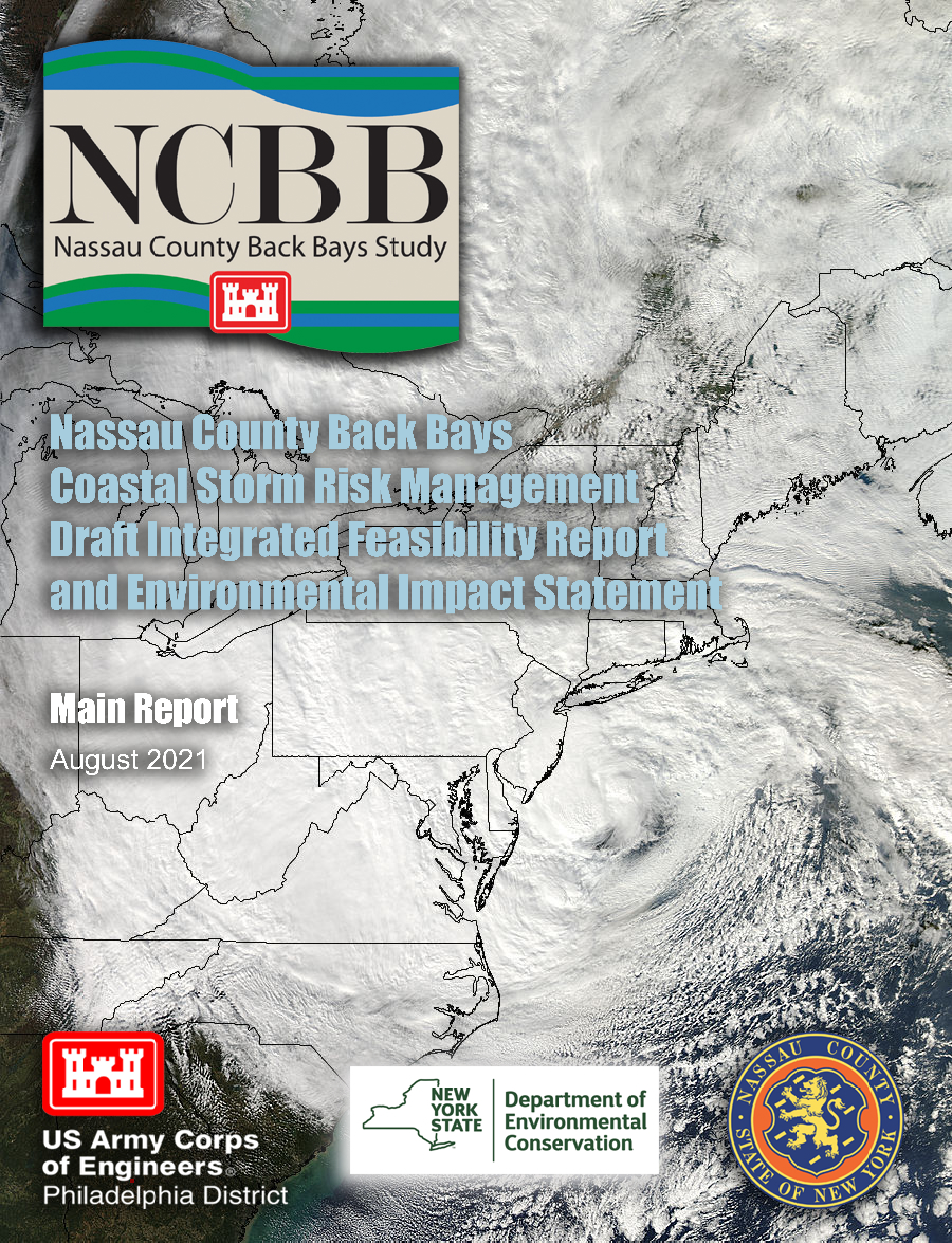

NCBB

Nassau County Back Bays Study

Nassau County Back Bays Coastal Storm Risk Management Draft Integrated Feasibility Report and Environmental Impact Statement

Main Report

August 2021

US Army Corps of Engineers
Philadelphia District

New York State Department of Environmental Conservation

Nassau County State of New York

NEPA Cover Sheet

Title: Nassau County Back Bays Coastal Storm Risk Management Feasibility Study *Draft* Feasibility Report & Environmental Impact Statement

Responsible Agencies: Lead Federal Agency - U.S. Army Corps of Engineers – Philadelphia District; Lead State Agency – New York State Department of Environmental Conservation; Cooperating Agencies – NOAA, FEMA, USEPA, USFWS

ABSTRACT: The Atlantic Coast of New York is fronted by an effective Federal coastal storm risk management (CSRM) program (USACE, 2013). However, the Nassau County back bay region currently lacks a comprehensive CSRM program. The Nassau County Back Bays (NCBB) feasibility study investigates CSRM problems and solutions to reduce damages from coastal flooding that affect population, critical infrastructure, critical facilities, property and ecosystems. The purpose of the NCBB CSRM feasibility study is to identify a plan for implementation of comprehensive CSRM strategies to increase resilience and to reduce risk from future storms and compounding impacts of sea level change. The NCBB is one of nine focus areas identified in the North Atlantic Coast Comprehensive Study.

CONTACT: For further information on this Environmental Impact Statement, contact Scott Sanderson, scott.sanderson@usace.army.mil, 215.656.6571

Public Comment: Comments may be submitted via email or in writing by October 18, 2021:

By email: PDPA-NAP@usace.army.mil

In writing: USACE Philadelphia District, Planning Division, 100 Penn Square E., Philadelphia, PA 19107

The EIS was prepared pursuant to 40 Code of Federal Regulations (CFR) Parts 1500 - 1508 (1978, as amended in 1986 and 2005).

U.S. Army Corps of Engineers
Philadelphia District

Nassau County Back Bays Coastal Storm Risk Management Feasibility Study

Draft Feasibility Report & Environmental Impact Statement

Executive Summary

The Nassau County coastline and its vital resources critical to the social, economic, and environmental welfare of the nation are at risk. When storms damage homes, businesses, and infrastructure the immediate fallout and the continued aftermath greatly affect the people who live in these coastal communities. Due to the importance of the Nassau County coast, the United States Army Corps of Engineers (USACE) has partnered with the New York State Department of Environmental Conservation (NYSDEC) and Nassau County to identify and recommend solutions to improve coastal storm risk management (CSRM) . The goals of this effort are to reduce storm risks to communities, promote public health and safety, support the economy and to advance coastal resilience in the face of sea level change (SLC) and coastal storms.

This draft Integrated Feasibility Report & Environmental Impact Statement (DIFR-EIS) presents the findings and recommendations of this study effort by the USACE, NYSDEC and Nassau County. Following the public review and comment period for this DIFR-EIS, the study team will document issues raised during the review and evaluate their effect on study recommendations before moving forward with completion of the final IFR-EIS. At the completion of the study, and upon approval by the Chief of Engineers of the USACE, a plan will likely be recommended to Congress for authorization and funding. If authorized and funded by Congress, subsequent phases of the project would include pre-construction engineering and design (PED), construction, and operation and maintenance.

ES-1 Study Information

The Nassau County Back Bays (NCBB) CSRM feasibility study investigates problems and opportunities to reduce damages from coastal flooding that affects population, critical infrastructure, property, and ecosystems. The purpose of this study is to identify a plan for implementation of comprehensive CSRM strategies to increase resilience and to reduce risk from future storms and compounding impacts of SLC.

Public Law (PL) 113-2 directed USACE to conduct a comprehensive study (the North Atlantic Coast Comprehensive Study, or– "NACCS") to address flood risks of vulnerable coastal populations in areas that were affected by Hurricane Sandy within the boundaries of the North Atlantic Division of USACE. The NACCS was completed in January 2015 and provides a step-by-step approach, with advancements in the state of science and tools, to conduct three levels of analysis. Tier 1 was a regional scale analysis (completed as part of the NACCS), Tier 2 was conducted at a State or watershed scale (conceptual Tier 2 evaluations were completed in each State and the District of Columbia), and Tier 3 would be a local-scale analysis that incorporates benefit-cost evaluations of CSRM plans. As part of the NACCS tiered analysis, NCBB was identified as one of nine high risk focus areas.

Study Authority. The study is authorized by Chapter 140 of Public Law 71 (15 June 1955), which states:

> *That in view of the severe damage to the coastal and tidal areas of the eastern and southern United States from the occurrence of hurricanes, particularly the hurricanes of August 31, 1954, and September 11, 1954, in the New England, New York, and New Jersey coastal and tidal areas… The Secretary of the Army… is hereby authorized and directed to cause an examination and survey to be made of the eastern and southern seaboard of the United States with respect to hurricanes, with particular reference to areas where severe damages have occurred.*

Study Sponsor. The non-Federal sponsor is the NYSDEC, in partnership with Nassau County, NY. A feasibility cost share agreement (FCSA) was executed on 30 September 2016. A revised FCSA was signed in June 2020 thereby transitioning the study to 100% Federal funding under the Bipartisan Budget Act of 2018 (Public Law 115-123).

Study Area. The study area is located within Nassau County, NY. The northern study area boundary along the mainland of Long Island was established using NACCS water level statistics for the 0.2% annual exceedance probability or AEP (500-year return period), while the southern boundary corresponds to the Atlantic Ocean offshore of the City of Long Beach and Jones Island. The east-west boundary of this feasibility study is limited to the east-west extent of Nassau County.

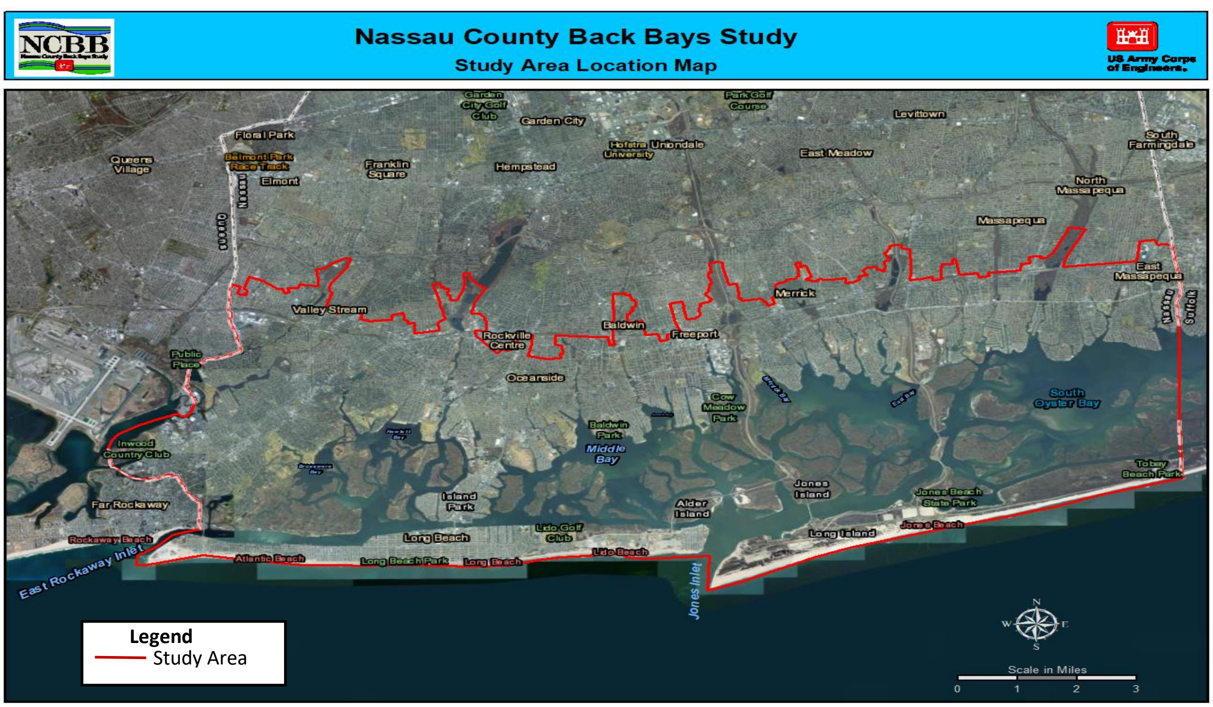

Figure ES- 1: Study Area

ES-2 Problems

The NCBB region currently lacks a comprehensive CSRM program. As a result, the NCBB region experienced major impacts and devastation during Hurricane Sandy and subsequent coastal events such as damaged property and the disruption of millions of lives. Damages from Hurricane Sandy were estimated at $65 billion.

Study Area, by the numbers

- Over 354,000 permanent inhabitants
- 100,000 inventory assets,
- $60 billion in damageable value
- $1 Billion in Future Without Project Damages

During that storm the tide gauge at the Battery in New York City reached +11.2 feet NAVD88, approximately 9 feet above the predicted water level. An adjacent gauge in Montauk reached +5.5 feet NAVD88, approximately 5 feet above the predicted level. As a result, Congress authorized USACE to undertake the NACCS to address flood risks of vulnerable coastal populations in areas affected by Hurricane Sandy. The NACCS evaluated the coastal storm damage risk to populations, infrastructure, the environment and cultural and historic sites from Virginia to Maine. The January 2015 NACCS final report identified nine high-risk focus areas in the North Atlantic region that were deemed to warrant additional analyses to address coastal flood risk, including the development of strategies to manage risk associated with relative sea level change (RSLC). The NCBB is one of nine high-risk focus areas identified in the NACCS.

Based on public coordination and an examination of existing and future without project (FWOP) conditions, the following problems were identified for the NCBB study area:

- **Inundation -** The NCBB study area is vulnerable to coastal storm-related inundation damages, including economic disruption to residential structures and infrastructure & life and safety risks.
- **RSLC/Climate Change -** The study area risk from storm damages will likely increase with RSLC for the FWOP condition.
- **Erosion -** The study area experiences shoreline losses from wave attack, wind forces and other elements.
- **Degraded Ecosystems -** The study area's coastal ecosystems fail to provide their natural ecosystem services.

Overall, our models indicate that the NCBB study are is anticipated to experience $1 billion in average annual damages for the study period from 2030 to 2080 with no federal project in place as a result of coastal storms, RSLC, erosion and inundation. This study looks to make a recommendation for a project to reduce those damages.

ES-3 Plans Considered

The feasibility study focused on critical infrastructure and highly vulnerable areas (HVAs) in Nassau County, NY with an overall study goal to promote resilience and sustainability of communities in the study area by reducing risk to life safety and reducing potential structure/content damage while allowing solutions to be adaptable to RSLC. In order to distinguish HVAs from the remainder of the Nassau County study area, the USACE utilized data from the NACCS (which ranked the value and density of critical infrastructure in Nassau County), as well as economic modeling outputs from Hydrologic Engineering

Center-Flood Damage Reduction Analysis (HEC-FDA). Per the NACCS, the Department of the Army Field Manual (FM) 3-34.170 was utilized to rank infrastructure that supports populations and communities. The sewage, water, electricity, academics, trash, medical, safety and other considerations (SWEAT-MSO) assessment process provided immediate feedback concerning the status of the basic services necessary to sustain population, as detailed in the FM. The SWEAT-MSO assessment represents a complete evaluation of assets susceptible to direct exposure from storm damage, as well as the indirect damages that would follow by identifying the assets within and support to a community. In addition, Average Annual Damage (AAD) outputs from HEC-FDA were evaluated and mapped to identify HVAs with a high AAD potential. Based on the combination of high potential for repetitive damage (AAD) and dense critical infrastructure, four HVAs (encompassing approximately 29% of the study area) were identified: Village of Freeport, Oceanside & East Rockaway Villages, Island Park Village and City of Long Beach.

The development and analysis of alternatives included structural, non-structural and natural and nature-based features (NNBF) and ultimately helped shape the focused array of alternatives that were evaluated and compared.

