five new groins are to be constructed. Table 6-2 provides and overview of the groin length, type and location. The groins that are recommended for NPS property are to ensure that the Recommended Plan does not negatively impact the NPS beaches. Final design will be developed in PED phase, in coordination with NPS. Detailed plans and sections are provided in the Engineering Appendix.

Table 6-2: Summary of Groin Lengths for the Recommended Plan

Reach	Groin ID	Street	HSS (ft)	ISS (ft)	OS (ft)	Total (ft)	Status
6a	63	34th	62	108	328	498	new
6a	62	37th	55	108	328	491	extension
6a	61	40th	90	108	328	526	extension
5	53	43rd	90	108	228	426	extension
5	52	46th	90	108	228	426	extension
5	51	49th	90	108	228	426	extension
4	47	92nd	66	108	128	302	new
4	46	95th	62	108	128	298	new
4	45	98th	63	108	128	299	new
4	44	101st	62	108	128	298	new
4	43	104th	66	108	128	302	new
4	42	106th	67	108	128	303	new
4	41	108th	66	108	128	302	new
3	35	110th	90	108	153	351	new
3	34	113th	90	108	178	376	new
3	33	115th	90	108	178	376	new
3	32	118th	90	108	178	376	new
3	31	121st	63	108	128	299	new

HSS: horizontal shore section extending along the design berm
ISS: intermediate sloping section extending from the berm to the design shoreline
OS: outer section extending from the shoreline to offshore.

An overview of the Atlantic Shorefront component is shown on Figure 6-5, with additional detail shown on Figures 6-6a through 6-6d.

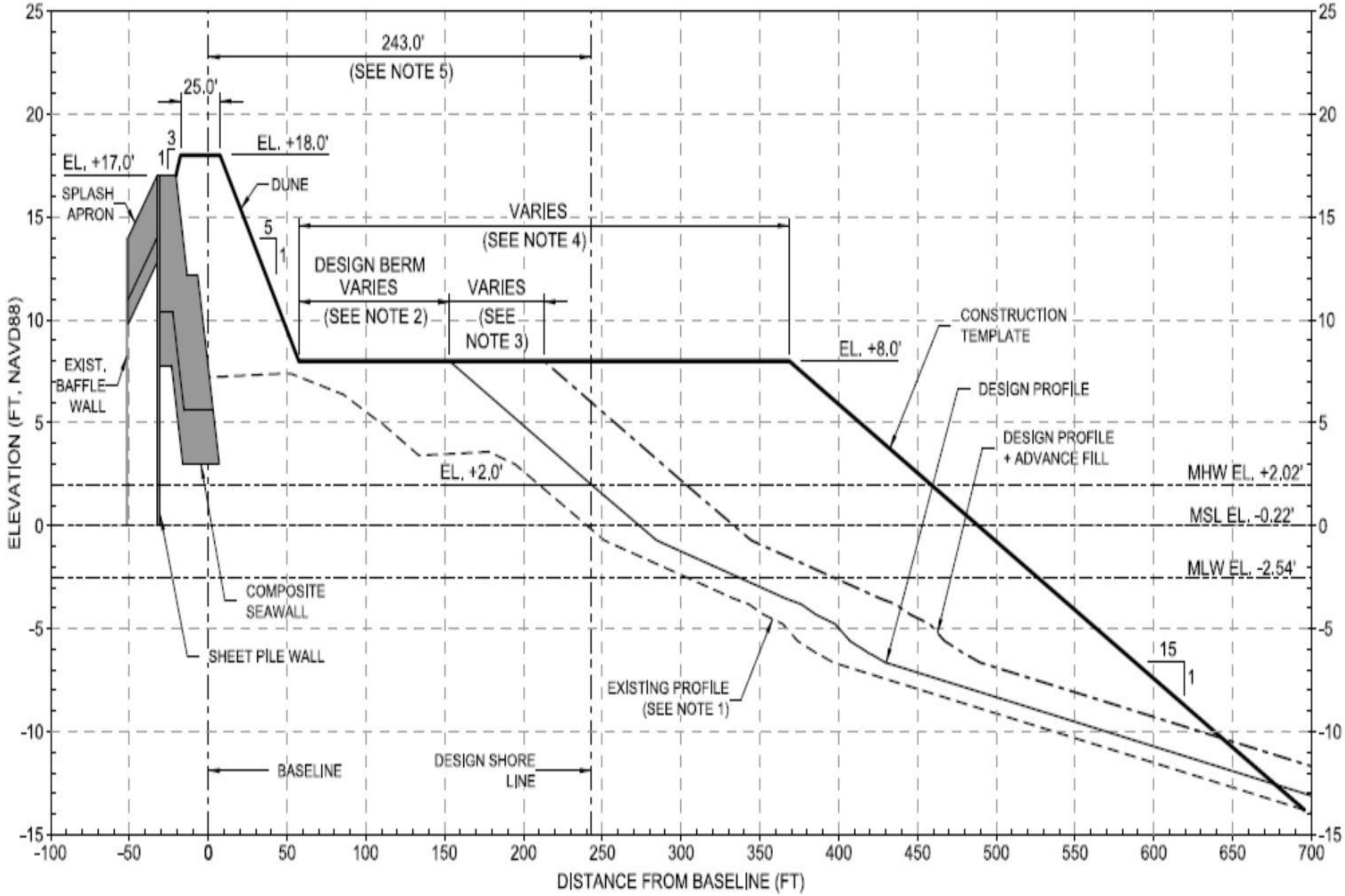


Figure 6-4: Design Beach Profile (note: existing profile varies)

Figure 6-5: Atlantic Shorefront Component of the Recommended Plan - Overview

Figure 6-6a: Atlantic Shorefront Component of Recommended Plan (1 of 4)

Figure 6-6b: Atlantic Shorefront Component of Recommended Plan (2 of 4)

Figure 6-6c: Atlantic Shorefront Component of Recommended Plan (3 of 4)

Figure 6-6d: Atlantic Shorefront Component of Recommended Plan (4 of 4)

6.2 HFFRRF Component

The Recommended Plan includes solutions to address high frequency flooding risks for communities vulnerable to high frequency events. A wide range of high frequency flooding risk reduction measures (HFFRRFs) were evaluated, and are included in the project costs, with three separate projects identified for the Recommended Plan:

- Cedarhurst-Lawrence;
- Motts Basin North; and
- Mid-Rockaway.

6.2.1 Cedarhurst-Lawrence

The Cedarhurst-Lawrence project (Figure 6-7) 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, and have been 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 cfs, which will be refined during the design phase.

6.2.1 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 6-8). 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 NAVD88.

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.

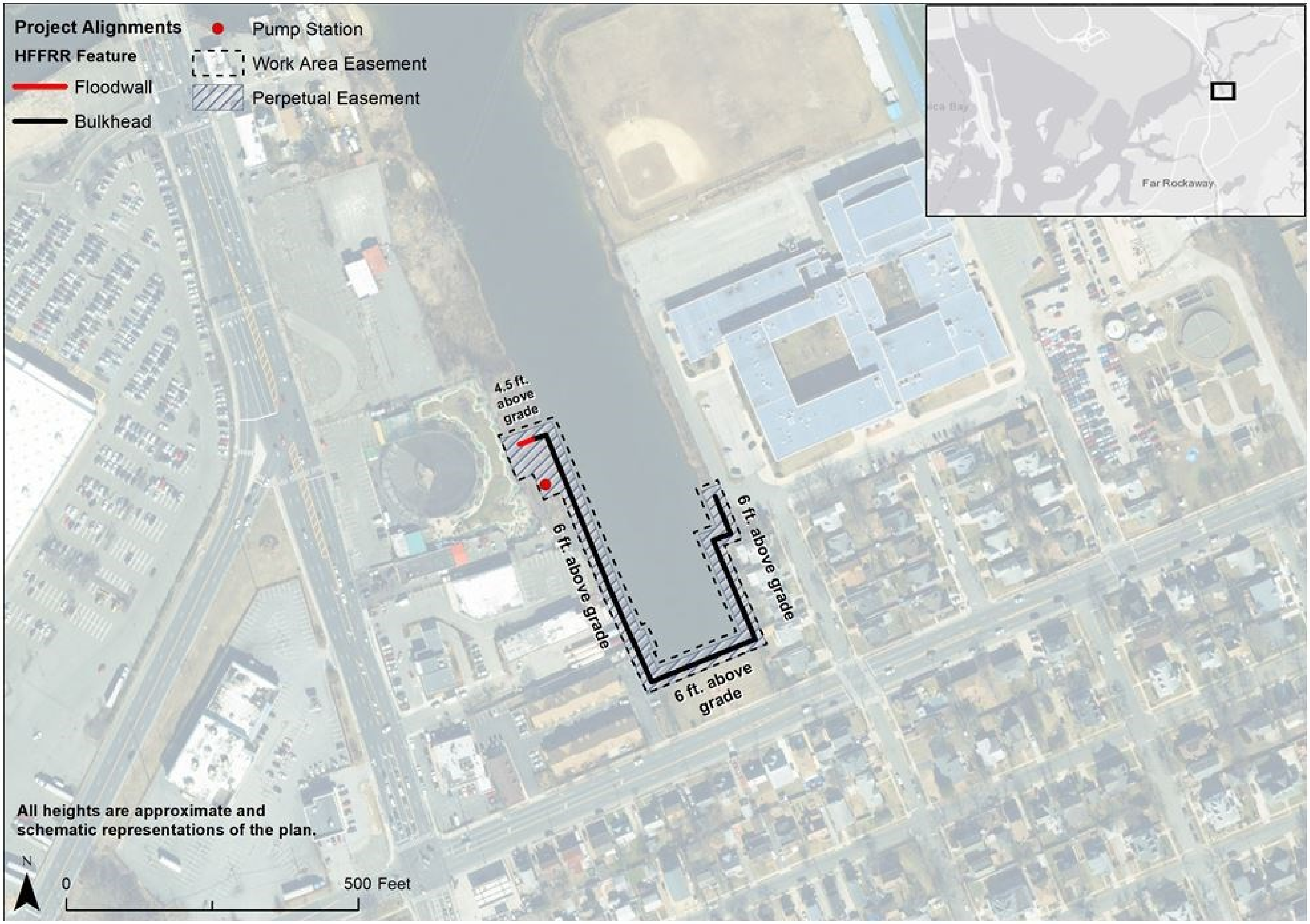


Figure 6-7: Cedarhurst-Lawrence HFFRRF Project Plan

Figure 6-8: Motts Basin North HFFRRF Project Plan

6.2.2 Mid-Rockaway

Mid-Rockaway is the largest HFFRRF. It operates as a system and is broken up into three adjacent reaches.

6.2.2.1 Edgemere Area

The eastern end of the project area (Figure 6-9) begins at high ground near the intersection of Beach Channel Drive and Beach 35th Street. The project alignment proceeds north and then west following and 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 placed as far landward as possible and weaves in and out between properties with the goal of providing structural protection to all occupied properties while minimizing impacts to wetland habitats. Efforts will be made during the PED phase to verify occupied status and to align project features in order to protect the greatest number of Rockaway residents. The hybrid berm is strategically used at these locations to minimize and avoid impacts to existing healthy wetland habitats. It should be noted that the alignment of the HFFRRF for the Mid-Rockaway Edgemere Area extends into NYC Park's Bayswater Park. Additional coordination with NYC Parks and NYCDOT (currently redesigning Beach 35th Street) will take place during PED.

This area also has been identified as a suitable 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 (smooth cordgrass) 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 transitions into 200 feet of shallow bulkhead, which continues north along existing water front properties and bulkheads. Approximately 200 feet of medium elevation floodwall then turns 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 suitable location for the use of NNBFs and to restore high marsh habitat. Project design elevations vary and have preliminarily been

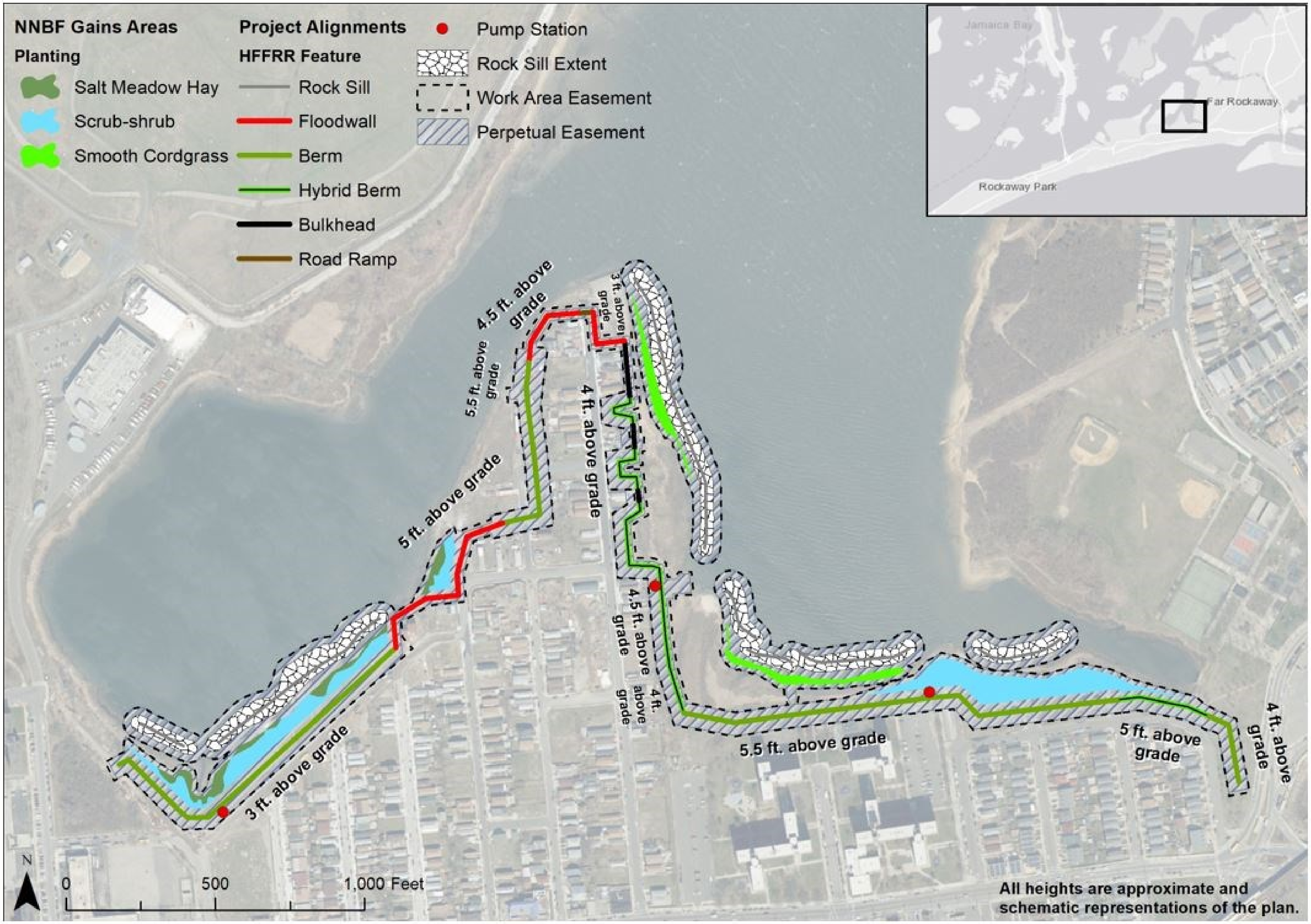


Figure 6-9: Mid-Rockaway - Edgemere Area HFFRRF Project Plan

established based on expected wave exposure. Project elevations range between +8.0ft and +9.5ft 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 nine outlets, which includes two existing outlets. Subbasin E2 was estimated to require six outlets, including one existing outlet (see Interior Drainage Appendix for additional information on Edgemere 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.

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 would be required 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 approximately 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.

6.2.2.2 Mid-Rockaway - Arverne Area

This area of the project (Figure 6-10) begins at high ground to the north of Almeda Avenue and Beach 58th Street. It should be noted that the alignment of the HFFRRF for the Mid-Rockaway Arverne Area extends into NYC Park's Rockaway Community Park. Additional coordination with NYC Parks will take place during PED.

An approximately 1,100 foot section of low berm runs south along Beach 58th Street. The alignment of the berm has been placed 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 (Salt meadow Hay) would 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 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

Figure 6-10: Mid-Rockaway - Arverne Area HFFRRF Project Plan

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 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 suitable candidate for NNBF. Based on existing elevations and profiles, a combination of either fill or excavation would be used to provide the appropriate elevations shoreward of the rock sills to maximize healthy subtidal habitats, with restoration of a transition area for low to high intertidal marsh. Eroded shorelines would be replaced with low intertidal (smooth cordgrass) habitats, and transition to either intermediate (salt meadow hay) 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 project footprint. The berm section has been positioned close to the roads to minimize impacts on habitat.

The berm section transitions into a high floodwall which runs 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 plantings of 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, and 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 connects 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 NAVD88 and +11.5ft NAVD88.

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 eight outfalls, including five existing outfalls. Subbasin A2 was estimated to require three outlets. Subbasin A3 was estimated to require five outlets, including three 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 Interior Drainage Appendix for additional information on Arverne outlets). 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 Street with an estimated capacity of 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.

6.2.2.3 Mid-Rockaway – Hammels Area

Two separate segments compose the Hammels area of the Mid-Rockaway project (Figure 6-11). 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 Hamels Wye adjacent to the Rockaway Line. The alignment heads west and south in a stair-step fashion to avoid impacts to 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

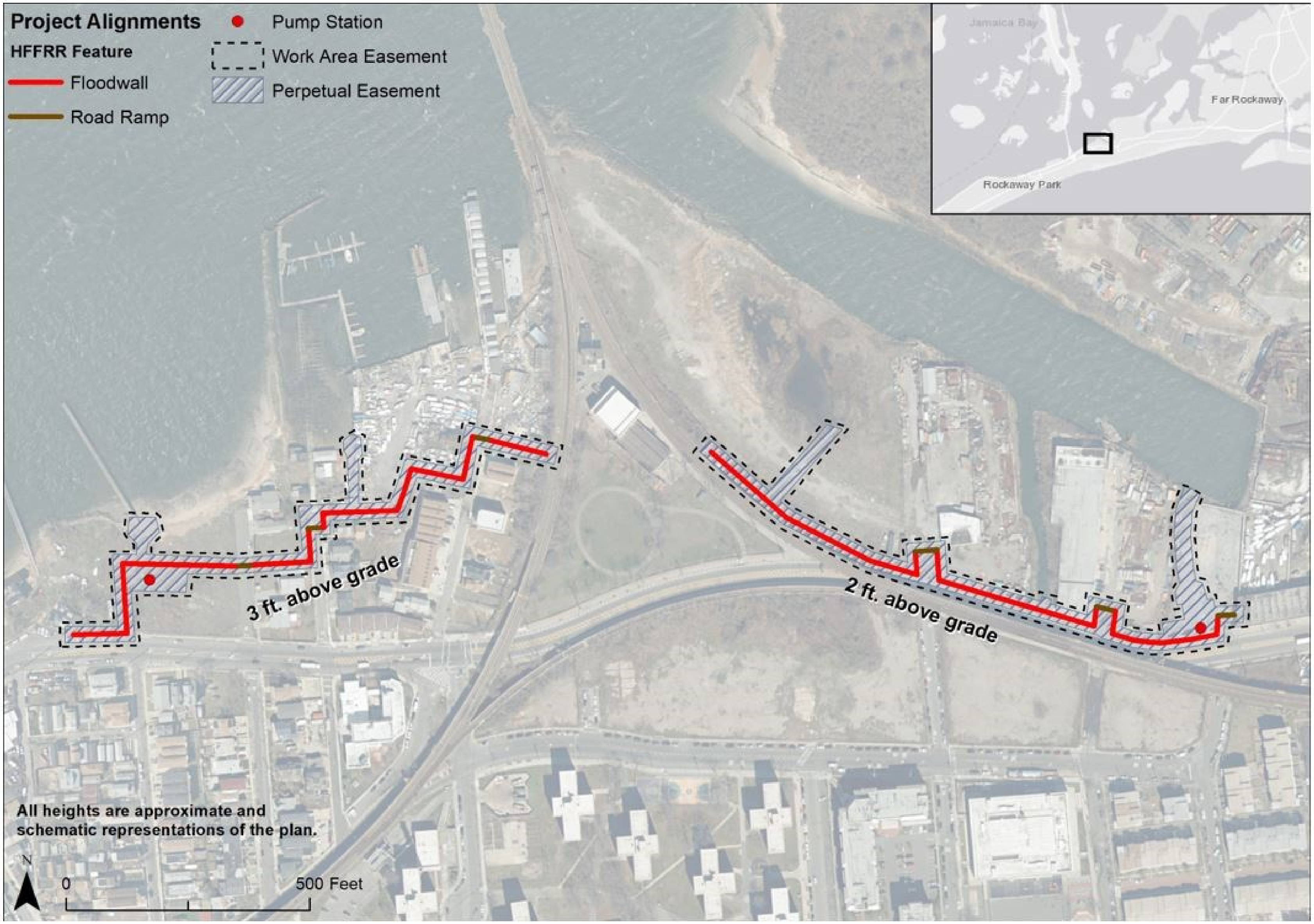


Figure 6-11: Mid-Rockaway - Hammels Area HFFRRF Project Plan

scattered grassy areas and is predominantly residential, with some commercial development. Subbasin H1 was estimated to require three outlets, which include two 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 estimated at 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.

6.3 Recommended Plan Cost Estimate

This section presents a summary of the detailed cost estimate (See Appendix C – Cost Engineering) developed for the Recommended Plan. Project first costs, annual operation, maintenance, repair, replacement and rehabilitation (OMRR&R – a 100% non-federal cost), monitoring and renourishment costs developed for the Recommended Plan are presented below.

6.3.1 Project First Costs and Fully Funded Cost

Project first costs for the entire Recommended Plan are provided in Table 6-3 below. Project first costs for the separable elements of the recommended plan are provided in Tables 6-4a through 6-4d. Please note that numbers may not add to totals due to rounding.

Table 6-3: Recommended Plan Project First Costs

Acct	Description	Cost ($)	Contingency ($)	Total ($)
01	Lands & Damages	**13,969,000**	**2,794,000**	**16,762,000**
02	Relocations	**4,453,000**	**1,110,000**	**5,564,000**
10	Breakwaters & Seawalls	**162,619,000**	**40,508,000**	**203,127,000**
11	Levees & Floodwalls	**101,194,000**	**25,208,000**	**126,401,000**
13	Pumping Plants	**38,331,000**	**9,548,000**	**47,879,000**
17	Beach Replenishment	**26,827,000**	**6,682,000**	**33,509,000**
30	Planning, Engineering, & Design	**32,434,000**	**8,079,000**	**40,512,000**
31	Construction Management	**20,505,000**	**5,108,000**	**25,614,000**
	Total	**400,330,000**	**99,036,000**	**499,366,000**

Table 6-4a: Shorefront Element Project First Costs

Acct	Description	Cost ($)	Contingency ($)	Total ($)
01	Lands & Damages	**53,000**	**11,000**	**63,000**
10	Breakwaters & Seawalls	**162,619,000**	**40,508,000**	**203,127,000**
17	Beach Replenishment	**26,827,000**	**6,682,000**	**33,509,000**
30	Planning, Engineering, & Design	**15,156,000**	**3,775,000**	**18,931,000**
31	Construction Management	**11,651,000**	**2,902,000**	**14,553,000**
	Total	**216,304,000**	**53,879,000**	**270,183,000**

Table 6-4b: Mid-Rockaway HFFRRF Project First Costs

Acct	Description	Cost ($)	Contingency ($)	Total ($)
01	Lands & Damages	**12,910,000**	**2,582,000**	**15,492,000**
02	Relocations	**4,155,000**	**1,035,000**	**5,191,000**
11	Levees & Floodwalls	**93,202,000**	**23,217,000**	**116,419,000**
13	Pumping Plants	**34,778,000**	**8,663,000**	**43,441,000**
30	Planning, Engineering, & Design	**15,856,000**	**3,950,000**	**19,806,000**
31	Construction Management	**8,126,000**	**2,024,000**	**10,151,000**
	Total	**169,027,000**	**41,471,000**	**210,498,000**

Table 6-4c: Motts Basin North HFFRRF Project First Costs

Acct	Description	Cost ($)	Contingency ($)	Total ($)
01	Lands & Damages	**375,000**	**75,000**	**450,000**
02	Relocations	**123,000**	**31,000**	**154,000**
11	Levees & Floodwalls	**1,699,000**	**423,000**	**2,122,000**
13	Pumping Plants			
30	Planning, Engineering, & Design	**219,000**	**54,000**	**273,000**
31	Construction Management	**112,000**	**28,000**	**140,000**
	Total	**2,527,000**	**611,000**	**3,138,000**

Table 6-4d: Cedarhurst-Lawrence HFFRRF Project First Costs

Acct	Description	Cost ($)	Contingency ($)	Total ($)
01	Lands & Damages	**631,000**	**126,000**	**757,000**
02	Relocations	**175,000**	**44,000**	**219,000**
11	Levees & Floodwalls	**6,293,000**	**1,568,000**	**7,860,000**
13	Pumping Plants	**3,553,000**	**885,000**	**4,438,000**
30	Planning, Engineering, & Design	**1,203,000**	**300,000**	**1,502,000**
31	Construction Management	**616,000**	**154,000**	**770,000**
	Total	**12,471,000**	**3,075,000**	**15,546,000**

6.3.2 Project Schedule and Interest During Construction

The project construction schedule begins in December of 2019, and continues through August of 2023, a period of 44 months. Schedules for the separable elements of the Recommended Plan are provided in Table 6-5 below.

Table 6-5: Recommended Plan Component Schedules

Recommended Plan Component	Construction Initiation	Construction Completion	Duration (months)
Shorefront Element	Dec 2019	July 2023	44
Mid-Rockaway HFFRRF	Jan 2020	May 2023	41
Motts Basin North HFFRRF	Jan 2020	Jun 2020	5
Cedarhurst-Lawrence HFFRRF	Jan 2020	Dec 2020	12

Interest during construction (Table 6-6) was calculated to account for the cost of capital during the construction period prior to the realization of project benefits. Costs were separated into two categories for the IDC analysis: initial costs (PED, Real Estate, and Utility Relocations), which will be incurred at the inception of each construction phase, and construction costs, which will be distributed evenly across each construction period of each phase. Project costs were amortized over the expected period of project construction for each of the Recommended Plan components at an interest rate of $2^{3/4}$ percent. Total interest during construction for the entire project equals $27,157,000.

Table 6-6: Interest During Construction

Recommended Plan Component	Project First Costs	Duration (months)	Interest During Construction
Shorefront Element	270,183,000	44	14,881,000
Mid-Rockaway HFFRRF	210,498,000	41	12,010,000
Motts Basin North HFFRRF	3,138,000	5	22,000
Cedarhurst-Lawrence HFFRRF	15,546,000	12	244,000
TOTAL			**27,157,000**

6.3.3 Operations and Maintenance

Annual OMRR&R and monitoring costs for maintaining the Recommended Plan are presented below in Table 6-7. Charges attributed to the OMRR&R of the project consist of annualized replacement costs, repair, anticipated energy charges, and labor charges for the care and cleaning of project facilities. Project components requiring routine care include levees and floodwalls, interior drainage closures, road closure gates, pump stations, beach dune grass and sand fence.

Major mechanical equipment within the pump stations have anticipated life expectancies of 20-25 years. The cost of periodic equipment replacement has been estimated, annualized over the 50-year period of analysis, and incorporated into the OMRR&R charge. In addition, electric power requirements based on the anticipated frequency of pump station and storm gate operation have been added to the project's annual operation charge.

Table 6-7: Recommended Plan Annual OMRR&R and Monitoring[32] Costs

Annual Cost Item	Shorefront ($)	HFFRRFs ($)
Scheduled Renourishment (planned/emergency)	6,364,000	
Coastal Monitoring Cost	403,000	
Major Rehabilitation	332,000	
Subtotal Monitoring & Rehabilitation	**7,099,000**	**0**
Groin & Seawall Maintenance	433,000	
Sea Level Rise Adaptions	1,453,000	
Levee, Floodwall, Interior Drainage, and Pumping Plant		1,235,000
Subtotal Operations & Maintenance	**1,886,000**	**1,235,000**
Total OMRR&R and Monitoring Annual Costs	**8,985,000**	**1,235,000**

6.3.4 Annual Project Costs

Annualized project costs for the entire Recommended Plan are provided in Table 6-8 below. Tables 6-9a through 6-9d provide annual costs for each of the project components. Project first costs and interest during construction were annualized at the FY18 discount rate of $2^{3/4}$ percent.

Table 6-8: Recommended Plan Annual Project Costs

Item	Cost ($)
Initial Project Cost	499,366,000
Interest During Construction	27,157,000
Total Investment Cost	526,523,000
Annual Costs	
Annualized Investment Cost	19,503,000
Annual Shorefront OMRR&R Costs	8,985,000
Annual HFFRRF OMRR&R Costs	1,235,000
Annual Project Cost (50 years)	**29,723,000**

[32] OMRR&R is a 100% non-federal cost that is calculated to determine the overall annual cost of the project for BCR determination. Monitoring is a project cost, cost-shared in accordance with cost-sharing requirements for coastal storm risk management construction.

Table 6-9a: Shorefront Element Annual Project Costs

Item	Cost ($)
Initial Project Cost	270,183,000
Interest During Construction	14,881,000
Total Investment Cost	285,064,000
Annual Costs	
Annualized Investment Cost	10,559,000
Annual Shorefront OMRR&R Costs	8,985,000
Annual Project Cost (50 years)	**19,544,000**

Table 6-9b: Mid-Rockaway HFFRRF Annual Project Costs

Item	Cost ($)
Initial Project Cost	210,498,000
Interest During Construction	12,010,000
Total Investment Cost	222,508,000
Annual Costs	
Annualized Investment Cost	8,242,000
Annual HFFRRF OMRR&R Costs	1,134,000
Annual Project Cost (50 years)	**9,376,000**

Table 6-9c: Motts Basin North HFFRRF Annual Project Costs

Item	Cost ($)
Initial Project Cost	3,138,000
Interest During Construction	22,000
Total Investment Cost	3,160,000
Annual Costs	
Annualized Investment Cost	117,000
Annual HFFRRF OMRR&R Costs	17,000
Annual Project Cost (50 years)	**134,000**

Table 6-9d: Cedarhurst-Lawrence HFFRRF Annual Project Costs

Item	Cost ($)
Initial Project Cost	15,546,000
Interest During Construction	244,000
Total Investment Cost	15,790,000
Annual Costs	
Annualized Investment Cost	585,000
Annual HFFRRF OMRR&R Costs	84,000
Annual Project Cost (50 years)	**669,000**

6.3.5 Economic Performance

Table 6-10 provides economic performance metrics for the entire Recommended Plan. As shown in the table, the overall plan is economically justified with a benefit-to-cost ratio of 1.7 and net benefits of $20,843,000excluding recreation benefits. When recreation benefits are added, the entire recommended plan is economically justified with a benefit-to-cost ratio of 2.7 and net benefits of $50,273,000.

Table 6-10: Recommended Plan Economic Performance Metrics

Without-Project Expected Annual Damages	
Shorefront (Flooding, Erosion, Waves)	18,512,000
Back-bay (Cross-Shore Flooding)	27,384,000
Back-bay (Jamaica Bay Flooding)	70,505,000
Back-bay Mainland and Broad Channel HFFRRF Areas (Jamaica Bay Flooding)	78,657,000
With-Project Expected Annual Damages	
Shorefront (Flooding, Erosion, Waves)	2,494,000
Back-bay (Cross-Shore Flooding)	10,947,000
Back-bay (Jamaica Bay Flooding)	70,505,000
Back-bay Mainland and Broad Channel HFFRRF Areas (Jamaica Bay Flooding)	61,489,000
Benefits: Reduced Damage to Structures	
Shorefront (Flooding, Erosion, Waves)	16,018,000
Back-bay (Cross-Shore Flooding)	16,437,000
Back-bay (Jamaica Bay Flooding)	0
Back-bay Mainland and Broad Channel HFFRRF Areas (Jamaica Bay Flooding)	17,168,000
Total Annual Damage Reduction Benefits	49,623,000
Ancillary Benefits: Reduced Maintenance	943,000
Ancillary Benefits: Recreation	29,430,000
TOTAL ANNUAL PROJECT BENEFITS	**79,996,000**
TOTAL ANNUAL PROJECT COSTS	**29,723,000**
BENEFIT TO COST RATIO (excluding recreation benefits)	**1.7**
NET EXCESS ANNUAL BENEFITS (excluding recreation benefits)	**20,843,000**
BENEFIT TO COST RATIO	**2.7**
NET EXCESS ANNUAL BENEFITS	**50,273,000**

Tables 6-11a through 6-11d provide economic performance metrics for each of the separable elements of the Recommended Plan. The tables show that each of the elements is economically justified on an individual basis.

Table 6-11a: Shorefront Element Economic Performance Metrics

Without-Project Expected Annual Damages	
Shorefront (Flooding, Erosion, Waves)	18,512,000
Back-bay (Cross-Shore Flooding)	27,384,000
With-Project Expected Annual Damages	
Shorefront (Flooding, Erosion, Waves)	2,494,000
Back-bay (Cross-Shore Flooding)	10,947,000
Benefits: Reduced Damage to Structures	
Shorefront (Flooding, Erosion, Waves)	16,018,000
Back-bay (Cross-Shore Flooding)	16,437,000
Total Annual Damage Reduction Benefits	32,455,000
Ancillary Benefits: Reduced Maintenance	943,000
Ancillary Benefits: Recreation	29,430,000
TOTAL ANNUAL PROJECT BENEFITS	**62,828,000**
TOTAL ANNUAL PROJECT COSTS	**19,544,000**
BENEFIT TO COST RATIO (excluding recreation benefits)	**1.7**
NET EXCESS ANNUAL BENEFITS (excluding recreation benefits)	**13,854,000**
BENEFIT TO COST RATIO	**3.2**
NET EXCESS ANNUAL BENEFITS	**43,284,000**

Table 6-11b: Mid-Rockaway HFFRRF Economic Performance Metrics

Without-Project Expected Annual Damages	
Back-bay Mainland Mid-Rockaway HFFRRF Area	44,304,000
With-Project Expected Annual Damages	
Back-bay Mainland Mid-Rockaway HFFRRF Area	32,429,000
Benefits: Reduced Damage to Structures	
Back-bay Mainland Mid-Rockaway HFFRRF Area	11,875,000
TOTAL ANNUAL PROJECT BENEFITS	**11,875,000**
TOTAL ANNUAL PROJECT COSTS	**9,376,000**
BENEFIT TO COST RATIO	**1.3**
NET EXCESS ANNUAL BENEFITS	**2,499,000**

Table 6-11c: Motts Basin North HFFRRF Economic Performance Metrics

Without-Project Expected Annual Damages	
Back-bay Mainland Motts Basin North HFFRRF Area	710,000
With-Project Expected Annual Damages	
Back-bay Mainland Motts Basin North HFFRRF Area	570,000
Benefits: Reduced Damage to Structures	
Back-bay Mainland Motts Basin North HFFRRF Area	140,000
TOTAL ANNUAL PROJECT BENEFITS	**140,000**
TOTAL ANNUAL PROJECT COSTS	**134,000**
BENEFIT TO COST RATIO	**1.0**
NET EXCESS ANNUAL BENEFITS	**6,000**

Table 6-11d: Cedarhurst-Lawrence HFFRRF Economic Performance Metrics

Without-Project Expected Annual Damages	
Back-bay Mainland Cedarhurst-Lawrence HFFRRF Area	12,655,000
With-Project Expected Annual Damages	
Back-bay Mainland Cedarhurst-Lawrence HFFRRF Area	7,501,000
Benefits: Reduced Damage to Structures	
Back-bay Mainland Cedarhurst-Lawrence HFFRRF Area	5,154,000
TOTAL ANNUAL PROJECT BENEFITS	**5,154,000**
TOTAL ANNUAL PROJECT COSTS	**669,000**
BENEFIT TO COST RATIO	**7.7**
NET EXCESS ANNUAL BENEFITS	**4,485,000**

6.4 Real Estate Considerations

The non-federal sponsors will be responsible for acquiring and furnishing all lands, easements, rights-of-way, relocations (i.e., P.L. 91-646 relocations and utility/facility relocations), borrow material, and dredged or excavated material disposal areas (LERRD) for the project areas, as required. All lands needed for this project will be acquired in fee, with the exception of the land needed for the flood protection levee easements, staging areas, perpetual road easements, and borrow area easements. Avoiding residential property impacts, where possible, has been a criterion in the development of the Recommended Plan. It is estimated that the Recommended Plan requires a total of 510.75 acres and impacts approximately 401 parcels:

- 329.25 acres in Perpetual Beach Storm Damage Reduction Easements,
- 27.47 acres in Flood Protection Levee Easements,
- 32.75 acres in Bank Protection Easements,
- 117.30 acres in Temporary Work Area Easements and;
- 3.98 acres in Fee; excluding minerals.

6.4.1 Lands, Easements, and Rights-of-Way

Real estate impacts and costs are discussed and presented in the Real Estate Plan, which is an appendix to this Revised Draft HSGRR/EIS. Table 6-12 below presents real estate impacts for the Recommended Plan. Real estate costs are included in Project First Costs under Account 01 – Lands and Damages.

Table 6-12: Recommended Plan Real Estate Impacts

Required Interest	Required Acres	Acres Below the MHWM	Number of Parcels		Number of Owners	
			Private	Public	Private	Public
Perpetual Beach Storm Damage Reduction Easement	**329.25**		0	15	0	2
Flood Protection Levee Easement	**27.47**		193	64		
Bank Protection Easement	**32.75**					
Temporary Construction Easement	**117.30**		193	78		
Fee excluding minerals	**3.98**		3	6	3	2

6.5 Habitat Impacts and Mitigation Requirements

Environmental impacts associated with the Recommended Plan were addressed by two complimentary evaluations:

- Permanent and temporary impacts using acreage as a metric. This provides a traditional measure to evaluate mitigation requirements, and does not account for the level of ecological service and/or functions provided by wetland habitats; and
- Evaluation for Planned Wetlands (EPW) to evaluate impacts to ecological functioning within coastal intertidal wetlands. The EPW habitat model obtained Regional Certification by USACE in July 2016. A USACE-certified model was not available to evaluate functional impacts to adjacent habitats including open water and uplands.

To facilitate an assessment of impact for both planning reaches, a comprehensive habitat mapping was completed for all lands within the anticipated project areas. Existing data sources were relied upon as a foundation for this mapping, and which include:

- Existing habitat mapping for select ecological restoration projects throughout Jamaica Bay as provided by USACE, NY District;
- New York state tidal wetlands for NYC and Long Island (New York Department of Environmental Conservation ([NYDEC] as provided at New York State Geographic Information System [GIS] Clearinghouse);
- MapPLUTO – Brooklyn & Queens as provided by New York City Department of City Planning. Includes extensive land use and geographic data at the tax-lot level.
- NOAA Coastal Change Analysis Program (C-CAP) Land Use data – 2010.

Ecological field work in both 2016 and 2018 was relied upon to complete the habitat mapping based upon revisions to existing data sources. Site-specific field maps were created at each of the visited field sites, and which were utilized to refine the habitat mapping. For those sites that were not visited during field work, best professional judgment was used while evaluating available aerial photography.

The limits of disturbance were assumed to be the "work area easement" as illustrated in project plans included above in Section 6.2. Temporary impacts were assumed to be those areas within the work area easement but not within a defined "perpetual easement" required by USACE to maintain the CSRM feature. These areas will be restored in kind within 1 year following construction of the project. Permanent impacts were assumed to be those areas that occur within the perpetual easement, and which will not be restored in kind following construction of the project. Further habitat modeling assumptions are included in Section 6.5.2.

6.5.1 Habitat Impacts Using Acreage as a Metric

Tables 6-13 and 6-14 present permanent and temporary habitat impacts using acreage as a metric. Habitat types are consistent with those described in Section 2.6. It is important to note that Waters / Wetlands are assumed to include all freshwater wetlands and intertidal habitats; inclusive of freshwater wetlands, beach and unvegetated shoreline, intertidal wetlands (i.e., both high and low marsh), mudflats, and subtidal bottom.

Table 6-13: Permanent Habitat Impacts – Acreage

Habitat Type	CL	MBN	MRE	MRA	MRH	TOTAL
Beach / Unvegetated Shoreline	0.000	0.000	0.036	0.773	0.000	0.809
Freshwater Wetland	0.000	0.000	0.000	0.000	0.056	0.056
Intertidal Wetlands	0.108	0.045	0.875	1.675	0.115	2.817
Mudflats	0.046	0.000	0.000	0.015	0.000	0.061
Subtidal Bottom	0.000	0.000	0.000	0.000	0.000	0.000
Maritime Forest	0.318	0.000	0.000	1.487	0.000	1.806
Upland Ruderal	0.000	0.000	0.000	0.000	0.000	0.000
Urban	0.000	0.000	0.000	0.000	0.000	0.000
Total	**0.472**	**0.045**	**0.910**	**3.950**	**0.171**	**5.549**
Total Waters/Wetlands	**0.154**	**0.045**	**0.910**	**2.463**	**0.171**	**3.743**

CL: Cedarhurst-Lawrence
MB: Motts Basin North
MRE: Mid-Rockaway Edgemere Area
MRA: Mid-Rockaway Arverne Area
MRH: Mid-Rockaway Hammels Area

Table 6-14: Temporary Habitat Impacts - Acreage

Habitat Type	CL	MBN	MRE	MRA	MRH	TOTAL
Beach / Unvegetated Shoreline	0.000	0.000	0.000	0.273	0.114	0.388
Freshwater Wetland	0.000	0.000	0.000	0.000	0.000	0.000
Intertidal Wetlands	0.005	0.000	0.051	0.013	0.000	0.069
Mudflats	0.440	0.000	0.000	1.917	0.015	2.371
Subtidal Bottom	0.058	0.000	3.985	7.191	0.000	11.234
Maritime Forest	0.000	0.000	0.000	0.000	0.000	0.000
Upland Ruderal	0.218	0.628	8.457	6.746	0.922	16.970
Urban	0.018	0.193	1.726	4.641	3.038	9.617
Total	**0.739**	**0.820**	**14.219**	**20.781**	**4.089**	**40.648**
Total Waters/Wetlands	**0.503**	**0.000**	**4.036**	**9.394**	**0.129**	**14.062**

CL: Cedarhurst-Lawrence
MB: Motts Basin North
MRE: Mid-Rockaway Edgemere Area
MRA: Mid-Rockaway Arverne Area
MRH: Mid-Rockaway Hammels Area

The following assumptions were made as part of accounting for permanent and temporary impacts:

- Shallow intertidal and subtidal bottom habitats will be restored "in-kind" on the waterward side of CSRM features, but within permanent easement – resulting in temporary impacts. This is inclusive of rock sills, which were assumed to occur uniformly in subtidal bottom and are included herein as a component of NNBFs to stabilize eroding shorelines and provide ecological benefits to coastal shoreline ecosystems.[33]

- Beach/shoreline habitats will be restored in-kind on the waterward side of features, but within the perpetual easement – resulting in temporary impacts.
- Intertidal wetlands will be permanently impacted within the temporary work area easement. This was a conservative assumption that allows for further refinement of impacts in final design that would include a formal waters and wetland delineation.
- Maritime forest will be permanently impacted within the temporary easement. This was a conservative assumption that allows for further refinement of impacts in final design.
- Temporary impacts to intertidal wetlands and maritime forest will be restored on-site and in-kind. It is recognized that compliance monitoring, and associated adaptive management, would be required under federal and state wetland permitting. This would specifically address successful establishment of native plantings, and control of invasive species.

6.5.2 NNBFs

A series of NNBFs were developed as part of the Recommended Plan HFFRRFs to not only control erosion and help manage coastal storm risk, but also to provide opportunities for habitat restoration and enhancement which would offset unavoidable permanent impacts to federal and state regulated areas. The four different types of proposed NNBFs are depicted in Figures 6-9 and 6-10 above. Specifically, these NNBFs provide the following ecological benefits and were incorporated in the feasibility design to also recognize future federal, state, and city permitting requirements.

6.5.2.1 Restoration / Creation of Low and High Marsh Habitats

For purposes of habitat accounting and recognizing the difficulty in differentiating between low and high marsh habitats during mapping, these habitats have been categorized as "intertidal wetlands" as described in Section 2.6.5. Specifically, these NNBF efforts target the following:

- Restoration of low marsh habitat in existing mudflat areas proximate to highly erosional shorelines; and

[33] It is recognized that there is a trade-off when converting intertidal habitats (i.e., mudflats or subtidal bottom to rock sill or intertidal vegetated wetland). The introduction of rock sills are intended to not only provide coastal storm risk management to vulnerable shorelines and communities, but also are intended to preserve and enhance/restore existing intertidal vegetated wetlands that are a critical, yet diminishing, natural habitat within Jamaica Bay. The restored intertidal wetlands will then further reduce wave energy, minimize erosion, improve water quality, as well as provide additional habitat to species of conservation concern that utilize the bay. To minimize impacts, the final design will include hydraulic and hydrologic analysis based upon site conditions and to ensure minimization of impacts immediate to the rock sill as well as along the adjacent shoreline. This recognizes that each HFFRRF will require additional design consideration to account for specific site conditions, shoreline types, erosion rate, fetch, tide range and bank height and slope.

- Restoration and/or creation of high marsh habitat in adjacent uplands that are dominated by common reed (*Phragmites australis*) and other invasive species.

6.5.2.2 Creation of Rock Sill Features

Creation of rock sill features provides protection for the subtidal and intertidal habitats, as well as provide a hard bottom habitat for increased ecological production. These features provide additional opportunities for shellfish habitat creation.

6.5.2.3 Restoration of Maritime Forest (upland)

Restoration of maritime forest (upland) within upland ruderal and urban habitats would take place in areas that have been significantly impacted by historic and current anthropogenic disturbance. While this feature would be in upland habitats, these restoration efforts account for anticipated state and city level permitting requirements.

Table 6-15 shows proposed restoration / creation, as well as enhancement efforts using acreage as a metric. While Table 6-13 above shows that the project will result in unavoidable impacts to 3.74 acres of federal and state regulated waters and wetlands[34], Table 6-15 shows that the project includes 7.65 (3.042 + 4.606) acres of wetland restoration or creation, and 0.468 acres of wetland enhancement. Regarding maritime forest, the project will result in unavoidable impacts to 1.81 acres (Table 6-13 above). Table 6-15 shows that the Recommended Plan offsets these loses through restoration of 1.35 acres.

Table 6-15: Restoration, Creation, & Enhancements – Acreage

Habitat Type	Restoration / Creation		Enhancement	
	Mid-Rockaway Edgemere Area	Mid-Rockaway Arverne Area	Mid-Rockaway Edgemere Area	Mid-Rockaway Arverne Area
Intertidal Wetland	3.042	4.606	0.468	0.000
Maritime Forest	0.000	1.348	0.000	0.000

6.5.3 Evaluation for Planned Wetlands Analysis

EPW also was used to characterize the functional impacts and benefits within intertidal wetlands associated with each HFFRRF project. The assessment provides estimates of current resource value loss, and the potential increase in resource value through implementation of NNBFs. EPW provides a quantitative measure for capacity of an intertidal wetland to perform the following five functions:

- Shoreline bank erosion control – capacity to provide erosion control and dissipate erosive forces at the shoreline bank
- Sediment stabilization – capacity to stabilize and retain previously deposited sediments

[34] Conservatively assumed to include the following habitat types: beach/shoreline, freshwater wetlands, intertidal wetlands, mudflats, and subtidal bottom.

- Water quality – capacity to retain and process dissolved or particulate materials to the benefit of downstream surface water quality
- Fish (tidal) – degree to which a wetland habitat meets the food/cover, reproductive, and water quality requirements for fish
- Wildlife – presence of characteristics that distinguish a wetland as unique, rare, or valuable.

Within each function, numerous elements (i.e., physical, chemical, and biological characteristics) are evaluated in order to identify a wetland's capacity to perform a given function. Element scores (unitless numbers ranging from 0.0 to 1.0, where 1.0 represents the optimal score) were assessed for the existing condition and proposed NNBFs. The scores were combined to produce a Functional Capacity Index (FCI) value from 0.0 to 1.0, which provides a relative index of a reference site's capacity to perform a given function. Total acreage of proposed intertidal wetland restoration, creation, or enhancement at the site is then multiplied by the FCI value to produce a wetland functional capacity unit (FCU), which represents the site's capacity to perform each wetland function (Bartoldus *et al.* 1994). Although no specific values are given to maritime or coastal buffer habitats with EPW, the wetland numbers are enhanced by having the adjacent buffer.

A summary of the analysis and the numerical results of the EPW functional assessment is provided in Tables 6-16 and 6-17. In summary, Table 6-16 shows that the project will result in the loss of 8.59 FCU's across the five functions. However, Table 6-17 shows that the NNBFs will result in the gain of 34.51 FCUs across the five functions. Similar to the acreage metric evaluation, the EPW functional assessment shows significant gains to the shoreline ecosystem through the incorporation of NNBFs.

Table 6-16: EPW Functional Assessment – FCI Losses

Function	CL	MBN	MRE	MRA	MRH	TOTAL
Shoreline Bank Erosion	0.000	-0.022	-0.420	-1.014	0.000	-1.456
Sediment Stabilization	-0.108	-0.033	-0.643	-1.255	-0.129	-2.168
Water Quality	-0.100	-0.038	-0.776	-1.415	-0.101	-2.43
Fish (tidal)	-0.075	-0.024	-0.444	-0.890	-0.065	-1.498
Wildlife	-0.048	-0.022	-0.365	-0.558	-0.045	-1.038
Total	**-0.330**	**-0.139**	**-2.648**	**-5.132**	**-0.340**	**-8.589**

CL: Cedarhurst-Lawrence
MB: Motts Basin North
MRE: Mid-Rockaway Edgemere Area
MRA: Mid-Rockaway Arverne Area
MRH: Mid-Rockaway Hammels Area

Table 6-17: EPW Functional Assessment – FCI Gains

Function	CL	MBN	MRE	MRA	MRH	TOTAL
Shoreline Bank Erosion	0.000	0.000	3.542	4.606	0.000	8.148
Sediment Stabilization	0.000	0.000	3.513	4.606	0.000	8.119
Water Quality	0.000	0.000	3.443	4.606	0.000	8.049
Fish (tidal)	0.000	0.000	2.470	3.224	0.000	5.694
Wildlife	0.000	0.000	1.965	2.533	0.000	4.498
Total	**0.000**	**0.000**	**14.933**	**19.574**	**0.000**	**34.507**

CL: Cedarhurst-Lawrence
MB: Motts Basin North
MRE: Mid-Rockaway Edgemere Area
MRA: Mid-Rockaway Arverne Area
MRH: Mid-Rockaway Hammels Area

6.6 Design and Construction Considerations

The planning level design used to identify the Recommended Plan gave significant consideration to existing infrastructure and habitats that are in close prominently to the work areas and CSRM structures. Construction activities would be closely monitored to ensure that there is not any damage to existing infrastructure. Coordination with numerous different stakeholders along with the project local sponsors will be required during the design phase.

6.6.1 Value Engineering

A Value Engineering Study will be performed on the plan carried forward during the design phase.

6.6.2 Design Adaptability to Relative Sea Level Change

Design and construction considerations for how the project would perform under relative sea level change focused on addressing the potential impacts of relative rise of sea level change in the study area. The intermediate USACE sea level change projections were used for the HFFRRFs, consistent with the Atlantic shoreline. However, sensitivity analysis was performed for the historic (low) rates and the high sea level change rates in order to understand how the project would perform under varying future conditions and also how the project could be adapted in the future based on actual future conditions.

6.6.2.1 Dune and Beach Restoration

Dune and beach restoration alternatives can be adapted to sea level change. Additional sediment can be included in each renourishment operation to offset losses from sea level rise. The natural berm elevation will rise in concert with the rising sea surface, so the design berm would be adjusted accordingly. The dune crest elevation will also need to be raised in response to sea level rise to maintain the design performance. It is recommended that the design berm elevation and dune crest elevation be increased in 1-foot increments in the future to accommodate sea level rise.

6.6.2.2 Seawalls

The buried seawall and composite seawall both may be adapted to rising sea levels in the future by adding an additional layer of armor stones as shown in Figure 6-5. The composite seawall would also require extending the concrete cap up to the elevation of the armor stone. Since the size of the median diameter of armor stone is fixed, the height of the seawalls following adaptation may actually increase more than the sea level rise – increasing the height of the seawalls by exactly 1 or 2 feet by adding smaller armor stone is not feasible because the smaller stone would not be stable under design storm conditions. Raising only the concrete cap in the composite seawall is also not feasible because wave forces on the cap and steel pile would increase dramatically without the protection of the armor stone on the storm-side of the structure. Consequently, there is considerably less flexibility in the adaptation of the seawalls in comparison to the dunes.

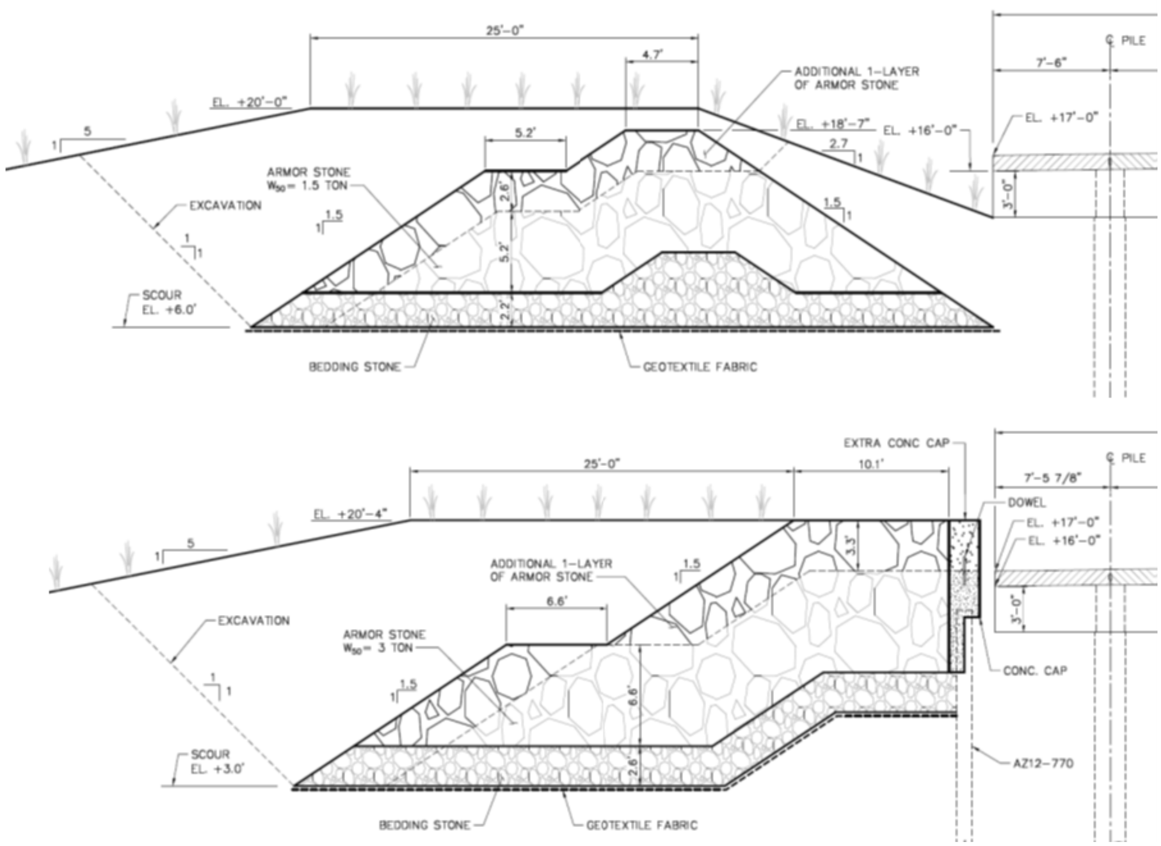


Figure 6-5: Atlantic Shorefront Component: Seawall Adaptability Measures

6.6.2.3 Groins

Due to the uncertainty in sea level change as well as the design/performance of the groin system, groins may be adapted in the future by adjusting renourishment quantities and placement locations. Even without considering sea level changes there will be some differences in the actual performance of the groins and the expected or modeled performance that will need to be adapted to by adjusting fill placement.

6.6.2.4 HFFRRFs

The HFFRRFs were designed to complement a potential future storm surge barrier which would reduce flood risk to the Jamaica Bay communities during large events. If sea levels rise more or faster than the intermediate USACE predictions used in the design of the HFFRRFs then they will be overtopped more frequently. If a storm surge barrier is ultimately recommended under the NYNJHAT study and constructed, then the CSRM plan for the Rockaway and Jamaica Bay Reformulation will be complete and a more comprehensive risk management strategy would be realized. Storm surge barriers are inherently adaptable up to a point because operators can increase the frequency with which they close the barrier in order to adapt to the more frequent flooding that comes with higher rates of sea level rise. Increased frequency of operation would need to be assessed for environmental impacts, but this is a potential adaptive strategy for sea level rise in the Back-Bay.

6.7 Summary of Accounts

6.7.1 National Economic Development (NED)

The average annual equivalent net benefits for the Recommended Plan are $77,338,000. The average annual equivalent net benefits for the Atlantic Ocean shorefront separable element are $10,687,000 excluding recreation benefits and $40,117,000 including recreation benefits.

6.7.2 Environmental Quality (EQ)

Potential impacts of the Recommended Plan on human and environmental resources have been identified and presented in Section 7 of this document, though the analysis of habitat impacts and mitigation requirements for the Recommended Plan are provided above in Section 6.5. All factors that may be relevant to the Recommended Plan were considered, including direct and indirect impacts on intertidal and freshwater wetlands, effects on essential fish habitat and listed species, air quality, water and sediment quality, hazardous materials, historic properties, socioeconomic, and environmental justice impacts. Environmental impacts to intertidal wetlands are the primary environmental effect.

6.7.3 Regional Economic Development Benefits (RED)

Construction of the Recommended Plan would reduce probabilities of direct damage to property, but also decreases the occurrence of secondary impacts, such as potential disruptions to commercial, industrial, and retail productivity. It is expected that a quantitative (input/output) model will not be used to estimate these secondary impacts (benefits other than direct damages); however, this will be confirmed following the concurrent public, policy, and technical reviews.

6.7.4 Other Social Effects

Hurricane Sandy resulted in 10 fatalities in the project area. Construction of the Recommended Plan would substantially reduce the risk of damage caused by coastal storms and presumably would have a positive effect on life-safety risk. Although based on a purely qualitative assessment, the expectation is that by reducing the risk of physical damage the Recommended Plan would positively affect life-safety risk. A quantitative model was not used to determine performance of plans against life-safety risk reduction. It is expected that the Recommended Plan would have a positive effect and no increase in risk. This will be confirmed following the concurrent public, policy, and technical reviews.

7 ENVIRONMENTAL CONSEQUENCES*

In accordance with CEQ regulations (40 CFR 1502.16), direct and indirect impacts are described in this section and cumulative impacts are described Section 7.21. The significance of potential impacts from implementation of the Proposed Action (referred to herein as the Recommended Plan) and the No Action Alternative were analyzed for each resource area identified in Section 2 Existing Conditions. Potential effects on environmental resources are described qualitatively rather than quantitatively; however, for some resource areas, preliminary qualitative analyses are provided. Note that the terms "effect" and "impact" are used synonymously in the CEQ regulations (40 CFR §1508.8) and those terms are used interchangeably in this Revised Draft HSGRR/EIS.

7.1 Geologic Setting

If an alternative would result in an increased geologic hazard or a change in the availability of a geologic resource, it could have an adverse significant impact. Such geologic and soil hazards would include, but not be limited to, seismic vibration, land subsidence, slope instability, or a reduction in the productive agricultural use of soils.

7.1.1 No Action Alternative

Under the No Action Alternative, no short- or long-term direct or indirect impacts to geology are anticipated in both planning reaches. However, adverse significant long-term direct impacts to area topography and soils would likely continue due to shoreline loss. Specifically, not implementing the Recommended Plan would allow continued shoreline erosion from continued coastal wave action and future extreme weather events.

7.1.2 Recommended Plan (Atlantic Shorefront & Jamaica Bay Combined)

7.1.2.1 Geology

An adverse geologic impact could occur if Recommended Plan elements alter bedrock conditions such that bedrock aquifer quality would be compromised; bedrock competency to support existing or future building foundations would be decreased; or would cause an increase in seismic activity at levels capable of damaging buildings and at a frequency above predicted levels.