The focused array of alternatives included the following:

1. No Action Plan – Potential for approximately $1 billion in storm damages from 2030 to 2080
2. Non-Structural (NS) Countywide Plan
    - Elevation of 14,183 residential structures to the modeled 1% AEP non-structural design water surface elevation (which includes intermediate sea level change projected to 2080).
    - Dry flood proofing of 2,667 industrial and commercial (non-residential) structures from the ground surface up to 3 feet above ground.
3. Comprehensive Structural HVA & NS Plan
    - Comprehensive Floodwall at the City of Long Beach
        - 46,400 linear feet of floodwall construction at elevation +16 feet NAVD88 (North Atlantic Vertical Datum of 1988)
        - Floodwall Type (Concrete Cantilever Wall on Piles) – Type B (waterborne construction) & Type C (construction from land)
        - 5 miter gates at elevation +16 feet NAVD88
        - 4 road & 1 rail closure gate at elevation +16 feet NAVD88
    - Elevation of 12,251 residential structures to the modeled 1% AEP non-structural design water surface elevation (which includes intermediate sea level change projected to 2080).
    - Dry flood proofing of 2,140 industrial and commercial structures from the ground surface up to 3 feet above ground.
4. Localized Structural Critical Infrastructure (CI) & NS Plan
    - Elevation of 14,159 residential structures to the modeled 1% AEP non-structural design water surface elevation (which includes intermediate sea level change projected to 2080).
    - Dry flood proofing of 2,427 industrial and commercial structures from the ground surface up to 3 feet above ground.
    - Localized floodwall around critical infrastructure in the Village of Freeport
        - 12,250 linear feet of floodwall construction at elevation +16 feet NAVD88
        - Floodwall Type – Type B & Type C
        - 3 road closure gates at elevation +16 feet NAVD88

- Localized floodwall around critical infrastructure in Island Park & Vicinity
  - 6,950 linear feet of floodwall construction at elevation +16 feet NAVD88
  - Floodwall Type – Type C
  - 2 road closure gates at elevation +16 feet NAVD88
  - 2 sluice gates at elevation +16 feet NAVD88
- Localized floodwall around critical infrastructure in the City of Long Beach
  - 10,280 linear feet of floodwall construction at elevation +16 feet NAVD88
  - Floodwall Type – Type C
  - 3 road & 1 rail closure gates at elevation +16 feet NAVD88

The three localized floodwalls discussed above were formulated in the HVAs and preliminary cost/benefit analysis was conducted for them. However, the USACE did not limit localized floodwall for critical facilities just to HVAs. The team reached out to the Non-Federal Sponsor and coordinated a site visit to identify any additional areas that would meet the established criterion. From that visit, the Cedar Creek Wastewater Treatment Plant (WWTP) in Wantagh, NY was identified as another location.

- Localized floodwall around Cedar Creek Wastewater Treatment Plant (Wantagh, NY)
  - 6,000 linear feet of floodwall construction at elevation +16 feet NAVD88
  - Floodwall Type – Type C
  - 1 road closure gate at elevation +16 feet NAVD88

In addition, evacuation routes were evaluated as a critical facility within the “Other” category of the SWEAT-MSO guidance. Figure 45 shows the four (4) major evacuation routes within Nassau County. Portions of Evacuation Routes No.1 and No. 4 that are within the 1% AEP floodplain were considered for a localized floodwall.

- Localized floodwall around Evacuation Route No. 1 (Far Rockaway, NY)
  - 7,000 linear feet of floodwall construction at elevation +16 feet NAVD88
  - Floodwall Type – Type C
  - 4 road closure & 1 sluice gate at elevation +16 feet NAVD88
- Localized floodwall around Evacuation Route No. 4 (Wantagh, NY)
  - 800 linear feet of floodwall construction at elevation +16 feet NAVD88
  - Floodwall Type – Type C

While the Cedar Creek WWTP localized floodwall and the Evacuation Routes 1 and 4 floodwalls have not gone through a cost/benefit analysis to date, their potential impacts are evaluated in this draft Integrated Feasibility Report and Environmental Impact Statement (DIFR-EIS) as they will be further analyzed as the study progresses.

5. Locally Preferred Plan – Not Applicable

Each alternative will potentially include NNBF measures as complementary features to be evaluated further during plan optimization.

ES-4 Environmental Considerations

The study area is a complex array of marine, estuarine, coastal, and terrestrial ecosystems. To facilitate a thorough description of conditions, the study area has been partitioned into a series of defined ecosystems and habitats.

Table ES- 1: NCBB Ecosystem and Habitat Designations

Ecosystem/Habitat	Definition
Marine Offshore Ecosystem	
Marine Offshore	Subtidal marine habitat ranging in depth from 30 to 100 feet; includes pelagic (open water) and benthic (bottom) zones
Atlantic Shores and Inlets Ecosystems	
Marine Nearshore	MLW to depth of 30 feet; includes pelagic and benthic zones
Marine Intertidal	Extends from mean low water (MLW) to mean high water (MHW) with a sandy and/or rocky substrate
Marine Beach	Extends from MHW on the ocean side to the boundary of the primary dunes and swales habitat within the barrier island ecosystem; sandy substrate
Inlets	Areas of water interchange between bay and ocean zones (e.g., Rockaway East Inlet, Jones Inlet, and Fire Island Inlet)
Barrier Island Ecosystems	
Dunes and Swales	Extends from the seaward toe of the primary dune through the most landward primary swale system; includes freshwater ponds, wetlands, and sparsely-vegetated shrub or forested communities found within this zone.
Terrestrial Upland	Extends from the landward boundary of the primary dunes and swales habitat on the ocean side to MHW of the bay intertidal habitat; includes all upland as well as any freshwater wetland habitats within this zone; bayside beach and maritime forested habitats are included in this habitat.
Maritime Forest	Forested communities found within the terrestrial upland habitat. These areas are defined by salt tolerant vegetation, high salinity and salt spray adapted soils and vegetation assemblages such as trees, shrubs, and herbaceous species.
Bayside Beach	Unvegetated sandy areas between MHW and the bayside limit of upland vegetation; included in the terrestrial upland habitat. This habitat is also present in association with the mainland upland habitat where mainland shoreline is adjacent to backbay areas.
Backbay Ecosystems	
Bay Intertidal	Extends from MHW to MLW on the bay side of the barrier island. Habitats such as sand shoals, mud flats, and salt marsh are included in bay intertidal habitat
Sand Shoal and Mud Flat	Unvegetated areas within the bay intertidal habitat exposed at low tide. Sand shoals and mud flats differ on the basis of sediment texture and grain size, providing separate but potentially overlapping infaunal and epifaunal habitats.
Salt Marsh	Bayside vegetation communities found within the bay intertidal habitat that are dominated and defined by salt-tolerant species, predominantly salt marsh cordgrass (*Spartina alterniflora*) and salt meadow cordgrass (*Spartina patens*). Occurs from the landward limit of the high marsh vegetation, sometimes also MHW or slightly landward, to the seaward limit of the intertidal marsh vegetation
Bay Subtidal	Bayside aquatic areas below MLW, including channels and deeper areas of the bay that are always inundated.
Submerged Aquatic Vegetation (SAV)	Bayside submerged aquatic vegetation (SAV) communities found within the bay subtidal habitat

Mainland Upland Ecosystem	
Mainland Upland	Area generally extends from the landward limit of the bay intertidal MHW line to the landward limit of the study area which generally correlates with Sunrise Highway (Route 27). This habitat also includes mainland wetlands and coastal ponds. Along the Atlantic shorefront, mainland upland begins at the landward toe of the primary dune. Along the mainland shoreline adjacent to backbay areas, this habitat also includes bayside beach.

Pertinent public laws applicable to the NCBB study are presented below. In some situations, the laws have been previously discussed and prior section references are provided. The status of compliance with applicable environmental laws and executive orders is provided in Table ES-2.

Table ES- 2: Compliance with Federal Environmental Protection Statutes and Executive Orders

Federal Statutes and Executive Orders	Level of Compliance for draft EIS*
Archaeological and Historic Preservation Act	Full
Bald and Golden Eagle Protection Act	Full
Clean Air Act	Full
Clean Water Act	Full
Coastal Barrier Resources Act	Full
Coastal Zone Management Act	Full
Comprehensive Environmental Response, Compensation and Liability Act	Full
Endangered Species Act	Full
Estuary Protection Act	Full
Farmland Protection Policy Act	Full
Fish and Wildlife Coordination Act	Full
Magnuson-Stevens Fishery Conservation and Management Act	Full
Marine Mammal Protection Act	Full
National Environmental Policy Act	Full
National Historic Preservation Act	Full
Resource Conservation and Recovery Act	Full
Rivers and Harbors Act	Full
Wild and Scenic Rivers Act	N/A
Executive Orders (EO), Memoranda, etc.	
Migratory Bird (EO 13186)	Full
Protection and Enhancement of Environmental Quality (EO 11514)	Full
Protection and Enhancement of Cultural Environment (EO 11593)	Full
Floodplain Management (EO 11988)	Full
Protection of Wetlands (EO 11990)	Full
Environmental Justice in Minority and Low-Income Populations (EO 12898)	Full
Invasive Species (EO 13112)	Full
Protection of Children from Health Risks and Safety Risks (EO 13045)	Full
Prime and Unique Farmlands (CEQ Memorandum, 11 August 1980)	N/A

Federal Statutes and Executive Orders	Level of Compliance for draft EIS*
*Level of Compliance Relevant to the current study phase: *Full Compliance (Full)*: Having met all requirements of the statute, E.O., or other environmental requirements. *Partial Compliance (Partial)*: Not having met some of the requirements at current stage of planning. Compliance with these requirements is ongoing. *Non-Compliance (NC)*: Violation of a requirement of the statute, E.O., or other environmental requirement. *Not Applicable (NA)*: No requirements for the statute, E.O, or other environmental requirement for the current stage of planning.	

While each of the above-referenced statutes and executive orders affected the plan formulation approach, it is important to note the impact of the Coastal Barrier Resources Act (CBRA) on alternative development. As discussed in Chapter 4, the presence of a CBRA System Unit in the study area greatly impacted alternative development, with specific impact on the storm surge barrier analysis (Chapter 4.5). While various combinations of storm surge barriers were modeled to evaluate their hydraulic effectiveness, the study area's hydraulic characteristics required at least one storm surge barrier and/or interior bay surge barrier to be located entirely within the footprint of a CBRA System Unit in order to effectively address both of the principle processes (storm surge propagation through tidal inlets - East Rockaway Inlet, Jones Inlet and Fire Island Inlet, and local wind-driven storm surge along the east-west bay axis) driving storm-related damages in the study area. Therefore, the study team modeled storm surge barrier combinations that included barriers within the CBRA System Unit to better understand their hydraulic effect, regardless of the CBRA System Unit constraint. For reasons further discussed in Chapter 4.5, the study team found that the storm surge barrier combinations were not effective CSRM solutions, regardless of the presence of or lack thereof of CBRA System Units. That being said, given the limited effectiveness and efficiency of the storm surge barriers and the large geographic presence of the CBRA System Unit, the USACE screened storm surge barriers from further consideration.

ES-5 Tentatively Selected Plan

The Tentatively Selected Plan (TSP) is the non-structural (NS) Countywide Plan and includes the following:

- Elevation of 14,183 residential structures to the modeled 1% AEP non-structural design water surface elevatio (which includes intermediate sea level change projected to 2080).
- Dry floodproofing of 2,667 industrial and commercial (non-residential) structures from the ground surface up to 3 feet above ground.

This plan maximizes National Economic Development (NED) Benefits by reducing coastal storm damage to the study area. The current TSP is subject to concurrent public, resource agency, technical and policy review. After the review period concludes the USACE will hold an internal meeting (Agency Decision Milestone) to discuss

> The TSP reasonably maximizes net NED benefits under the Intermediate RSLC curve with approximately $475 million in average annual net benefits (AANB) and a 4.5 Benefit Cost Ratio. Approximately 14,183 residential structures and 2,667 non-residential structures are eligible for elevations and dry flood proofing,

the review comments and the path forward, where this plan is either affirmed in a Final IFR-EIS and subsequent Chief of Engineers Report, or revised based on the aforementioned concurrent review feedback.

Table ES- 3: TSP Economic Summary

Future Without-Project Average Annual Damages (AAD)	$1,011,964,000
Future With-Project AAD	$401,393,000
Total Reduced AAD	**$610,571,000**
Total Initial Construction	$3,849,693,000
Average Annual OMRR&R	$0
Average Annual Cost (AAC)	**$135,733,000**
Average Annual Net Benefits	**$474,839,000**
Benefit-Cost Ratio	**4.5**
Residual Damages	40%
Eligible Nonstructural	16,850

Figure ES-4 shows structures within the study are to be elevated (red dots) and flood proofed (yellow dots) as part of the TSP.

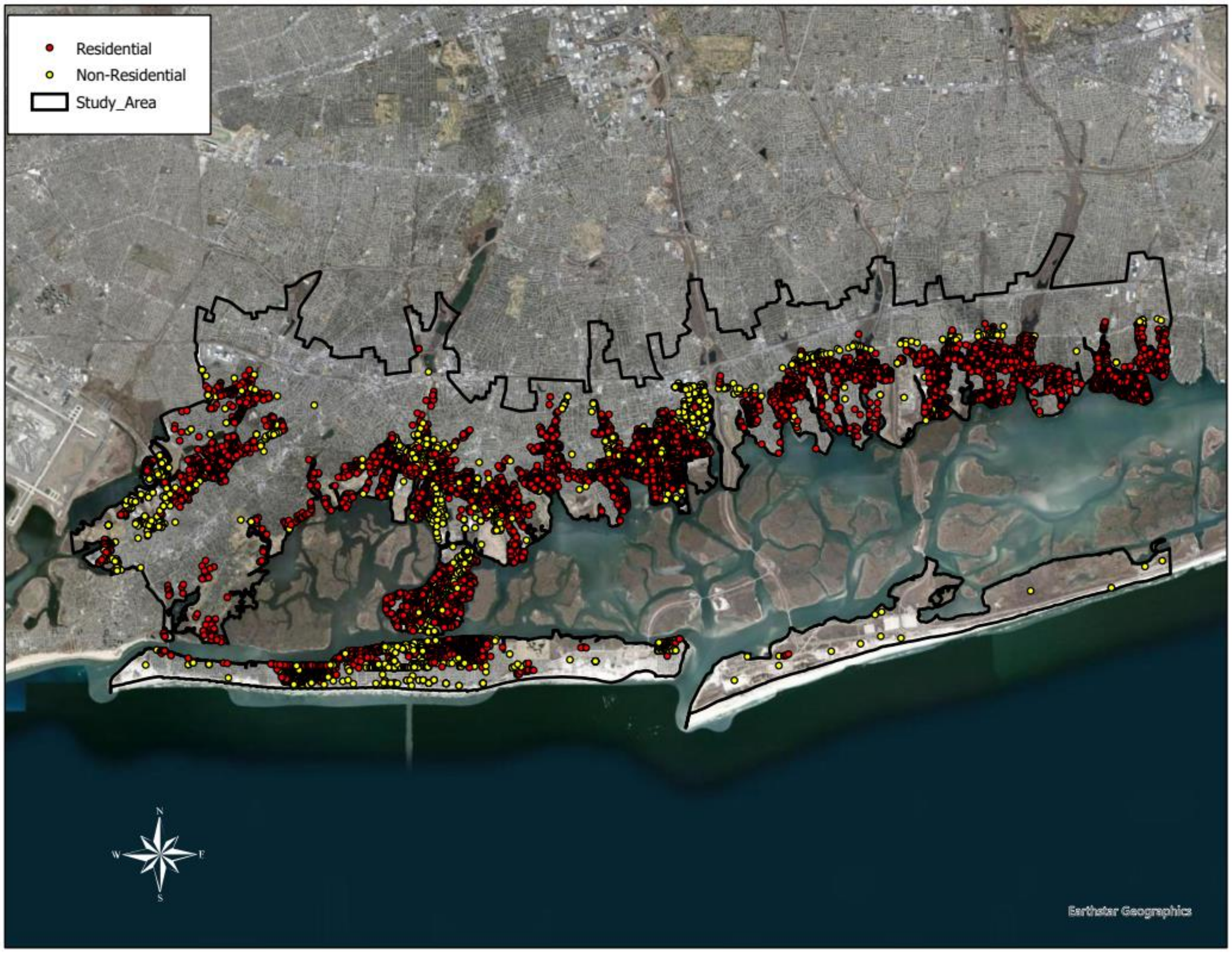

Figure ES- 2: Tentatively Selected Plan Location

Based on the variability of structure type and condition in the study area, the USACE identified three potential methodologies for residential structure elevation: Elevation with Piles, Elevation with Posts/Columns and Elevation with Extended Foundations.