No impacts on geology are anticipated from implementation of the Recommended Plan. The Atlantic Shorefront component and HFFRRFs would have a negligible impact on bedrock, and all other construction activities would occur above bedrock elevation.

7.1.2.2 Topography

Adverse minor long-term direct impacts to topography are anticipated from construction or extension of temporary and permanent near-shore and on-shore features in both planning reaches.

With respect to the Atlantic Shoreline Planning Reach, direct impacts to topography are anticipated from the construction of groins and beach fill placement elements of the Recommended Plan. The impacts on topography would exist for as long as built structures remain in place. However, the built structures are intended to provide both CSRM benefits as well as reduce long-term maintenance requirements associated with this eroding shoreline. Following proposed project activities, the topography in beach fill areas would be characteristically like natural beach/dune communities found along the Atlantic in the vicinity of the Project Area. The groins represent long-term structures but are intended as the most cost efficient approach to sediment control and reduction of long-term maintenance (i.e., additional placement of beach fill).

With respect to the Jamaica Bay Planning Reach, minor impacts to topography are anticipated from the construction of rock sills, restored intertidal wetlands, floodwalls, bulkheads, and berms. It is recognized that bulkheads can have minor long-term adverse impacts on bathymetry, as scouring at toe of the structural measure may result from amplified wave energy and increased erosion and sediment transport associated with these hardened structures. However, these features are generally recommended where a similar structure is already present and as such only minor impacts are anticipated. It is recognized that rock sills represent long-term in-water structures, but the construction of these features is intended to preserve existing shoreline topography throughout the planning reach by protecting against future shoreline erosion and flooding. These rock sills also provide long-term ecological benefits by preservation or restoration of intertidal wetlands along the affected shorelines (discussed further below).

7.1.2.3 Soils

Adverse minor direct short-term impacts to soils would occur due to such construction activities as clearing, grading, trench excavation, backfilling, and the movement of construction equipment within the project areas. Impacts include soil compaction and disturbance to and mixing of discrete soil strata. To reduce the impacts of construction on beach soils, Best Management Practices (BMPs) would be implemented to control erosion and sedimentation during construction (e.g., installation of silt fences). Areas disturbed to support construction activities (e.g., temporary access roads) would be restored at the end of project execution. Contamination from spills or leaks of fuels, lubricants, and coolant from construction equipment could adversely affect soils. The effects of contamination are typically minor because of the low frequency and volumes of spills and leaks. Spill prevention and countermeasures BMPs would be implemented to minimize the potential for impacts associated with an inadvertent spill of hazardous materials.

Specific to the Atlantic Shoreline Planning Reach, beneficial long-term direct and indirect impacts on soils would occur from built structures (e.g., groins, dunes and buried seawall) that retain and capture littoral materials native to the beach communities and/or limit the effects of wave and storm surge erosion. Construction and extension of groins and construction of buried seawalls would result in continued protection of upland soils from wave action and erosion that are anticipated from significant storms along project area shorelines and would reduce the amount of renourishment fill required in the future. The groin and seawall structures would help slow the long-term beach erosion rate in the project area. Beneficial long-term direct impacts on soils would also occur due to beach renourishment actions, where beach sands are replenished at prescribed intervals over the project life cycle. The texture of the nourishment material to be used would be compatible with native sand material.

Specific to the Jamaica Bay Planning Reach, all elements of the Recommended Plan would have a beneficial long-term direct and indirect impact by slowing shoreline erosion and protecting both wetland and upland native soils. Specifically, the NNBF components of the Recommend Plan 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 (smooth cordgrass) 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. 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 and preserving native soils.

7.2 Bathymetry and Sediments

7.2.1 No Action Alternative

Within the Atlantic Ocean Shorefront Planning Reach, long-term direct adverse impacts to sediment budgets are anticipated under the No Action Alternative. Beach-fill continues to be insufficient to offset the sediment deficit created by the overarching longshore sediment transport trend. The No Action alternative would leave the coast vulnerable to the strong waves and storm surges associated with extreme weather events, resulting in flooding, overwash, and loss of sand from dunes and some upland areas. The resulting loss of sand would increase adverse impacts on bathymetry and sediment budgets.

Within the Jamaica Bay Planning reach, the No Action Alternative would maintain exiting degraded conditions as it relates to bathymetry, sediment transport, and sediment quality. Specifically, the following processes would be expected to continue: (1) shoreline erosion from continued coastal wave action and future extreme weather events; (2) continual slowing of water that reduces sediment transport; and (3) continued presence of contaminated sediments.

7.2.2 Recommended Plan – Atlantic Shorefront

The Atlantic Ocean Shorefront Planning Reach components will have a direct long-term benefit on the shoreline bathymetry and associated sediment quantities by stabilizing erosion and minimizing the long-term requirements for beach renourishment. However, it is noted that construction of groins could have minor long-term effects by causing enhanced erosion on the down-current side due to the modified sand transport. In addition, some sand would be expected to be diverted offshore as longshore currents flow into deeper waters around the groins. However, it is anticipated that the Recommended Plan will meet the overall objectives to better retain existing beaches as well as protect from future erosion and flooding.

Beachfill quantities required for initial construction were estimated based on the expected shoreline position in June of 2018, and are provided below in Table 7-1. 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 7-1: Recommended Plan 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**

No short- or long-term direct or indirect adverse impacts to sediment quality would occur from implementation of the Atlantic Shorefront element. Beach replenishment is not expected to have an adverse impact on sediment quality, as all imported sands will be brought from dredge areas that have been tested for grain size, compatibility, and potential toxicity.

7.2.3 Recommended Plan – Jamaica Bay

The Jamaica Bay HFFRRF components, with emphasis on the areas which include NNBFs, will have a net long-term benefit on the shoreline bathymetry and associated sediment quantities by stabilizing erosion and minimizing the loss of native shoreline habitats. In fact, the NNBFs strategically target restoration of native habitats where shoreline loss has historically occurred. As a result, the project will have a long-term benefit on both bathymetry and sediments.

Similar to discussion of groins above, construction of off-shore rock sills could have minor long-term effects by causing enhanced erosion on the down-current side due to the modified sand transport. However, the construction of rock sills will attenuate waves and allow intertidal wetlands to re-establish on existing mudflats to further protect the bathymetry and sediments over the long-term.

Construction of revetments and/or bulkheads would have minor long-term adverse impacts on bathymetry, as scouring at toe of the structural measure may result from amplified wave energy and increased erosion and sediment transport associated with these hardened structures. However, these features are generally recommended where a similar structure is already present.

No short- or long-term direct or indirect adverse impacts to sediment quality would occur from implementation of the Jamaica Bay Planning Reach components. Intertidal wetland restoration through placement of sand will require clean fill materials that have been tested for grain size, compatibility, and potential contamination.

7.3 Surface Water

7.3.1 No Action Alternative

Under the No Action Alternative, the Atlantic Shoreline Planning Reach will remain vulnerable to coastal storm hazards and SLR. As a result, the No Action Alternative with have long-term direct adverse impacts. In terms of tidal currents and wind and wave climate, the No Action

Alternative will have no short- or long-term direct or indirect adverse impact. Baseline conditions would remain as described in Section 2.3 Surface Water.

7.3.2 Recommended Plan - Atlantic Shorefront & Jamaica Bay Combined

7.3.2.1 Coastal Storm Hazards

The Recommended Plan provides direct and in-direct benefits to both planning reaches in terms of vulnerability to flooding from coastal storm risks.

7.3.2.2 Tidal Currents

Proposed activities in the Atlantic Ocean Shorefront Planning Reach would have a direct impact on near shore tidal currents and associated shorelines. Specifically, to address CSRM objectives for the planning reach, the construction of groins will reduce the energy in tidal currents which currently occur, and affect, the project area. Consistent with discussion of sediment budgets in Section 7.2 Bathymetry and Sediments, the recommended plan is expected to provide long-term CSRM benefits to the shoreline within the Atlantic Shorefront Planning Reach by reducing shoreline erosion and in turn reducing long-term need for beach renourishment.

In terms of the Jamaica Bay Planning Reach, the project will also have a direct impact on near shore tidal currents in areas where rock sills are proposed as part of a larger NNBF. Like the discussion above for the Atlantic Shorefront, the rock sills are intended to reduce the energy of tidal currents and waves that currently occur, and affect, the project area.

The recommended plan is expected to provide long-term CSRM benefits, as well as ecological functional benefits, by reducing shoreline erosion and facilitating preservation and/or restoration of intertidal wetlands (which also are intended to reduce wave energies, provide wildlife habitat, and improve water quality). During pre-construction engineering and design, hydraulic and hydrologic modeling will be conducted, taking into consideration anticipated sea level rise, to review the interaction of typical and storm tidal conditions on the NNBFs and associated shorelines. The final design of all NNBFs will include consideration of site specific conditions, shoreline type, erosion rate, fetch, tidal range, bank height and morphology, etc.

7.3.2.3 Wind and Wave Climate

Implementation of the recommended plan will have a long-term benefit by directly addressing anticipated wave climate and preventing future shoreline erosion in both planning reaches. Under implementation of the Atlantic Shorefront component of the Recommended Plan, tidal current flow speeds and directions within the Atlantic Ocean shorefront reach would not be measurably affected. Groins have the potential to alter wave climates but would have a long-term benefit by reducing future beach renourishment requirements.

Under implementation of the Jamaica Bay component of the Recommended Plan, wind and wave climate will be specifically addressed in certain locations through the construction of in-water rock sills. These features are specifically designed to attenuate wave climate and reduce long-term shoreline erosion. In fact, these rock sills are commonly part of a larger NNBF that strategically restores intertidal wetlands on the landward side of these rock sills to further attenuate waves.

7.4 Water Quality

7.4.1 No Action Alternative

With respect to both planning reaches, the No Action Alternative would maintain baseline conditions as described in Section 2.4 Water Quality, and therefore have a direct impact on long-term water quality due to continued shoreline erosion. Specifically, the No Action Alternative would have minor direct adverse effects on water quality through the continued, on-going impacts to nearshore and aquatic habitats from high energy storm events. Storms will temporarily increase water turbidity and changes in water chemistry from high energy wave action caused by storms. The loss of intertidal wetlands and mudflats could also impact water quality within Jamaica Bay.

With respect to the Jamaica Bay Planning Reach, the bay continues to be threatened by poor water quality. Almost the entire watershed is urbanized such that Jamaica Bay receives pollution from point and non-point sources around the bay, such as the CSOs, runoff from the roads and the airport, leachate from landfills, windblown trash, and other sources. However, it is recognized that NYCDEP is implementing a multiyear plan to address water quality in Jamaica Bay that will have a direct benefit to long-term water quality under the No Action Alternative.

7.4.2 Recommended Plan - Atlantic Shorefront & Jamaica Bay Combined

Minor short-term direct adverse impacts to ocean waters would occur from disturbance of subsurface sediments during construction of in water and shoreline components associated with both planning reaches. Water quality would quickly return to baseline conditions after construction activities are completed. It is anticipated that these adverse construction impacts would be minimized by implementation of BMPs.

Spills or leaks of fuels, lubricants, or coolant from construction equipment could adversely affect water quality; however, the effects of contamination are typically negligible because of the low frequency and volumes of spills and the use of spill prevention standard construction BMPs. Leaks and spill effects would be minimized by immediate implementation of spill control and countermeasure BMPs (e.g. good housekeeping, adsorbents, storage containers).

Periodic renourishment activities over the project life-cycle would cause impacts similar to those generated during initial construction; however, because of tidal and current influences and the relatively quick settling velocity of subsurface sediments, turbidity is expected to dissipate rapidly, both spatially and temporally (Naqvi and Pullen 1982). Adherence to USACE and the New York State Section 404(b)(1) water-quality guidelines would further ensure minimal adverse water quality impacts.

Stormwater discharges to Jamaica Bay are proposed as part of the HFFRRFs, given the requirement for stormwater retention associated with these features. In terms of long-term impacts to water quality, the HFFRRFs will manage the transport of stormwater in these vulnerable locations that under the no action alternative would likely be impacted by high sediment loads and potential shoreline loss. In addition, adherence to USACE and the New York State Section 404(b)(1) water-quality guidelines would further ensure minimal adverse water quality impacts. The preservation and/or restoration of intertidal wetlands along the shoreline will also assist in mitigating water quality impacts of stormwater discharges.

Finally, the preservation, restoration and enhancement of intertidal wetlands along the Jamaica Bay shoreline associated with the HFFRRFs will provide potential long-term benefits to water quality. Specifically, wetlands provide a natural biogeochemical process that filters numerous constituents of concern within the bay and can improve water quality conditions.

To address potential water quality impacts on the landward side of the proposed rock sills as part of the HFFRRFs, the final design will include hydraulic and hydrologic analysis based upon site conditions and to ensure minimization of impacts immediate to the rock sill as well as along the adjacent shoreline. This recognizes that each HFFRRF will require additional design consideration to account for specific site conditions, shoreline types, erosion rate, fetch, tide range and bank morphology.

7.5 Air Quality Impacts

7.5.1 No Action Alternative

The No Action Alternative may result in greater pollutant emissions due to the repeated coastal management that would need to be conducted as individual projects or emergency actions (i.e., less efficient implementation). For example, additional mobilization and demobilization, emergency response conditions, and other elements associated with numerous individual projects would continue to be needed under the No Action Alternative, which may in turn lead to increases in pollutant emissions from multiple actions.

Further, from the pollutant perspective, there is the potential that not all of the individual or emergency actions would necessarily trigger General Conformity, resulting in no offsetting of construction emissions associated with 'de minimis' projects. In this scenario, the ongoing projects and activities associated with the No Action Alternative would continue to be reviewed with respect to General Conformity applicability and there is the potential that individual projects might not be subject to the requirements of General Conformity and therefore not be fully offset. If this were the case, the No Action Alternative could actually result in higher levels of emissions than with implementation of the Recommended Plan.

7.5.2 Recommended Plan

7.5.2.1 General Conformity

The Recommended Plan will temporarily produce emissions associated with diesel-fueled equipment relating to dredging, beach sand placement, and related landside construction activities. For the purposes of the air quality impact analysis, a conservative construction duration of three years was used (impacts would be higher under a three year construction schedule rather than a schedule of longer duration). Localized emission increases from the diesel-fueled equipment will last only during the project's construction period (and primarily only locally to where work is actually taking place at any point in time), and then end when construction is completed. Therefore, any potential impacts would be temporary in nature.

Construction of the Recommended Plan will occur in Queens and Nassau Counties, New York and the General Conformity applicability trigger levels for 'moderate' ozone nonattainment areas are: 100 tons per year (any year of the project) for NO_x and 50 tons per year for VOC (40 CFR§93.153(b)(1)). For areas designated as 'maintenance' for $PM_{2.5}$, the applicability trigger levels are: 100 tons for direct $PM_{2.5}$, SO_2, and CO per year (40 CFR§93.153(b)(2)).

General Conformity-related emissions associated with the project are estimated as part of the General Conformity Review and are summarized below, by calendar year (assuming 5 year construction duration, regardless of start and end dates) below in Table 7-2. Emission calculations are provided in Attachment D7 of the Environmental Compliance Appendix.

Table 7-2: Recommended Plan Construction Emissions Estimate – Tons per Year

Pollutant	2020	2021	2022	2023	2024	2025-2028
NO_X	158.3	158.3	158.3	158.3	158.3	0.0
VOC	6.0	6.0	6.0	6.0	6.0	0.0
$PM_{2.5}$	8.2	8.2	8.2	8.2	8.2	0.0
SO_2	0.08	0.08	0.08	0.08	0.08	0.0
CO	17.7	17.7	17.7	17.7	17.7	0.0

The emission levels of NO_x exceed the ozone 'de minimis' trigger levels for General Conformity; therefore, applicable NO_x emissions will need to be fully offset as part of the project. Because NO_x will be fully offset, by rule, the net NO_x emissions increase will be zero and therefore will produce no significant impacts.

A Statement of Conformity (SOC) will be utilized to ensure that the project meets the General Conformity requirements. The associated mitigation and tracking over the life of the project will be coordinated through the Regional Air Team (RAT) that consists of EPA Region 2, NYSDEC, NJDEP, USACE New York District, and other agencies associated with the mitigation efforts associated with the Harbor Deepening Project and the Hurricane Sandy-related Authorized-But-Unconstructed (ABU) projects. This approach was successfully used to fully offset emissions from the Harbor Deepening Project, which covered a construction period from 2005 through 2016.

The mitigation options for NO_x include: use of available Surplus NOx Emission Offsets (SNEOs) generated by the Harbor Deepening Project, establishment of a Marine Vessel Engine Replacement Program (MVERP; see Environmental Appendix), the purchase of EPA Cross-State Air Pollution Rule (CSAPR) ozone season NO_x allowances, statutory exemption, State Implementation Plan accommodation, or elongation of the construction schedule so as not to trigger GC. The final combination of the above options will be coordinated and tracked through the RAT.

In meeting the General Conformity requirements, the project, by definition will not incur significant impacts. Project emissions of VOC, $PM_{2.5}$, SO_2, and CO are all significantly below their respective trigger levels and therefore, by rule, are considered 'de minimis' and will have only temporary impacts around the construction activities with no significant impacts.

7.6 Shoreline Habitats

A summary of impacts to shoreline habitats, inclusive of both terrestrial and aquatic, as identified in Section 2.3.7 is included in Section 6 Habitat Impacts and Mitigation Requirements. The following provides additional discussion of impacts to these habitats.

7.6.1 No Action Alternative

Shoreline erosion in both planning reaches would be expected to continue, with a long-term direct impact on native habitats. The loss of shoreline habitat would in turn have significant impacts on both recreational uses as well as aquatic and terrestrial wildlife.

7.6.2 Recommended Plan – Atlantic Shorefront

Construction of buried seawalls and/or groins along the Atlantic Ocean Shorefront Planning Reach would have short-term minor adverse impacts on terrestrial and aquatic habitats within each nourishment area. With respect to the seawall, the feature will be buried with sand in an effort to restore the existing habitat type. With respect to the groins, habitats will be preserved outside the footprint of these features and benthic aquatic habitats are expected to-establish to a similar community within a 1 to 2-year period (USACE 1995, USACE 2001). Overall, the intention for the Recommended Plan is to have a net long-term benefit on these beach and dune habitats by stabilizing the shoreline, increasing sediment the sediment budget, and minimizing future renourishment activities necessary to support a healthy North Atlantic Upper Ocean Beach community.

7.6.3 Recommended Plan – Jamaica Bay

The design of the HFFRRs has been refined to minimize impact to sensitive shoreline habitats, and primarily occur in mapped upland ruderal or urban habitats. Within these degraded habitats, the condition will primarily be restored as a temporary impact.

The project would have direct adverse impacts on native habitats that include beach and unvegetated shoreline, freshwater wetland, intertidal wetland, mudflats, subtidal bottom, and maritime forest. Specifically, as detailed in Section 6.5 Habitat Impacts and Mitigation Requirements, the project will result in 14.1 acres of temporary impacts and 5.5 acres of permanent impacts to these habitats (See Section 6.5, Table 6-14 above). Specific to federal and state regulated waters and wetlands, the project will temporarily impact 14.1 acres and permanently impact 3.7 acres (Table 6-13 above). Temporary impacts assume that habitat will be replaced on-site and in-kind. The majority of temporary impacts to federal and state regulated waters and wetlands will occur in open water habitats (i.e., subtidal bottom, mudflat), or beach and unvegetated shorelines where subsequent planting will not be required and the time to full restoration of ecological services will be relatively quick compared to habitats that require development of native plant community.

To account for permanent impacts, NNBFs associated with the HFFRRs will result in the restoration and/or creation of 7.6 acres of intertidal wetlands, enhancement to 0.5 acres of intertidal wetlands, and restoration of 1.3 acres of maritime forest (See Section 6.5, Table 6-15 above). Overall, the Recommended Plan that includes NNBFs will attenuate waves, stabilize shorelines, and facilitate the restoration or enhancement of native shoreline habitats. As such, the long-term benefit realized by this plan will likely exceed the NNBF acreage noted above. For example, shore slopes behind the rock sill structures will be regraded to reduce risk of erosion further and create suitable elevation gradients and substrates for future establishment of tidal marsh plants. As such, the total restoration of intertidal marsh habitats will likely exceed the proposed planting area of 7.6 acres. The graded habitat behind the structure will also be designed to allow the shoreward migration of various habitats with rising sea levels, thereby extending the life of these important ecological systems. Finally, the rock sills will provide opportunities for shellfish habitat creation and will provide habitat complexity to near shore open water habitats (that is currently absent in project areas) which will support a diversity of both aquatic and terrestrial wildlife (discussed below), as well as improve near shore water quality.

As discussed in Section 6.5 above, EPW also was used to characterize the functional impacts and benefits within intertidal wetlands associated with each HFFRRF. The assessment results estimate current resource value loss, and the potential increase in resource value through implementation of NNBFs. A summary of the analysis and the numerical results of the EPW functional assessment is provided in Section 6, Tables 6-12 and 6-13 above. The project will result in the loss of 8.6 FCUs across the five functions. However, the NNBFs will result in the gain of 34.5 FCUs across the five functions. Similar to the metric evaluation, the EPW functional assessment shows significant gains to the shoreline ecosystem through the incorporation of NNBFs.

7.7 Invertebrate and Benthic Resources

7.7.1 No Action Alternative

No short- or long-term direct impacts on benthic species are anticipated under the No Action Alternative. Baseline conditions would remain as described in Section 2.7 Invertebrate and Benthic Resources.

The No Action Alternative would potentially have minor indirect adverse effects on the benthic species in both project study areas through the continued, on-going impacts to aquatic habitats from high energy storm events. Intertidal wetlands and mudflats that function as habitat for many invertebrate species would continue to experience significant erosion. Storms will also temporary increase water turbidity and changes in water chemistry from high energy wave action caused by storms. These adverse impacts can reduce the quality and extent of subtidal bottom and shellfish reef habitats that are important for benthic invertebrates.

7.7.2 Recommended Plan – Atlantic Shoreline Planning Reach

Beneficial long-term direct impacts to benthic shellfish species would be realized from implementation of the Atlantic Shorefront component. Constructed groins would create areas suitable for recruitment and protection for numerous shellfish species. Beneficial impacts to the benthic community include the increase in food source, spawning beds, and shelter in the project area (USACE 2015, [Jones Inlet EA]). Construction and extension of groins would provide living spaces for the floral and faunal communities on which benthic species rely. In addition to creating living spaces and increasing food availability, implementation of the Recommended Plan would provide shelter from wave attacks for the existing and surrounding benthic communities. Some species, such as rockweeds (*Fucus spp.*), and shellfish would flourish on the newly constructed groins (Carter 1989). Various floral species such as rockweed and spongomorpha (*Spongomorpha spp.*), and shellfish are expected to move into the area and colonize living space on groins (USACE 1995). Rockweeds are known to support numerous organisms, including both autotrophs and heterotrophs. In addition, rockweeds provide shelter, moisture at low tide, and food especially for the sessile epifaunal and epiphytic groups (Oswald et al. 1984). Gastropods, bivalves, and crustaceans are all common inhabitants of rockweeds.

It is noted that recent literature has shown direct adverse effects of shoreline armoring on mobile upper shore invertebrates (Dugan et al 2008, Dugan 2011). Specific to this project, the upper shore is heavily utilized and historically disturbed by continuous recreational activities. As such, research of natural shorelines may not be comparable to this heavily urbanized beach. It is recognized that while certain benthic invertebrate populations may be displaced by the proposed in water features (i.e., groins), it is expected that the habitat complexity will support a diverse assemblage of benthic species that would continue to function as prey for both aquatic and terrestrial wildlife that utilize this shoreline.

Minor short-term direct adverse impacts to benthic communities are anticipated from construction activities, including future periodic renourishment. Construction would cause increased sedimentation, resulting in the smothering of existing sessile benthic communities in the vicinity of construction areas. Some mortality of shellfish, and polychaetes is expected for individuals that cannot escape during the construction process. Mobile shellfish species would be able to relocate temporarily outside of the immediate project area. Benthic resources would begin to recolonize areas immediately following project completion. Infaunal organisms are likely to recolonize the area from nearby communities and re-establish to a similar community within a 2 to 6.5 month period (USACE 1995; USACE 2001). Short-term adverse impacts would occur because of short-term changes to water quality during construction, including resuspension of sediments in the water column and changes to the quality or quantity of soft bottom substrates, as discussed in Section 7.2 Bathymetry and Sediments. Construction related increases in turbidity and suspended solids cause a short-term reduction in oxygen levels (Reilley, et al. 1978; Courtenay, et al. 1980). Impacts are expected to be minor, given the temporary nature of the disturbance and the availability of suitable adjacent habitat and given the large extent of the Atlantic Ocean compared to the project construction footprint. Implementation of BMPs to control sedimentation and erosion during construction would further minimize adverse impacts on benthic invertebrate species. It is possible that the species composition of the benthic community that reestablishes would be slightly different than the pre-construction composition given disturbance and potential change in substrate type.

Minor, but recurring, short-term, direct adverse impacts on nearshore benthic communities would occur as a result of dredging sand from the borrow areas and occur at each nourishment. Minor long-term direct impact on benthic invertebrates, particularly to the abundance and size structure of sand dollar (*Echinarachnius parma*) populations (USACE 2001), would be experienced due to displacement and/or mortality during dredging for borrow areas. Impacts to benthic communities in the borrow area are considered short-term and minor because benthic invertebrate species are expected to recolonize the borrow area within 2 to 2.5 years (USACE 2001). Consistent with final determinations associated with previously shoreline beach nourishment projects, borrow efforts have not shown significant direct adverse impacts to benthic and invertebrate populations (GMP/EIS 2014).

7.7.3 Recommended Plan – Jamaica Bay Planning Reach

Components of the Jamaica Bay Planning reach would have parallel effects on benthic and invertebrate populations. Overall, the construction of rock sills and restoration of shoreline intertidal wetlands would have minor short-term direct adverse impacts to benthic communities. Some mortality of shellfish, and polychaetes is expected for individuals that cannot escape during the construction process. Mobile shellfish species would be able to relocate temporarily outside of the immediate project area. Benthic resources would begin to recolonize areas immediately following project completion. In addition, construction related increases in turbidity and suspended solids would cause a short-term reduction in oxygen levels. However, implementation of BMPs to control sedimentation and erosion during construction would minimize these adverse impacts.

Overall, the NNBF portions of the HFFRRs are intended to preserve and restore native shoreline habitats that are critical to support a diverse assemblage of benthic communities. The rock sills and adjacent shoreline habitats would provide living spaces for the floral and faunal communities on which benthic species rely. These benthic species would then provide a critical food source for aquatic and terrestrial wildlife that utilize these shorelines. As noted above, the rock sills would also provide opportunities for shellfish habitat creation.

Overall, the direct long-term benefits of the NNBFs outweigh the minor short-term effects that Recommended Plan will have on benthic communities.

7.8 Finfish

7.8.1 No Action Alternative

The No Action Alternative will potentially have minor indirect adverse effects on the fish species over the long-term as the result of continued, on-going impacts to aquatic habitats from high energy storm events. Intertidal wetlands along the Jamaica Bay shorelines that function as important nursery habitat for many fish species would experience continued erosion.

7.8.2 Recommended Plan – Atlantic Shoreline and Jamaica Bay Combined

Beneficial long-term direct impacts to fish species are anticipated from implementation of both the Atlantic Shorefront and Jamaica Bay Planning Reaches. Constructed groins and rock sills would create in water habitat areas suitable for recruitment and protection for numerous fish species. Beneficial impacts to the fish community would include the increase in food source, spawning beds, and shelter in the project area (USACE 2015). Construction of groins and rock sills would also provide living spaces for the food resource on which fish species rely. In addition to creating living spaces and increasing food availability of the project area, the proposed would potentially provide shelter for fish from wave attacks during large coastal storm events.

There would be minor short-term direct adverse impacts on adult and juvenile life stages of nearshore fish during construction activities, as mobile fish would be temporarily displaced from foraging habitat as they retreat from the area in response to construction activities. Construction related increases in turbidity and suspended solids will cause a short-term reduction in oxygen levels and reduce visibility for feeding (Reilley et al. 1978, Courtenay et al., 1980). Impacts are expected to be minor, given the temporary nature of the disturbance and the availability of suitable adjacent habitat. Adult and juvenile life stages and their prey species would quickly reestablish themselves after completion of construction.

Additional minor short-term direct adverse impacts on nearshore fish communities would occur as a result of dredging sand from the borrow areas. Additional minor short-term direct impact on benthic feeding fish species (e.g., windowpane, summer and winter flounder) would be experienced, due to temporary displacement during dredging for borrow areas. Impacts are considered minor because benthic feeding fish species are expected to avoid construction areas and feed in the surrounding area; therefore, would not be adversely affected by the temporary localized reduction in available benthic food sources. There are expected to be no impacts to fish assemblages of finfish foraging habits in offshore borrow areas consistent with conclusions of past regional beach renourishment projects (USACE 2001). The essential fish habitat requirements of the Magnuson-Stevens Fishery Conservation and Management Act and implementing regulations are discussed below in Section 7.12.

Minor short-term direct adverse impacts on nearshore fish communities would be realized by less mobile life stages (eggs and larvae) of nearshore fish, e.g., Atlantic butterfish, red hake, windowpane flounder, winter flounder, summer flounder, and scup, if present at the time of construction activities. Impacts would occur because of short-term changes to water quality, including resuspension of sediments in the water column and changes to the quality or quantity of soft bottom substrates, as discussed above in Section 7.2 Bathymetry and Sediments. Impacts to nearshore fish community assemblages are considered minor and not a threat to long-term sustainability of the identified species of concern given the large extent of the Atlantic Ocean and Jamaica Bay compared to the project construction footprint. Implementation of BMPs to control sedimentation and erosion during construction would further minimize adverse impacts on eggs and larvae of nearshore fish species.

With respect to the Jamaica Bay Planning Reach, the NNBFs are intended to preserve and restore native shoreline habitats that are critical to support a diverse assemblage of fish populations. The rock sills and adjacent shoreline habitats would provide living spaces for the floral and faunal communities on which benthic species rely and which provide a critical food source for fish.

7.9 Reptiles and Amphibians

7.9.1 No Action Alternative

The No Action Alternative will potentially have minor indirect long-term adverse effects on the amphibian and reptile species through the continued, on-going impacts to their habitats from high energy storm events. Beach/dune systems, uplands, intertidal wetlands, and mudflat habitats continue to experience significant erosion, and temporary increases in turbidity and changes in water sd chemistry from high energy wave action caused by storms. Erosion of buffer habitats like intertidal wetlands may also have indirect adverse impacts on maritime and coastal shrub and forest habitats. These adverse impacts can reduce the quality and extent of these habitats in Jamaica Bay, negatively impacting the reptiles and amphibian species that use them.

7.9.2 Recommended Plan – Atlantic Shoreline and Jamaica Bay Combined

Beneficial long-term direct impacts on herptiles (i.e., reptiles and amphibians) are anticipated from implementation of the recommended actions in both planning reaches. Construction of buried seawalls associated with the Atlantic Ocean Shorefront Planning Reach, as well as the HFFRRFs in the Jamaica Bay Planning Reach, would protect shoreline vegetation from physical degradation, thereby preserving both terrestrial and aquatic reptile and amphibian habitat.

Minor short-term direct adverse impacts on reptiles and amphibians are anticipated from construction activities. Native as well as disturbed and urban habitats would be temporarily impacted from construction activities such as clearing and grading to support construction. In addition, there will be permanent impacts to habitats within the Jamaica Bay Planning Reach as outlined in Section 6.5 above. However, NNBFs as part of the HFFRRFs will provide restoration, creation, and enhancement of native habitats to compensate for both the temporary and permanent impacts. Overall, the benefits of the enhanced ecological services associated with the shoreline ecosystem are expected to offset these minor-short term impacts associated with the project.

Effects of the project on federal and state listed reptiles is addressed in Section 7.12 below.

7.10 Birds

7.10.1 No Action Alternative

The No Action Alternative will potentially have minor indirect long-term adverse effects on the bird species through the continued, on-going impacts to their habitats from high energy storm events. Beach/dune systems, uplands, intertidal wetlands, and mudflat habitats continue to experience significant erosion, and temporary increases in turbidity and changes in water chemistry from high energy wave action caused by storms. Erosion of buffer habitats like intertidal wetlands may also have indirect adverse impacts on maritime and coastal shrub and forest habitats. These adverse impacts can reduce the quality and extent of these habitats in Jamaica Bay, negatively impacting the bird species that use them.

7.10.2 Recommended Plan – Atlantic Shoreline and Jamaica Bay Combined

Beneficial long-term direct impacts on birds are anticipated from implementation of project elements in both planning reaches. Specific to the Atlantic Shoreline Planning Reach, proposed actions would support a healthy North Atlantic Upper Ocean Beach that in turn benefits many bird species of conservation concern. Specifically, beach nesting birds like piping plover and least terns that are known to nest at several locations within the study area. However, placement of beach fill and dune restoration is likely to increase overall habitat value for these species along the affected beachfront by expanding the area of suitable breeding, nesting and foraging habitat. In addition, stabilizing the eroding beaches and shorelines under the Recommended Plan would have a long term positive effect on maintaining or increasing suitable shoreline nesting or foraging habitat.

Potential short-term impacts to piping plover and other nesting shorebirds could result from proposed permanent hard structures such as seawalls and groins, as they 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 within the Atlantic Shoreline Planning Reach), and most of the habitat that will be impacted is not of high habitat value to nesting and/or foraging birds. Specifically, these beaches are heavily utilized by humans (i.e., 5 million visitors in 2017) and most of the groins will be constructed in subtidal habitats (i.e., less favorable foraging habitat compared to intertidal areas). In addition, predator populations are not anticipated to increase due to human use of the project area. Overall impacts directly within the footprint of these structures would be permanent, but are not expected to significantly affect nesting shorebird, or other migratory birds, breeding or foraging activities for the long term. These impacts are assumed to be offset from the long-term benefits that will result from the project as beach fill and dune restoration is likely to increase overall habitat value for these species along the affected beachfront by expanding the area of suitable breeding, nesting and foraging habitat.

With respect to the Atlantic Shorefront Planning Reach, to minimize potential adverse impacts on the piping plover, 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 avian 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 from 1 April through 1 September when the presence of this species within an area of potential effect is confirmed. Conducting the beach fill operations outside of the piping plover nesting season is the easiest way to avoid adverse impacts. In addition, beach slope is also a critical factor for piping plover habitat selection and use. In order to maintain existing habitat conditions, the slope of the placement material will be consistent with adjacent existing beaches that contain successful brooding areas.

It is recognized that minor adverse short-term direct impacts on birds are anticipated from construction associated with components of both planning reaches. Native habitats would be temporarily and permanently impacted due to such construction activities. Terrestrial habitats could be impacted by vegetation clearing necessary to support construction, and degrading habitat structure important to birds. Aquatic habitats would be impacted by temporary changes in surface water quality from increases in near shore turbidity and suspended solids as described in Section 7.3 Surface Water, affecting freshwater-dependent and saltmarsh-dependent bird species. In addition, the project will result in some permanent habitat loss along these shorelines. However, it is recognized that these habitat losses would be offset through ecosystem restorations as part beach fill and dune restoration within the Atlantic Shorefront Planning Reach, as well as the NNBFs in the Jamaica Bay Planning Reach, specifically providing greater ecological services throughout the shoreline ecosystem.

7.11 Mammals

7.11.1 No Action Alternative

The No Action Alternative will potentially have minor indirect long-term adverse effects on mammal species within both planning reaches through the continued, on-going impacts to their habitats from high energy storm events. Erosion of buffer habitats like intertidal wetlands can have an indirect adverse impact on maritime and coastal shrub and forest habitats that are commonly utilized by mammals. These adverse impacts can reduce the quality and extent of these habitats in Jamaica Bay, negatively impacting the mammals that use them.

7.11.2 Recommended Plan – Atlantic Shoreline and Jamaica Bay Combined

Beneficial long-term direct impacts on mammals are anticipated from implementation of the common project elements in both planning reaches. Specific to the Atlantic Shoreline Planning Reach, proposed actions would support a healthy North Atlantic Upper Ocean Beach and near shore environment that in turn benefits many terrestrial and aquatic mammals that utilize these habitats. Overall habitat within the intertidal zone would increase as the beach is widened with beach fill, and groin structures would reduce the rate of beach loss. In terms of aquatic mammals, the increased shoreline diversity will likely increase fish usage and potentially provided enhanced foraging opportunities along the near shore. In terms of terrestrial mammals, the buried seawalls will protect adjacent upland habitats that provide critical habitat to a diversity of species.

Specific to the HFFRRFs in the Jamaica Bay Planning Reach, the proposed actions will support the preservation and restoration of native shoreline habitats through incorporation of NNBFs. These features will minimize shoreline loss, and in turn protect both aquatic and terrestrial habitats utilized by mammals. In term, the proposed actions will increase habitat diversity in both the aquatic and terrestrial environments to sustain healthy, and diverse mammal communities.

Minor short-term direct adverse impacts on mammals are anticipated from construction associated with components of both planning reaches. Native habitats would be temporarily and permanently impacted due to such construction activities and proposed features. However, species are expected to modify behaviors to utilize adjacent suitable habitats during construction and minimize these adverse impacts. It is recognized that these habitat losses would be offset through ecosystem restorations as part of the HFFRRFs and provide greater long-term ecological services along the targeted shorelines.

Effects of the project on federal and state listed mammals is addressed in Section 7.12 below.

7.12 Protected Species

7.12.1 No Action Alternative

No short- or long-term direct or indirect impacts on federal and state listed threatened and endangered species are anticipated under the No Action Alternative. Baseline conditions would remain as described in Section 2.12 Threatened and Endangered Species.

However, as noted in Section 7.8 through 7.11, the No Action Alternative would have potentially minor indirect long-term adverse effects on federal and state protected species and associated habitats through the continued, on-going impacts to their habitats from high energy storm events. Continued loss of sensitive habitat that these species rely on will negatively impact the long-term survival of these populations within the study area.

7.12.1 Recommended Plan – Atlantic Shoreline and Jamaica Bay Combined

7.12.1.1 Federal Species

Through formal consultation with USFWS, as well as follow-up consultation with the New York State Department of Environmental Conservation (NYSDEC) and New York City Department of Parks and Recreation (DPR), three federally-listed species are likely to occur within the project area:

- Piping plover, federally threatened;
- Seabeach amaranth, federally threatened; and
- Rufa red knot, federally threatened

A Biological Assessment has been prepared specific to these species (Attachment D2 of the Environmental Compliance Appendix) to support continuation of a formal consultation process with USFWS. The Biological Assessment concludes 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. As such, 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.

NOAA NMFS completed the consultation under Section 7 of the Endangered Species Act (ESA), and concluded that the proposed action is not likely to adversely affect the ESA-listed species and/or designated critical habitat on their jurisdiction. The letter dated January 12, 2017 is included as Attached D2 of the Environmental Compliance Appendix). However, USACE is currently consulting with NOAA NMFS regarding proposed actions that may adversely affect Essential Fish Habitat (EFH) pursuant to the Magnuson-Stevens Fishery Conservation and Management Act. An EFH Assessment Report is included as Attachment D3 of the Environmental Compliance Appendix.

As part of this consultation, minimally, the latest protective BMPs will be incorporated into the projects' Plans and Specifications detailing specific conservation measures to be undertaken to minimize potential adverse effects to protected aquatic species under NOAA NMFS jurisdiction (i.e., no-dredge windows on Atlantic Shorefront). The planned construction methods will incorporate BMPs, thereby reducing the temporary water quality impacts and general disturbances resulting from in-water construction activities. Additionally, transient listed species are expected to avoid the project area during construction activities.

7.12.1.2 Migratory Birds

A determination of direct and indirect effects to migratory birds is consistent with that discussed in Section 7.10. Beneficial long-term direct impacts on birds are anticipated from implementation of the common project elements in both planning reaches. Stabilizing the eroding beaches and shorelines under the Recommended Plan would have a long term positive effect on maintaining or increasing suitable shoreline nesting or foraging habitat.

Minor adverse short-term direct impacts on birds are anticipated from construction associated with components of both planning reaches. Native habitats would be temporarily and permanently impacted due to such construction activities. Terrestrial habitats could be impacted by vegetation clearing necessary to support construction, and degrading habitat structure important to birds. However, birds are expected to modify behavior to utilize adjacent more suitable habitats during construction. It is also recognized that these habitat losses would be offset over the long-term through ecosystem restorations as part of the NNBFs specifically providing greater ecological services throughout the shoreline ecosystem.

7.12.1.3 State Species of Concern

Minor adverse short-term direct impacts on New York State species of conservation concern are anticipated from construction associated with components of both planning reaches. Native habitats would be temporarily and permanently impacted due to such construction activities. Terrestrial habitats could be impacted by vegetation clearing necessary to support construction, and degrading habitat structure important to birds. However, mobile species (i.e., fish, birds, mammals, reptiles) are expected to modify behavior to utilize adjacent more suitable habitats during construction. It is also recognized that these habitat losses would be offset over the long-term through ecosystem restorations as part of the NNBFs specifically providing greater ecological services throughout the shoreline ecosystem.

As discussed above, it is also assumed that the latest protective BMPs will be incorporated into the projects' Plans and Specifications detailing specific conservation measures to be undertaken to minimize potential adverse effects to protected state listed species. The planned construction methods will incorporate BMPs, thereby reducing the temporary impacts and general disturbances resulting from proposed construction activities.

7.13 Special Management Areas

A significant impact could occur if elements of an alternative were not in compliance with development and management requirements established for a regulated Special Management Area. Additionally, impacts could be significant if the project resulted in the degradation of characteristic natural or man-made features of Special Management Areas.

7.13.1 No Action Alternative

No short- or long-term direct impacts on special management areas are anticipated under the No Action Alternative.

7.13.2 Recommended Plan

No long-term direct adverse impacts on special management areas are anticipated under the Recommended Plan. Special management areas that would realize protection from the common project elements include:

- NPS Gateway National Recreation Area (portions Jacob Riis Park);
- Special Natural Waterfront Area (portions of Jacob Riis Park);
- Coastal Zone Boundary (portions of Rockaway Peninsula); and
- NYC Waterfront Revitalization Program (same areas as Coastal Zone Boundary).

Negligible short-term direct impacts during project construction are anticipated from disruption of access to the special management areas listed above. Negligible short-term indirect impacts are anticipated from construction noise and dust, slightly diminishing the visitor experience in the special management areas listed above. Construction BMPs would be implemented to reduce the severity of these impacts to negligible levels to the maximum extent possible. BMPs would include limiting construction hours to standard allowable hours, using noise suppressing mufflers on construction equipment, water tanker trucks for dust suppression, covering trucks with tarps to prevent airborne dust, etc.

7.14 Recreation

An alternative could have a significant impact on recreation resources if it reduced or prevented use of designated recreational areas. Additionally, an impact could be significant if actions associated with an alternative permanently degraded the characteristics of a recreation resource that make the resource appealing to the public.

7.14.1 No Action Alternative

Significant long-term direct impacts on recreation are anticipated under the No Action Alternative. The No Action alternative would leave Atlantic Ocean Shorefront Planning Reach vulnerable to coastal storm risks from waves, storm surge, and inundation. Extreme storms would be detrimental to recreational resources. Under the No Action Alternative, beaches would experience erosion and eventually be as much as half the width of existing beaches, limiting recreational land use. Rockaway Beach would continue to experience erosion at a rate of about 10 feet per year. Based on responses to beach surveys completed in the summer of 2015, it is estimated that a 50 percent reduction in beach width would reduce the annual number of visits to Rockaway Beach by over 4.5 million visits. Beach visits per year were interpolated between these two points based on survey responses (Economics Appendix).

Additionally, the No Action Alternative could result in similar significant adverse impacts on recreational resources as occurred during Hurricane Sandy in October 2012, which devastated the area, sweeping away the majority of the Rockaway boardwalk, and many of the adjacent recreational areas on Rockaway. Following Hurricane Sandy, more than $140 million was invested to repair and restore Rockaway Beach. As part of this work, intact sections of the boardwalk were repaired, damaged beach buildings were renovated with new boardwalk islands constructed around them, public restrooms and lifeguard stations were installed to replace destroyed facilities and interim shoreline protection measures were created. The No Action Alternative would offer no protection to the recently constructed Rockaway Boardwalk (i.e. NYP Rockaway Boardwalk EA 2014).

7.14.2 Recommended Plan

Beneficial long-term direct impacts on recreation would be realized by implementation of the recommended plan. Construction of seawalls and groins, along with beach renourishment actions, would stabilize areas currently used for recreation, protecting recreational resources from the detrimental influence of winds, waves, currents, and sea-level changes. Long-term benefits to recreational resources generally result from:

- Additional areas available for sport fishing (i.e., additional groins);
- An increase in the size of recreational beach area (Rockaway);
- Improved access to comfort stations and lifeguard headquarters (Rockaway);
- Protection of beaches (Rockaway); and
- Protection of the newly constructed Rockaway Boardwalk (NYC Parks EA, 2014);

The shorefront component of the Recommended Plan is designed to maintain the beaches in the study area to a width of approximately 200 feet of beach (Economics Appendix). Maintaining the width of existing beaches would create an enhanced recreation experience relative to the future condition of the beach without maintenance, which would be reflected in an increase in visitation. The Rockaway Beach Attendance Study demonstrated that people would be more willing to visit Rockaway Beach if the beach restoration projects were implemented. Based on responses to beach surveys completed in the summer of 2015, it was estimated that a 50 percent reduction in beach width would reduce the annual number of visits to Rockaway Beach by over 4.5 million visits (Economics Appendix). For example, the total annual Rockaway Beach project recreation benefits are $38.6 million dollars (Economics Appendix). CSRM provided by the Recommended Plan would also support future planning and implementation efforts for NYC's Rockaway Parks Conceptual Plan.

Negligible short-term direct impacts are anticipated from disruption of access to recreation resources during project construction (e.g., beaches, parks, historic sites). Additionally, negligible short-term indirect impacts are anticipated from construction noise and dust, slightly diminishing the recreational experience of visitors who visit recreation areas during active construction. BMPs would include limiting construction hours to standard allowable hours, using noise suppressing mufflers on construction equipment, water tanker trucks for dust suppression, and covering trucks with tarps to prevent airborne dust.

7.15 Navigation

An alternative could have a significant impact if it significantly reduced, impeded, or prevented the overwater navigation of commercial and recreational vessels.

7.15.1 No Action Alternative

No short- or long-term direct or indirect impacts on navigation are anticipated under the No Action Alternative.

7.15.2 Recommended Plan

No short- or long-term direct or indirect impacts on navigation are anticipated from implementation of the recommended plan. Jamaica Bay's navigation channels were viewed in GIS along with the project alignments of the Recommended Plan. The navigation channels are in proximity to the Recommended Plan elements at two locations: near the Mid-Rockaway HFFRRF project located at Arverne; and near the Motts Basin North HFFRRF project. The nearest point from the navigation channel to the Mid-Rockaway Arverne HFFRRF project is roughly 350 feet, and the nearest point from the navigation channel to the Motts Basin North HFFRRF project is approximately 550 feet. With or without implementation of the recommended plan, commercial or recreational vessel usage of Jamaica Bay, including the Federal Navigation Channel, would be maintained to support baseline conditions or future projected conditions.

The rock sills as part of the HFFRRF will be located in the near shore environment and are not anticipated to have an adverse effect on recreational navigation. The rock sills are designed to be higher than the MHHW, and as such will be visible throughout an average tidal cycle; thus, minimizing risk to recreational boating traffic. In fact, the rock sills will enhance in water structure and potentially provide direct benefits to fish. As such, the rock sills could have direct benefits to recreational fishing.

7.16 Infrastructure

An alternative could have a significant effect on infrastructure if it would increase demand on a given infrastructure beyond the infrastructure's capacity, requiring a substantial system expansion or upgrade. Additionally, an impact could be significant if it would result in substantial system deterioration over current infrastructure condition beyond normal "wear and tear".

7.16.1 No Action Alternative

No short- or long-term direct or indirect impacts on infrastructure are anticipated under the No Action Alternative, and the No Action Alternative would not prevent similar adverse significant impacts on waterfront infrastructure as occurred during Hurricane Sandy in October 2012.

7.16.2 Recommended Plan

No long-term direct or indirect adverse impacts on infrastructure are anticipated from implementation of the Recommended Plan, as no infrastructure components are in the construction foot print of Recommended Plan elements. It is important to note that borrow areas have been specifically selected to avoid pipeline and cable structures buried offshore.

Negligible short-term direct impacts on roads and traffic are anticipated from implementation of the Recommended Plan. Roadways used for the transportation of materials and equipment to access project construction sites would experience negligible short-term direct impacts from increased traffic congestion and wear. Temporary disruption of traffic on local roadways and thoroughfares in the area may occur during delivery of stone rubble and other construction-related materials and equipment. The primary roads affected by construction in the common project elements include those that access Rockaway Peninsula:

- Flatbush Avenue;
- Marine Parkway Bridge (aka Gil Hodges Memorial Bridge);
- Cross Bay Boulevard;
- Cross Bay Veterans Memorial Bridge;
- Rockaway Beach Boulevard;
- Beach Channel Drive; and
- Shore Front Parkway.

7.17 Hazardous, Toxic, and Radioactive Waste

An alternative could have a significant effect if it would result in a substantial increase in the generation of hazardous substances, increase the exposure of persons to hazardous or toxic substances, increase the presence of hazardous or toxic materials in the environment, or place substantial restrictions on property use due to hazardous waste, materials, or site remediation.

7.17.1 No Action Alternative

No short- or long-term direct or indirect impacts related to HTRW are anticipated under the No Action Alternative. Following Hurricane Sandy, New York DEP undertook a study to understand the impact of the storm on sites that store hazardous substances, in accordance with Local Law 26 of 1988, more commonly known as the NYC Right-to-Know Law. Of 367 facilities that had filed reports under Local Law 26, 46 facilities were severely affected by Hurricane Sandy, but reported no spills and showed no evidence of spills. Only 11 facilities reported spills related to Hurricane Sandy, but the spills had been cleaned up by the facility prior to DEP inspection or spills were completely washed out by the storm. The DEP study concluded that though the lack of evidence of contamination may indicate that the impacted businesses had secured these chemicals sufficiently prior to Hurricane Sandy or adequately remediated their sites post-storm, it also may reflect the particular reality of Hurricane Sandy, as the high volume of water may have diluted and washed away any spills that occurred.[35]

7.17.2 Recommended Plan

Adverse minor short term direct impacts could occur during construction of the Recommended Plan project elements. Operation of the construction vehicles would increase the likelihood for release of vehicle operating fluids (e.g., oil, diesel, gasoline, anti-freeze, etc.) in the work zones. However, releases are expected to be immediately addressed by site safety spill prevention and control measures to minimize potential impacts.

7.18 Cultural Resources

7.18.1 No Action Alternative

Adverse significant short- and long-term direct impacts on cultural resources are anticipated under the No Action Alternative. Not implementing the proposed coastal protective measures would leave cultural resources vulnerable to degradation and destruction by future extreme weather events.

7.18.2 Recommended Plan

As described in Section 2 above, historic properties have been identified within the Area of Potential Effect (APE) for Rockaway and Jamaica Bay. This section analyzes the potential for the construction and operation of the project elements to adversely impact those historic properties identified within the respective APE. In cases where previous research investigations for cultural resources was inadequate or unknown within the APE, USACE will execute an Programmatic Agreement to continue to identify historic properties and determine the effect of project elements on historic properties, if identified (Attachment D6 of the Environmental Compliance Appendix).

7.18.2.1 Groin Construction and Extensions

These elements require excavating potentially undisturbed sediments up to 10 feet below the seafloor. Based on previous investigations, the potential for buried/submerged cultural resources in this area is low. Accordingly, the potential for this element to adversely impact cultural resources is low. However, USACE will consider utilizing a cultural monitor during excavation for the groin footings to document the discovery of potential cultural resources. The groins within the Jacob Riis Park Historic District may be contributing elements to the historic district and their modification may be considered an adverse effect. Additional research and documentation on the groins will be required by the Programmatic Agreement. No groins or groin extensions are proposed for the Jamaica Bay APE.

[35] http://www.nyc.gov/html/sirr/downloads/pdf/final_report/Ch11.5_EnvironProtection_FINAL_singles.pdf

7.18.2.2 Renourishment

Panamerican conducted a remote sensing survey at Borrow Area A-West and A-East in 2005 (Panamerican, 2005). Sixty-seven magnetic anomalies were recorded within the project area. Based on signal characteristics, three anomalies have the potential to represent significant cultural resources. Panamerican recommended avoidance of all three targets. If avoidance is not an option, additional archaeological investigations are recommended to identify the source of the magnetic anomalies. Additional work should consist of remote-sensing target refinement and diver assessment of the refined target location. Diver assessment should consist of a visual and tactile investigation of the ocean bed at the center of highest gamma deviation for each. In the event that there is no source of magnetic deflection located directly on the ocean bed, sub-ocean bed investigations should be conducted with a probe or hydroprobe to a depth sufficient to either meet proposed project requirements or to locate and delineate the anomaly source. All targets should be assessed as to historical significance, relative to NRHP criteria. The remaining anomalies represent debris deposited for fish havens along and in the western edge of the project area, as well as a pipeline that parallels the southern project area boundary (Panamerican, 2005).

A remote sensing survey has not been conducted at Borrow Area B-West. If USACE plans to use this borrow area, a remote sensing survey will be conducted prior to dredging any material. USACE will share the results with the SHPO and provide recommendations for avoidance or additional investigation, as warranted (See Attachment D6 of the Environmental Compliance Appendix).

7.18.2.3 Borrow Area Dredging

Panamerican conducted a remote sensing survey at Borrow Area A-West and A-East in 2005 (Panamerican, 2005). Sixty-seven magnetic anomalies were recorded within the project area. Based on signal characteristics, three anomalies have the potential to represent significant cultural resources. Panamerican recommended avoidance of all three targets. If avoidance is not an option, additional archaeological investigations are recommended to identify the source of the magnetic anomalies. Additional work should consist of remote-sensing target refinement and diver assessment of the refined target location. Diver assessment should consist of a visual and tactile investigation of the ocean bed at the center of highest gamma deviation for each. In the event that there is no source of magnetic deflection located directly on the ocean bed, sub-ocean bed investigations should be conducted with a probe or hydroprobe to a depth sufficient to either meet proposed project requirements or to locate and delineate the anomaly source. All targets should be assessed as to historical significance, relative to NRHP criteria. The remaining anomalies represent debris deposited for fish havens along and in the western edge of the project area, as well as a pipeline that parallels the southern project area boundary (Panamerican, 2005).

A remote sensing survey has not been conducted at Borrow Area B-West. If USACE plans to use this borrow area, a remote sensing survey will be conducted prior to dredging any material. USACE will share the results with the SHPO and provide recommendations for avoidance or additional investigation, as warranted (See Attachment D6 of the Environmental Compliance Appendix).

7.18.2.4 Buried Seawall, Beach and Dune Restoration

The buried seawall, with its beach and dune restoration, would not have an adverse effect on the Jacob Riis Historic District. However, this measure requires the installation of pilings up to 8 feet below NAVD88. Although the presence of buried cultural resources in the piling footprint is low, USACE will consider utilizing a cultural monitor during construction activities.

Furthermore, this element is designed to reach an elevation of approximately 17-18 feet NAVD88, which is several feet higher than the current ground elevation. Therefore, this element has the potential to adversely impact the viewshed when looking out at the Atlantic Ocean from within the Jacob Riis Historic District. As project plans are developed, the effect of the buried seawall on views from aspects within the Jacob Riis Historic District will be evaluated.

No buried seawall with beach and dune restoration is proposed for the Jamaica Bay APE.

7.18.2.5 Bulkheads, floodwalls, wetland creation and pump stations

The proposed high frequency flood risk reduction measures located within the APE consist of a combination of bulkheads, floodwalls, wetland creation and pump stations. All of these measures have the potential to cause ground disturbance. Although the areas around Jamaica Bay, in general, and in the Jamaica Bay APE in particular, consist of both original shorelines and filled land, there is a potential to encounter original groundsurfaces and features. In accordance with the Programmatic Agreement, additional documentary research, field investigations and other activities will look to further identify and evaluate historic properties as features and elements are designed (See Attachment D6 of the Environmental Compliance Appendix). None of these features will be constructed within the Rockaway APE.

7.19 Socioeconomics and Environmental Justice

Environmental justice issues would arise if activities associated with an alternative caused a disproportionate impact to low-income or minority populations. Disproportionate impacts could be related to human health effects or environmental effects. As described in Section 2.17, the NYSDEC identifies "Potential Environmental Justice Areas" (PEJAs) as census block groups meeting one or more of the following NYSDEC criteria in the 2000 U.S. Census (NYSDEC, 2016):

- 51.1% or more of the population are members of minority groups in an urban area;
- 33.8% or more of the population are members of minority groups in a rural area, or;
- 23.59% or more of the population in an urban or rural area have incomes below the federal poverty level.

Figure 7-1 provides an overview of the Recommended Plan project areas with PEJAs highlighted throughout the study area. The NYSDEC publishes county maps identifying PEJAs, including Kings, Queens, and Nassau counties (NYSDEC, 2016).

7.19.1 No Action Alternative

Adverse significant long-term direct impacts on PEJAs are anticipated under the No Action Alternative. The No Action alternative would leave the Atlantic Ocean Shorefront Planning Reach and Jamaica Bay Planning Reach PEJAs vulnerable to property damage from strong waves and storm surges associated with extreme weather events (Figure 7-1). Adverse impacts are felt more deeply by communities with high levels of poverty.

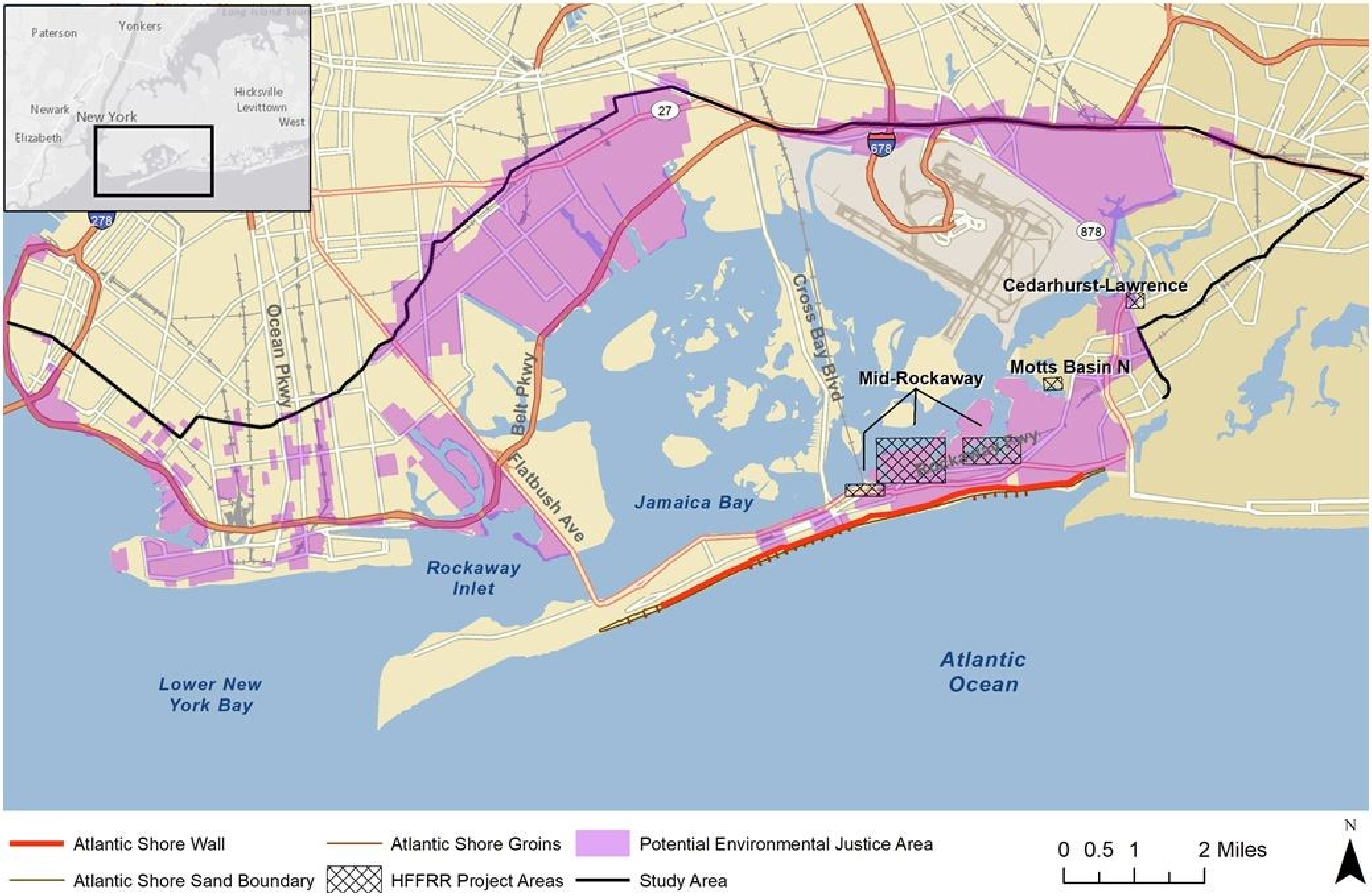


Figure 7-1: Potential Environmental Justice Areas and Project Locations

7.19.1 Recommended Plan

Beneficial long-term direct impacts on Potential Environmental Justice Areas (PEJAs) would be realized by implementation of the Recommended Plan. Construction of seawalls and groins, along with beach renourishment actions as part of the Atlantic Ocean Shorefront component, would provide coastal storm risk reduction to residential areas defined as PEJAs. Adverse impacts from storm damage are felt more deeply by communities with high levels of poverty, because community residents have limited financial resources available for rebuilding structures and replacing damaged possessions. In addition, benefits of the HFFRRFs of the Recommended Plan would be beneficial to areas with higher levels of poverty (e.g., PEJAs). As shown in Figure 7-1 above, PEJAs are located in or adjacent to all Recommended Plan elements – demonstrating that PEJA communities would directly benefit from Recommended Plan implementation.