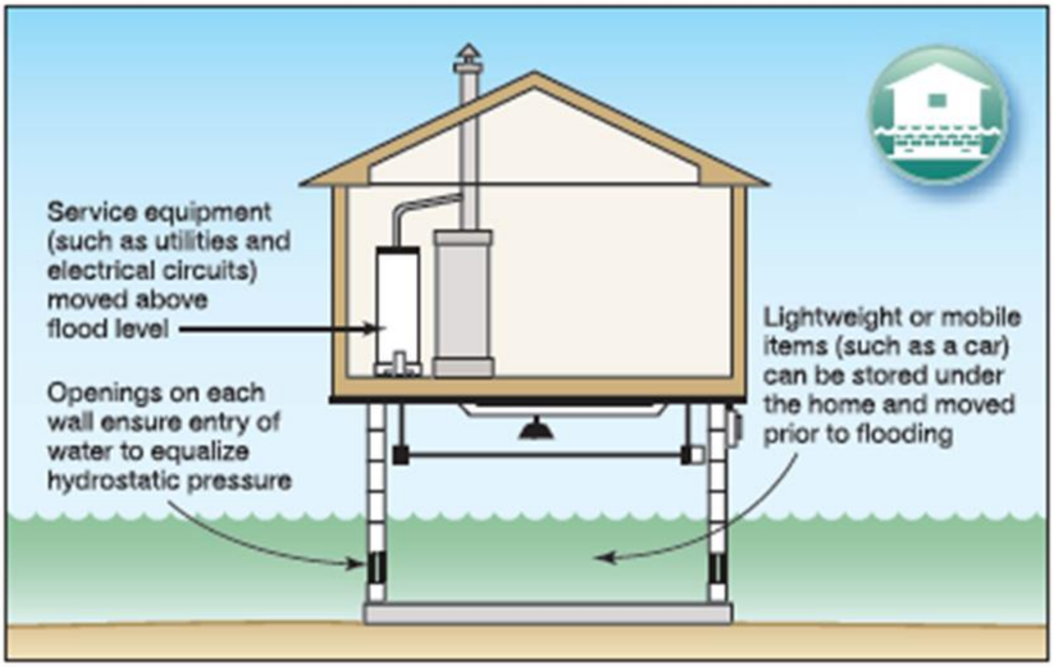

Figure ES- 3: Home Elevation Concept Diagram (Courtesy of Google Images)

Figure ES- 4: Before/After Home Elevation Renderings

In addition to structure raising, the study team evaluated solutions that involved dry floodproofing properties that could not be elevated. Per FEMA, dry floodproofing includes measures that make a structure watertight below the level that needs flood protection to prevent floodwaters from entering. In this study, dry floodproofing included installing stop logs, flood shields and impervious membranes around commercial/industrial/police/fire structures in order to prevent water from entering the building. For at-risk industrial and commercial facilities, dry floodproofing generally consisted of sealing all areas from the ground level up to approximately 3 feet of a structure. Such dry floodproofing measures will help make walls, doors, windows and other openings resistant to penetration by storm surge waters. Water and sewer back-flow prevention mechanisms (such as drain plugs, standpipes, grinder pumps and back-up valves) are also included in dry floodproofing. Openings, such as doors, windows, sewer lines and vents, may also be closed temporarily, with sandbags or removable closures.

Figure ES- 5: Dry Flood Proofing Rendering @ Island Park Fire Department

Figure ES- 6: Example Stop Log

Recognizing that the initial non-structural formulation will inherently have residual risk, none of the other non-structural measures have been screened out at this point because they will be further analyzed during feasibility-level design to ensure a complete plan is formulated. Residual risk is the coastal storm risk that remains in the floodplain even after a proposed coastal storm risk management project is constructed and implemented. Residual risk in the study area will be approximately 40% of the without project damages, alternatively, this project will reduce damages by approximately 60%.

Table ES- 4: Project Costs and Cost Sharing (October 2020 Price Level)

	Federal Cost (65%)	Non-Federal Cost (35%)	Total Cost
Coastal Storm Risk Management Cost	$2,502,300,450	$1,347,392,550	$3,849,693,000
LERRD Cost	$0	$0*	$3,849,693,000
Total Cost	$2,502,300,450	$1,347,392,550	$3,849,693,000

Note: *Please refer to Section 4.9.2 for details on the LERRD cost sensitivity analysis

Nassau County Back Bays Coastal Storm Risk Management Feasibility Study

Draft Feasibility Report & Environmental Impact Statement

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1.0 Introduction (*NEPA Required)

Nassau County is located on Long Island, NY, between Queens County to the west and Suffolk County to the east. Nassau County has a population of 1.3 million people, a land area of 287 square miles, and 166 square miles of water. Southern Nassau County is typified by dense, low elevation mixed-use development (residential and commercial), a highly developed shoreline, and many roads, rail roads, and critical facilities that serve Long Island and parts of New York City. Beaches and back bay wetland areas provide habitat for many regionally and nationally important aquatic and terrestrial species. It is assumed that future land use will be similar to current land use. It is further assumed that the location and use of major infrastructure such as roads, rail roads, wastewater treatment plans, fire departments, and police departments will not significantly change in the future.

The Nassau County Back Bays (NCBB) region currently lacks a comprehensive coastal storm risk management (CSRM) program. As a result, the NCBB region experienced major impacts and devastation during Hurricane Sandy and subsequent coastal events such as damaged property and the disruption of millions of lives.

The NCBB is one of nine focus areas identified in the North Atlantic Coast Comprehensive Study (NACCS), the goals of which are to:

a. Provide a risk management framework, consistent with National Oceanic and Atmospheric Administration (NOAA)/U.S. Army Corps of Engineers (USACE) Infrastructure Systems Rebuilding Principles; and

b. Support resilient coastal communities and robust, sustainable coastal landscape systems, considering future sea level and climate change scenarios, to reduce risk to vulnerable populations, property, ecosystems, and infrastructure.

While the NACCS provides a regional scale analysis, the NCBB CSRM Study employs NACCS outcomes and applies the NACCS CSRM framework to formulate a more refined and detailed watershed-scale analysis to develop a comprehensive CSRM program for the NCBB region. The study considers potential municipal or community level implementation opportunities, strategies and measures to help communities understand and manage their short-term and long-term coastal risk in a systems context.

The USACE formulated and evaluated non-structural and structural measures, as well as NNBF, in accordance with USACE plan formulation policy. The measures were compared against the study objectives and for consistency with the study purpose. Alternative development focused on critical infrastructure and highly vulnerable areas (HVAs) in Nassau County, NY with an overall study goal to promote resilience and sustainability of communities in the study area by reducing risk to life safety and reducing potential structure and content damage while allowing solutions to be adaptable to RSLC. In order to

> Plan Formulation Summary
>
> Non-structural measures are intended to reduce human exposure to a flood hazard without altering the nature or extent of the hazard.
>
> Structural measures are engineering solutions to manage flood risk and reduce damage from coastal storms. Structural measures are intended to physically limit flood water inundation from causing damage.
>
> NNBF measures include natural coastal features and engineered nature-based features intended to mimic natural features and provde flood risk management.

distinguish HVAs from the remainder of the Nassau County study area, the USACE utilized data from the NACCS (which ranked the value and density of critical infrastructure in Nassau County), as well as economic modeling outputs from Hydrologic Engineering Center-Flood Damage Reduction Analysis (HEC-FDA). Per the NACCS, the Department of the Army Field Manual (FM) 3-34.170 was utilized to rank infrastructure that supports populations and communities. The sewage, water, electricity, academics, trash, medical, safety and other considerations (SWEAT-MSO) assessment process provided immediate feedback concerning the status of the basic services necessary to sustain population, as detailed in the FM. The SWEAT-MSO assessment represents a complete evaluation of assets susceptible to direct exposure from storm damage as well as the indirect damages that would follow by identifying the assets within and support to a community. In addition, Average Annual Damage (AAD) outputs from HEC-FDA were evaluated and mapped to identify HVAs with a high AAD potential. Based on the combination of high potential for repetitive damage (AAD) and dense critical infrastructure, four HVAs (encompassing approximately 29% of the study area) were identified: Village of Freeport, Oceanside & East Rockaway Villages, Island Park Village and City of Long Beach.

After the initial cycles of plan formulation, the Tentatively Selected Plan (TSP)/Proposed Action is the Non-Structural (NS) Countywide Plan, which includes elevating 14,183 residential structures and floodproofing 2,667 industrial/commercial structures. This TSP was selected because it is the plan that reasonably maximizes National Economic Development (NED) benefits (i.e., it has the highest average annual net benefits). The USACE will continue to evaluate the impacts of the Localized Structural Critical Infrastructure & NS Plan, because it has a high potential to increase community resilience and minimize environmental degradation by more effectively reducing damages and/or disruption to large-scale critical infrastructure.

1.1 Study Authority

The study is authorized by Chapter 140 of Public Law 71 (15 June 1955), which states:

That in view of the severe damage to the coastal and tidal areas of the eastern and southern United States from the occurrence of hurricanes, particularly the hurricanes of August 31, 1954, and September 11, 1954, in the New England, New York, and New Jersey coastal and tidal areas… The Secretary of the Army… is hereby authorized and directed to cause an examination and survey to be made of the eastern and southern seaboard of the United States with respect to hurricanes, with particular reference to areas where severe damages have occurred.

1.2 Study Area

The study area limits were established using the following principles and assumptions. It included all of the tidally influenced bays and estuaries hydraulically connected to the south shore of Nassau County on the Atlantic Ocean. The regular rise and fall of tides in the ocean lead to tidal flow through East Rockaway, Jones, and Fire Island Inlets that causes a corresponding rise and fall of water levels in the back bays. The study area is thus subject to tidal impacts under non-storm conditions, as well as to more widespread inundation during coastal storm events.

The back bay area of Nassau County has hydraulic connections to areas to the west in Queens County, NY, and Suffolk County NY to the east. In addition, all of these areas experienced significant adverse effects from Hurricane Sandy. However, vulnerable areas in Queens and Suffolk Counties are being addressed under other study authorities (Jamaica Bay-Rockaway NY and Fire Island to Montauk Point NY, respectively), and have construction capability as part of the Sandy Appropriation (Public Law 113-2); therefore, the east-west boundary of this feasibility study will be limited to the east-west extent of Nassau County (Figure 1).

The northern study area boundary along the mainland of Long Island was established using NACCS water level statistics for the 0.2% annual exceedance probability or AEP (500-year return period). The vertical datum used in the NACCS water level calculations is local mean sea level (LMSL) in meters. The NACCS water surface elevations were converted to units of feet relative to NAVD88 using the application known as VDatum, developed and maintained by NOAA. This conversion was necessary because NAVD88 is the standard vertical datum used for topographic (elevation) surveying and mapping. Three feet was added to the NACCS water surface elevations to account for potential future relative sea level change (RSLC), then each value was rounded to the nearest whole foot. The resulting elevation contour selected as the northern study area boundary was thus +19 feet NAVD88. The boundary line was smoothed using engineering judgment so that it did not cut through real estate parcels. The typical distance from the northern study area boundary to the ocean shoreline of Long Beach, Jones, and Fire Islands is between 5 and 7 miles.

The southern boundary corresponds to the Atlantic Ocean offshore of Long Beach and Jones Island.

Nassau County is a highly developed, low-lying region in the New York City metropolitan area that is home to over 700,000 residents and thousands of businesses. Communities in the study area include villages and unincorporated municipalities in the towns of Hempstead and Oyster Bay that border Hewlett Bay, Middle Bay, Jones Bay, South Oyster Bay, and connected creeks, channels, and minor water bodies, as well as the City of Long Beach.

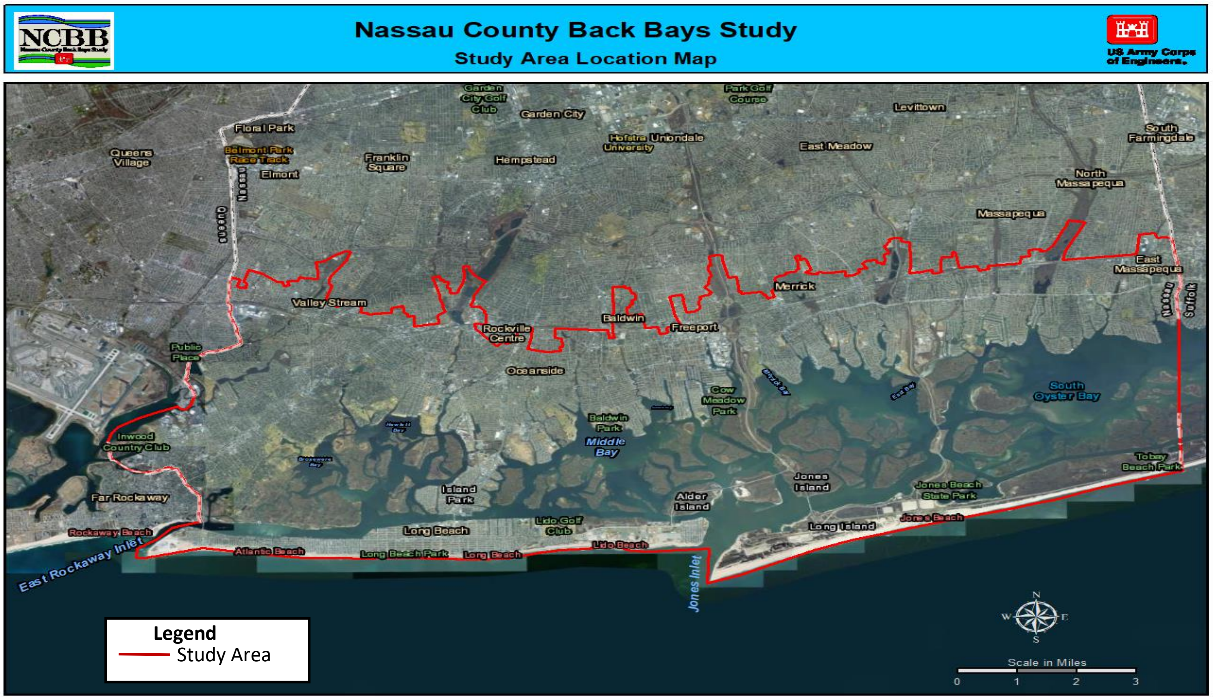


Figure 1 - Study Area

1.3 Problems and Opportunities

The following problems and opportunities were identified based on public coordination and an examination of existing and future without project (FWOP) conditions.