In addition to the beneficial long-term impacts, PEJA communities would experience adverse effects from construction of the Recommended Plan. Demolition and construction work can cause an increase in sound that is well above the ambient level. A variety of sounds are emitted from loaders, trucks, saws, and other work equipment. Construction equipment usually exceeds the ambient sound levels by 20 to 25 dBA in an urban environment and up to 30 to 35 dBA in a quiet suburban area. PEJA communities also would experience increased traffic and traffic disruptions during construction of the Recommended Plan.

7.20 Aesthetics

An alternative could significantly affect visual resources if it resulted in abrupt changes to the complexity of the landscape and skyline (i.e., in terms of vegetation, topography, or structures) when viewed from points readily accessible by the public.

7.20.1 No Action Alternative

Adverse long-term direct impacts on aesthetics are anticipated under the No Action Alternative. The No Action alternative would leave land along the coast vulnerable to change and instability from strong waves and storm surge. Coastal storms would negatively alter the aesthetic landscape, including beaches, parks, and landmark structures. Negative impacts to aesthetics would contribute to the loss in recreational beach visits, as described in Section 7.14 Recreation.

7.20.2 Recommended Plan

Beneficial long-term direct impacts on aesthetics would be realized by implementation of the Recommended Plan. Construction of seawalls and groins, along with beach renourishment actions would stabilize areas currently frequented by residents and visitors seeking to connect with significant natural or built features, including area beaches, parks, and landmark structures. Implementation of protective features and beach renourishment would protect the project area's natural and culturally significant resources from the detrimental influence of winds, waves, currents, and sea-level changes. As discussed under impacts to recreation, based on responses to beach surveys completed in the summer of 2015, it was estimated that a 50 percent reduction in beach width would reduce the annual number of visits to Rockaway Beach by more than 4.5 million (Economics Appendix).

Negligible short-term direct impacts to area aesthetics are anticipated from the presence in the viewshed of heavy equipment during project construction and from temporary increases in dust and exhaust from construction activities. Construction BMPs would be implemented to reduce the severity of these impacts to negligible levels to the maximum extent possible. BMPs would include limiting construction hours to standard allowable hours, using noise suppressing mufflers on construction equipment, water tanker trucks for dust suppression, and covering trucks with tarps to prevent airborne dust.

7.21 Cumulative Impacts

As defined by CEQ Regulations at 40 CFR Part 1508.7, cumulative impacts are those that "result from the incremental impact of the Recommended Plan (for NEPA purposes the Proposed Action is the Recommended Plan) when added to other past, present, and reasonably foreseeable future actions, without regard to the agency (federal or non-federal) or individual who undertakes such other actions." Cumulative impact analysis captures the effects that result from the Recommended Plan in combination with the effects of other actions in the Recommended Plan's region of influence (ROI). A cumulative impacts analysis is intended to give a better picture of the additive or total impacts a given resource may experience when the impacts of unrelated actions or events are added to the predicted impacts of the alternative being evaluated. Analysis of cumulative impacts considers how the Recommended Plan affects sensitive resources directly or indirectly, and also what other effects have occurred, are occurring, or might occur to these resources from other, related or unrelated activities within the Recommended Plan's ROI. The analysis of cumulative effects is an extension of the impacts analysis performed to determine the significance of direct and indirect, project-specific effects.

The first step in cumulative impacts analysis is identification of resources that could be impacted by the Recommended Plan, as presented in Sections 7.1 through 7.24 above. Resources deemed to have no impacts from the Recommended Plan were eliminated from the cumulative impacts analysis; resource areas that would not experience impacts could not contribute cumulatively to regional effects. Based on the impacts analysis, resources with minor adverse impacts from the Recommended Plan were considered for inclusion in the cumulative impacts analysis. The following resources were included in the cumulative impacts analysis, based on the conclusion that the Recommended Plan would have a minor adverse impact on the resource and could contribute to cumulative regional impacts.

- Soils
- Sediments (bathymetry and sediment budgets)
- Water Quality (surface and ocean)
- Vegetation (including invasive species and terrestrial habitat)
- Wetlands (including aquatic habitat)
- Fish
- Benthic Community
- Wildlife
- Protected Species and Critical Habitat

Secondly, the ROI for each resource under each alternative scenario was defined in order to evaluate cumulative impacts resulting from projects that are proposed or anticipated within the foreseeable future. The ROI for all resources considered for the cumulative impacts analysis is defined as the "greater New York Metropolitan area" coastal and estuarine regions.

Thirdly, the relevant past, present, and reasonably foreseeable future actions in the ROI were researched. Regional projects were evaluated for inclusion in the analysis that could cumulatively affect each identified resource, considering both the magnitude and significance of the potential cumulative effects.

Representative projects were researched and considered in broad categories of regional projects. Dozens of regional projects were identified, and those with a potential to introduce cumulative impacts in conjunction with potential effects of the Recommended Plan were included in the analysis.

Recent, on-going, and proposed actions planned over the next several years with a potential interaction with effects of the Recommended Plan are described below. The project sub-headings are broad project classifications. Cumulative impacts for the resource areas identified in Table 7-3 are summarized in Section 7.25.8 Summary of Cumulative Impacts; the analysis concludes that all adverse cumulative impacts are less than significant. Beneficial cumulative impacts are also summarized in Section 7.25.8 Summary of Cumulative Impacts.

Table 7-3: Region of Influence for Cumulative Impact Analysis

Resource Area	Region of Influence (ROI)
Aquatic and Terrestrial Habitat	The Atlantic Coast in Rhode Island, Connecticut, New York, and New Jersey
Threatened and Endangered Species and Critical Habitat	The extent of each species' known range of critical habitat
Erosion and Larger Scale Coastal Zone Management	The Atlantic Coast in Rhode Island, Connecticut, New York, and New Jersey
Water Quality	The greater New York metropolitan area

7.21.1 Special Aquatic Habitat Programs Including Wetlands

Regional programs are being implemented to restore degraded or diminished aquatic habitat, including wetlands. Regional projects are described in the following subsections.

7.21.1.1 Yellow Bar, Black Wall and Rulers Bar Marsh Island Restoration 2012

The Marsh Islands Complex is an integral part of Jamaica Bay, targeted for restoration by the USACE, PANYNJ, National Park Service (Gateway), NYSDEC, NYCDEP, the National Resources Conservation Service and the New York/New Jersey Harbor Estuary Program. Restoring intertidal wetlands in Jamaica Bay are a critical component of the Comprehensive Restoration Plan for the Hudson Raritan Estuary. Since 2007, more than 160 acres (0.68 kilometers2) of marsh island habitat have been restored at Elders Point East and West, Yellow Bar Hassock, Black Wall, and Rulers Bar. Additional marsh islands, including Pumpkin Patch, Duck Point, Elders East/West, and Stoney Point are being designed as part of the HRE Ecosystem Restoration Feasibility Study.

The NYSDEC, NYCDEP with the local non-profit organizations EcoWatchers, Jamaica Bay Guardian and the American Littoral Society, completed a community-based planting effort to vegetate 30 new acres created at Black Wall and Rulers Bar. Plantings in June 2013 included a mixture of smooth cord grass or salt marsh cord grass (*Spartina alterniflora*), salt marsh cord grass, salt meadow cord grass or salt hay (*Spartina patens*), and spike grass (*Distichis spicata*).

The marsh island restoration efforts are being monitored by a project team that is providing valuable data on the cause of problems and assisting to identify optimum effective future restoration options. This program also has significant implications for the future success of restoration activities from beneficially using sand from the Operations and Maintenance (OMRR&R) Program

7.21.1.2 Broad Channel's Sunset Cove Salt Marsh Restoration Project

In 2009, NYCDPR acquired a former marina at Sunset Cove located in the center of Jamaica Bay. The site is adjacent to Big Egg Marsh, a large wetland complex owned and managed by the NPS. The restoration plan for Sunset Cove Park was created by a partnership of NYCDPR, NPS, NY-HEP, New England Interstate Water Pollution Control Commission (NEIWPCC), Jamaica Bay EcoWatchers, Broad Channel Civic Association, and the American Littoral Society. The plan incorporates approximately 4 acres (0.02 kilometers2) of salt marsh restoration and preservation, 500 feet (152.4 meters) of shoreline restoration, and approximately 7 acres (0.03 kilometers2) of upland habitat restoration. Together, these restoration efforts will establish a sustainable salt marsh, remove concrete tailings, debris, and construction fill, expand the existing wetland complex at Big Egg Marsh, and create an upland walking path through a coastal shrubland. In addition, Phase 2 of the plan, in partnership with the Governor's Office of Storm Recovery, proposes enhancements to amenities for public waterfront access, including a boardwalk and access to the water for educational programs. The plan also includes berms along the upland perimeter to provide shoreline protection, enhancing resiliency to climate change and laying the foundation for regional economic growth. The project is currently under construction.

7.21.2 Beach Front Measures

Regional projects affecting beach fronts include the beach renourishment and replenishment projects identified in Section 7.25.4 USACE Overall Program. Additional regional projects are described in the following subsections.

7.21.2.1 Rockaway Boardwalk Reconstruction Project

The NYC Department of Parks and Recreation and the NYC Economic Development Corporation have funded this project, which is designed to reconstruct the boardwalk between Beach 20th and Beach 126th Streets in a similar footprint. The existing constructed project at Rockaway includes precast concrete panels shown on the landside of the boardwalk. This wall consists of precast concrete panels, extending to +6 ft NAVD88 supported by H piles, and is not considered a significant CSRM feature. The primary function of the panels is to 1) limit access underneath the boardwalk and 2) contain wind-blown sand.

Existing concrete foundations in the way of new construction are to be removed and new steel foundations would be spaced approximately 30 feet apart. The reconstructed boardwalk will not intrude on the seaward side of the mean high water spring elevation. The typical boardwalk surface would be designed to be 3.0 feet above the 100-year storm surge elevation. This new elevation would result in raising the new boardwalk sections from approximately 1.4 feet at the eastern portion of the site to approximately 8.0 feet to the west. The reconstruction would also incorporate a sand-retaining wall underneath the boardwalk that would prevent sand migration and help to protect the adjacent beach vegetation community. Between Beach 126th and Beach 149th Streets, the project includes providing structured access to the beach with stairs and ramps across the new dunes currently being constructed as part of the USACE beach renourishment project. In addition, the project would maintain the five existing at-grade crossings through the existing dunes between Beach 9th and Beach 20th Streets.

7.21.3 Borrow Area Usage

Regional projects affecting beach fronts include the beach renourishment and replenishment projects identified in Section 7.25.4, USACE Overall Program and Coastal Zone Habitat Modifications. Each of these projects includes dredging borrow materials from off-shore sources. Regional projects requiring borrow material are discussed in this section. Some projects may have completed initial construction activities, but are considered for cumulative impacts because of plans for future, periodic replenishment. Sufficient sand has been identified for all of the listed beach nourishment projects in this section and the borrow areas for the East Rockaway Inlet to Rockaway Inlet Atlantic shoreline will be exclusively used for this project.

7.21.3.1 Coney Island

The project includes approximately 3 miles of public beachfront from Corbin Place to West 37th Street. The constructed beach has a minimum design berm elevation of +13 ft. NGVD (+11.9 ft. NAVD88), with a width of 100 feet measured from the Coney Island boardwalk seaward and an additional 50 feet of advanced nourishment fill. Approximately 2.3 million cubic yards were dredged from the borrow area offshore, south of the project shoreline within the East Bank Shoal and there is more available for future nourishments if necessary.

7.21.3.2 Long Beach

This USACE project entails the construction of a beach berm, dune and groin system to reduce the potential for storm damage along approximately 35,000 linear feet of shoreline, including the creation or rehabilitation of at least 22 groins and the addition of more than 4.7 million cubic yards of sand. Work began in spring 2016 and is the first of two contracts. Contract one includes 4 new groins and 18 groin rehabilitations. Contract two, including a dune, sand replenishment and construction of crossovers, was awarded in early 2018, and is scheduled for completion in spring 2019.

7.21.3.3 The Westhampton Beach Project

The project is designed to provide beach fill, taper an existing groin field, and fill the compartments of the groins in the villages of Westhampton Dunes, Westhampton Beach, and Southampton. Including re-nourishments, approximately 6.5 million cubic yards of sand were placed along 21,460 linear feet of beach. The project is reportedly performing better than expected.

7.21.3.4 West of Shinnecock Project

Starting in 2004, this project placed approximately 450,000 cubic yards of sand from the inlet channel on adjacent beaches. Approximately 40,000 to 60,000 cubic yards were placed just west of the inlet jetties to address severe erosion problems in front of the fishing cooperative. The remainder were placed further downdrift to accomplish sand bypassing around the inlet. The timing of future fill to address erosion west of the jetties is still uncertain.

7.21.3.5 Fire Island Inlet to Moriches Inlet Stabilization Project (FIMI)

The Fire Island to Moriches Inlet (FIMI) project includes one reach within the overall FIMP Project area. The USACE is currently constructing a project to reinforce the existing dune and berm system along the island. The stabilization effort was developed as a one-time, stand-alone construction project to repair damages caused by Hurricane Sandy and to stabilize the island. The offshore borrow areas used for construction is approximately 5,000,000 cy of sand to be removed from one borrow area and placed in the fill areas between Fire Island Inlet and Davis Park. Approximately 700,000 cy to be removed from another borrow area, and approximately 1,300,000 cy to be removed from a third borrow area for fill areas between Smith Point County Park and Moriches Inlet.

7.21.4 USACE Overall Program and Coastal Zone Habitat Modifications

The USACE New York District plans and executes an overall ecosystem restoration program to provide a comprehensive approach for addressing problems associated with disturbed and degraded ecological resources. Restoration techniques include wetland creation and restoration, streambank stabilization, reclamation and treatment of contaminated waterways, flood damage prevention, shoreline and coastal protection, and coastal zone habitat modification projects also involving beach renourishment and replenishment (similar to the Recommended Plan). Projects in USACE's overall program that were considered for potential cumulative impacts are described in the following subsections. USACE will adopt the conservation recommendation of the USFWS to dredge in thin layers and avoid digging deep pits during dredging, which results in quicker recovery of borrow areas according to research and monitoring performed by the USACE New York District.

7.21.4.1 Hurricane Sandy Coastal Restoration in New York

USACE is carrying out near-term coastal restoration work at previously completed coastal storm risk reduction projects throughout the northeast that were impacted by Hurricane Sandy in October 2012. This involves the placement of millions of cubic yards of sand along beaches impacted by Hurricane Sandy in order to restore them. The USACE New York District manages projects in New York and in New Jersey north of Manasquan Inlet. (Work south of Manasquan Inlet is managed by the USACE Philadelphia District.) Near-term coastal restoration work includes the following five projects in New York.

- Rockaway Beach – Placed approximately 3.5 million cubic yards of sand through two contracts to repair and restore this CSRM beach project.

- Coney Island - Placed approximately 600,000 cubic yards of sand to repair and restore this CSRM beach project.
- Gilgo Beach - Placed approximately 1.5 million cubic yards of sand to complete the repair of this CSRM beach that is part of dual-purpose navigation (Fire Island Inlet) and CSRM project and to bolster nearby municipal beaches using additional funds provided by the state of New York.
- West of Shinnecock Inlet - Placed approximately 450,000 cubic yards of sand to repair and restore this CSRM beach project.
- Westhampton – USACE awarded a construction contract for this work and expects to oversee the placement of roughly 1 million cubic yards of sand by the end of this year to repair and restore this CSRM beach project.

7.21.4.2 North Atlantic Coast Comprehensive Study

The North Atlantic Coast Comprehensive Study (NACCS) provides a step-by-step approach, with advancements in the state of the science and tools to conduct three levels of analysis (available at http://www.nad.usace.army.mil/CompStudy). Tier 1 is a regional scale analysis (completed as part of this study), Tier 2 would be conducted at a State or watershed scale (conceptual Tier 2 evaluations were completed in each State and the District of Columbia and can be found in State and District of Columbia Analyses Appendix), and Tier 3 would be a local-scale analysis that incorporates benefit-cost evaluations of CSRM plans.

Using the tiered analyses will enable communities to understand and manage their short-term and long-term coastal risk in a systems context. The NACCS addresses the coastal areas defined by the extent of Hurricane Sandy's storm surge in the District of Columbia and the States of New Hampshire, Massachusetts, Connecticut, Rhode Island, New York, New Jersey, Pennsylvania, Delaware, Maryland, and Virginia. Maine was not included in the study because minimal impacts from storm surge were documented as part of the Federal Emergency Management Agency's (FEMA's) Modeling Task Force (MOTF) Hurricane Sandy Impact Analysis. Additionally, the USACE Hurricane Sandy Coastal Projects Performance Evaluation Study included an assessment of 13 USACE CSRM projects in northern Massachusetts and Maine, and noted that Hurricane Sandy was generally less than a 20 percent flood with negligible damages to project features. Based on minimal impacts and the authorization language that defined the study area as areas affected by Hurricane Sandy, Maine was not included as part of the NACCS study area. Regardless, as the Maine coastline is primarily affected by nor'easters and periodically by tropical storms and hurricanes, stakeholders and communities could apply the study results to address coastal storm risk as well as utilize the various products generated as part of the NACCS.

7.21.4.3 NY & NJ Harbor Deepening Contract Areas and Future OMRR&R Projections

The project area is the main navigation channels in the Port of New York and New Jersey that support the container terminals. The non-federal sponsor is The Port Authority of New York & New Jersey. The authorized project provides 50-foot water access to the four container terminals by deepening Ambrose Channel from deep water in the Atlantic Ocean to the Verrazano-Narrows Bridge, the Anchorage Channel (from the Verrazano-Narrows Bridge to its confluence with the Port Jersey Channel), the Kill Van Kull Channel, the main Newark Bay Channel to Pt. Elizabeth and the Port Elizabeth and South Elizabeth tributary channels, the Arthur Kill Channel adjacent to the New York Container Terminal), and the Port Jersey. Also authorized but deferred is the deepening of the Bay Ridge channel to 50 ft to the South Brooklyn Marine Terminal. The project also facilitated the beneficial use of nearly all dredged material from the channel deepening project. Some of the beneficial uses include creating fishing reefs from blasted rock, creating marshes, capping the Historic Area Remediation Site (HARS), and capping existing impacted landfills and brownfields.

The project includes 21 dredging contracts and construction of four marsh restoration projects. Two marsh restoration projects at Woodbridge, NJ and Elders Point East, Jamaica Bay, NY (2006-2007, 40 acres of wetlands) were constructed as mitigation for the channel deepening. In 2009 through 2012, the project was modified to include the restoration of two additional Jamaica Bay marsh islands (Elders West and Yellow Bar Hassock) through the beneficial reuse of dredged material. In 2010 with 100 percent non-federal sponsor funding, 339,235 cubic yards of sand was beneficially used for the restoration of Lincoln Park, New Jersey. Twenty dredging contracts have been awarded with 19 physically complete and one underway. Two of the last three contracts removed accumulated shoals and debris (partially due to Hurricane Sandy) in previously deepened channel areas inside the Narrows to facilitate transition of the project from construction to operation. The last contract, which involves the removal of material in utility corridors and other shoals in the Anchorage and Port Jersey Channels, is underway and will be completed shortly following the abandonment of two existing water supply siphons within Anchorage Channel. This water siphon relocation construction work by the Port Authority of NY and NJ and the NYC Economic Development Corporation was severely impacted and delayed by Hurricane Sandy such that the utility corridor deepening contract is not expected to be completed until summer of 2016.

7.21.4.4 Hudson-Raritan Estuary (HRE) Comprehensive Restoration Plan

The Hudson Raritan Estuary (HRE) is within the boundaries of the Port District of New York and New Jersey, and is situated within a 25-mile radius of the Statue of Liberty National Monument. The HRE study area includes 8 Planning Regions: 1) Jamaica Bay; 2) Lower Bay; 3) Lower Raritan River; 4) Arthur Kill/Kill Van Kull; 5) Newark Bay, Hackensack River and Passaic River; 6) Lower Hudson River; 7) Harlem River, East River, and Western Long Island Sound; and 8) Upper Bay.

The study purpose is to identify the water resources problems, existing conditions and factors contributing to environmental degradation within the estuary in order to develop potential solutions aimed at ecosystem restoration, while building upon existing restoration efforts and management plans (e.g., Harbor Estuary Program's Comprehensive Conservation Management Plan).

The HRE Ecosystem Restoration Program will enable USACE, its non-federal cost-sharing sponsors, and other regional stakeholders to restore and protect lost or degraded aquatic, wetland and terrestrial habitats within the HRE study area. These activities will be accomplished by implementing various site-specific ecosystem restoration projects formulated within the context of an overall strategic plan.

As a first step, the USACE, with participation of the regional stakeholders, developed a Comprehensive Restoration Plan (CRP) that serves as a master plan and blueprint for future restoration in the HRE region. The CRP provides the framework for an estuary-wide ecological restoration program by utilizing restoration targets - Target Ecosystem Characteristics (TECs) developed by the region's stakeholders. The CRP Program goal is to develop a mosaic of habitats that provide society with renewed and increased benefits from the estuary environment. Each TEC is an important ecosystem property or feature that is of ecological and/or societal value including restoration of intertidal wetlands, shellfish reefs, eelgrass beds, water bird islands, public access, maritime forest, tributary connections, shorelines and shallow habitat, fish crab and lobster habitat, reduction of contaminated sediments and improvement of enclosed and confined waters. The CRP provides a strategic plan to achieve the TEC goals, identify potential restoration opportunities and mechanisms for implementation.

The HRE Feasibility Study will recommend specific restoration projects throughout the HRE Study Area that advance the CRP goals and provide solutions for water resource problems. Projects will be recommended for near-term construction and future feasibility study spin-offs (per Civil Works Transformation). Recommendations from the HRE- Lower Passaic River, HRE- Hackensack Meadowlands, Flushing Creek and Bay, Bronx River Basin, and Jamaica Bay, Marine Park, Plumb Beach Feasibility Studies will be incorporated into the HRE Feasibility Report and Environmental Assessment. These recommendations may include benthic habitat restoration, tidal wetland restoration, vegetative buffer creation, shoreline stabilization, and aquatic habitat improvement.

7.21.4.5 Spring Creek North Restoration Project and Spring Creek South Hazard Mitigation Grant Program

The USACE), NYSDEC, NYCDPR, NYCDEP, NPS, the Federal Emergency Management Agency (FEMA), the Governor's Office of Storm Recovery (GOSR), and the U.S. Department of Housing and Urban Development (HUD), among others, have partnered to restore the Spring Creek area located along the north shore of Jamaica Bay. The site consists of two separately funded projects referred to as Spring Creek North and Spring Creek South. Spring Creek North is owned by NYCDPR and the restoration project is being funded by the USACE and NYCDPR pursuant to the Continuing Authorities Program (CAP). Spring Creek South is owned by NPS and the restoration project is funded by a grant provided to NYSDEC under the FEMA Hazard Mitigation Grant Program (HMGP). These projects are also being coordinated with the Governor's Office of Storm Recovery's Howard Beach New York Rising Community Reconstruction Plan (March 2014).

Spring Creek North is a tidal creek that has retained its meandering pattern and has several smaller side channels with exposed mudflats at low tide. The proposed ecosystem restoration project at this site consists of excavating and re-contouring uplands to achieve intertidal elevation, as well as removing invasive plant species and replanting the area with native plants. A total of approximately 8 acres (0.03 kilometers2) of low marsh, 5.5 acres (0.02 kilometers2) of high marsh, and almost 25 acres (0.1 kilometers2) of maritime upland habitat would be restored.

In addition, NYCDPR received a National Fish and Wildlife Foundation (NFWF) Grant to conduct complementary actions to provide coastal storm risk management (CSRM) features and improve resiliency at the site.

Spring Creek South was originally recommended as a potential restoration opportunity for the USACE's Jamaica Bay, Marine Park, and Plumb Beach Ecosystem Restoration Feasibility Study. As part of FEMA's HMGP, NYSDEC, USACE (as a planning and construction management contractor), and NPS have reevaluated the restoration plans to include Natural/Nature Based Features (NNBFs) providing CSRM benefits and enhanced coastal resiliency to the Howard Beach Community. A protective berm, in conjunction with up to 178 acres (0.72 kilometers^2) of maritime upland habitat and 51 acres (0.21 kilometers^2) of wetlands, could be restored at Spring Creek South.

7.21.5 Long-Term Combined Sewer Overflow (CSO) Projects

Municipalities are concerned about CSOs because of their effect on water quality and recreational uses in local waterways. Water treatment plants are affected by heavy rain and snow storms when combined sewers receive higher than normal flows. Treatment plants are unable to handle flows that are more than twice design capacity and when this occurs, a mix of excess stormwater and untreated wastewater discharge directly into waterways at certain outfalls. The following subsections describe CSO projects evaluated for cumulative impacts.

7.21.5.1 Jamaica Bay CSO Upgrade Projects

NYC Department of Environmental Protection (DEP) prepared a 2014 update to the Jamaica Bay Watershed Protection Plan. The plan, first issued in 2007, focuses on water quality improvements, ecological restoration and enhancing valuable natural resources. The update outlines the numerous initiatives DEP has undertaken, along with state and federal partner agencies, environmental advocates, leading educational institutions and community groups, to protect one of the most bountiful wildlife habitats in the Northeastern Unites States.

Ongoing initiatives include wastewater treatment plant upgrades, shellfish pilot restoration projects, wetlands restoration, green infrastructure projects and mapping.

7.21.5.2 NYC CSO Control Plan

Recent NYCDEP construction projects have included upgrades in key wastewater treatment facilities, storm sewer expansions and the construction of several large CSO retention tanks to further mitigate this chronic source of pollution. Existing infrastructure developments have increased NYCDEP's standardized CSO capture rate from about 30% in 1980 to over 80% today. Some of the most recent increases can be attributed to the implementation of additional CSO control measures such as the Spring Creek and Flushing Bay CSO Retention Facilities that came online in 2007, and the Paerdegat Basin and Alley Creek CSO Retention Facilities, which came online in 2010.

7.21.6 Community Development Plans

Community development plans in the ROI can have direct cumulative effects, but such projects are also known to induce associated development. For example, improved recreational opportunities at area beaches often bring commercial development designed to serve increased visitor traffic. Regional projects are described in the following subsections.

7.21.6.1 Replacement or Repair of the Gil Hodges Bridge

The Metropolitan Transportation Authority (MTA) includes a feasibility study repair or replacement of the Gil Hodges Bridge in the 2015-2019 Capital Program budget. The feasibility study is programed for 2018. Repair or replacement of the bridge is not included in this cumulative impacts analysis because the outcome of the feasibility study is speculative at this point in time. The 2015-2019 Capital Program budget includes rehabilitation/repair of the bridge's underwater structure, which is programmed for major construction in 2018. This 2018 action is considered in the cumulative impact analysis.

7.21.6.2 The Arverne Urban Renewal Area

The 308-acre Arverne Urban Renewal Area is bounded by Beach 32nd Street, Beach 81st Street, Rockaway Freeway, and the Rockaway Boardwalk. The project is to be developed in phases. Phase I, Water's Edge, was completed in the Spring of 2001 and consisted of the construction of 40 two-family homes on four infill sites between Beach 59th Street and Beach 62nd Street, south of Rockaway Beach Boulevard. In 2006, construction began on Phase II, which consists of 130 condominiums in the same area as Phase I. The area also contains two other projects. Arverne by the Sea is intended to produce 2,300 units, half of which will be affordable to households making no more than $92,170 for a family of four. An area adjacent to Arverne by the Sea, Arverne East, has the goal of building 1,600 units of middle-income units. Forty-three percent of the units will be reserved for households with incomes no greater than $92,170 for a family of four.

7.21.7 Summary of Cumulative Impacts

The minor adverse impacts of Recommended Plan implementation on the aforementioned resource areas would not increase to significant adverse impact levels when combined with past, present, or reasonably foreseeable future impacts from other regional projects. These minor impacts are primarily associated with construction of the Recommended Plan. Cumulative adverse impacts on recreation, intertidal wetlands, water quality, sediment transport, fish and wildlife, and essential fish habitat would remain minor and short-term. This is due to the coastal storm risk reduction afforded by the Recommended Plan to regional projects that have or are planned to restore and/or protect coastal resources located within the study area. Accordingly, the minor adverse impacts associated primarily with construction of the Recommended Plan would be offset by the cumulative long-term beneficial impacts of the Recommended Plan on, and in combination with, restorative regional projects.

Implementation of the Recommended Plan is not expected to have a significant cumulative adverse impact on any of the resource areas evaluated in this Revised Draft HSGRR/EIS. Cumulative net positive impacts would be realized in the local socioeconomic environment and many resource areas where protection from coastal storm events is beneficial to the resource (e.g., vegetation, wildlife, recreation).

The Recommended Plan would not significantly, cumulatively increase regional impacts in the areas identified by the cumulative impact analysis methodology. Minor and beneficial cumulative impacts are discussed in the following sections.

7.21.7.1 Soils

The Recommended Plan would cumulatively contribute to beneficial long-term direct impacts that would occur from the resulting built structures (e.g., groins, seawalls, dunes) that retain and capture littoral materials native to the beach communities and/or limit the effects of wave and storm surge erosion. Construction and extension of groins and construction of seawalls and dunes under the Recommended Plan and similar regional projects would result in continued protection of beach sands and upland soils from wave action and erosion that result from significant storm events. Cumulative beneficial long-term direct impacts on soils would occur as a result of the Recommended Plan and similar regional projects due to beach renourishment actions, where beach sands are replenished at prescribed intervals over project life cycles.

Cumulative minor adverse direct short-term impacts to soils would occur as a result of implementation of the Recommended Plan due to construction activities (e.g., clearing, grading, trench excavation, backfilling) and the movement of construction equipment within the project areas. Soil compaction and disturbance to and mixing of discrete soil strata cumulative impacts would be reduced through implementation of BMPs to control erosion and sedimentation during construction (e.g., installation of silt fences). Cumulative impacts would be reduced further because areas disturbed by construction activities (e.g., temporary access roads) would be restored at the end of project execution.

7.21.7.2 Sediments (bathymetry and sediment budgets)

7.21.7.3 Water Quality (surface and ocean)

Implementation of the Recommended Plan would cumulatively contribute to long term benefits by directly addressing anticipated wave climate, and preventing future shoreline erosion. Groins have the potential to alter wave climates, but would have a long-term benefit by reducing future beach renourishment requirements.

The Recommended Plan would cumulatively contribute to minor short-term direct adverse impacts to ocean waters due to disturbance of subsurface sediments during construction of groins, walkovers, bulkheads, seawalls, and dredging of sand from the offshore borrow area. Water quality would quickly return to baseline conditions after construction activities are completed. It is anticipated that these minor short-term direct adverse construction impacts would be further minimized by implementation of BMPs.

Minor direct short-term impacts to surface water quality would occur due to common construction activities such as clearing, grading, trench excavation, backfilling, and the movement of construction equipment used during execution of the common project elements. Water quality impacts to surface water would primarily be related to increases in turbidity and suspended solids as a result of increased erosion and sedimentation, which would cause a short-term reduction in oxygen levels. These adverse construction impacts would be minimized by implementation of BMPs (e.g., silt curtains, work at low tide out of the water).

7.21.7.4 Vegetation (including invasive species and terrestrial habitat)

The Recommended Plan would contribute positive benefits to regional terrestrial habitats in conjunction with other similar projects listed in Sections 7.21.1 and 7.21.4 above. Projects initiated in the ROI would benefit from the shoreline and inlet CSRM features of the Recommended Plan, which would serve to impede extreme storm surges, such as those experienced during Hurricane Sandy, from destroying or impeding establishment of beach vegetation communities.

A summary of impacts associated with habitat type is included in Section 6.5.1 Habitat Impacts Using Acreage as a Metric. To address impacts to existing native vegetation, as well as federal and state regulated waters and wetlands, a series of NNBFs were developed as part of the HFFRRFs. In terms of vegetated intertidal wetlands, the Recommended Plan will result in a net gain (i.e., approximately 2:1 gain versus impact) based upon an acreage metric. In terms of vegetated Maritime Forest, the Recommend Plan will restore approximately 75 percent of the impacted area.

7.21.7.5 Wetlands (including aquatic habitat)

As described in Section in Section 6.5.1 Habitat Impacts Using Acreage as a Metric, federal and/or state regulated waters and wetlands are assumed to include all freshwater wetlands and intertidal habitats waterward of the MHWS; inclusive of freshwater wetlands, beach and unvegetated shoreline, intertidal wetlands, mudflats, and subtidal bottom. The Recommended Plan would contribute positive benefits to regional aquatic habitats in conjunction with other similar projects listed in Sections 7.21.1 and 7.21.4 above. Projects initiated in the ROI would benefit from the shoreline features and NNBFs of the Recommended Plan. As noted above, a series of NNBFs were developed as part of the HFFRRFs within the Jamaica Bay Planning Reach. In terms of intertidal wetlands, the Recommended Plan will result in a net gain (i.e., approximately 2:1 gain versus impact) based upon an acreage metric.

Construction of buried seawalls and/or groins along the Atlantic Ocean Shorefront Planning Reach, as well as portions of the HFFRRFs, would have short-term minor adverse impacts on beach habitats, aquatic habitat, and potentially associated dune habitats at each nourishment area. These aquatic and terrestrial habitats are likely to be recolonized from nearby communities and benthic aquatic habitats are expected to-establish to a similar community within a 1 to 2-year period (USACE 1995). No permanent impacts associated with habitat structure and/or vegetation are anticipated in this segment, as the seawall will be buried with sand in an effort to restore the existing habitat type. In fact, the project will have a net long-term benefit on these habitats by stabilizing the shoreline, increasing sediment the sediment budget, and minimizing future renourishment activities necessary to support a healthy North Atlantic Upper Ocean Beach community.

7.21.7.6 Fish

NOAA NMFS completed the consultation under Section 7 of the Endangered Species Act (ESA), and concluded that the proposed action is not likely to adversely affect the ESA-listed species and/or designated critical habitat on their jurisdiction. The letter dated January 12, 2017 is included as Attachment D2b of the Environmental Compliance Appendix). However, USACE is currently consulting with NOAA NMFS regarding proposed actions that may adversely affect Essential Fish Habitat (EFH) pursuant to the Magnuson-Stevens Fishery Conservation and Management Act. An EFH Assessment Report is included as Attachment D3 of the Environmental Compliance Appendix. While the EFH Assessment Report provides a detailed analysis of direct and indirect impacts to fisheries, a summary is provided herein.

As noted in the EFH Assessment Report, the Recommended Plan would contribute positive benefits to regional fish species. Constructed groins and rock sills would create in water habitat areas suitable for recruitment and protection for numerous fish species. Beneficial impacts to the fish community would include the increase in food source, spawning beds, and shelter in the project area (USACE, 2015). Construction of groins and rock sills would also provide living spaces for the food resource on which fish species rely. In addition to creating living spaces and increasing food availability of the project area, the proposed would potentially provide shelter for fish from wave attacks during large coastal storm events.

The Recommended Plan would contribute to minor short-term direct adverse impacts on adult and juvenile life stages of nearshore fish during construction, as mobile fish would be temporarily displaced from foraging habitat as they retreat from the area in response to construction activities. Construction related increases in turbidity and suspended solids will cause a short-term reduction in oxygen levels and reduce visibility for feeding (Reilley et al. 1978, Courtenay et al., 1980). Impacts are expected to be minor, given the temporary nature of the disturbance and the availability of suitable adjacent habitat. Adult and juvenile life stages and their prey species would quickly reestablish themselves after completion of construction.

Additional minor short-term direct adverse impacts on nearshore fish communities would occur as a result of dredging sand from the borrow areas. According to the NPS environmental documents prepared for borrow efforts indicate the adverse impacts are not significant (GMP/EIS, 2014). Additional minor short-term direct impact on benthic feeding fish species (e.g., windowpane, summer and winter flounder) would be experienced, due to temporary displacement during dredging for borrow areas. Impacts are considered minor because benthic feeding fish species are expected to avoid construction areas and feed in the surrounding area; therefore, would not be adversely affected by the temporary localized reduction in available benthic food sources. Because adverse effects to essential fish habitat would be minor, the essential fish habitat requirements of the Magnuson-Stevens Fishery Conservation and Management Act and implementing regulations would be satisfied.

Minor short-term direct adverse impacts on nearshore fish communities would be realized by less mobile life stages (eggs and larvae) of nearshore fish, e.g., Atlantic butterfish, red hake, windowpane flounder, winter flounder, summer flounder, and scup, if present at the time of construction activities. Impacts would occur because of short-term changes to water quality, including resuspension of sediments in the water column and changes to the quality or quantity of soft bottom substrates, as discussed in Section 7.2 Bathymetry and Sediments. Impacts are considered minor, given the large extent of the Atlantic Ocean compared to the project construction footprint. Implementation of BMPs to control sedimentation and erosion during construction would further minimize adverse impacts on eggs and larvae of nearshore fish species.

7.21.7.7 Benthic Community

The Recommended Plan would contribute positive benefits to regional benthic shellfish species. Constructed groins would create areas suitable for recruitment and protection for numerous shellfish species. Construction and extension of groins would provide living spaces for the floral and faunal communities on which benthic species rely and would provide shelter from wave attacks for the existing and surrounding benthic communities. Some species, such as rockweeds (*Fucus spp*.), and barnacles (*Balanus spp*.) would flourish on the newly constructed groins

(Carter 1989). Various floral species such as rockweed and spongomorpha (*Spongomorpha spp*.), and faunal species such as barnacle, and blue mussel are expected to move into the area and colonize living space on groins (USACE 1995). Rockweeds are known to support numerous organisms, including both autotrophs and heterotrophs. In addition, rockweeds provide shelter, moisture at low tide, and food especially for the sessile epifaunal and epiphytic groups (Oswald et al. 1984). Gastropods, bivalves, and crustaceans are all common inhabitants of rockweeds.

Minor short-term direct adverse impacts to benthic communities are anticipated from construction activities associated with future periodic renourishment. Construction would cause increased sedimentation, resulting in the smothering of existing sessile benthic communities in the vicinity of construction areas. Some mortality of shellfish, and polychaetes is expected for individuals that cannot escape during the construction process. Motile shellfish species would be able to relocate temporarily outside of the immediate project area.

7.21.7.8 Wildlife

The Recommended Plan would cumulatively contribute to the beneficial long-term direct and indirect impacts on protected species populations, as discussed in Section 7.9 through 7.12. Beach renourishment of Rockaway beaches associated with the Recommended Plan would support healthy North Atlantic Upper Ocean Beach communities; therefore, species that rely on these habitat types would benefit from the Recommended Plan and similar regional projects. In addition, the project is intended to have a long-term benefit by reducing maintenance activities (i.e., additional beach renourishment).

Within both planning reaches, the Recommended Plan and similar regional actions may cause minor adverse impacts associated with short-term construction activities that may cause direct mortality of individuals or contribute indirectly to mortality of individuals due to temporary destruction of habitat on which a species relies.

It is recognized that USFWS prepared a Planning Aid Letter (PAL) dated August 18, 2016 to assure equal consideration and coordination of fish and wildlife resources. The PAL recognized the potential for direct and indirect adverse impacts to fish and wildlife resources within the project area. However, USACE will continue to work with USFWS to incorporate recommended actions to avoid, minimize, and mitigate project impacts. Many of the recommendations are already included herein, and include but potentially are not limited to:

- Observation of protective time-of-year restrictions.
- Incorporation of NNBFs where possible to reduce shoreline hardening, and promote restoration of native habitats (i.e., both wetlands and uplands).
- Incorporation of construction BMPs to minimize sedimentation and turbidity

7.21.7.9 Protected Species and Critical Habitat

A Biological Assessment has been prepared specific to three species (i.e, piping plover, seabeach amaranth, and Rufa red knot) to support continuation of a formal consultation process with USFWS (Attachment D2 of the Environmental Compliance Appendix). The Biological Assessment concludes 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. As such, 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.

NOAA NMFS completed the consultation under Section 7 of the Endangered Species Act (ESA), and concluded that the proposed action is not likely to adversely affect the ESA-listed species and/or designated critical habitat on their jurisdiction. The letter dated January 12, 2017 is included as Attached D2 of the Environmental Compliance Appendix). However, USACE is currently consulting with NOAA NMFS regarding proposed actions that may adversely affect Essential Fish Habitat (EFH) pursuant to the Magnuson-Stevens Fishery Conservation and Management Act. An EFH Assessment Report is included as Attachment D3 of the Environmental Compliance Appendix.

Potential short-term impacts to piping plover and other nesting shorebirds, as well as seabeach amaranth, could result from proposed permanent hard structures such as buried seawalls and groins, as they 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 within the Atlantic Shoreline Planning Reach), and most of the habitat that will be impacted is not of high habitat value to nesting and/or foraging birds. Specifically, these beaches are heavily utilized by humans (i.e., 5 million visitors in 2017) and most of the groins will be constructed in subtidal habitats (i.e., less favorable foraging habitat compared to intertidal areas). In addition, predator populations are not anticipated to increase due to human use of the project area. Overall impacts directly within the footprint of these structures would be permanent, but are not expected to significantly affect nesting shorebird, or other migratory birds, breeding or foraging activities for the long term. These impacts are assumed to be offset from the long-term benefits that will result from the project as beach fill and dune restoration is likely to increase overall habitat value for these species along the affected beachfront by expanding the area of suitable breeding, nesting and foraging habitat.

In summary, the Recommended Plan would cumulatively contribute to beneficial long-term direct impacts on federally and state listed threatened and endangered species. As discussed in Section 7.12 Protected Species, vegetation stabilization and renourishment of Rockaway Beach would support healthy North Atlantic Upper Ocean Beach; therefore, habitats for seabeach amaranth, piping plover, red knot, roseate tern and other species that use this habitat would benefit for the 50-year life of the project. Construction of seawalls associated with the Atlantic Ocean Shorefront Planning Reach would protect shoreline vegetation from physical degradation, likewise preserving habitat for these species. Overall supporting habitats for nesting and breeding of identified shorebirds of concern, as well as seabeach amaranth, would increase as the beach is widened with beach fill and groin structures would reduce the rate of beach loss; as well as reduce long-term maintenance activities. The physical characteristics of the intertidal habitat will not be altered because the grain size of fill material will be the same as that of project footprint native sand.

In summary, the Recommended Plan would cumulatively contribute to minor short-term direct impacts to threatened and endangered species. Shoreline intertidal, subtidal, upper beach and dune, and intertidal wetland habitats would be impacted due to such construction activities as clearing and grading for temporary access road construction, or construction of proposed CSRM measures. However as described in Section in Section 6.5.1 Habitat Impacts Using Acreage as a Metric, the Recommended Plan would contribute positive benefits to terrestrial and aquatic habitats that support federal and state protected species. In addition, USACE will continue to consult with USFWS and NMFS to ensure the latest reasonable and prudent measures for protected species and standard BMPs are incorporated into the projects' Plans and Specifications detailing specific conservation measures to be undertaken to minimize potential adverse effects to protected species under their jurisdiction. Many of the recommendations are already included herein, and include but potentially are not limited to:

- Observation of protective time-of-year restrictions;
- Incorporation of NNBFs where possible to reduce shoreline hardening, and promote restoration of native habitats (i.e., both wetlands and uplands); and
- Incorporation of construction BMPs to minimize sedimentation and turbidity.

7.22 Summary of Environmental Effects

7.22.1 Unavoidable Adverse Environmental Impacts

Implementation of the Recommended Plan would have direct adverse impacts on native habitats that include beach and unvegetated shoreline, freshwater wetland, intertidal wetland, mudflats, subtidal bottom, and maritime forest. Specifically, as detailed in Section 6.6 Habitat Impacts and Mitigation Requirements, the project will result in 14.1 acres of temporary impacts and 5.5 acres of permanent impacts to these habitats (See Section 6.5, Table 6-14 above). Specific to federal and state regulated waters and wetlands, the project will temporarily impact 14.1 acres and permanently impact 3.7 acres (Table 6-13 above).

Temporary impacts assume that habitat will be replaced on-site and in-kind. The majority of temporary impacts to federal and state regulated waters and wetlands will occur in open water habitats (i.e., subtidal bottom, mudflat), or beach and unvegetated shorelines where subsequent planting will not be required and the time to full restoration of ecological services will be relatively quick compared to habitats that require development of native plant community.

To account for permanent impacts, NNBFs associated with the HFFRRs will result in the restoration and/or creation of 7.6 acres of intertidal wetlands, enhancement to 0.5 acres of intertidal wetlands, and restoration of 1.3 acres of maritime forest (See Section 6.5, Table 6-15 above). Overall, the Recommended Plan that includes NNBFs will attenuate waves, stabilize shorelines, and facilitate the restoration or enhancement of native shoreline habitats. As such, the long-term benefit realized by this plan will likely exceed the NNBF acreage noted above. For example, shore slopes behind the rock sill structures will be regraded to reduce risk of erosion further and create suitable elevation gradients and substrates for future establishment of tidal marsh plants. As such, the total restoration of intertidal marsh habitats will likely exceed the proposed planting area of 7.6 acres. The graded habitat behind the structure will also be designed to allow the shoreward migration of various habitats with rising sea levels, thereby extending the life of these important ecological systems. Finally, the rock sills will provide opportunities for shellfish habitat creation and will provide habitat complexity to near shore open water habitats that will support a diversity of both aquatic and terrestrial wildlife (discussed below), as well as improve near shore water quality.

As discussed in Section 6.5 above, EPW also was used to characterize the functional impacts and benefits within intertidal wetlands associated with each HFFRRF. The assessment results estimate current resource value loss, and the potential increase in resource value through implementation of NNBFs. A summary of the analysis and the numerical results of the EPW functional assessment is provided in Section 6, Tables 6-12 and 6-13 above. The project will result in the loss of 8.6 FCUs across the five functions. However, the NNBFs will result in the gain of 34.5 FCUs across the five functions. Similar to the metric evaluation, the EPW functional assessment shows significant gains to the shoreline ecosystem through the incorporation of NNBFs.

No other long-term environmental impacts are expected to occur as a result of Recommended Plan implementation.

7.22.2 Irreversible and Irretrievable Commitments of Resources

The labor, capital, and material resources expended in the planning and construction of this project are irreversible and irretrievable commitments of human, economic, and natural resources. Careful attention was paid to selecting and placing CSRM structures to minimize environmental impacts, nonetheless implementation of the Recommended Plan would cause permanent habitat impacts (see discussion above). No other long-term environmental impacts are expected to occur as a result of Recommended Plan implementation.

7.23 Short-Term Use and Long-Term Productivity of the Environment

Implementation of the Recommended Plan would result in the loss of habitat types as indicated in Section 6, and as restated above.

7.24 Energy and Natural or Depletable Resource Requirements and Conservation Potential of Various Alternatives and Mitigation Measures

NEPA regulations in 40 CFR 1502.16 (e) and (f) require a discussion of project energy requirements and natural or depletable resource requirements, along with conservation potential of alternatives and mitigation measures in an EIS. Energy (fuel) will be required to construct the new levee system and reconstruct existing systems, but this is a short-term impact. Construction of the Recommended Plan would not result in a significant depletion of depletable energy or natural resources.

8 COMPLIANCE WITH ENVIRONMENTAL LAWS AND REGULATIONS

This Revised Draft HSGRR/EIS has been prepared to satisfy the requirements of all applicable environmental laws and regulations and has been prepared using the Council on Environmental Quality (CEQ) NEPA regulations (40 CFR Part 1500–1508) and the USACE's regulation ER 200-2-2 -Environmental Quality: Policy and Procedures for Implementing NEPA, 33 CFR 230. In implementing the Recommended Plan, USACE would follow provisions of all applicable laws, regulations, and policies related to the Recommended Plan, including agreement from the NPS on plans affecting GNRA. The following sections present brief summaries of federal environmental laws, regulations, and coordination requirements applicable to this Revised Draft HSGRR/EIS.

Clean Air Act as amended, 42 U.S.C. §§ 7401-7671q.

In compliance

Temporary air emission impacts resulting from construction of the Recommended Plan have been calculated; the analysis is presented Attachment D7 of the Environmental Compliance Appendix. The USACE is committed to fully offsetting the emissions generated as a result of the disaster relief and coastal protection work associated with this project. USACE will demonstrate conformity with the New York State Implementation Plan by utilizing the emission offset options listed below. The demonstration can consist of any combination of options, and is not required to include all or any single options to meet conformity. The options for meeting general conformity requirements include the following:

a. Emission reductions from project and/or non-project related sources in an appropriately close vicinity to the project location. In assessing the potential impact of this offset option, USACE recognizes the possibility of lengthening the time period in which offsets can be generated as appropriate and allowable under the general conformity rule (40CFR§93.163 and §93.165).

b. Use of Surplus NOx Emission Offsets (SNEOs) generated under the Harbor Deepening Project (HDP). As part of the mitigation of the HDP, USACE and the Port Authority of New York & New Jersey developed emission reduction programs coordinated through the Regional Air Team (RAT). The RAT is comprised of the USACE, NYSDEC, New Jersey Department of Environmental Protection, United States Environmental Protection Agency (EPA) Region 2, and other stakeholders. SNEOs will be applied in concurrence with the agreed upon SNEO Protocols to ensure the offsets are real, surplus, and not double counted.

c. Development of a Marine Vessel Engine Repower Program (MVERP) which replaces older, more polluting marine engines with cleaner engines, the delta in emissions being used to offset project emissions. The MVERP approach worked successfully for offsetting the HDP's construction emissions. The details of the MVERP, its implementation, and tracking would be coordinated with the RAT.

d. Use of Cross-State Air Pollution Rule (CSAPR) ozone season NO_x Allowances with a distance ratio applied to allowances, similar to the one used by stationary sources.

e. Rescheduling the project by elongating the construction schedule so as not to exceed the 100 tons per year threshold for NOx in any one calendar year.

Clean Water Act, as amended, (Federal Water Pollution Control Act) 33 U.S.C. §§ 1251-1388.

In compliance

Clean Water Act Section 404 of the CWA regulates dredge-and/or-fill activities in waters of the U.S. In New York, Section 401 of the CWA (State Water Quality Certification Program) is regulated by the NYSDEC. Compliance will be achieved through coordination of the Revised Draft HSGRR/EIS with NYSDEC to obtain water quality certification for the Recommended Plan. Coordination includes an evaluation of the Recommended Plan based on the Section 404(b)(1) Guidelines as presented in Attachment D4 of the Environmental Compliance Appendix.

Submittal of this Revised Draft HSGRR/EIS to NYSDEC initiates USACE's requested Section 401 State Water Quality Certification for the Recommended Plan. USACE has determined that construction and operation of the Recommended Plan will not violate water quality standards. The proposed alignment of the Rockaway Atlantic Ocean CSRM, and borrow area has been located to minimize, to the greatest extent practicable, impacts on the Rockaway shoreline and to avoid and minimize impacts on the aquatic ecosystem in the Atlantic Ocean. The Recommended Plan is the least environmentally damaging practicable alternative; overall, the Recommended Plan provides protection from coastal storms that would otherwise damage the environment to a far greater degree than the No Action Alternative.

Endangered Species Act, as amended. 16 U.S.C. §§ 1531-1544.

In Compliance

USACE prepared a draft Biological Assessment (BA) (included as Attachment D2a in the Environmental Compliance Appendix) to describe the potential effects of Recommended Plan implementation on the piping plover, seabeach amaranth, and rufa red knot. 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 requests 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.

To be proactive, conservative and risk averse, USACE has agreed to include East Rockaway in its ongoing 'batch' BA (for multiple coastal projects) to ensure that consultation is sufficiently covered under Section 7 for all possible outcomes. The trigger to reinitiate consultation might not occur (no predetermination will be made), but, if it does, USACE will be in compliance under the ongoing Consultation, which will result in the BO containing the ITS for all affected projects.

Given the best possible and latest information with no predetermination, East Rockaway is in total compliance with Section 7 per USACE's documented NLAA/Concurrence for this project.

The NMFS Assistant Regional Administrator for Protected Resources' letter dated 12 January 2017 to the USACE New York District Environmental Analysis Branch Chief states "*Based on our knowledge, expertise, and the action agency's materials, we concur with the action agency's conclusion that the proposed action is not likely to adversely affect the ESA-listed species and/or designated critical habitat under our jurisdiction. Therefore, no further consultation pursuant to Section 7 of the ESA is required.*" This letter is included as Attachment D2b of the Environmental Compliance Appendix.

Magnuson-Stevens Fishery Conservation and Management Act of 1976

In compliance

The Magnuson-Stevens Fishery Conservation and Management Act (PL 94-265), as amended, establishes procedures for identifying Essential Fish Habitat (EFH) and required interagency coordination to further the conservation of Federally-managed fisheries. Its implementing regulations specify that any Federal agency that authorizes, funds, or undertakes, or proposes to authorize, fund, or undertake, an activity that could adversely affect EFH is subject to the consultation provisions of the Act and identifies consultation requirements. EFH consists of those habitats necessary for spawning, breeding, feeding, or growth to maturity of species managed by Regional Fishery Management Councils in a series of Fishery Management Plans.

Submittal of this Revised Draft HSGRR/EIS to National Marine Fisheries Service (NMFS) initiates EFH consultation between USACE and NMFS for the Recommended Plan. It contains an assessment of impacts on EFH. Direct and indirect impacts associated with the Atlantic Shoreline Planning Reach would result from dredging offshore in the borrow site; construction of groins, seawalls, and beach fill placement in the intertidal zone and nearshore. Due to the mobility of larger fish, direct impacts from dredging and near shore construction activities (i.e., sand placement, and groin construction) would be limited to eggs, larvae, small fish, and benthic invertebrates or shellfish which would be removed, buried, or displaced. Specifically, dredging activities could have direct impacts to eggs, larvae, and potential juvenile EFH due to impingement or entrainment. They would also have an indirect impact through the loss of benthic invertebrate prey species within the footprint of the proposed project. Small motile and sedentary epifaunal species (*e.g.*, small crabs, snails, tube- dwelling amphipods), and all infaunal species (*e.g.*, polychaetes), would be most vulnerable to suction dredging and/or burial. However, they are expected to recolonize quickly following construction.

Direct and indirect impacts associated with the Jamaica Bay Planning Reach would result from construction of bulkheads, revetments, and rock sills in the intertidal zone and nearshore. Similarly, the placement of material would have an immediate direct effect on eggs, larvae, small fish, and benthic invertebrates or shellfish that would be buried or displaced. In addition, there would be indirect impacts through the loss of benthic invertebrate species within the footprint of the project. However, impacted areas are expected to be recolonized quickly following construction. Therefore, implementation of the Recommended Plan may adversely affect EFH, but likely would result in minimal adverse effects as the resulting changes to EFH and its ecological functions would be relatively small and insignificant. In addition, it is anticipated that ecosystem restoration efforts as part of this Recommended Plan would result in long-term, net benefits to managed species (all life stages), associated species, and EFH. In summary, USACAE has concluded that the Federal project will not cause significant adverse effects to EFH or EFH species.

Coastal Zone Management Act

In compliance

Under the New York State Coastal Management Program (NYCMP), enacted under the Coastal Zone Management Act in 1972, the NY Department of State (NYDOS) reviews federal activities to determine whether they are consistent with the policies of the NYCMP. The waterward boundary extends 3 miles into open ocean, to shared state lines in Long Island Sound and the New York Bight and to the International boundary in the Great Lakes, Niagara and St. Lawrence Rivers. Generally, the inland boundary is approximately 1,000 feet from the shoreline following well-defined features such as roads, railroads or shorelines. In urbanized and other developed locations along the coast, the landward boundary is approximately 500 feet from the shoreline or less than 500 feet at locations where a major roadway or railway line runs parallel to the shoreline. The seaward boundary of New York State's coastal area includes all coastal waters within its territorial jurisdiction.

USACE has prepared a Consistency Determination that evaluates the Recommended Plan for consistency with the NYCMP; it is provided as Attachment D5 of the Environmental Compliance Appendix. USACE has concluded that the Recommended Plan is consistent to the maximum extent practicable with the enforceable policies of the NYSDOS program.

Fish and Wildlife Coordination Act, as amended, 16 U.S.C. §§ 661-665, 665a, 666, 666a-666c.

In compliance

The Fish and Wildlife Coordination Act requires governmental agencies, including the USACE, to coordinate activities so that adverse effects on fish and wildlife would be minimized when water bodies are proposed for modification.

The Revised Draft HSGRR/EIS contains information regarding impacts associated with implementing the Recommended Plan. The USFWS is currently updating the Coordination Act Report (CAR), and will provide it to USACE when completed. Any additional information included in the updated CAR will be incorporated into the Final HSGRR/EIS impact evaluations and implementation recommendations.

Marine Mammal Protection Act of 1972

In compliance

The Marine Mammal Protection Act was passed in 1972 and amended through 1997. It is intended to conserve and protect marine mammals and establish the Marine Mammal Commission, the International Dolphin Conservation Program, and a Marine Mammal Health and Stranding Response Program.

NOAA NMFS completed the consultation under Section 7 of the Endangered Species Act (ESA), and concluded that the proposed action is not likely to adversely affect the ESA-listed species and/or designated critical habitat on their jurisdiction. The letter dated January 12, 2017 is included as Attachment D2b of the Environmental Compliance Appendix). However, USACE is currently consulting with NOAA NMFS regarding proposed actions that may adversely affect Essential Fish Habitat (EFH) pursuant to the Magnuson-Stevens Fishery Conservation and Management Act. An EFH Assessment Report is included as Attachment D3 of the Environmental Compliance Appendix.

Additionally, USACE anticipates receiving draft recommendations from NMFS through the EFH consultation process as previously described. USACE will incorporate these into the Final HSGRR/EIS impact evaluations and implementation recommendations.

National Historic Preservation Act, as amended, 54 U.S.C. §§ 300101-307108

Compliance in progress

Compliance with the National Historic Preservation Act of 1966, as amended, requires the consideration of effects of the undertaking on all historic properties in the project area and development of mitigation measures for those adversely affected properties in coordination with the NY SHPO and the Advisory Council on Historic Preservation.

USACE has initiated Section 106 consultation with the NY SHPO and selected Native American Tribes. Copies of Section 106 consultation letters are provided in the Environmental Compliance Appendix. Additionally, USACE anticipates executing a Programmatic Agreement among USACE, the NY SHPO, and non-federal implementation sponsors to address the identification and discovery of cultural resources that may occur during the construction and maintenance of proposed or existing facilities. USACE will also invite the ACHP and Native American Tribes to participate as signatories to the anticipated Programmatic Agreement.

Federal Water Project Recreation Act

In compliance

This 1995 Act requires consideration of opportunities for outdoor recreation and fish and wildlife enhancement in planning water-resource projects. The Recommended Plan is expected to have substantial and positive long- term effects on outdoor recreation opportunities in the Project Area.

Farmland Protection Policy Act of 1981 and the CEQ Memorandum Prime and Unique Farmlands

In compliance

In 1980, the CEQ issued an Environmental Statement Memorandum “Prime and Unique Agricultural Lands” as a supplement to the NEPA procedures. Additionally, the Farmland Protection Policy Act, passed in 1981, requires federal agencies to evaluate the impacts of federally funded projects that may convert farmlands to nonagricultural uses and to consider alternative actions that would reduce adverse effects of the conversion. The Recommended Plan will not impact prime or unique farmlands identified by the Natural Resource Conservation Service or NYSDEC.