Problems

- **Inundation -** The NCBB study area is vulnerable to coastal storm-related inundation damages, including economic disruption to residential structures and infrastructure & life and safety risks.
- **RSLC/Climate Change -** The study area risk from storm damages will likely increase with RSLC for the FWOP condition.
- **Erosion -** The study area experiences shoreline losses from wave attack, wind forces and other elements.
- **Degraded Ecosystems -** The study area's coastal ecosystems fail to provide their natural ecosystem services.

Opportunities

- Manage coastal storm risk to structures, infrastructure and life safety.
- Apply solutions that are adaptable and sustainable with rising sea levels.
- Establish solutions designed to combat erosion.
- Integrate storm risk management and apply the qualitative NACCS resilience criteria designed to improve adaptive capacity.
- Improve ecosystem goods and services provided through quantitative review of measures and alternatives.

1.4 Purpose and Need (*NEPA Required)

The purpose of the study is to determine the feasibility of a project to reduce the risk of coastal storm damage in the back bays of Nassau County, New York, while contributing to the resilience of communities, important infrastructure, and the natural environment. The area includes significant critical infrastructure at risk of damage from future flooding and coastal storms including: Long Island Rail Road (serving 31.5 million annual rides); over two dozen police, fire and emergency support service facilities; three major hospitals; energy facilities; communication and information technology facilities; water and wastewater facilities; and public housing (including that for low-income senior citizens). Additionally, the study area includes important habitat for federally threatened and endangered species. The study is needed because the study area experiences frequent flooding from high tides, spring tides, sunny day flooding, and coastal storms; is considered at high risk of coastal storm flooding with an associated threat to life safety; includes a degraded back bay ecosystem supporting sensitive species and habitats; and is susceptible to RSLC. The study will utilize a system-wide, integrated approach that incorporates the natural, social, and built systems to support resilient coastal communities and sustainable ecosystems. Protection and restoration of natural systems can contribute to addressing coastal storm risk reduction and improve resiliency to the system.

As a result of Hurricane Sandy, Congress authorized USACE to undertake the NACCS to address flood risks of vulnerable coastal populations in areas affected by Hurricane Sandy. This culminated with the January 2015 completion of the NACCS final report, which identified nine high-risk focus areas in the North Atlantic region that were identified for additional analyses to address coastal flood risk, including the development of strategies to manage risk associated with RSLC. One of the nine high-risk focus areas is Nassau County. This study will be a targeted investigation into opportunities to address flood risks within Nassau County.

The purpose of this NEPA action is to evaluate impacts from alternatives that address the need for the action. The current TSP addresses the need to reduce flood risks. Additional complimentary CSRM measures are being further considered to reduce risk to critical infrastructure and incorporate NNBF to utilize an improved ecosystem to support CSRM.

1.5 Planning Goals and Objectives

The Federal Government investigates prospective projects from a national point of view. When determining the need for Federal investment in a project, the primary analysis centers on the significance of the problem and the benefits of possible solutions. In the case of this study, the primary goal is focused on CSRM benefits. It is also in the Federal and non-Federal sponsor's interest to select a cost-efficient plan, specifically one in which the benefits exceed the costs. It is important to note that benefits can include non-monetary benefits such as reducing life-safety issues and improving the environmental quality. Federal interest in the project is identified when both requirements are satisfied.

USACE developed planning objectives to apply to the entire study area over the 50-year period of analysis (2030 to 2080):

- Reduce potential life loss related to coastal flooding in the study area through 2080.
- Reduce the risk of coastal storm damage to public infrastructure and important societal resources, as well as highly vulnerable portions of Nassau County through 2080.
- Contribute to the long-term sustainability and resilience of coastal communities in Nassau County through 2080.

1.6 Planning Constraints

Constraints are actions to avoid, or conditions that cannot be changed while trying to meet study objectives.

- Avoid construction within Coastal Barrier Resources Act (CBRA) System Units
- Avoid impacts to life safety activities for the U.S. Coast Guard
- Avoid impacts to Federal navigation channels
- Avoid impacts to constructed and planned resilience projects
- Avoid impacts to Threatened and Endangered Species
- Minimize or avoid effects on cultural resources and historic structures, sites and features

1.7 Planning Considerations

- Avoid induced coastal flooding in adjacent communities, and flooding from rainfall or overwhelming of existing interior drainage systems
- Avoid degradation to water quality

1.8 Prior Reports & Existing Projects

The south shore of Long Island has repeatedly suffered devastating impacts from storms of both extra-tropical (northeasters) and tropical origin, including major northeasters in 1950, 1962, 1979, 1984, 1991, 1992, 1993, and 1995; and Tropical Storm Lee in 2011. Hurricanes resulting in significant damage include the great unnamed storm of 1938, Carol in 1954, Donna in 1960, Gloria in 1985, Bob in 1991, Felix and Luis in 1995, Irene in 2011, and Sandy in 2012. Flooding along the coast, other overland flooding, and wind damage from the continuous threat of storms have resulted in a multitude of projects and initiatives to reduce storm risks.

USACE has a series of navigation and CSRM projects within the region in Queens, Nassau, and Suffolk Counties: East Rockaway Inlet Dredging; Jones Inlet to Freeport Channel Navigation Improvements; The Atlantic Coast of New York, Jones Inlet to East Rockaway Inlet, Long Beach, New York Storm Damage Reduction Project; East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Project; Long Beach Erosion Control; The Fire Island Inlet to Montauk Point, New York, Combined Beach Erosion Control and Hurricane Protection Project; and Jamaica Bay Ecosystem Restoration; Shinnecock Inlet Navigation Project; the Westhampton Interim Project; the Moriches Inlet Navigation Project; and the West of Shinnecock Project. Regional efforts have been documented in prior USACE reports including 1) Integrated Hurricane Sandy General Reevaluation Report and EIS, Atlantic Coast of New York, East Rockaway Inlet to Rockaway Inlet and Jamaica Bay, 2018 (Sections 1.7 and 7.21); and 2) the Fire Island Inlet to Montauk Point Reformulation Study Draft Environmental Impact Statement, 2016 (Section 1.3). Projects (general and specific) described in more detail in these reports include:

- Inlet Stabilization - Fire Island, Moriches, and Shinnecock Inlets
- Navigation Channel Maintenance Dredging
- Breach Contingency Planning - Fire Island to Montauk Point
- Beach, dune, and berm placement and restoration (beach fill or replenishment), and associated off-shore borrow area use – Coney Island, Village of Westhampton, Shinnecock Inlet, Fire Island Inlet to Moriches Inlet Stabilization Project, Long Beach
- Major and minor structural projects including groins, bulkheads, revetments, geotextile-type structures, tetrapod structures, and other measures (cars buried in dunes) - Fire Island, Village of Westhampton, Downtown Montauk Stabilization Project, Long Beach

In addition to flood and storm risk-focused projects, the USACE 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. USACE completed near-term coastal restoration work at previously completed coastal storm risk reduction projects throughout the northeast that were impacted by Hurricane Sandy. These projects included the placement of millions of cubic yards of sand along impacted beaches to restore them at Rockaway Beach, Coney Island, Gilgo Beach, West of Shinnecock Inlet, and Westhampton.

Other regional USACE projects include:

- NY & NJ Harbor Deepening Contract Areas and Future OMRR&R Projections - The project provides 50-foot water access to the four container terminals linked to the main navigation channels in the Port of New York and New Jersey. The project includes 21 dredging contracts and construction of four marsh restoration projects. Marsh restoration projects are also part of the project at Woodbridge, NJ; and Elders West, Yellow Bar Hassock, and Elders Point East, Jamaica Bay, NY.
- Hudson-Raritan Estuary (HRE) Comprehensive Restoration Plan – The project is focused on to restoring and protect lost or degraded aquatic, wetland and terrestrial habitats within the HRE study area.
- Spring Creek North Restoration Project and Spring Creek South Hazard Mitigation Grant Program – The site along the north shore of Jamaica Bay consists of two separately funded projects referred to as Spring Creek North and Spring Creek South. Spring Creek North is focused on ecosystem restoration of low and high marsh and uplands while the Spring Creek South plans include NNBFs providing CSRM benefits and enhanced coastal resiliency to the Howard Beach Community.
- Jamaica Bay Marsh Islands, NY – Restoration of 125.5 acres of wetlands at Yellow Bar Hassock, Elders Point East, and Elders Point West. Yellow Bar Hassock wetland restoration incorporated the beneficial use of dredged material.

Additionally, regional wetlands restoration efforts by others include Yellow Bar, Black Wall and Rulers Bar Marsh Island Restoration; Broad Channel's Sunset Cove Salt Marsh Restoration Project; and Lido Beach Wildlife Management Area.

A number of long-term combined sewer projects (CSO) and wastewater treatment improvement projects have been undertaken to improve water quality and recreational use in local waterways. The following projects are some examples.

- Jamaica Bay CSO Upgrade Projects - Initiatives include wastewater treatment plant upgrades, shellfish pilot restoration projects, wetlands restoration, green infrastructure projects and mapping.
- NYC CSO Control Plan – Initiatives include upgrades in key wastewater treatment facilities, storm sewer expansions and the construction of several large CSO retention tanks to mitigate pollution.
- Bay Park Conveyance Project – The project will result in the conveyance of treated water from the Bay Park Sewage Treatment Plant to the Cedar Creek Water Pollution Control Plant's ocean outfall to reduce pollution in the Back Bay ecosystem.
- Point Lookout Sewer Feasibility Study
- Long Beach Consolidation Project

Additional projects developed after Hurricane Sandy were initiated under the Living With the Bay Project in Nassau County, NY, which was funded by the HUD Rebuild by Design Grant ($125 million). In addition, the City of Long Beach has initiated a bulkhead improvement project utilizing funding from FEMA. The details and status of that bulkhead project can be found at https://www.longbeachny.gov/bulkhead.

The Living With the Bay Project aims to increase the resiliency of communities along the Mill River and around the South Shore's bays by mitigating damage from storm surges; managing stormwater to mitigate damages from frequnet rain events; improving habitat and water quality; and increasing access to the Mill River through both educational and increased recreational opportunities.

Seven infrastructure projects and two social resiliency partners were selected by the Governors Office of Storm Recovery (GOSR) to comprise the Living with the Bay Project. The infrastructure projects stretch from the northernmost reaches of the Mill River at Hempstead Lake State Park and extend south to Bay Park at the mouth of Hewlett Bay and will be constructed in collaboration with Nassau County, Town of Hempstead, the Village of Rockville Centre, and East Rockaway School District. Specific details of each project in the portfolio can be found at Living with the Bay | Governor's Office of Storm Recovery (GOSR) (ny.gov).

1.9 USACE Civil Works Guidance and Initiatives

The USACE planning process is grounded in the 1983 Economic and Environmental Principles and Guidelines for Water and Related Land Implementation Studies (hereafter Principles and Guidelines). The Principles and Guidelines provide for the formulation of reasonable plans responsive to national, state, and local concerns. Within this framework, the USACE seeks to balance economic development and environmental needs as it addresses water resources problems. The Federal objective of water and related land resources planning is to contribute to NED consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable Executive Orders (EOs), and other Federal planning requirements.

The Planning Guidance Notebook (ER 1105-2-100) provides the overall direction to formulate, evaluate, and select projects for implementation. The study was conducted under the USACE's Civil Works modernization process by utilizing Specific, Measurable, Attainable, Risk-Informed, and Timely (SMART) planning to effectively execute and deliver the study in a timely manner. The study also meets the USACE Campaign Plan goals and the USACE Environmental Operating Principles by undertaking a proactive public involvement campaign, including a project website, and targeted stakeholder meetings. Active and responsive public involvement has informed the development of solutions to the problems this study seeks to address and has facilitated the sharing and distribution of data and knowledge. The relationships that the study team have developed with non-governmental organizations (NGOs), local officials, community, special interest groups, and agency partners have facilitated the consensus-building process to create a mutually supportable economic and environmentally sustainable solution for the Nation.

1.10 National Environmental Policy Act Compliance and Report Structure

This report integrates a Draft Environmental Impact Statement (EIS) into the feasibility report, resulting in a Draft Integrated Feasibility Report and Environmental Impact Statement (DIFR-EIS). Report sections required for compliance with the National Environmental Policy Act (NEPA) of 1969, as amended are indicated with an asterisk following the section heading. Currently this report is in a draft format.

This DIFR-EIS will undergo public review, legal and policy review, Agency Technical Review (ATR), and Independent External Peer Review (IEPR). The USACE will consider comments and present the TSP at an Agency Decision Milestone (ADM) meeting before developing a Final Integrated Feasibility Report and Environmental Impact Statement (FIFR-EIS). Comments received on this DIFR-EIS will be addressed at the internal ADM meeting with the non-Federal sponsor present.

The USACE serves as the lead agency for the preparation of the DIFR-EIS. This DIFR-EIS has been prepared to analyze and disclose the potential impacts of the NCBB study and reasonable alternatives on the natural and human environment. It is intended to be sufficient in scope to address Federal, state, and local requirements with respect to the proposed activities. Agency and tribal coordination are included in Appendix G1.

1.11 Non-Federal Sponsor and Congressional Representation

The non-Federal study sponsor is the New York State Department of Environmental Conservation (NYSDEC) in partnership with Nassau County, NY. A Feasibility Cost Sharing Agreement (FCSA) between USACE and NYSDEC was executed on 30 September 2016. An FCSA Amendment was executed between USACE and NYSDEC on 30 June 2020, thereby transitioning the study to 100% Federal funding under the Bipartisan Budget Act of 2018 (Public Law 115-123).

The study area is represented by NY Senators Charles Schumer and Kirsten Gillibrand, Representative Peter King (NY-02), Representative Kathleen Rice (NY-04), and Representative Gregory Meeks (NY-05).

2.0 Existing Conditions

2.1 Climate Change

Several trends associated with climate change have been identified for the NCBB Region, including RSLC, increases in damages from coastal storms, and increases in more intense storm events.

2.1.1 Sea Level Change

Global sea level change (SLC) is often caused by the global change in the volume of water in the world's oceans in response to three climatological processes: 1) ocean mass change associated with long-term forcing of the ice ages ultimately caused by small variations in the orbit of the earth around the sun; 2) density changes from total salinity; and most recently, 3) changes in the heat content of the world's ocean, which recent literature suggests may be accelerating due to global warming. Global SLC can also be caused by basin changes through such processes as seafloor spreading. Thus, global sea level, also sometimes referred to as global mean sea level, is the average height of all the world's oceans.

Relative (local) SLC (RSLC) is the local change in sea level relative to the elevation of the land at a specific point on the coast. RSLC is a combination of both global and local SLC caused by changes in estuarine and shelf hydrodynamics, regional oceanographic circulation patterns (often caused by changes in regional atmospheric patterns), hydrologic cycles (river flow), and local and/or regional vertical land motion (subsidence or uplift). RSLC in the study area is higher than global SLC.

Historical RSLC for this study (3.90 mm/yr) is based on NOAA tidal records at Sandy Hook, NJ. Sandy Hook, NJ is selected to represent long-term trends in RSLC for the study area because this station best represents the regional oceanographic/atmospheric patterns and local vertical land motion. Figure 2 and Figure 3 show historical RSLC at Sandy Hook for 1933 – 2020 and 1983 – 2020, respectively. Several metrics for sea level are presented, the monthly mean sea level (light blue), 5-year moving average (orange), and 19-year moving average (dark blue). It is apparent that over long time scales (19 years) mean sea level is steadily increasing. However, over shorter time scales mean sea level may increase or decrease (USACE ER 1100-2-8162, EP 1100-2-1).

The monthly mean sea level, light blue line in Figure 2, appears to go up and down every year capturing the seasonal cycle in mean sea level. The 5-year moving average, orange line in Figure 3, captures the interannual variation (2 or more years) of sea level. Predicted future RSLC is based on these data and is discussed in Section 3.1.1.

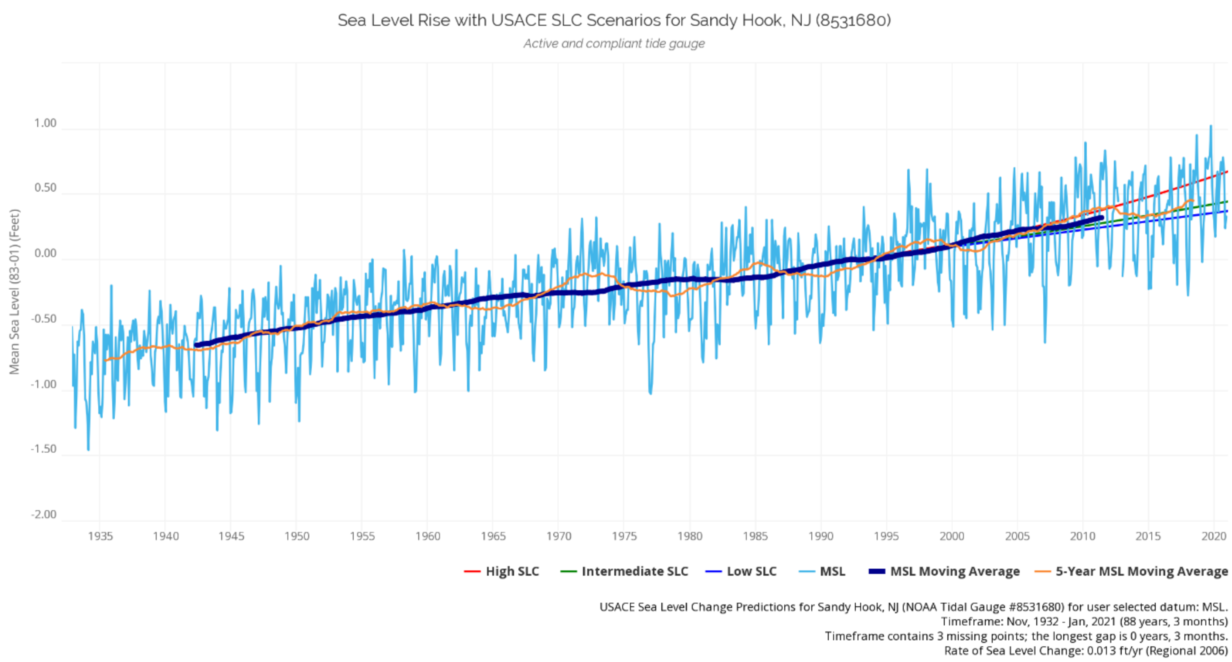


Figure 2 - Historical (1933-2021) Relative Sea Level Change at Sandy Hook, NJ

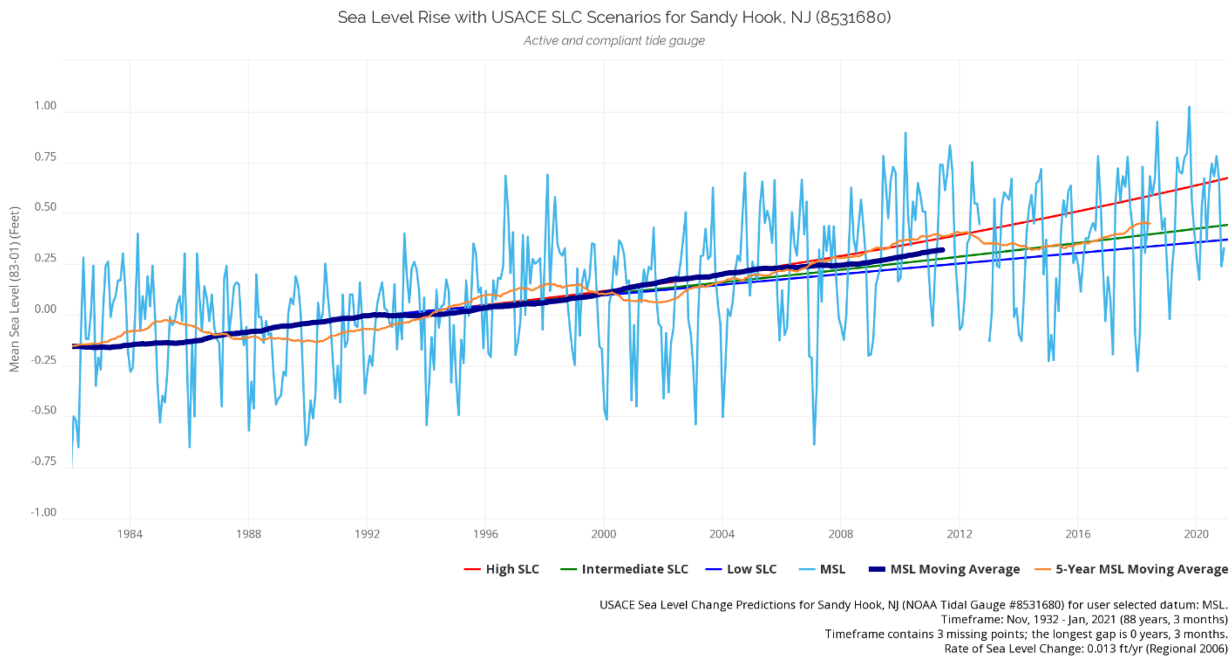


Figure 3 - Historical (1983-2021) Relative Sea Level Change at Sandy Hook, NJ

2.1.2 High Frequency Flooding

High-frequency flooding, also known as nuisance flooding, recurrent flooding, or sunny-day flooding, includes flood events caused by tides and/or minor storm surge that occur more than once per year. High-frequency flooding mostly affects low-lying and exposed assets or infrastructure, such as roads, public storm-, waste- and fresh-water systems (Sweet et. al 2018) and is likely more disruptive (a nuisance) than damaging. However, the cumulative effects of high-frequency flooding may be a serious problem to residents who live and work in these low-lying areas.

Flooding from rainfall and inadequate storm water systems are closely related to high-frequency flooding but are treated separately in this study. It is common for municipalities in the study area to have gravity-based storm water systems that are unable to drain water when tidal level exceeds the elevation of the storm drain. When this happens, water starts ponding around the drain and may flood many of the same low-lying areas as high-frequency flooding.

The National Weather Service (NWS), with the help of NOAA and USGS, provide real time flood status of stream gages and tidal stations. The NWS has established three coastal flood severity thresholds: minor, moderate, and major flood stages. The NWS minor and moderate flood stages are the most representative of high-frequency flooding events right now.

The NWS' definitions of minor, moderate, and major flooding are set discussed in detail in Appendix B. An example of the flood inundation area associated with the three NWS Flood stages is shown in Figure 4 and Figure 5 for Long Beach/Island Park and Freeport, respectively. The impact of minor flooding can be seen to be very limited to a few particularly low-lying areas. The impact of moderate flooding is more widespread impacting some streets and properties and major flooding is widespread impacting several streets and blocks near the bay shoreline.

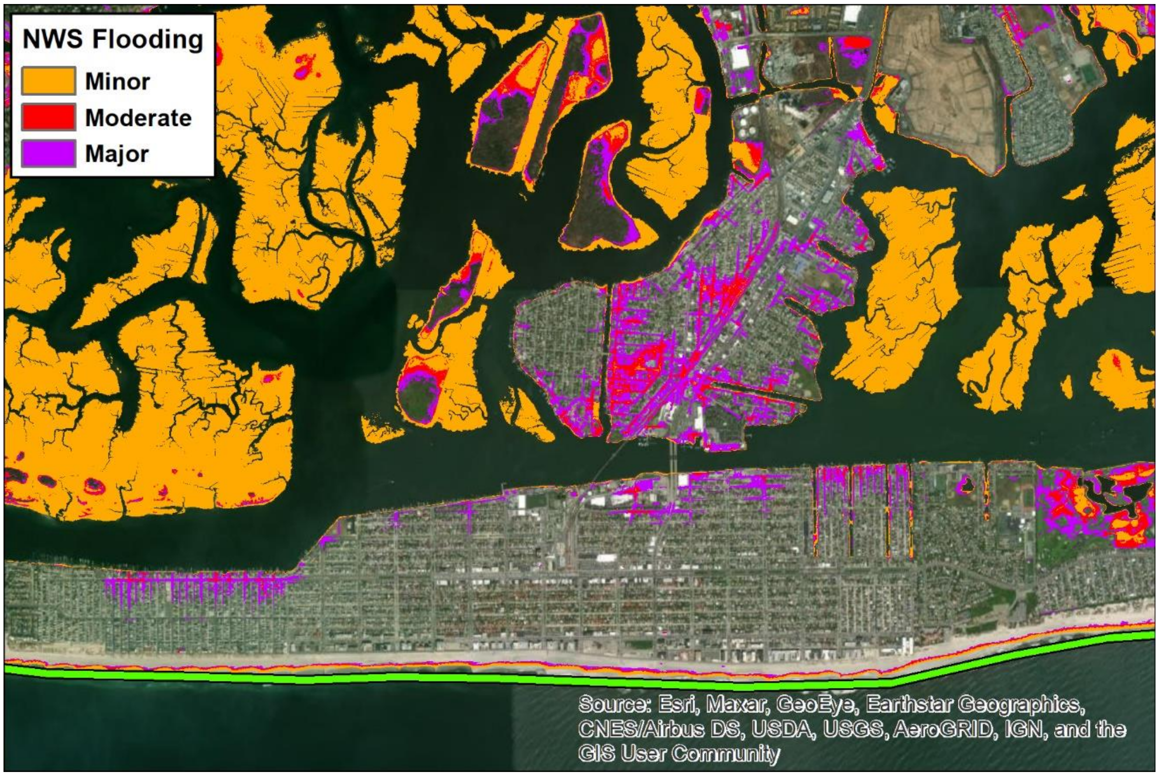


Figure 4 - Floodplain associated with NWS Stages at Long Beach and Island Park, NY

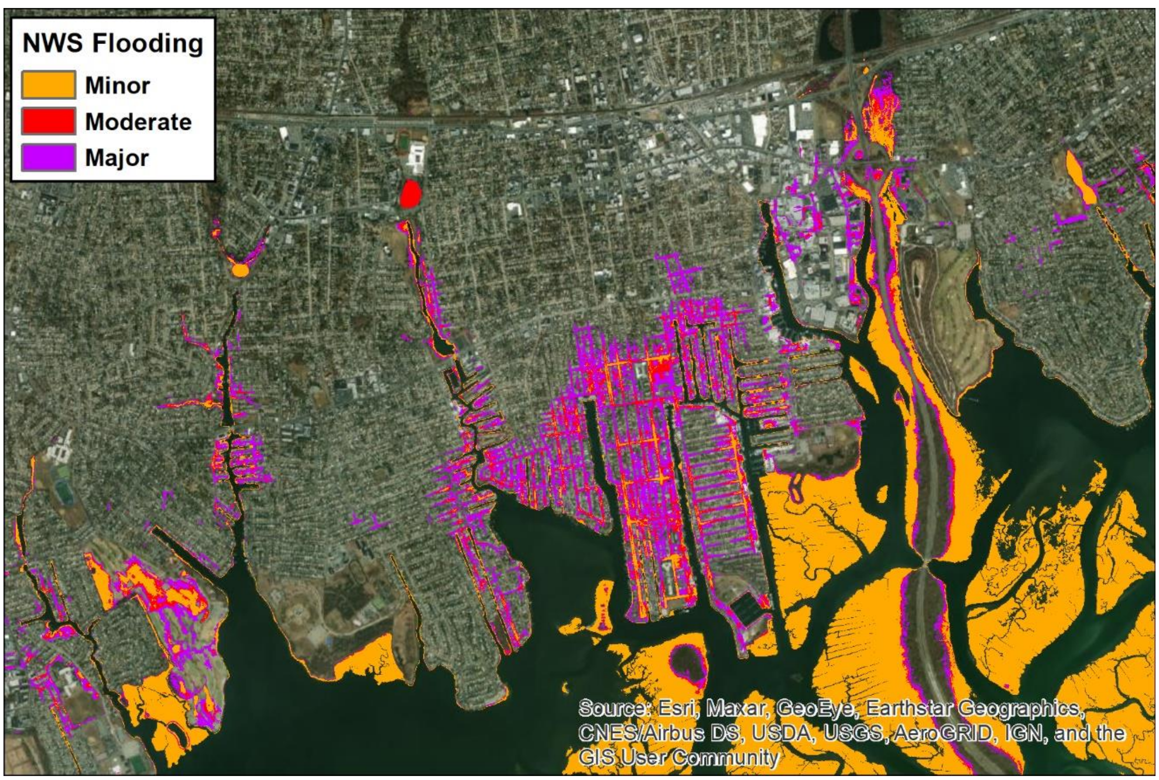


Figure 5 - Floodplain associated with NWS Stages at Freeport, NY

Sandy Hook, NJ has one of the longest tidal records (1932-Present) out of any of NOAA or USGS stations and is therefore well suited for investigating how often high-frequency flooding has occurred in the past and how the rate of flooding has been affected by historic RSLC. Hourly verified data from NOAA CO-OPS station at Sandy Hook, NJ was downloaded for the years 1932-2020. The number of days in which the daily maximum water level equaled or exceeded the NWS flood stages was calculated. The top panel of Figure 6 shows historic record of water levels and a dot for any day in which the NWS flood stages were exceeded. The bottom panel of Figure 6 shows a histogram of the total number of days in a given year that the NWS flood stages were exceeded. It is readily observed from Figure 6 that annual rate of NWS minor flooding has increased over time, with a dramatic increase in the last 20 years. The annual rate of NWS moderate flooding has a seen a small but visible increase and with little or no increase in NWS major flooding. The study area has seen a steady increase in high frequency flood events that is liley to persist into the future.

These trends match the increase and acceleration in high tide driven flooding seen across the country's coastlines (Sweet et al. 2018). The same report notes that high tide flooding along the Northeast Atlantic mainly occurs due to tidal forcing and storm surge events, particularly between September and April due to prevailing northeasterly winds. By the end of the century, high flooding is predicted to continue to occur more frequently in this region, occurring as often as every other day along the East Coast. Future high frequency flooding is further discussed in Section 3.1.2.