Executive Order 11988, Floodplain Management

In compliance

Executive Order 11988 directs federal agencies to evaluate the potential effects of proposed actions on floodplains. Such actions should not be undertaken that directly or indirectly induce growth in the floodplain unless there is no practicable alternative. The Water Resources Council Floodplain Management Guidelines for implementation of Executive Order 11988, as referenced in USACE ER 1165-2-26, requires an eight-step process that agencies should carry out as part of their decision making on projects that have potential impacts on or within the floodplain. The eight step assessment, presented in the Section 9.1 below, concludes that all practicable alternatives have been considered in developing the Recommended Plan, and that the main federal objective of reducing coastal flood risk cannot be achieved by alternatives outside the floodplain. Additionally, USACE has determined that the Recommended Plan does not induce direct or indirect floodplain development within the base floodplain.

Executive Order 11990, Protection of Wetlands

In compliance

Executive Order 11990 directs federal agencies to avoid undertaking or assisting in new construction located in wetlands, unless no practicable alternative is available. While the project will result in unavoidable permanent impacts to 3.74 acres of federal and state regulated waters and wetlands, the project includes 7.65 acres of wetland restoration or creation, and 0.472 acres of wetland enhancement. All practicable measures have been taken to minimize the loss of wetlands. Alternatives to avoid the loss of wetlands were evaluated, and the CSRM elements were carefully located to minimize the loss.

Coastal Barrier Improvement Act of 1990

In compliance

This act is intended to protect fish and wildlife resources and habitat, prevent loss of human life, and preclude the expenditure of federal funds that may induce development on coastal barrier islands and adjacent nearshore areas. The Coastal Barrier Improvement Act of 1990 expanded the CBRS and created a new category of lands known as otherwise protected areas (OPAs). The only federal funding prohibition within OPAs is federal flood insurance. Other restrictions to federal funding that apply to CBRS units do not apply to OPA's. The western portion of Rockaway Peninsula and all of Jamaica Bay are located within the designated CBRA OPA (Unit NY-60P) and has determined that the National Park Service has local jurisdiction of the CBRA Unit. Accordingly, no further coordination under the CBIA or CBRA is necessary.

Executive Order 12898, Environmental Justice

In compliance

This EO directs federal agencies to determine whether the Preferred Alternative would have a disproportionate adverse impact on minority or low-income population groups within the project area. Based on a demographic analysis of the study area (presented in Section 7.19 Socioeconomics and Environmental Justice), implementation of the Recommended Plan would not have a disproportionately high and adverse impact on any low-income or minority population. Rather, USACE has determined that implementation of the Recommended Plan will provide long-term benefits to PEJA communities by protecting infrastructure resources (e.g. housing, transportation, commercial, retail, and recreational facilities) from damage caused by coastal storms.

Executive Order 13186, Responsibilities of Federal Agencies to Protect Migratory Birds and the Migratory Bird Treaty Act

The Migratory Birds and the Migratory Bird Treaty Act (MBTA) of 1918 (as amended) is the domestic law that affirms, or implements, the United States' commitment to four international conventions with Canada, Japan, Mexico and Russia for the protection of shared migratory bird resources. The MBTA governs the taking, killing, possession, transportation, and importation of migratory birds, their eggs, parts and nests. The take of all migratory birds is governed by the MBTA's regulation of taking migratory birds for educational, scientific, and recreational purposes and requiring harvest to be limited to levels that prevent over utilization. Executive Order 13186 (2001) directs executive agencies to take certain actions to implement the act. USACE will be in consultation with the USFWS with regard to this activity's potential effects on migratory birds, and the USACE will incorporate recommendations from consultation into the Final HSGRR/EIS.

Executive Order 13045, Protection of Children from Environmental and Safety Risks

In compliance

Executive Order 13045 states that every federal agency, to the extent permitted by law and appropriate, should make it a high priority to identify and assess environmental health and safety risks that may disproportionately affect children, and to ensure that its policies, programs, activities, and standards address these risks. Analysis and disclosure of these potential effects under NEPA is necessary because some physiological and behavioral traits of children render them more susceptible and vulnerable than adults to environmental health and safety risks. Children may have higher exposure levels to contaminants (through pathways such as degraded water quality or contaminants exposed during construction) because they generally eat more food, drink more water, and have higher inhalation rates relative to their body size. Also, children's normal activities, such as putting their hands in their mouths or playing on the ground, can result in higher exposures to contaminants as compared with adults. In addition, a child's neurological, immunological, digestive, and other bodily systems are also potentially more susceptible to exposure-related health effects. It has been well established that lower levels of exposure can have negative toxicological effects in children as compared to adults, and childhood exposure to contaminants can have long-term negative health effects.

Following the direction of this Excuitive Order, USACE conducted an analysis of the proximity of locations associated with children to the project area. For the purpose of this analysis the project area includes both permanent and temporary easements proposed for the Rockaway project in this revised draft HSGRR/EIS. The project area is shown as orange polygons in Figure 8-1. Next, data representing public elementary schools, private elementary schools, day care facilites, and playgrounds were obtained. The data on public and private schools was obtained from ESRI as the U.S. MapData Schools layer, which was published in 2004. The day care facilites data was compiled by the U.S. Department of Homeland Security (DHS) and includes all state-licensed childcare centers that care for 10 or more children during the workday. This data was last updated by the DHS in 2008. The playgrounds data came from the New York City Department of Information Technology and Telecommunications as the Brooklyn and Queens NYC Parks layer, which was published in 2016. The playgrounds data was part of a larger NYC parks dataset that contained several different types of parks, including playgrounds, community parks, nature areas, green streets, etc. Playgrounds were broken out of the rest of the data as a location associated with children.

Figure 8-1: Locations Associated with Children within 200 feet of the Project Area

Displaying these data on a map, it was clear that there were many locations associated with children on the Rockaway Penninsula. Not all of these locations would be affected by the construction associated with the proposed Rockaway project though. Analysis was done to identify locations 200 feet or less from the project area where children frequent and which could potentially therefore be a hazardous area for children during construction of the Recommended Plan. Two hundred feet was choosen as a precautionary distance, following the "New York City 200 Foot Rule". The '200 foot rule' is a New York City zoning rule that prohibits the sale of alcohol (a dangerous substance) within 200 feet of a school or church. The reasoning with our application of the 200 foot rule here is that construction is also a dangerous thing for children to be close to, and that there needs to be a buffer between children and constrution. For the purpose of our analysis here, any locations associated with children that are within 200 feet of our project area will need to receive special treatment to keep kids safe during the construction period.

The locations associated with children within 200 feet of the project area were found by running a "select by location" application in ArcMap. This search found that there were four playgrounds within 200 feet of the project area (Figure 8-1). In other words, there were no schools (either public or private) or day care facilities within 200 feet of the project area. These four parks include: the Conch Playground, the Beach 9 Playground, the Beach 17 Playground, and the Beach 59th St. Playground.

Knowing that these locations are present, USACE will take special precautions in these areas during construction. During construction staging areas will be placed as far away from the playgrounds as possible, construction traffic will be directed as far away as possible, and safety signage and notices of when work will occur will be posted. Appropriate barriers will be constructed and signage installed to prevent accidental incursion of children into dangerous work sites. Assuming the project as proposed meets the required federal, state and local permitting requirements outlined in the EIS, required mitigation measures should minimize the amount of criteria pollutants emitted to the environment, thereby reducing the potential for sensitive populations, such as children, to be exposed to unhealthy levels of environmental contaminants.

9 EXECUTIVE ORDER 11988 AND PUBLIC LAW 113-2 CONSIDERATIONS

This study has considered the requirements of Executive Order 11988, Flood Plain Management and PL 113-2, the Disaster Relief Appropriations Act of 2013. Specifically, this section of the report addresses:

- The Water Resources Council Floodplain Management implementing guidelines for EO 11988;
- The specific requirements necessary to demonstrate that the project is economically justified, technically feasible, and environmentally acceptable, per PL 113-2; and
- The specific requirements necessary to demonstrate resiliency, sustainability, and consistency with the North Atlantic Coast Comprehensive Study (NACCS), per PL 113-2.

9.1 Executive Order 11988

Executive Order 11988 requires federal agencies avoid, to the extent possible, the long and short term adverse impacts associated with the occupancy and modification of flood plains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. In accomplishing this objective, "each agency shall provide leadership and shall take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health, and welfare, and to restore and preserve the natural and beneficial values served by flood plains in carrying out its responsibilities."

The Water Resources Council Floodplain Management Guidelines for implementation of Executive Order 11988, as referenced in USACE ER 1165-2-26, requires an eight step process that agencies should carry out as part of their decision making on projects that have potential impacts to, or are within the floodplain. The eight steps and project-specific responses to them are summarized below.

1. Determine if a proposed action (Recommended Plan) is in the base floodplain (that area which has a one percent of greater chance of flooding in any given year). The proposed action is within the base floodplain. However, the project is designed to reduce damages to existing infrastructure located landward of the proposed project.
2. If the action is in the base flood plain, identify and evaluate practicable alternatives to the action or to location of the action in the base flood plain. Section 5 of this document presents an analysis of potential alternatives. Practicable measures and alternatives were formulated and evaluated against USACE guidance, including nonstructural measures such as retreat, demolition and land acquisition.
3. If the action must be in the flood plain, advise the general public in the affected area and obtain their views and comments. There has been extensive coordination with pertinent federal, state and local agencies. Once the Revised Draft report is released, public meetings will be scheduled in the study area during the public review period.
4. Identify beneficial and adverse impacts due to the action and any expected losses of natural and beneficial flood plain values. Where actions proposed to be located outside the base flood plain will affect the base flood plain, impacts resulting from these actions should also be identified. The anticipated impacts associated with the proposed action

are summarized in Section 7 of this report. The project would not alter or impact the natural or beneficial flood plain values.

5. If the action is likely to induce development in the base flood plain, determine if a practicable non-flood plain alternative for the development exists. The project provides benefits solely for existing and previously approved development, and is not likely to induce development. Real estate requirements required for construction of the project will reduce the level of development that is at risk.
6. As part of the planning process under the Principles and Guidelines, determine viable methods to minimize any adverse impacts of the action including any likely induced development for which there is no practicable alternative and methods to restore and preserve the natural and beneficial flood plain values. This should include reevaluation of the No Action Alternative. There is no mitigation to be expected for the proposed action. The project would not induce development in the flood plain and the project will not impact the natural or beneficial flood plain values. Section 5 of this report summarizes the alternative identification, screening and selection process. The No Action Alternative was evaluated as part of the the plan formulation phase.
7. If the final determination is made that no practicable alternative exists to locating the action in the flood plain, advise the general public in the affected area of the findings. The Revised Draft HSGRR/EIS will be provided for public review and public meetings will be scheduled during the public review period. Each comment received will be addressed and, if appropriate, incorporated into the Final Report. A record of all comments received will also be included in the Pertinent Correspondence Appendix.
8. Recommend the plan most responsive to the planning objectives established by the study and consistent with the requirements of the Executive Order. The Recommended Plan is the most responsive to all of the study objectives and the most consistent with the executive order.

9.2 Resiliency, Sustainability, and Consistency with the NACCS

This section has been prepared to address how the Recommended Plan contributes to the resiliency of the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay study area; how it affects the sustainability of environmental conditions in the affected area; and how it will be consistent with the findings and recommendations of the North Atlantic Coast Comprehensive Study (NACCS).

Resiliency is defined in the February 2013 USACE-NOAA Infrastructures Systems Rebuilding Principles white paper as the ability to adapt to changing conditions and withstand, and rapidly recover from disruption due to emergencies. Sustainability is defined as the ability to continue (in existence or a certain state, or in force or intensity), without interruption or diminution.

9.2.1 Resiliency

One of the planning objectives of this General Reevaluation is to “restore coastal processes and nature based measures to the maximum extent possible to provide resiliency and reduce storm damages”. The Recommended Plan features have all been designed with enhancing the resiliency of the coastal system, particularly with regard to future Sea Level change.

CSRM projects are engineered beaches that are designed, constructed, and periodically renourished to reduce the risk of economic losses arising from coastal storms, primarily along communities with high-value public and private infrastructure immediately landward of the beach. The intent is to replicate the function of beaches in areas that were once part of natural, undeveloped systems that have subsequently experienced significant human development and utilization. Storms reduce the degree of storm risk management provided by the beach fill project; elevated water levels and larger-than-normal waves displace sand from the berm and dune portions of the engineered beach profile and transport it principally in the offshore direction. After the storm, normal tide and wave conditions return, typically resulting in onshore-directed sand transport that rebuilds at least a portion of the berm (i.e., beach). This natural recovery of the beach berm occurs over a period that may range from days to months. Natural rebuilding of the dune is a process that requires years to decades, given its dependence on wind transport and an adequate sand supply on the beach. In the period between the storm and the partial natural recovery, an increased level of storm damage risk exists due to the eroded condition of the project berm and dune relative to the level of risk associated with a constructed, fully maintained project. Consequently, repair of an engineered beach to its design dimensions is usually accomplished as a planned renourishment, which is included in the authorized period of analysis cycle, or as an emergency activity under the USACE Flood Control and Coastal Emergencies authority (PL 84-99), to restore the storm damage risk reduction function for which the project was authorized. This post-storm repair is necessary because the engineered beach may not otherwise fully recover to its authorized dimensions naturally, or at least not in a time frame that would minimize risks due to the deteriorated condition. In this regard, it is apparent that storm risk management projects involving beach replenishment possess intrinsic "resilience", in light of the large volume of sediment that remains within the system after a major disturbance and the associated repair or replenishment that is included to restore the project design dimensions.

9.2.2 Sustainability/Adaptability

As described in this Revised Draft HSGRR/EIS, the Recommended Plan meets the economic, environmental, and community sustainability goals for the fifty year length of the project. Economic principals are used in benefit calculations, plan formulation ranking, and project justification by their contributions to the National Economic Development account. Environmental concerns are evaluated in this document and through coordination and review by the resource agencies including the US Environmental Protection Agency, the US Department of Interior, and the New York State Department of Environmental Conservation as part of the feasibility study process. Social accounts are intrinsic in beach nourishment projects since they maintain habitat for beach patrons. The nexus of these three pillars indicates that a project is sustainable.

9.2.3 Consistency with the North Atlantic Coast Comprehensive Study

The North Atlantic Coast Comprehensive Study (NACCS, 2015) was released in January 2015 and provides a risk management framework designed to help local communities better understand changing flood risks associated with climate change and to provide tools to help those communities better prepare for future flood risks. In particular, it encourages planning for resilient coastal communities that incorporates wherever possible sustainable coastal landscape systems that takes into account, future sea level and climate change scenarios. The process used to identify the Recommended Plan utilized the NACCS Risk Management framework that included evaluating alternative solutions and also considering future sea level change and climate change. The Recommended Plan echoes many of the principles of the NACCS, in that it considers the entire area as a system, the formulation considered multiple plan components to address the multiple risks, the plan considered non-structural components, would reestablish coastal processes, and has been developed in recognition of balancing the needs for coastal storm risk management with the requirements of the partner agencies.

10 IMPLEMENTATION REQUIREMENTS

This section provides a summary of the preliminary implementation requirements for Recommended Plan. The Final HSGRR/EIS will provide additional and more detailed implementation requirements.

10.1 Division of Plan Responsibilities and Cost-Sharing Requirements

The Project Partnership Agreement (PPA) is a good faith agreement between the federal government and the non-federal sponsor, which must be approved and executed prior to the start of construction. The PPA sets forth the obligations of each party. The non-federal sponsors must agree to meet the requirements for non-federal responsibilities, which will be identified in future legal documents. Construction of this project is authorized and funded at 100% federal expense, subject to the available funds in P.L. 113-2, except for the renourishment which will need authorization by the Assistant Secretary for the Army (Civil Works). A Chief's Report is required to seek authorization for the renourishment included in the Recommended Plan. 'Items of local cooperation' in standard Coastal Storm Risk Management PPAs are listed below to indicate likely responsibilities were P.L. 113-2 funds to be fully depleted. Items not related to cost-sharing are likely responsibilities for the PPA:

- Provide a minimum of 35 percent of initial project costs assigned to coastal and storm damage reduction, plus 100 percent of initial project costs assigned to protecting undeveloped private lands and other private shores which do not provide public benefits, and 50 percent of periodic nourishment costs assigned to coastal and storm damage reduction, plus 100 percent of periodic nourishment costs assigned to protecting undeveloped private lands and other private shores which do provide public benefits, and as further defined below:
- Provide, during design, 35 percent of design costs allocated to coastal and storm damage reduction in accordance with the terms of a design agreement entered into prior to commencement of design work for the project;
- Provide all lands, easements, rights-of-way, including suitable borrow areas, and perform or assure performance of all relocations, including utility relocations, as determined by the federal government to be necessary for the initial construction, periodic nourishment or operation and maintenance of the project;
- Provide, during construction, any additional amounts necessary to make its total contribution equal to 35 percent of initial project costs assigned to coastal and storm damage reduction plus 100 percent of initial project costs assigned to protecting undeveloped private lands and other private shores which do not provide public benefits;
- Prevent obstructions or encroachments on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) such as any new developments on project lands, easements, and rights-of-way or the addition of facilities which might reduce the outputs produced by the project, hinder operation and maintenance of the project, or interfere with the project's proper function;
- Inform affected interests, at least yearly, of the extent of protection afforded by the flood risk management features; participate in and comply with applicable federal floodplain

management and flood insurance programs; comply with Section 402 of the Water Resources Development Act of 1986, as amended (33 U.S.C. 701b-12); and publicize floodplain information in the area concerned and provide this information to zoning and other regulatory agencies for their use in adopting regulations, or taking other actions, to prevent unwise future development and to ensure compatibility with protection levels provided by the flood risk management features;

- Operate, maintain, repair, replace, and rehabilitate the completed project, or function portion of the project, at no cost to the federal government, in a manner compatible with the project's authorized purposes and in accordance with applicable federal and state laws and regulations and any specific directions prescribed by the federal government;
- For so long as the project remains authorized, ensure continued conditions of public ownership and use of the shore upon which the amount of federal participation is based;
- Provide and maintain necessary access roads, parking areas, and other public use facilities, open and available to all on equal terms;
- At least twice annually and after storm events, perform surveillance of the beach to determine losses of nourishment material from the project design section and provide the results of such surveillance to the federal government;
- Give the federal government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-federal sponsor owns or controls for access to the project for the purpose of completing, inspecting, operating, maintaining, repairing, rehabilitating, or replacing the project;
- Hold and save the United States free from all damages arising from the initial construction, periodic nourishment, operation, maintenance, repair, replacement, and rehabilitation of the project, except for damages due to the fault or negligence of the United States or its contractors;
- Keep, and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project, for a minimum of 3 years after completion of the accounting for which such books, records, documents, and other evidence are required, to the extent and in such detail as will properly reflect total cost of the project, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and local governments at 32 CFR, Section 33.20;
- Perform, or ensure performance of, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 USC 9601-9675, that may exist in, on, or under lands, easements, or rights-of-way that the Federal government determines to be necessary for the initial construction, periodic nourishment, operation and maintenance of the project;
- Assume, as between the federal government and the non-federal sponsor, complete financial responsibility for all necessary cleanup and response costs of any hazardous substances regulated under CERCLA that are located in, on, or under lands, easements, or

rights-of-way required for the initial construction, periodic nourishment, or operation and maintenance of the project;

- Agree, as between the federal government and the non-federal sponsor, that the non-federal sponsor shall be considered the operator of the project for the purpose of CERCLA liability, and, to the maximum extent practicable, operate, maintain, repair, replace, and rehabilitate the project in a manner that will not cause liability to arise under CERCLA;
- Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended, (42 U.S.C. 1962d-5b) and Section 101(e) of the WRDA 86, Public Law 99-662, as amended, (33 U.S.C. 2211(e)) which provide that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until the non-Federal sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element;
- Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended, (42 U.S.C. 4601- 4655) and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way necessary for construction, operation, and maintenance of the project including those necessary for relocations, the borrowing of material, or the disposal of dredged or excavated material; and inform all affected persons of applicable benefits, policies, and procedures in connection with said act;
- Comply with all applicable federal and state laws and regulations, including, but not limited to: Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d), and Department of Defense Directive 5500.11 issued pursuant thereto; Army Regulation 600- 7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army"; and all applicable Federal labor standards requirements including, but not limited to, 40 U.S.C. 3141-3148 and 40 U.S.C. 3701-3708 (revising, codifying and enacting without substantive change the provisions of the Davis- Bacon Act (formerly 40 U.S.C. 276a et seq.), the Contract Work Hours and Safety Standards Act (formerly 40 U.S.C. 327 et seq.), and the Copeland Anti-Kickback Act (formerly 40 U.S.C. 276c); and
- Not use funds from other federal programs, including any non-federal contribution required as a matching share therefore, to meet any of the non-federal sponsor's obligations for the project unless the federal agency providing the funds verifies in writing that such funds are authorized to be used to carry out the project.

10.2 Costs for the Recommended Plan

The cost estimate included in this document is intended to provide an estimate of total costs of the Recommended Plan. A revised and more detailed MCACES cost estimate will be provided for the plan selected in the Final HSGRR/EIS. The Recommended Plan project first cost is shown above in Table 6-3. The fully funded cost escalated to the midpoint of construction is shown in Table 10-1. Note that the total fully funded cost estimate of $536,161,000 differs from the estimate of project first costs of $499,179,000 shown in Table 6-3. This difference is due to the addition of $36,982,000 in escalation costs, which reflect expected cost increases between the FY 2018 quarter 1 price level and the varying midpoints of construction.

Table 10-1: Recommended Plan Fully Funded Costs

Acct	Description	Cost ($)	Contingency ($)	Escalation ($)	Fully Funded ($)
01	Lands & Damages	**13,968,000**	**2,794,000**	**431,000**	**17,192,000**
02	Relocations	**4,454,000**	**1,110,000**	**200,000**	**5,764,000**
10	Breakwaters & Seawalls	**162,619,000**	**40,508,000**	**15,803,000**	**218,930,000**
11	Levees & Floodwalls	**101,193,000**	**25,207,000**	**10,152,000**	**136,553,000**
13	Pumping Plants	**38,330,000**	**9,548,000**	**3,833,000**	**51,711,000**
17	Beach Replenishment	**26,827,000**	**6,682,000**	**1,723,000**	**35,232,000**
30	Planning, Engineering, & Design	**32,433,000**	**8,079,000**	**2,097,000**	**42,609,000**
31	Construction Management	**20,506,000**	**5,108,000**	**3,190,000**	**28,804,000**
	Total	**400,330,000**	**99,036,000**	**37,429,000**	**536,795,000**

10.3 Cost Sharing Apportionment

Once a final cost estimate is developed for the plan carried forward for feasibility-level design, a cost-sharing apportionment table will be developed. Cost sharing will be based on Public Law 113-2 (29Jan13), The Disaster Relief Appropriations Act of 2013, which provides 100% federal funding, as long as the appropriated funds remain available for initial construction. Renourishment costs will be cost-shared as 65% federal and 35% non-federal, since it is expected that construction authorization for the project would modify the existing construction authority.

10.4 Views of the Non-Federal Sponsors and Others

The New York State Department of Environmental Conservation, acting as the non-federal sponsor, supports the Recommended Plan. The NYC Mayor's Office of Recovery and Resiliency, the local sponsor to New York State, also supports the Recommended Plan, as do the Village of Cedarhurst and the Town of Hempstead, additional local sponsors to New York State. Other project partners, including NYC Department of Parks and Recreation, NYC Department of Environmental Protection, and the National Park Service also support the Recommended Plan. Letters of Support for the project by the non-federal sponsors can be found in Appendix H.

Based upon the review of the proposed project during the feasibility phase, the NYSDEC will require during the PED Phase further justification or component revisions to ensure the protection of water quality, habitat quality, and public access.

10.5 Recommended Plan and Recent USACE Initiatives

10.5.1 USACE Campaign Plan

The Recommended Plan addresses the Chief of Engineers Campaign Plan Goal 2: Deliver enduring and essential water resource solutions using effective transformation strategies.

Objective 2a: Modernize the Civil Works project planning program and process. This Revised Draft HSGRR/EIS contributes to the objective defined within Goal 2. This report recommends specific solutions to water resource problems and opportunities based on risk-informed decisions. It was developed in close collaboration with stakeholders and partners.

Objective 2c: Deliver quality solutions and services. This objective is measured by successfully meeting or exceeding established commitments for schedule, cost, and quality to ensure consistent, high-quality performance. A Cost and Schedule Risk Analysis and a Risk Management Plan will be developed to ensure the authorized cost limits are set and cost risks are managed.

10.5.2 Environmental Operating Principles

Environmental consequences of construction and operation of the Recommended Plan have been considered in avoiding and minimizing impacts; remaining unavoidable impacts would be fully mitigated. Sustainability was an integral consideration in the development of coastal storm risk reduction recommendations. A risk management and systems approach was developed with input from the USACE Risk Management Center and the Flood Risk Management Planning Center of Expertise; operation of the projects will also employ a risk management approach. Coordination with stakeholders and the general public began with four public scoping meetings, continued with stakeholder updates, and extensive resource agency input during impact modeling. Resource agency knowledge and evaluation methods developed for similar projects were applied in the impact analysis. A thorough NEPA and engineering analysis has ensured that the USACE will meet its corporate responsibility and accountability for actions that may impact human and natural environments. This analysis will be transparent and communicated to all individuals and groups interested in USACE activities.

11 PUBLIC INVOLVEMENT

11.1 Public Involvement Activities

A series of public scoping meetings were held in the study area after the Alternatives Milestone meeting, but prior to the TSP Milestone Meeting. A Notice of Intent (NOI) to prepare an Environmental Impact Statement for East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Reformulation Study was issued on April 2, 2015 in the Federal Register. The NOI also invited public comment on the scope of the issues and alternatives to be addressed in the draft EIS. Input was received through public meetings with both oral and written comments being provided and written comments were also submitted and considered throughout the study process. The meeting format included a presentation of the study purpose, alternatives considered and analyses of performance and cost of alternative plans. Posters highlighting pertinent analyses and findings of the study were available before and after the presentation to allow the attendees to circulate from area to area and pose questions and express concerns to technical staff.

Common concerns expressed included the sense of urgency to move to construction of a risk management feature. Other concerns included maintaining access to the water, preserving views, and balancing risk management with environmental impacts (see Appendix G—Public Engagement—for more information). Consistent with the USACE planning paradigm, the features were presented at this early stage in the study were shown as lines only, and no renderings were available.

The post-Hurricane Sandy environment afforded USACE an unusual opportunity to coordinate the reformulation effort with many Agencies and stakeholders. A Public Agency Council convened regularly to address Jamaica Bay issues of flooding, environmental quality and sustainability, and USACE. Reformulation goals and objectives were jointly identified. Without project conditions reflected careful consideration of ongoing efforts of partner agencies, and impacts of the Reformulation effort considered all proposals for future efforts of other agencies within the study area.

Following public release of the document, additional public meeting were held to solicit comments on the TSP. The study team met with stakeholders and members of the public and received over one thousand comments on the Tentatively Selected Plan (Appendix G). These comments were summarized and presented to the decision makers prior to the agency decision on whether or not to finalize the recommendation. The Rockaway study team held additional public meetings throughout the the Feasibility Study. Local elected officials also facilitated a number of public meetings where they requested and obtained participation from the Rockaway study team members in order to further the public engagement on this study. There will be additional opportunities for public engagement as part of the public review period of this Revised Draft GRR/EIS prior to the preparation of the Final GRR/EIS.

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12 RECOMMENDATIONS

12.1 Overview

A diligent effort was made to coordinate and collaborate with resource agencies, non-governmental entities, and environmental interests throughout the study process and public meetings. Environmental resource concerns were addressed early in the study process to assure that adverse impacts were avoided to the maximum extent practicable. The recommendations contained herein reflect the information available at this time. To ensure the Recommended Plan complies with all applicable laws and policies and is acceptable to the public, this Revised Draft HSGRR/EIS will undergo public, policy, and technical review. The results of these reviews and the results of additional investigations will support the final recommendation contained in the Final HSGRR/EIS.

12.2 Recommendation

Analyses performed to identify and assess CSRM alternatives for the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay study area support the recommendation for comprehensive storm risk management. This does not preclude a decision to refine or alter the Recommended Plan based on responses from public, policy, and technical reviews of this Revised Draft HSGRR/EIS. A final decision will be made following the reviews and higher-level coordination within USACE to select a plan for design and implementation. Coordination with the natural resource agencies will continue throughout the study process as required by the Fish and Wildlife Coordination Act.

The recommendations contained herein reflect the information available at this time and current Departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of higher review levels with the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to the Congress as proposals for authorizations and implementation funding. However, prior to transmittal to the Congress, the non-federal sponsor, the state, interested federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

13 References

Baltimore Sun, 2000. Barren Island's harsh past brought to life. By Kirk Johnson. December 3, 2000. http://articles.baltimoresun.com/2000-12-03/news/0012030148_1_barren-island-garbage-new-york

Barnes, J.D., N.M. Laymon, E.W. 1977. *Power Plant Construction Noise Guide*. Prepared for the Empire State Electric Energy Research Corporation, Report No. 3321, 1977. Wood.Bolt, Beranek and Newman, Inc.

Black, F.R. 1981. Jamaica Bay: A History, Gateway National Recreation Area, New York--New Jersey. Cultural Resources Management Study No. 3. Division of Cultural Resources, North Atlantic Regional Office, National Park Service, U.S. Dept. of Interior, Washington, D.C.

Buxton, H.T. and P.K. Shernoff. 1999. Ground-water Resources of Kings and Queens Counties, Long Island, New York. U.S. Geological Survey Water Supply Paper 2498. Prepared in cooperation with New York City Department of Environmental Protection and New York State Department of Environmental Conservation. Available online at http://pubs.er.usgs.gov/publication/wsp2498.

Cadwell, D. H. 1986. Surficial Geologic Map of New York. New York State Museum – Geological Survey, NY.

Camp, Dresser, and McKee, 1983. Study Overview.

Cartwright, Richard A. 2002. History and Hydrologic Effects of Ground-Water Use in Kings, Queens, and Western Nassau Counties, Long Island, New York, 1800s through 1997. United States Geological Survey Water-Resources Investigations Report 01-4096. In cooperation with New York City Department of Environmental Protection, New York 2002.

Cialone, Mary A., T. Chris Massey, Mary E. Anderson, Alison S Grzegorzewski, Robert E. Jensen, Alan Cialone, David J. Mark, Kimberly C. Pevey, Brittany L. Gunkel, Tate O. McAlpin, Norberto N. Nadal-Caraballo, Jeffrey A. Melby, and Jay J. Ratcliff. 2015. North Atlantic Coastal Comprehensive Study (NACCS) Coastal Storm Model Simulations: Waves and Water Levels.