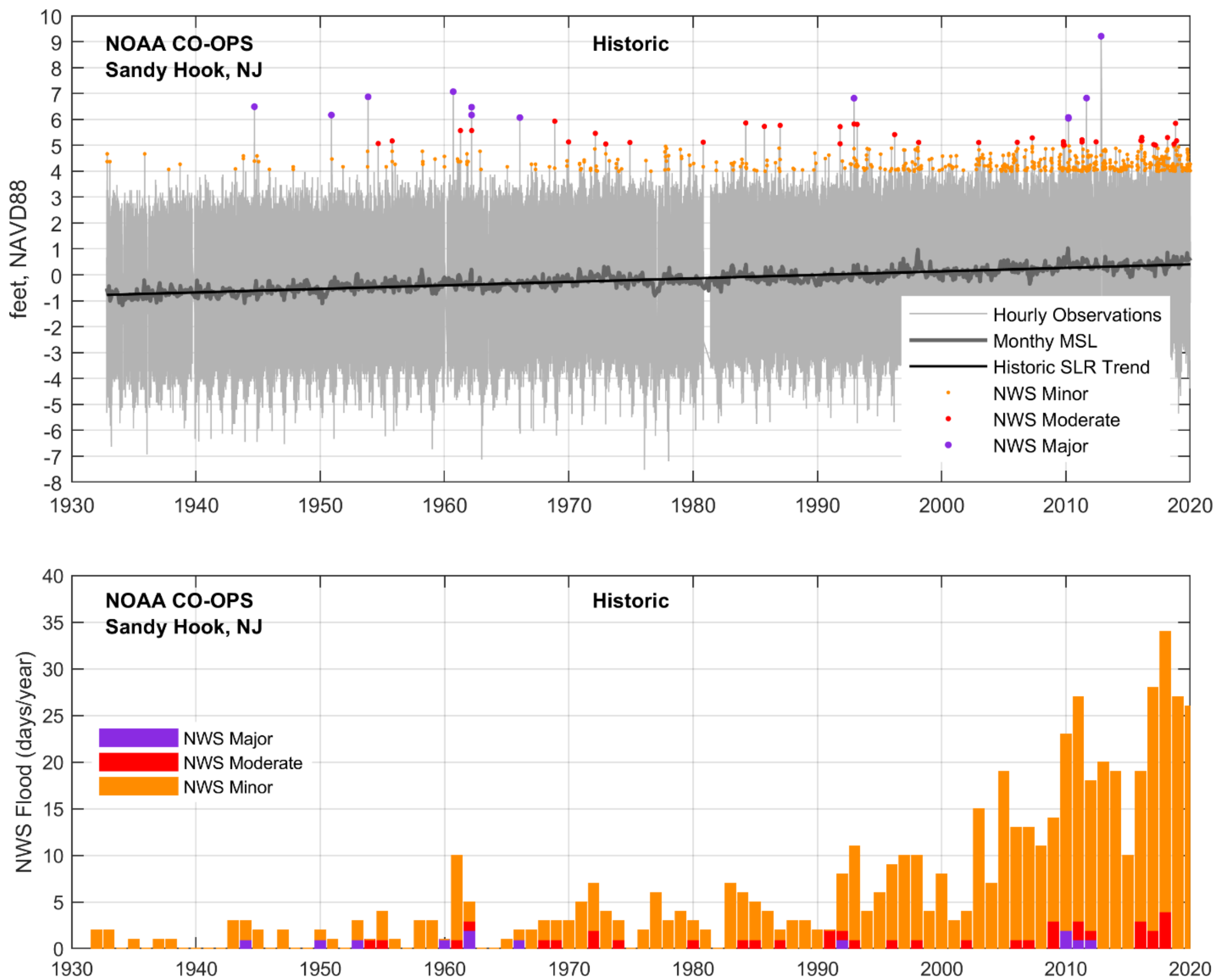


Figure 6 - Historic High-Frequency Flooding at Sandy Hook, NJ

2.1.3 Economic and Social

The study area covers the entire width of Nassau County and includes major population centers such as the City of Long Beach, the Village of Freeport, and the Village of East Rockaway. In total, the study area covers 350,000 persons (U.S. Census Bureau) within Nassau County, roughly half of the population of the entire county. The study area captures 100,900 structures with over $59.7 billion in damageable assets and critical infrastructure systems.

Table 1 provides a breakdown of the various category and occupancy types within the Nassau County study area. The table also provides the associated depreciated replacement values (DRV) for both structure and contents. Appendix F provides the methods used to identify and valuate structures in the analysis.

Table 1 - Structure Inventory Descriptive Statistics (in thousands)

		Count	Structure Value	Content Value	Total Value
Residential	One-Story	40824	$10,011,000	$5,009,000	$15,020,000
	Multi-Story	48129	$14,467,000	$7,233,000	$21,700,000
	TOTAL	**88953**	**$24,477,000**	**$12,243,000**	**$36,720,000**
Commercial	Offices	2842	$1,839,000	$1,141,000	$2,980,000
	Retail	2408	$2,186,000	$2,665,000	$4,851,000
	Other	1004	$887,000	$600,000	$1,487,000
	TOTAL	**6254**	**$4,912,000**	**$4,406,000**	**$9,318,000**
Industrial	Warehouses	2376	$1,744,000	$2,669,000	$4,413,000
	Other	55	$118,000	$165,000	$283,000
	TOTAL	**2431**	**$1,862,000**	**$2,834,000**	**$4,696,000**
Multi-Use	One-Story	51	$151,000	$19,000	$170,000
	Multi-Story	1850	$3,353,000	$519,000	$3,872,000
	TOTAL	**1901**	**$3,504,000**	**$538,000**	**$4,042,000**
Public	Religious	389	$376,000	$153,000	$529,000
	Recreation	136	$186,000	$65,000	$251,000
	Other	263	$447,000	$254,000	$701,000
	TOTAL	**788**	**$1,010,000**	**$472,000**	**$1,482,000**
Critical Infrastructure	Medical Offices	181	$184,000	$131,000	$315,000
	Schools	148	$924,000	$256,000	$1,180,000
	Service Stations	114	$348,000	$631,000	$979,000
	Other	130	$733,000	$210,000	$943,000
	TOTAL	**573**	**$2,189,000**	**$1,228,000**	**$3,417,000**
TOTAL	-	**100900**	**$37,954,000**	**$21,721,000**	**$59,675,000**

Figure 7 shows the LiDAR-derived digital elevation model (DEM) for the study area. Shown in 2ft increments, the areas directly adjacent to the back bay have the lowest ground elevation (yellow/green) and are most at risk for coastal storm impacts. The northern end of the City of Long Beach and the southern extent of the Village of Freeport are particularly vulnerable when only evaluating natural ground elevation though other locations throughout the study area are also at significant risk from coastal storms.

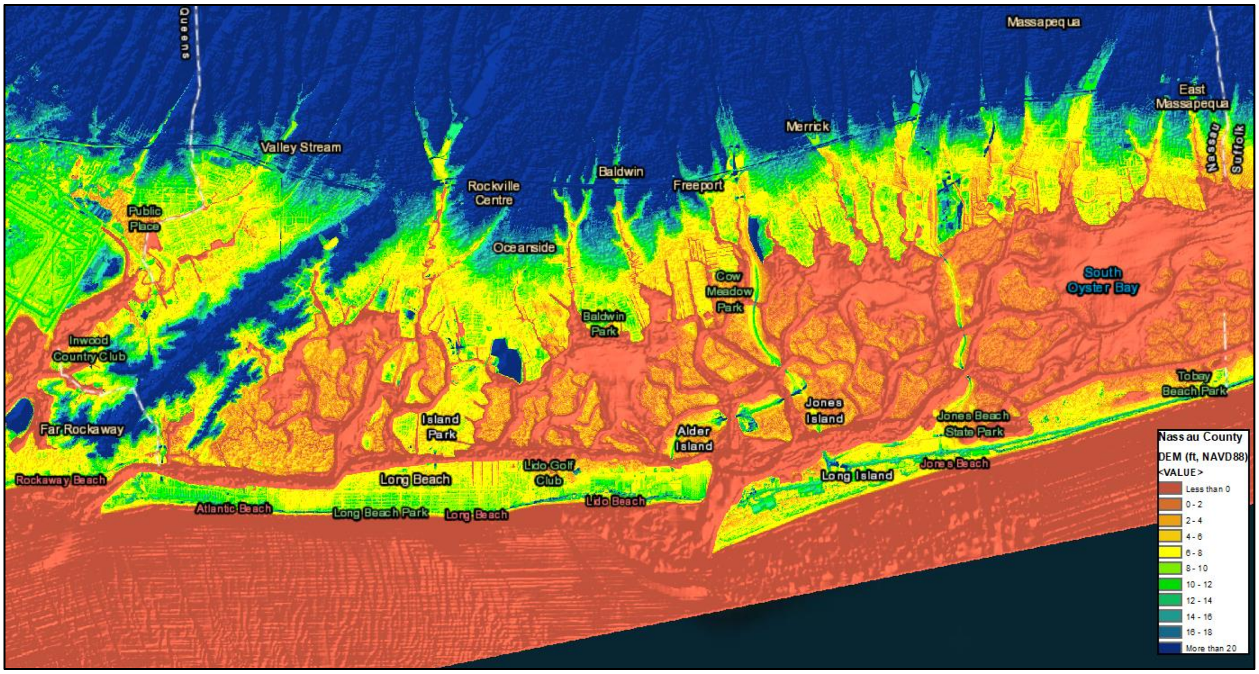


Figure 7: Nassau County Back Bays DEM

2.2 Land Use

The study area is a highly urbanized area with broad expanses of wetlands and tidal waters fronted by a developed barrier island and beach along the Atlantic Ocean. The level of development within the study area ranges from low to high density residential areas. Overall, 58.5% of the study area is developed (low, medium, or high intensity). There are isolated pockets of industrial areas along working rail lines and power generation stations in Nassau County as well as deciduous forests. Nearly 20% (18.6%) of the study area is undeveloped (wetlands, forest, and pasture) and approximately 17% (16.8%) is open water. Figure 8 depicts current land cover data for the area (USGS 2016). Table 2 provides the acreage by major land cover categories.

Table 2 - Land Use (NCLD 2016)

Land Use	Acres	Percent
Developed, High Intensity	5,234	16.2%
Developed, Low Intensity	3,676	11.4%
Developed, Medium Intensity	9,991	30.9%
Developed, Open Space	1,961	6.1%
Emergent Herbaceuous Wetlands	4,746	14.7%
Woody Wetlands	260	0.8%
Mixed Forest	22	0.1%
Deciduous Forest	225	0.7%
Evergreen Forest	5	0.0%
Shrub/Scrub	29	0.1%
Barren Land	518	1.6%
Herbaceuous	150	0.5%

Land Use	Acres	Percent
Hay/Pasture	61	0.2%
Cultivated Crops	0	0.0%
Open Water	5,419	16.8%
Total	32,296	

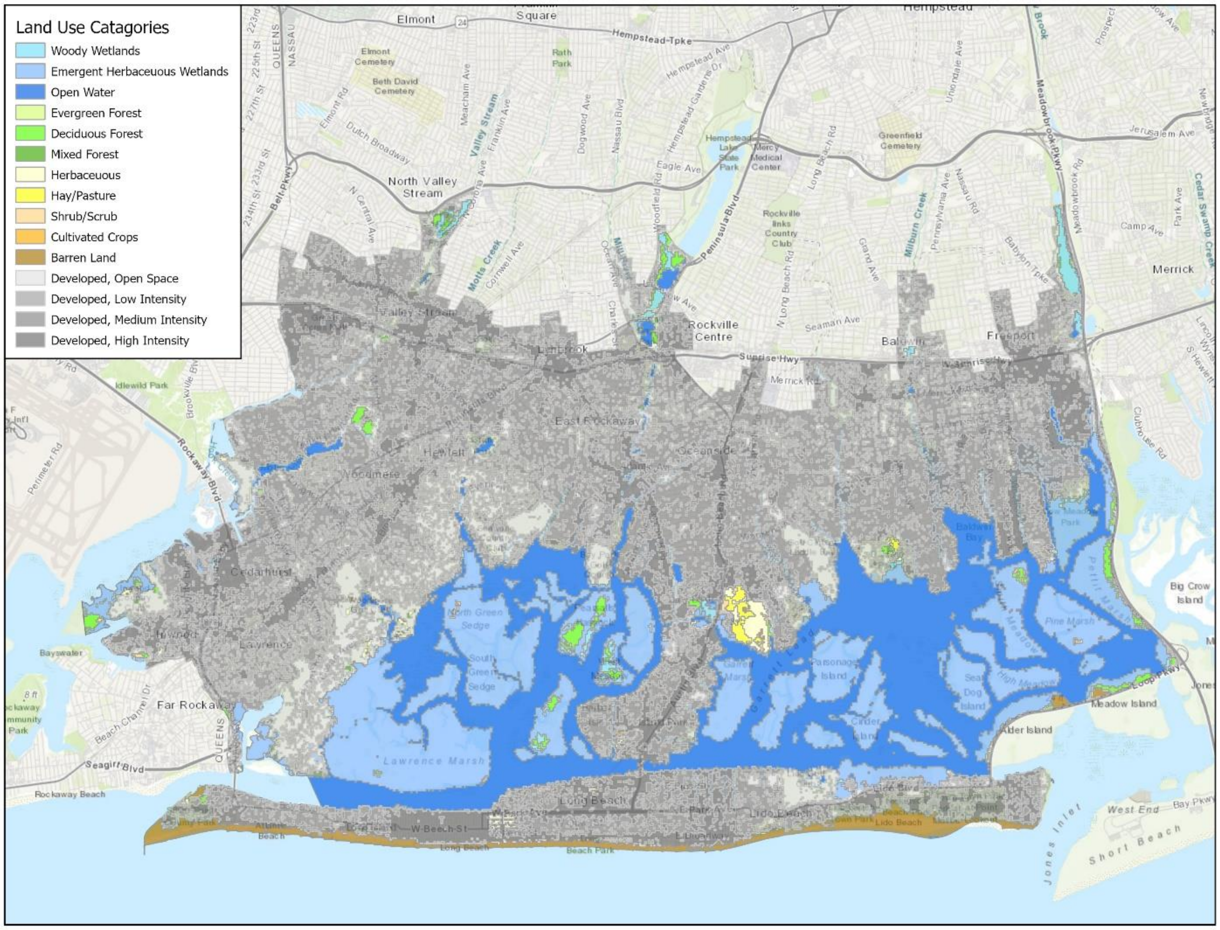


Figure 8 – Current Land Cover Date for the Study Area

2.2.1 Critical Infrastructure

Critical infrastructure is defined in the NACCS and the Department of the Army Field Manual (FM) 3-34.170 SWEAT-MSO process as infrastructure that could be considered essential services, operations or necessary functions to ensure civil order. This definition was further elaborated for the purposes of flood risk management as infrastructure that is essential to the community to resume functionality after a major coastal storm event. The study area includes significant critical infrastructure at risk of damage from future flooding and coastal storms including: Long Island Rail Road; over two dozen police, fire and emergency support service facilities; three major hospitals; energy facilities; communication and information technology facilities; water and wastewater facilities; and public housing (including that for low-income senior citizens). Those facilities and structures listed in the previous sentence were mapped by USACE to ascertain their location as well as locations where high concentrations of the types of facilities covered in Army Field Manual exist (see Figure 9).

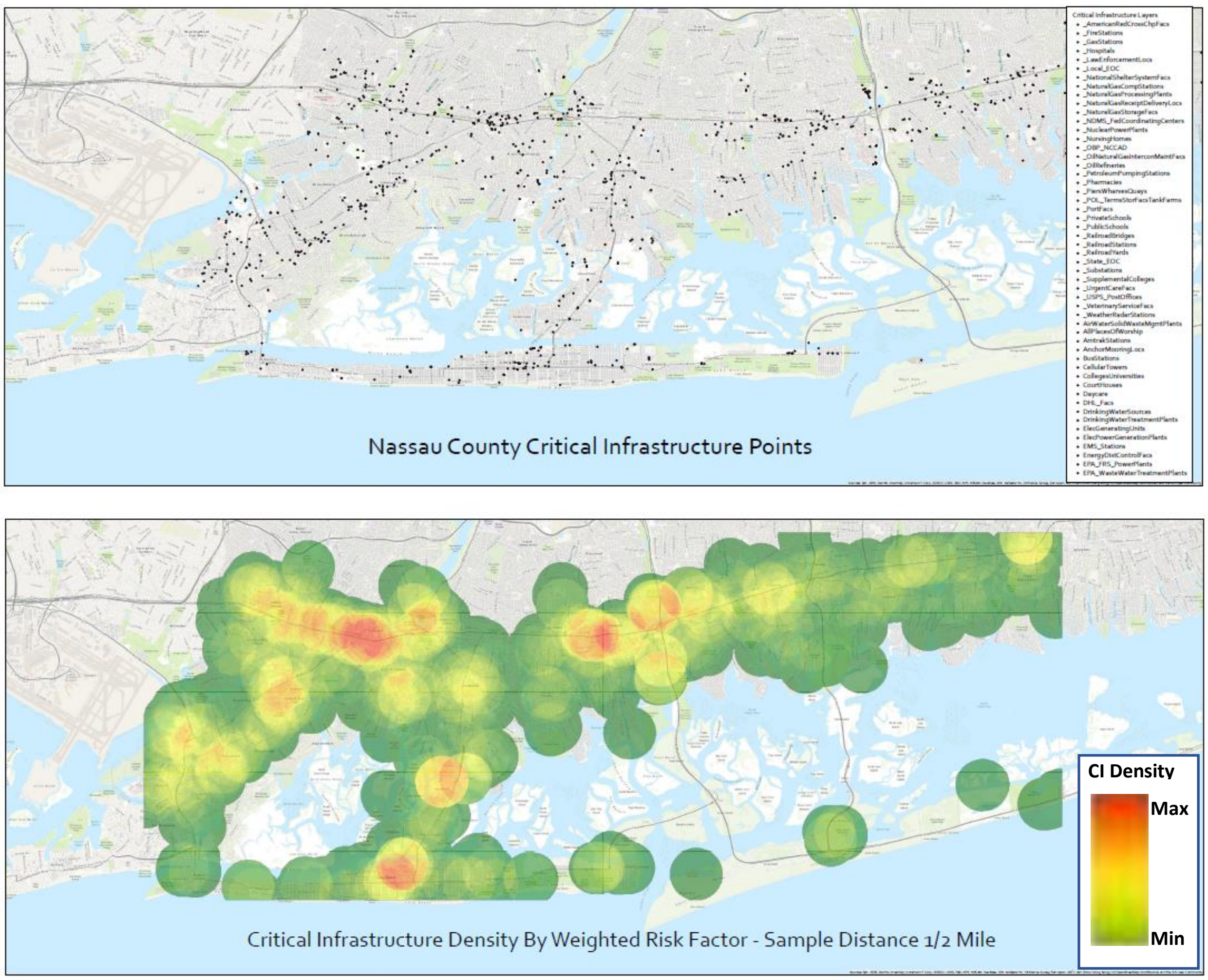


Figure 9. NCBB Critical Infrastructure (Courtesy of USACE-NAP)

Critical infrastructure assets were also assessed using the structure inventory described in Section 2.1.1. The critical infrastructure category in Table 3 contains assets, such as schools, hospitals, fire departments, and police stations. Table 3 provides more detail on the physical depreciatied replacement value (DRV) of these structures. Only critical infrastructure that resembles traditional building types (e.g. medical offices, hospitals) and largescale infrastructure that resembles an entire industrial complex (e.g. wastewater treatment plants, natural gas power station) were valued in Table 3. Infrastructure that does not resemble buildings in any way (e.g. evacuation routes, ports, utility lines) was not valued. Values in Table 3 only considers replacement value of the structures, it does not consider the non-physical value of the critical infrastructure to a community (i.e., the economic value of power or wastewater services). Appendix F provides additional detail on the valuation of these structures. The total DRV of the critical infrastructure is $3.4 billion. Most of the critical infrastrcutrue and development is concentrated on the Long Beach/Oceanside/East Rockaway Corridor as indicated by the yellow/orange shading in Figure 9. Critical infrastrcuture, exlcuding residential property, is valued at over three billion dolars in the study area (Table 3).

Table 3 - Critical Infrastructure Types and Valuation (in thousands)

Infrastructure	Count	Structure Value	Content Value	Total Value
MEDICAL OFFICE	167	$176,000	$123,000	$299,000
SCHOOL	148	$924,000	$256,000	$1,180,000
SERVICE STATION	114	$348,000	$631,000	$979,000
EMERGENCY SERVICES[1]	72	$91,000	$108,000	$199,000
FUEL OIL / PROPANE	31	$32,000	$46,000	$78,000
NURSING HOMES	19	$130,000	$13,000	$143,000
VETERINARY	14	$7,000	$8,000	$15,000
WASTEWATER PLANT[2]	3	$39,000	$5,000	$44,000
HOSPITAL	3	$21,000	$16,000	$37,000
ELECTRIC[3]	2	$420,000	$22,000	$442,000
TOTAL	**573**	**$2,189,000**	**$1,228,000**	**$3,417,000**

[1] Police Stations, Fire Stations, EMS Stations, etc.

[2] Bay Park Water Reclamation Facility, Long Beach Wastewater Treatment, Cedar Creek Wastewater Treatment

[3] EF Barrett Generation Station, Equus Power Plant

2.2.2 Protected Lands

2.2.2.1 NY State Coastal Zone

The Coastal Zone Management Act (CZMA) requires that federal actions that have reasonably foreseeable effects on any land or water use or natural resource of the coastal zone should be consistent, to the maximum extent practicable, with the enforceable policies of that state's federally approved Coastal Management Plan.

The New York State Coastal Management Program (CMP) was approved by NOAA in 1982, and is administered through the DOS, Division of Coastal Resources (DCR). The program contains policies and recommended measures to protect the visual quality and scenic resources of areas within the jurisdiction of DOS DCS, including aesthetics and scenic resources associated with both the natural and cultural landscapes.

Additionally, the Waterfront Revitalization of Coastal Areas and Inland Waterways Act offers local governments the opportunity to participate in the State's CMP on a voluntary basis by preparing and adopting a Local Waterfront Revitalization Program (LWRP). LWRPs provide more detailed implementation of the CMP through use of existing broad powers as zoning and site plan review. There are no communities with approved LWRPs in the study area.

Because the study occurs within the New York coastal zone, a Federal consistency determination is required in accordance with CZMA regulations. A federal agency may use its NEPA documents as a vehicle for its consistency determination. 15 CFR 930.37. To that end, the TSP and all alternatives will be evaluated for consistency with the policies in New York's CMP.

The DOS will review the consistency determination for consistency with the policies of the State's CMP.

2.2.2.2 Coastal Barrier Resources Act Areas

The Coastal Barrier Resources Act (CBRA) of 1982 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. Being included in these areas prevents the Federal Government from constructing flood risk management features including seawalls, floodwalls and storm surge barriers within its boundaries. The CBRA established the Coastal Barrier Resources System (CBRS), which consists of mapping undeveloped coastal barriers and other areas located on the coasts of the U.S. that were made ineligible for most Federal expenditures and financial assistance. The CBIA 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 pertains to Federal flood insurance. New or substantially improved structures may only obtain federal flood insurance if they are certified to be "used in a manner consistent with the purpose for which the area is protected" according to FEMA regulations (44 CFR §71.3). Other restrictions to Federal funding that apply to CBRS units do not apply to OPAs. Within the NCBB study area, there is one existing CBRS unit (NY-59) that extends from the western end of Long Beach to the western end of Fire Island. There are also small pockets of OPAs (NY-59P) within NY-59. The structural and nonstructural measures proposed by this study would avoid construction in the CBRS.

The US Fish and Wildlife Service prepared "Draft Revised" CBRA maps as part of the Hurricane Sandy Remapping Project, which include a number of proposed changes to existing CBRS units and OPAs within the NCBB study area; however, these changes require Congressional authorization. As indicated on Figures 10 and 11, some existing CBRS units are proposed to be changed to OPAs. The proposed changes have undergone public review and are slated to be submitted to Congress in 2020 for adoption. Maps of the existing CBRA areas and "Draft Revised" areas are provided in Figure 10 and 11, respectively.

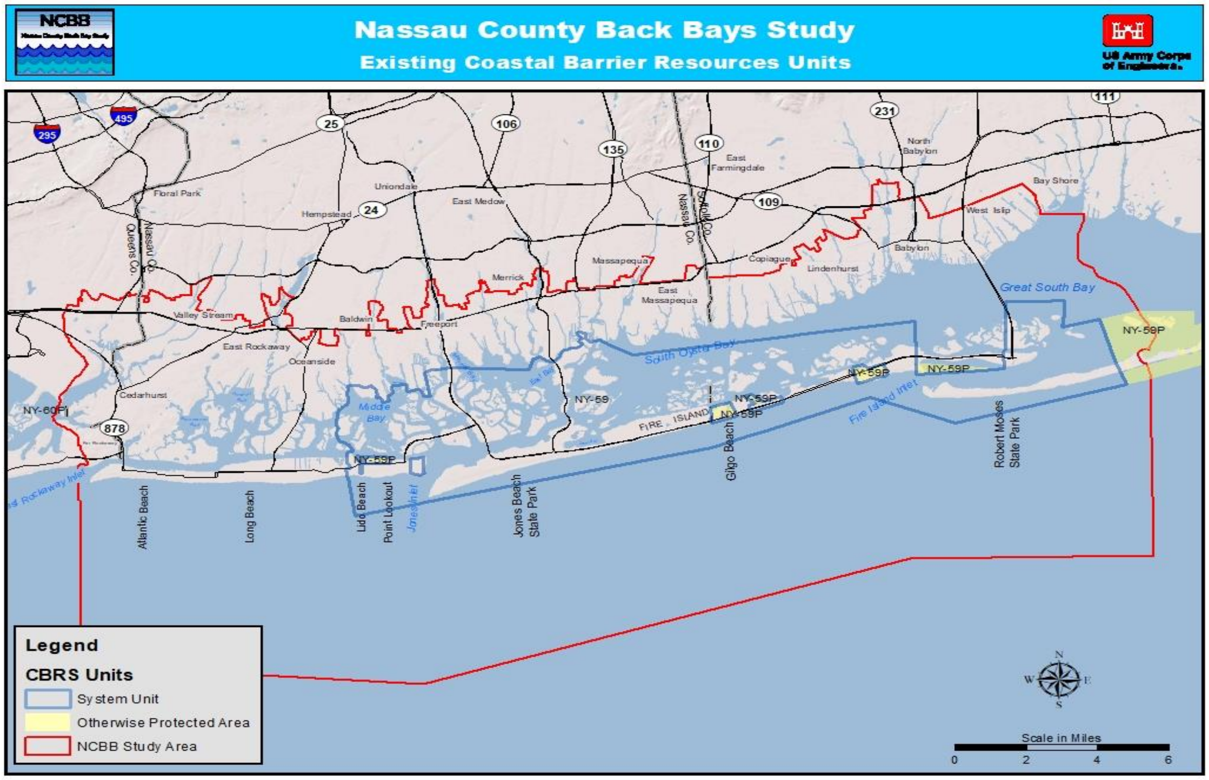


Figure 10. Existing CBRS Units and OPAs

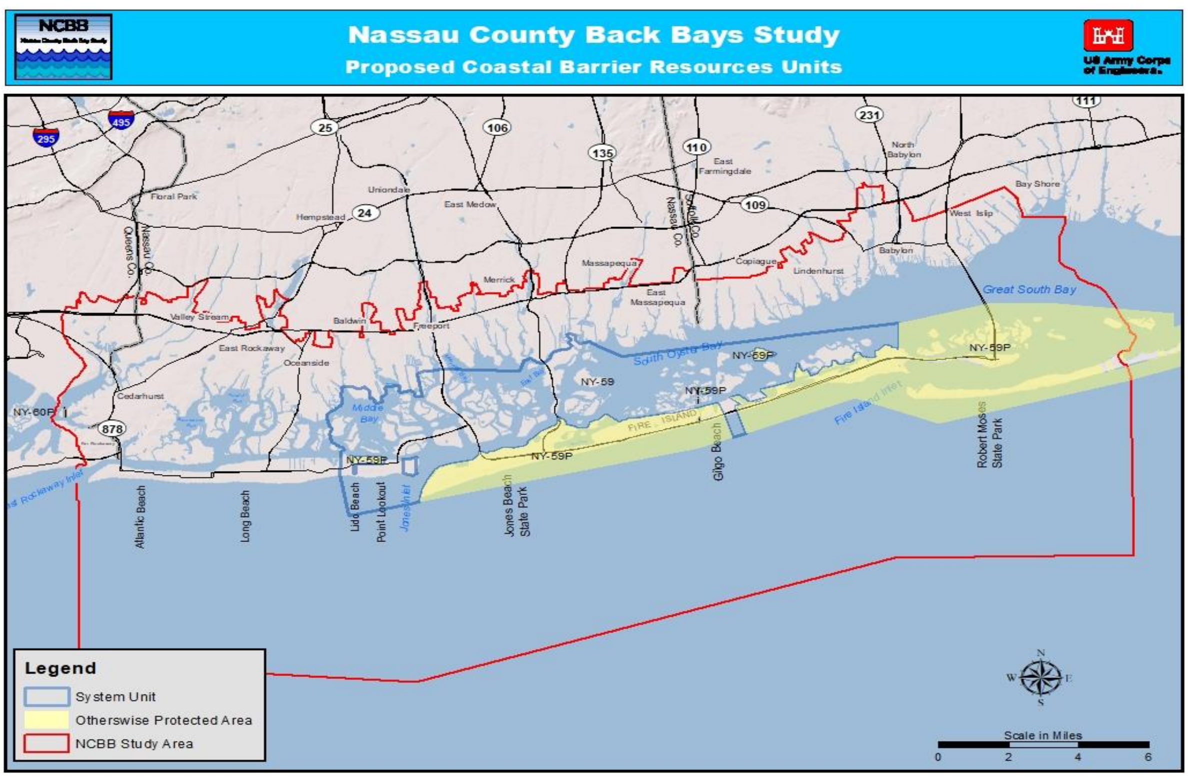


Figure 11. Proposed CBRS Units and OPAs

2.2.2.3 National Wildlife Refuges

While the study area overlaps with the Lido Beach Wildlife Management Area of the Long Island National Wildlife Refuge (NWR) Complex, no structural or non-structural measures are proposed for the wildlife management area; therefore, a compatibility determination by the NWR is not required. Lido Beach is part of Hempstead Estuary and is dominated by tidal wetlands comprised of low and high saltmarsh and mudflats. The management area is known for diverse bird species, including shorebirds, wading birds, waterfowl, songbirds, and raptors.

2.2.2.4 Parks and Wildlife Management Areas

There are numerous parks throughout the study area, including the following county parks.

- Gold Property
- Brooklyn Waterworks
- Grossman's Farm
- Trout Lake
- Parkway Drive Property Extension
- 490 North Central Avenue

2.2.2.5 State Natural Areas

The following New York State parks and preserves are in the study area.

- Tanglewood Preserve
- Nickerson Beach State Park
- Brookside Preserve
- Valley Stream State Park
- Hempstead State Park
- Jones Beach State Park

The Long Island South Shore Estuary Reserve (SSER) overlaps with the study area and the structural measures. The SSER was established in 1993 by the Long Island South Shore Estuary Reserve Act (Act). It is administered by the DOS and the Long Island South Shore Estuary Reserve Council. West to east, the SSER extends 75 miles from the Nassau County/Queens County line to the Village of Southampton in Suffolk County. South to north the SSER extends from the mean high tide line on the ocean side of the barrier island north to the inland limits of the drainage areas.

2.2.2.6 National Reserves

The study area does not overlap with any portions of the National Estuarine Research Reserve System (NERRS) or any other national reserve.

2.2.2.7 Wild and Scenic Rivers

There are no wild and scenic rivers designated in the study area.

2.2.2.8 National Estuary Programs

No National Estuary Programs overlap with the study area.

2.3 Floodplains

Floodplains are defined as those areas adjoining the channel of a river, stream, lake, ocean, or other water body that are prone to flooding (Tetra Tech EMI 2007). Inundation dangers associated with floodplains have prompted Federal, state, and local legislation that limits a majority of development in these areas to recreation and preservation activities. Executive Order 11988, *Floodplain Management* (42 Federal Register [FR] 26951, 3 CFR 1977), requires Federal agencies to take action to reduce the risk of flood damage, restore and preserve the natural and beneficial values served by floodplains, and minimize the impacts of floods on human safety, health, and welfare.