City of New York Environmental Quality Review (CEQR), 2014. Chapter 19 – Noise. Issued by the NYC Mayor's Office of Sustainability. Available online at: http://www.nyc.gov/html/oec/downloads/pdf/2014_ceqr_tm/19_Noise_2014.pdf

Columbia University, 2008. Bedrock Geology In and Around the Jamaica Bay Estuary. Center for International Earth Science Information Network: Jamaica Bay Research and Management Information Network. http://www.ciesin.columbia.edu/jamaicabay/photogallery/jb_bed_geology.pdf

Cowan, J.P., 1994. *Handbook of Environmental Acoustics.* New York, New York: John Wiley & Sons.

Dugan JE, Airoldi L, Chapman MG, Walker SJ, and Schlacher T (2011) Estuarine and Coastal Structures: Environmental Effects, A Focus on Shore and Nearshore Structures. In: Wolanski E and McLusky DS (eds.) Treatise on Estuarine and Coastal Science, Vol 8, pp. 17–41. Waltham: Academic Press.

Dugan, J.E., Hubbard, D.M., 2006. Ecological responses to coastal armoring on exposed sandy beaches. Shore and Beach 74 (1), 10–16.

Ehrler, M.—NPS, Gateway National Recreation Area, 2013. Personal communication from Marilou Ehrler re: Uses of Fort Hancock's Officers' Row, Hurricane Sandy damage at Breezy Point Surf Club, National Register nominations and Determinations of Eligibility, etc.

Engebretsen, Jan, 1982. New York Harbor and Adjacent Channels Study Shipwreck Inventory. Submitted to the U.S. Army Corps of Engineers, New York District.

Federal Energy Regulatory Commission (FERC), 2013. 2013 Report of Enforcement, Docket No. AD07-13-006.

Federal Energy Regulatory Commission (FERC), 2014. Rockaway Delivery Lateral Project, Northeast Connector Project, Final Environmental Impact Statement. February, 2014.

Federal Interagency Committee on Noise (FICON). 1992. Federal Agency Review of Selected Airport Noise Analysis Issues. August 1992. Available online at: http://airportnoiselaw.org/65dnl.html

Federal Transit Authority (FTA), 2006. Transit Noise and Vibration Impact Assessment. FTA-VA-90-1003-06. May, 2006. https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/FTA_Noise_and_Vibration_Manual.pdf

FEMA, 2013. Flood Insurance Study, City of New York, New York. Flood Insurance Study number 360497V000B. Preliminary: December 5, 2013.

Fugro, 2016. Lafayette River Tidal Protection Alternatives Evaluation, City of Norfolk, City-wide Coastal Flooding Project, Work Order No. 7, January 2016.

Freshkills Park Alliance, 2011. New York City Landfills, Past and Present. Presentation dated November 29, 2011. Accessed 2016. http://freshkillspark.org/wp-content/uploads/2011/12/marty-bellew-lecture-112911_lowrez.pdf

Gittman et al. 2014 Ocean & Coastal Management

Google, 2016. Search results for "Marinas near Jamaica Bay, NY" and "Marinas near Rockaway, NY". Search performed by Mabbett & Associates, Inc. Available online at: www.google.com

Hess, L., and W. H. Harris. 1987. Morphology and sediment budget during recent evolution of a barrier beach, Rockaway, New York. Northeastern Geology 9:94-109.

Hunter, Richard and Damon, Tvaryanas, 2002. Phase 1A Cultural Resource Documentary Study For Gerritsen's Creek Ecosystem Restoration, Borough of Brooklyn, Kings County, New York. Report on file with the U.S. Army Corps of Engineers, New York, New York. Included in: "USACE – New York District: Final Ecosystem Restoration Report and Environmental Assessment, Gerritsen Creek Ecosystem Restoration Section 1135, Brooklyn, NY, October 2003".

Incident Management Team (IMT), 2012h. "Jacob Riis Park, Preliminary Damage Assessment." In NPS Response to Effects of Hurricane Sandy, November 11, 2012. Incident Management Team, National Park Service, Gateway National Recreation Area.

Incident Management Team (IMT), 2012i. "Breezy Point Surf Club and Silver Gull Beach Club, Preliminary Damage Assessment." In NPS Response to Effects of Hurricane Sandy, November 11, 2012. Incident Management Team, National Park Service, Gateway National Recreation Area.

Kopper, Steven, 1979. Cultural Resources Reconnaissance Dredging Project, East Rockaway Inlet, New York. Report to the New York District, U.S. Army Corps of Engineers.

Lane, Frenchman, and Associates, 1992. Jacob Riis Park Cultural Landscape Report, Gateway National Recreation Area. Prepared for the Denver Service Center, National Park Service.

Liboiron, Max, 2013. Detritus from Historic Deadhorse Bay: Trash Meant to be Left Behind. Published at Discard Studies. https://discardstudies.com/2013/07/11/detritus-from-historic-deadhorse-bay-trash-meant-to-be-left-behind/

Long Island American Water, 2016. Typical Water Quality Information. http://www.amwater.com/files/NY_2902835_TWQ.pdf

Louis Berger Associates, Inc., 1990. The VanDeventer-Fountain House Site Ca. 1786 to 1901 Staten Island, New York. Report prepared for the U.S. Department of the Navy, Northern Division. Louis Berger Associates, Inc.

Mabbett, 2016. Telephone communication with the US National Park Service regarding visitor statistics. April 11, 2016.

Misut, Paul E. and Jack Monti, Jr., 1999. Simulation of Ground-Water Flow and Pumpage in Kings and Queens Counties, Long Island, New York, United States Geological Survey Water-Resources Investigations Report 98-4071. 1999.

Nassau County, 2016. Building and Zoning Permits. https://www.nassaucountyny.gov/3482/Building-and-Zoning-Permits

National Park Service, n.d.i. Cultural Resource Index with Hurricane Sandy Assessments, Gateway National Recreation Area, provided by Helen Mahan March 6, 2013.

National Park Service, 1978. National Register of Historic Places Nomination Form, Floyd Bennett Field, Jamaica Bay Unit, Gateway National Recreation Area.

National Park Service, 1979b. National Register of Historic Places Nomination Form, Jacob Riis Park, Jamaica Bay Unit, Gateway National Recreation Area.

National Park Service, 1980b. Historic Structure Report, Historical Data Section, Fort Tilden, Gateway National Recreation Area, New York, Denver Service Center.

National Park Service (NPS), 2002. Olmstead Center for Landscape Preservation. https://www.nps.gov/oclp/index.htm

National Park Service, 2004e. National Register Nomination Form: U.S. Coast Guard Station Far Rockaway, Queens, Gateway National Recreation Area.

National Park Service, 2009a. Archeological Overview and Assessment, Sandy Hook Unit, Gateway National Recreation Area. United States Department of the Interior, National Park Service.

National Park Service, 2010c. National Register of Historic Places Nomination Form, Floyd Bennett Field (expanded), Jamaica Bay Unit, Gateway National Recreation Area.

National Park Service, 2011a. Archeological Overview and Assessment, Gateway National Recreation Area, Great Kills Park, Staten Island Unit, Richmond County, New York. United States Department of the Interior, National Park Service.

National Park Service, 2011b. Archeological Overview and Assessment, Gateway National Recreation Area, Fort Wadsworth, Staten Island Unit, Richmond County, New York. United States Department of the Interior, National Park Service.

National Park Service, 2011c. Archeological Overview and Assessment, Gateway National Recreation Area, Jamaica Bay Unit, Kings and Queens Counties, New York. United States Department of the Interior, National Park Service.

National Park Service (NPS), 2013. Gateway National Recreation Area – Draft General Management Plan/Environmental Impact Statement. July, 2013.

National Park Service (NPS), 2013b. National Register of Historic Places, Registration Form, Far Rockaway Beach Bungalow Historic District. May 31, 2013. Available online at: https://www.nps.gov/nr/feature/places/pdfs/13000499.pdf

National Park Service (NPS), 2014. Gateway National Recreation Area, Final General Management Plan, Environmental Impact Statement. April 2014.

National Park Service (NPS), 2014a. A New Vision for a Great Urban National Park Gateway National Recreation Area Final General Management Plan / Environmental Impact Statement. April.

National Park Service (NPS), 2015. https://www.nps.gov/gate/planyourvisit/thingstodojamaicabay.htm

National Park Service (NPS), 2016. https://www.nps.gov/gate/learn/historyculture/detailedforttilden.htm

NED, 2015. NED Recreation Benefit for Rockaway Beach, NY.

Nersesian, G. K., 1977. Beach fill design and placement at Rockaway Beach, New York, using offshore ocean borrow sources. Coastal Sediments '77, ASCE: 228-247.

New York City Comprehensive Waterfront Plan (NYCCWP, 1992. Reclaiming the City's Edge: Chapter on Visual Corridors. NYC Department of City Planning. Summer, 1992. Available online at: http://www1.nyc.gov/assets/planning/download/pdf/about/publications/cwp.pdf

New York City Department of City Planning (NYCDCP), 1999b. Waterfront Revitalization Program. http://www.nyc.gov/html/oec/downloads/pdf/dme_projects/07DME025M/DEIS/07DME025M_%20DEIS_12_Waterfront_Revitalization.pdf

New York City Department of City Planning (NYCDCP), 2016. Article VI, Special Regulations Applicable to Certain Areas; Chapter 2 – Special Regulations Applying in the Waterfront Area, Effective March 22, 2016. Available online at: http://www1.nyc.gov/assets/planning/download/pdf/zoning/zoning-text/art06c02.pdf

New York City Department of Environmental Protection (NYCDEP). 2007. Notice of Adoption of Rules for Citywide Construction Noise Mitigation.

New York City Department of Environmental Protection (NYSDEP), 2011. Jamaica Bay Waterbody/Watershed Facility Plan Report, October 2011. Available online at: http://www.hydroqual.com/projects/ltcp/wbws/jamaica_bay.htm

New York City Department of Parks and Recreation, 2016. Forever Wild; Dubos Point Wildlife Sanctuary. http://www.nycgovparks.org/greening/nature-preserves/site?FWID=29

New York City Department of Parks and Recreation, 2016. Jamaica Bay and the Rockaways. http://www.nycgovparks.org/parks/jamaica-bay-and-the-rockaways

New York City Health, 2007. Proposed Adulticiding of the Rockaways. http://www.nyc.gov/html/doh/images/public/press05/pr093-05.jpg

New York City Local Laws (NYCLL), 2005. New York City Noise Code §24-232. Available online at: http://www.nyc.gov/html/dep/html/noise/index.shtml.

New York City Natural Hazard Mitigation Plan (NYCNHMP), 2009. Section III: Natural Hazard Risk Assessment. March 2009. http://www.nyc.gov/html/oem/downloads/pdf/hazard_mitigation/section_3h_earthquake_hazard_analysis.pdf

New York City Planning Commission (NYCPC), 2012. *Hudson Square Rezoning Final EIS.* Prepared by AKRF, Inc. January 2013. New York City Planning Commission (NYCPC), 2012a.

625 West 57th Street Final EIS, New York City Planning Commission. Prepared by AKRF, Inc., and Philip Habib & Associates. December 2012.

New York City Planning Commission (NYCPC), 2013. *Hudson Square Rezoning Final EIS.* Prepared by AKRF, Inc. January 2013.

New York Department of State, Office of Planning and Development, 2016. NYS Coastal Boundary Map. https://appext20.dos.ny.gov/coastal_map_public/map.aspx

New York Harbor Parks, 2016. http://nyharborparks.org/podcasts/rs-hawks.html

New York State Department of Environmental Conservation (NYSDEC), 1990. Jamaica Bay Critical Environmental Area (CEA). http://www.dec.ny.gov/docs/permits_ej_operations_pdf/jamaicabay.pdf

New York State Department of Environmental Conservation (NYSDEC), 2001. Assessing and Mitigating Noise Impacts Program Policy. Issued 6 October 2000; Revised February 2, 2001.

New York State Department of Transportation (NYSDOT), 2013. Traffic Data Viewer Shapefiles 2013: TDV_AADT_2013.shp. Available at: https://www.dot.ny.gov/tdv

New York State Office of the State Comptroller (NYSOSC), 2011. An Economic Snapshot of Coney Island and Brighton Beach. July, 2011. Available online at: http://www.osc.state.ny.us/osdc/rpt8-2012.pdf

New York State Office of the State Comptroller (NYSOSC), 2014. An Economic Snapshot of Brooklyn. May, 2014. Available online at: http://www.osc.state.ny.us/osdc/rpt4-2015.pdf

New York Times, 1984. A cooperative on the beach loves privacy. By Elaine Sciolino. http://www.nytimes.com/1984/09/10/nyregion/a-cooperative-on-the-beach-loves-privacy.html

New York Times, 1999. Defunct Equine Esturary. By Daniel B. Schneider. http://www.nytimes.com/1999/07/18/nyregion/fyi-634484.html

New York Times, 2009. A Wooded Prairie Springs From a Site Once Piled High With Garbage, by Kenneth Chang. September 6, 2009. http://www.nytimes.com/2009/09/07/science/earth/07landfill.html?_r=0

New York-New Jersey Harbor & Estuary Program (HEP), 2001. 2001 Status Report: A Regional Model for Estuary and Multiple Watershed Management – Report by the Habitat Workgroup of the HEP. April 2001. Available online at: http://mss3.libraries.rutgers.edu/dlr/outputds.php?pid=rutgers-lib:34653&ds=PDF-1

NOAA, 2013. NOAA Water Level and Meteorological Data Report: Hurricane Sandy. https://www.tidesandcurrents.noaa.gov/publications/Hurricane_Sandy_2012_Water_Level_and_Meteorological_Data_Report.pdf

NOAA, 2016. FEMA Flood Zones. From NOAA Coastal Flood Exposure Mapper. Available online at: http://go.usa.gov/cuj9Y.

NOAA, 2016. United States – East Coast, New York, Jamaica Bay and Rockaway Inlet, Map 12350, 1:20,000 scale. Last corrected February 25, 2016. Available online at: http://www.charts.noaa.gov/InteractiveCatalog/nrnc.shtml?rnc=12350

Northeast Regional Climate Center, 2016. Accessed in 2016. Available at: http://www.nrcc.cornell.edu/wxstation/comparative/comparative.html#

NPS, 2012. *Gateway General Management Plan/Environmental Impact Statement Newsletter No.3.* United States Department of the Interior, National Park Service, Gateway National Recreation Area. August 2012.

NYC Planning, 2016. Special Use Districts. Available online at: http://maps.nyc.gov/doitt/nycitymap/template?z=4&p=991423,157389&a=ZOLA&c=ZOLA&f=DCP_SPEC_PURPOSE_DISTRICT

NYCDEP, 2016. Jamaica Bay Tidal Barrier Water Quality Modeling Analysis, New York City Department of Environmental Protection, draft in preparation.

NYCDCP, 2016b. Community Portal – District Descriptions. Available online at: http://www1.nyc.gov/site/planning/community/community-portal.page

NYCDEP, 2010. Restoring Brooklyn's Pennsylvania and Fountain Landfills. Presentation dated January 26, 2010. https://freshkillspark.files.wordpress.com/2010/01/012610-fkp-talks_mclaughlin.pdf

NYS Comptroller, 2012. Accessed April 2016. Available Online at:

NYSDEC, 1990. Critical Environmental Areas, Jamaica Bay (Kings and Queens Counties). Available online at: http://www.dec.ny.gov/permits/25123.html

NYSDEC, 2003. Commissioner Policy 29, DEC Environmental Justice Policy. Issued on March 19, 2003. Available at: http://www.dec.ny.gov/docs/permits_ej_operations_pdf/cp29a.pdf

NYSDEC, 2016. County Maps Showing Potential Environmental Justice Areas. Accessed April 2016. Available online at: http://www.dec.ny.gov/public/899.html

NYSDEP, 2007. Chapter 28, Citywide Construction Noise Mitigation, in Title 15 of the Rule of the City of New York. Available online at: http://www.nyc.gov/html/dep/pdf/noise_constr_rule.pdf

NYC Metropolitan Transportation Authority (NYCMTA), 2016. Marine Parkway-Gil Hodges Memorial Bridge. Available online at: http://web.mta.info/bandt/html/marine.html.

Panamerican Consultants, 2003. Cultural Resources Baseline Study, Jamaica Bay Ecosystems Restoration Project, Kings, Queens and Nassau Counties, New York. July, 2003. Included as the Cultural Resources Phase 1A Report in USACE, June 2010: Volume 2: Jamaica Bay, Marine Park and Plumb Beach, New York, Environmental Restoration Project, Draft Interim Feasibility Report, Kings and Queens Counties, New York.

Panamerican Consultants, 2003. Final Report, Underwater Inspection of Targets Borrow Area 2, Atlantic Coast of Long Island, East Rockaway Inlet to Rockaway Inlet, Queens County New York, Storm Damage Reduction Project. September 2003.

Panamerican Consultants, 2005. Remote Sensing Survey of the Proposed Borrow Area for the East Rockaway Reformulation Project, Queens County, New York. Submitted to the U.S. Army Corps of Engineers, New York District. Final Report dated November, 2005.

Panamerican Consultants, 2006. Remote Sensing Survey of the Swinburne Beneficial Use Site In Connection With The New York and New Jersey Harbor Navigation Study Of The Upper and Lower Bay Port of New York and New Jersey, Richmond County, New York. Submitted to the U.S. Army Corps of Engineers, New York District. Draft Report dated May, 2006.

PBS&J, 2009. Marine Archeological Assessment for the Rockaway Delivery Point Project, Queens County, New York. Prepared for Gateway National Recreation Area.

Port Authority of NJ and NY, 2016. AirTrain JFK. http://www.panynj.gov/airports/jfk-airtrain.html

Riess, Warren C., 1994. *East Rockaway Inlet To Rockaway Inlet And Jamaica Bay, New York -- Section 934 Study Remote Sensing Survey Of Borrow Area* 2 1993. Prepared by WCH Industries, Waltham, Massachusetts in association with Boston Affiliates, Inc., Boston, Massachusetts. Submitted to the U.S. Army Corps of Engineers, New York District.

Ruijs, M., 2011. The Effects of the "Ike Dike" Barriers on Galveston Bay, Delft University of Technology, June 2011.

Selvek, C., 2005. Draft Cultural Landscape Report for Fort Tilden, Gateway National Recreation Area (95% Draft), September 2005. Olmsted Center for Landscape Preservation, National Park Service, Boston, Massachusetts.

Skanska, 2014. Rockaway Boardwalk, Project Informational Session, Phase 4B Construction Logistics, October 28, 2014. Available online at: https://www.nycgovparks.org/pagefiles/79/Rockaway-Boardwalk-Phase-4B-Construction-Logistics.pdf

Structures of Coastal Resilience (SCR), 2014. Phase 1, Context, Site, and Vulnerability Analysis. Section 07, Shifting Sands: Sedimentary Cycles for Jamaica Bay, New York. Available online at: http://dev.structuresofcoastalresilience.org/wp-content/uploads/2014/10/Phase_1_JB.pdf

Student Conservation Association, 2016. http://sandy.thesca.org/jamaica-bay-ny

Sykes L. R., Armbruster J.G, Kim W. and Seeber L. 2008. Observations and Tectonic Setting of Historic and Instrumentally Located Earthquakes in the Greater New York – Philadelphia Area. Bulletin of the Seismological Society of America, Vol. 98, No. 4, pp. 1696 – 1719, August 2008.

Tunstead, R. 1999. Telephone Communication on July 1, 1999, between R. Tunstead, Geologist, U.S. Department of Agriculture, National Resources Conservation Service, Staten Island, New York, and M. Van Brocklin, Northern Ecological Associates, Inc., Canton, NY.

USACE, 1979. Rockaway B-149th Street Groin, General Design Memorandum Supplement and EIS Supplement. February, 1979.

USACE, 1993. Atlantic Coast of New York City, East Rockaway Inlet to Rockaway Inlet and Jamaica Bay, New York. Final Reevaluation Report (Section 934 of WRDA 1986). May, 1993.

USACE, 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". U.S. Army Engineer District, New York and U.S. Army Engineer Research and Development Center, Waterways Experiment Station http://www.nan.usace.army.mil/Missions/CivilWorks/ProjectsinNewJersey/SandyHooktoBarnegatInlet/BiologicalMonitoringProgram.aspx

USACE, 2005. Jamaica Bay March Islands, Jamaica Bay, New York, Integrated Ecosystem Restoration Report, Environmental Assessment and Finding of No Significant Impact. December 2005.

USACE, 2013. Waterborne Commerce of the United States. Data for Jamaica Bay. Available online at: http://www.navigationdatacenter.us/wcsc/pdf/wcusatl13.pdf

USACE, 2015. 2015 Strategic Sustainability Performance Plan. June 30, 2015. Available online at: http://www.usace.army.mil/Portals/2/docs/Sustainability/Performance_Plans/2015_USACE_Sustainability_Plan.pdf

USACE. 2015a. Raritan Bay and Sandy Hook Bay, New Jersey, Combined Erosion Control and Coastal Storm Risk Management Project. Borough of Highlands Feasibility Study. Appendix B2: Coastal Engineering.

USACE, 2016. East Rockaway Inlet to Rockaway Inlet, NY Reformulation Study, Appendix B – Borrow Source Investigation. April 7, 2016.

U.S. Bureau of Labor Statistics, 2016. Civilian Labor Force in Nassau County, NY [NYNASS9LFN], retrieved from FRED, Federal Reserve Bank of St. Louis https://research.stlouisfed.org/fred2/series/NYNASS9LFN, April 2016.

U.S. Bureau of Labor Statistics, 2016. Unemployment Rate in Nassau County, NY [NYNASS9URN], retrieved from FRED, Federal Reserve Bank of St. Louis https://research.stlouisfed.org/fred2/series/NYNASS9URN, April 2016.

U.S. Census Bureau Economics, 2012. Accessed April 2016. Available Online at:

U.S. Census Bureau Housing, 2012. Accessed April 2016. Available Online at:

U.S. Census Bureau Quick Facts, 2016. Accessed April 2016. Available Online at:

U.S. Census Bureau. 2015. Income and Poverty in the United States: 2014. Current Population Reports. P60-252. Issued September 2015. https://www.census.gov/content/dam/Census/library/publications/2015/demo/p60-252.pdf

U.S. Census Bureau. 2014. 2014 American Community Survey 1-Year Estimates. On-line at: http://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_14_1YR_S1701&prodType=table (accessed April 2016).

U.S. Census Bureau. 2014a. U.S. Poverty Thresholds in 2014. On-line at: https://www.census.gov/hhes/www/poverty/about/overview/measure.html (accessed April 2016).

U.S. Code of Federal Regulations, 1982. CBRA; 16 U.S.C. § 3505.

U.S. Code of Federal Regulations. 36 CFR Part 60.4.

U.S. Code of Federal Regulations. 36 CFR Part 800.

U.S. Department of Housing and Urban Development (HUD, 1991. Noise Abatement and Control (24 CFR Part 51B). Available online at: http://portal.hud.gov/hudportal/documents/huddoc?id=noiseabatement.pdf

U.S. Department of Agriculture (USDA), 2001. Soil Survey of Gateway National Recreation Area, New York and New Jersey.

U.S. Department of the Interior, National Park Service (NPS), 2015. Jamaica Bay Wildlife Refuge West Pond Trail Breach Repair Environmental Assessment. October, 2015.

U.S. EPA, 1971. Noise from Construction Equipment and Operations, Building Equipment, and Home Appliances. Prepared by Bolt, Beranek and Newman under contract 68-04-0047 for the U.S. Environmental Protection Agency Office of Noise Abatement and Control, Washington, D.C. 20460. December 31, 1971.

U.S. EPA, 1974. Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety. Publication No. 550/9-74-004. Washington D.C. March 1974.

U.S. EPA, 1978. Protective Noise Levels. A Supplement to the USEPA Report: Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety, EPA/ONAC 550/9-74-004, March, 1974, Office of Noise Abatement and Control, Washington, D.C.).

U.S. EPA, 1981. Noise Effects Handbook. A Desk Reference to Health and Welfare Effects of Noise. Office of Noise Abatement and Control. October 1979, Revised July 1981.

U.S. EPA, 1983a. Region 2 Brooklyn - Queens Aquifer System: Support Document Kings and Queens Counties New York December 1983. Available on the Internet at:

U.S. EPA, 1983b. Region 2 Nassau-Suffolk Aquifer System: Support Document Nassau and Suffolk Counties, New York December May 1975. Available on the Internet at:

U.S. EPA. 1983. Brooklyn-Queens Aquifer System, Support Document. Available online at http://www.epa.gov/region2/water/aquifer/brooklyn/brooklyn.htm.

USDA, 2016a. Custom Soil Resource Report for Kings County, New York, Nassau County, New York, and Queens County, New York. Rockaway API. Web Soil Survey. http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm

USDA, 2016b. Custom Soil Resource Report for Kings County, New York, Nassau County, New York, and Queens County, New York. Jamaica Bay API. Web Soil Survey. http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm

USFWS, 1997. Significant habitats and habitat complexes of the New York Bight watershed. U.S. Fish & Wildlife service, Southern New England, New York Bight Coastal Ecosystems Program, Charlestown, RI.

USFWS, 2016. Coastal Barrier Resources System. Available online at: http://www.fws.gov/ecological-services/habitat-conservation/coastal.html

USGS, 2013. Geology of the New York City Region, A Preliminary Regional Field-Trip Guidebook. Available online at: http://3dparks.wr.usgs.gov/nyc/index.html

USGS, 2014. Quaternary fault and fold database for the United States, accessed 2016, from USGS web site: http://earthquake.usgs.gov/hazards/qfaults/map/hazfault2014.html

USGS, 2015. Geology of National Parks, 3D and Photographic Tours. Plumb Beach, Coney Island. Modified January 20, 2015. Available online at: http://3dparks.wr.usgs.gov/nyc/parks/loc71.htm

USGS, 2016. Earthquake Hazards Program. http://earthquake.usgs.gov/, http://earthquake.usgs.gov/earthquakes/shakemap/background.php

USGS, 2016. Topographic maps for Lynbrook, Brooklyn, Coney Island, Far Rockaway, Lawrence, Jamaica Bay, and The Narrows Quadrangles. 7.5 Minute Topographic maps, New York 2013.

USNDC, 2016. Port Facility Data Layer, Accessed April 2016. Available online at: http://www.navigationdatacenter.us/gis/arcexplorsteps.htm, http://www.navigationdatacenter.us/db/gisviewer/port_facility.kmz

Yasso, W. E. and E. M. Hartman, Jr. 1976. Beach Forms and Coastal Processes. MESA New York Bight Atlas, Monograph 11. New York Sea Grant Institute, Stony Brook, NY.

Yue, C., Mahoney, E., and Herbowicz, T., 2013. Economic Benefits to Local Communities from National Park Visitation, 2011. National Park Service, U.S. Department of the Interior, Natural Resource Report NPS/NRSS/ARD/NRR–2013/632. Available online at: https://www.nature.nps.gov/socialscience/docs/NPSSystemEstimates2011.pdf

USACE, 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". U.S. Army Engineer District, New York and U.S. Army Engineer Research and Development Center, Waterways Experiment Station http://www.nan.usace.army.mil/Missions/CivilWorks/ProjectsinNewJersey/SandyHooktoBarnegatInlet/BiologicalMonitoringProgram.aspx

14 INDEX*

15 LIST OF ACRONYMS

AAEQ	Average Annual Equivalent
ABU	Authorized-But-Unconstructed
ADM	Agency Decision Milestone
AEP	Annual Exceedance Probability
APE	Area of Potential Effect
ATR	Agency Technical Review
BA	Biological Assessment
BFE	Base Flood Elevation
B-IBI	Benthic Index of Biological Integrity
BMP	Best Management Practice
CAR	Coordination Act Report
CBRA	Coastal Barrier Resources Act
CBRS	Coastal Barrier Resources System
CDP	Census-Designated Place
CEA	Critical Environmental Area
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cfs	Cubic Feet Per Second
CSO	Combined Sewer Overflow
CSRM	Coastal Storm Risk Management
DASNY	Dormitory Authority of the State of New York
DCP	New York City Department of City Planning
DPR	New York City Department of Recreation
EAD	Equivalent Annual Damages
EFH	Essential Fish Habitat
EPW	Evaluation for Planned Wetlands
ER	Engineer Regulation
ESA	Endangered Species Act
FCI	Functional Capacity Index
FCU	Functional Capacity Unit
FEMA	Federal Emergency Management Agency

FERC	Federal Energy Regulatory Commission
FIRM	Flood Insurance Rate Map
FWOP	Future Without Project
GHG	Greenhouse Gas
GNRA	Gateway National Recreation Area
GOSR	Governor's Office of Storm Recovery
GRR	General Reevaluation Report
HEP	New York/New Jersey Harbor Estuary Plan
HFFRRF	High Frequency Flooding Risk Reduction Feature
HQUSACE	U.S. Army Corps of Engineers Headquarters
HRE CRP	Hudson-Raritan Estuary Comprehensive Restoration Plan
HSGRR/EIS	Hurricane Sandy General Reevaluation Report & Environmental Impact Statement
HTRW	Hazardous, Toxic, and Radiological Waste
IEPR	Independent External Peer Review
LAA	Likely to Adversely Affect
LF	Linear Feet
MHHS	Mean High Water Springs
MHHW	Mean Higher High Water
MHW	Mean High Water
MLLW	Mean Lower Low Water
MVERP	Marine Vessel Engine Replacement Program
NACCS	North Atlantic Coast Comprehensive Study
NAVD88	North American Vertical Datum of 1988
NED	National Economic Development
NEPA	National Environmental Policy Act
NLAA	Not Likely to Adversely Affect
NMFS	National Marine Fisheries Service
NNBF	Natural and Nature Based Feature
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NRC	National Research Council
NYC	New York City

NYCLPC	New York City Landmarks Preservation Commission
NYNJHATS	New York / New Jersey Harbor and Tributaries Study
NYSDEC	State of New York Department of Environmental Conservation
NYSDOS	New York State Department of State
O&M	Operations and Maintenance
OMRR&R	Operation, Maintenance, Repair, Replacement & Rehabilitation
P&G	Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies
PAL	Planning Assistance Letter
PDT	Project Delivery Team
PED	Preconstruction, Engineering, and Design
PEJA	Potential Environmental Justice Area
PPA	Project Partnership Agreement
ROI	Region of Influence
RSLR	Relative Sea Level Rise
SLC	Sea Level Change
TSP	Tentatively Selected Plan
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
WWTP	Wastewater Treatment Plant