The study area lies adjacent to coastal waters placing much of the study area within the 100-year and 500-year floodplains. The 100-year floodplain designation defines areas that have a 1 percent chance of flooding in any given year, and the 500-year floodplain designation defines areas that have a 0.2 percent chance of experiencing a flood during any given year. Much of the study area is prone to flooding due to the low, flat topography and the large amount of rain and snowfall that is received. All of the study area is located at less than 100 feet above mean sea level (MSL), with a majority of the south shore of the mainland having an elevation of less than 20 feet above MSL. Outlying barrier islands and areas immediately along the coast typically have an elevation of less than 5 feet above MSL.

Floodplains located within the study area include the barrier island, back bay, and mainland floodplains within Nassau County. The 100-year floodplains have been mapped by the Federal Emergency Management Agency (FEMA), however, RSLC and potential changes in barrier island structure are expected to increase the area of impact for a 100-year flood, as well as floodplain areas in general. Much of the development that has taken place along the shorelines of the study area over the last 75 years was not subjected to the requirements of the National Flood Insurance Program or related local floodplain management ordinances. Many mainland areas located along the south shore of Long Island are particularly vulnerable to flooding due to the low, flat topography typical of this area. 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.

Regulatory floodplains are defined by the elevation of the base flood in relation to the elevation of the ground. It is a system that has been used by surveyors and engineers for most of the 20th Century as the basis for relating ground and flood elevations.

2.4 Physical Resources

2.4.1 Geological Resources

The study area is located in the Atlantic Coastal Plain Physiographic Province (USACE 2019). Topography is low-lying, flat terrain with elevations less than 100 feet above MSL, but primarily less than 20 ft above MSL. Dominant landforms consist of shallow brackish lagoons and low relief sandy barrier islands and associated dunes. No prime, unique, or important farmland soils exist within the study area; therefore the Farmlands Protection Policy Act does not apply to the proposed project (Tunstead 1999 as cited in USACE 2015a). The geology of the inner continental shelf fronting the south shore of Long Island is characterized by Holocene sediments of variable thickness. These sediments generally consist of either organic-rich muds (backbarrier deposits typically found in the sheltered waters leeward of a barrier island) or modern marine and inlet-filling sands. The USGS has compiled published and unpublished sediment texture and other geologic data about the seafloor from diverse sources into the usSEABED database (Reid et al 2005). Figure 12 depicts the data available for the seafloor in the study area.

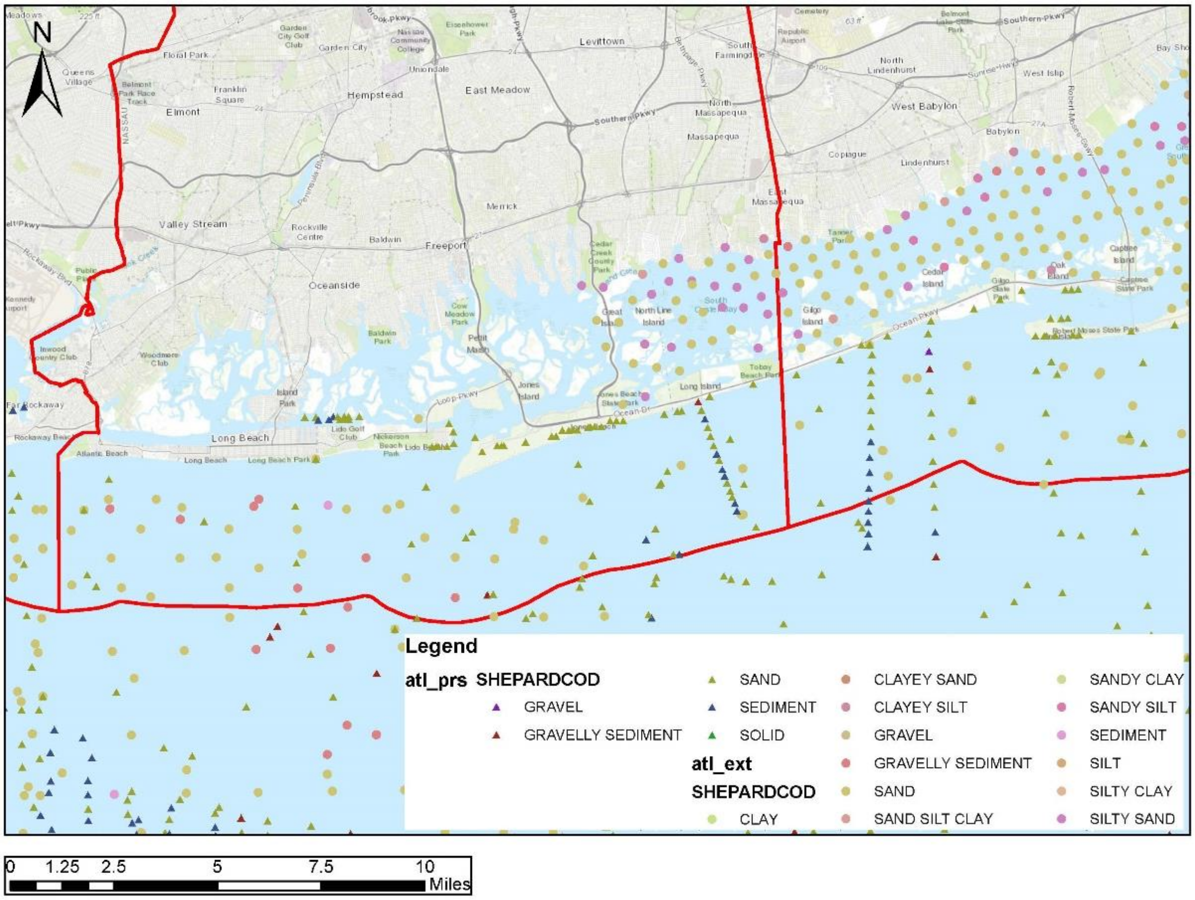


Figure 12 - Surficial Sediment Sampling Data Compiled in usSEABED

Soils within the study area are categorized as Upidsamments-beaches-urban land, ipswick-udipsamments, urban land-upidsamments-sudbury, urban land, and urban land-riverhead. See Figure 13 for a general soil map of Nassau County (reproduced from USDA-NRCS) and descriptions of the soils types (USDA 1987).

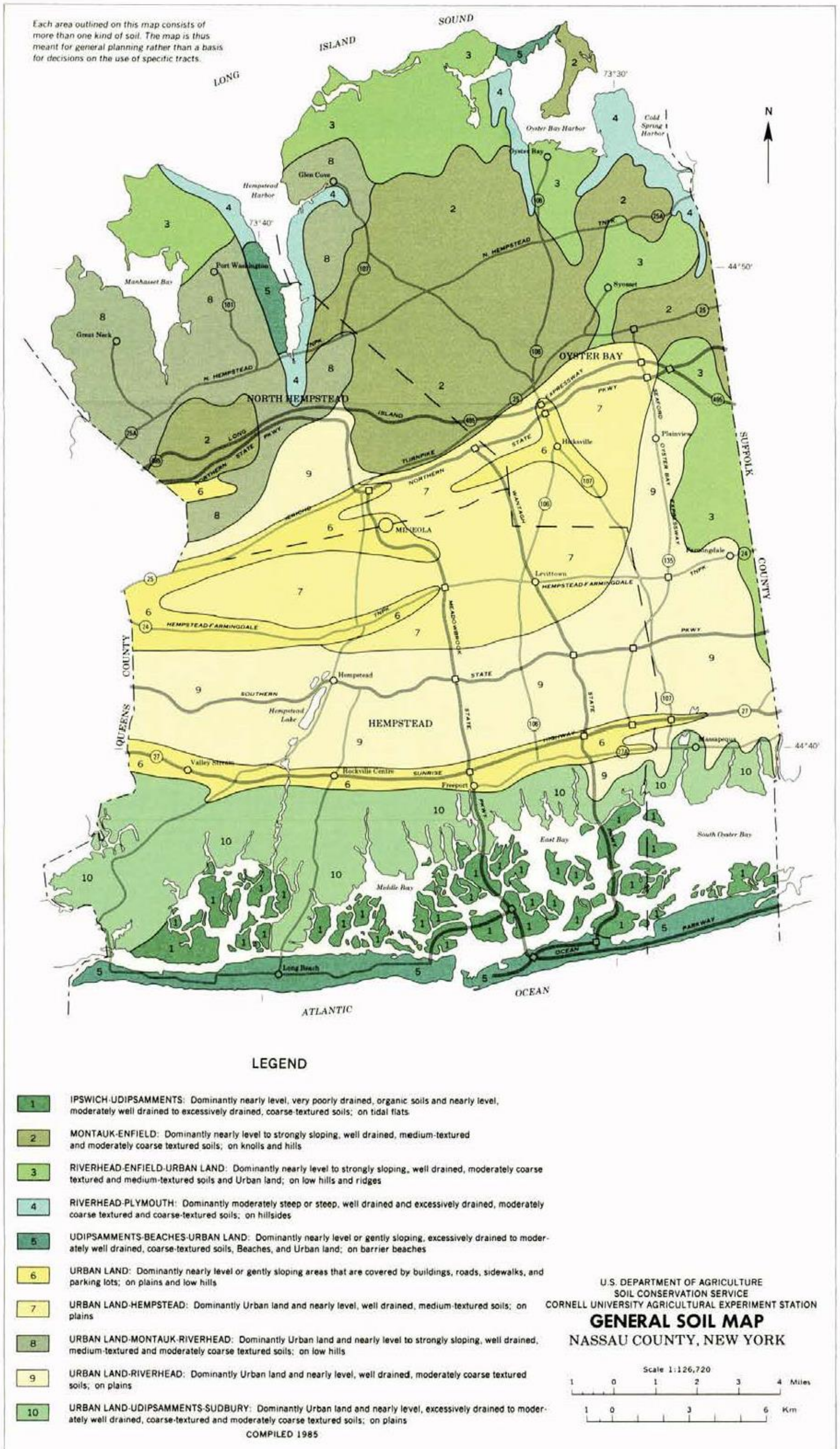


Figure 13 - General Soil Map of Nassau County (reproduced from USDA-NRCS)

The study area comprises generally low lying, morainal shorelines and barrier beach. The wind and storm surge associated with Hurricane Sandy (2012) caused numerous overwashes and three breaches on the south shore barrier island system of Long Island. Breaches and overtopping of the barrier island occur periodically in conjunction with larger storms. Barrier Island breaching often results in the formation of flood tidal deltas on the bay side of the barrier. These breaches are likely to provide suitable substrate for future SAV growth or the development of emergent tidal marshes if the elevation is sufficient. These flood tidal deltas typically benefit a variety of wildlife species, especially shorebirds, by increasing the available foraging and loafing area, and potential nesting sites. Flood tidal deltas and the dynamic sand spits associated with bay inlets also provide optimal habitat for the rare plants, seabeach amaranth and sea beach knotweed.

2.4.2 Water Resources

2.4.2.1 Watersheds and Freshwater Inflow

The study area lies within the Southern Long Island subwatershed (HUC 8-02030202) of the Lower Hudson-Long Island watershed (hydrologic unit code 4 (HUC 4) identified as 0203). There are nine HUC 12 subwatersheds within the Southern Long Island subwatershed (Figure 14) (USGS and NRCS 2018). More specifically, the western edge of the study area lies within the Hook Creek-Head of bay watershed (HUC 12-020301040501). Hook and Motts Creeks act as conduits for storm surge that floods communities in Nassau and Queens Counties. Hook and Motts Creeks are hydraulically connected to Jamaica Bay at Head of Bay (south of JFK). The eastern boundary of the study area is the Seaford Creek-South Oyster Bay (HUC 12-020302020202) and Massapequa Creek (HUC 12-020302020201) subwatersheds.

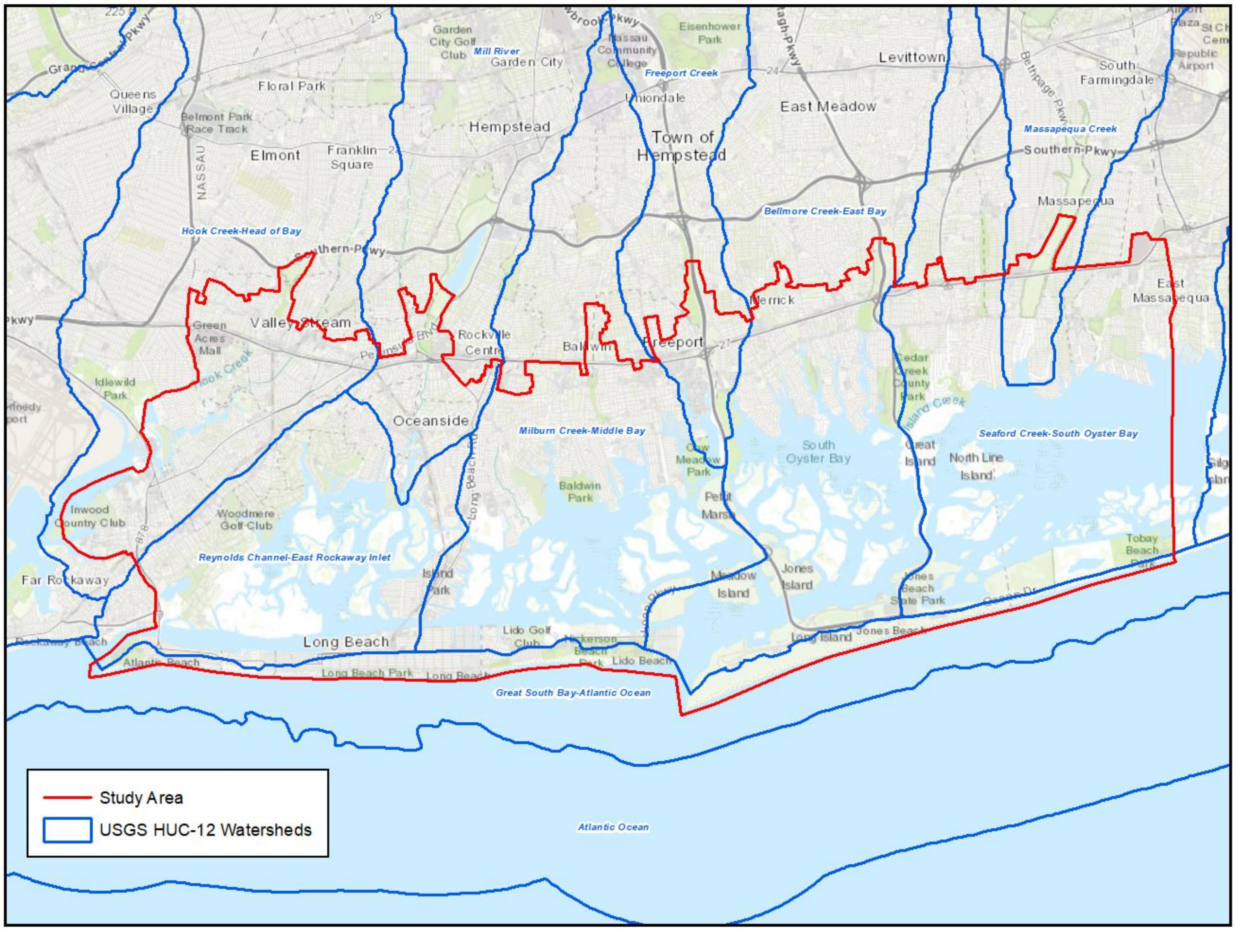


Figure 14. Watersheds (HUC 12) within the study area

2.4.2.2 Groundwater and Hydrology

The study area is situated above the North Atlantic Coastal Plan Aquifer System, which is the sole source aquifer (SSA) pursuant to Section 1424 (c) of the Safe Drinking Water Act. Specifically, the study area is served by the Upper Glacial Aquifer and Magothy Aquifers (NYSDEC 2019a). The single unconfined aquifer in Nassau County is the Glacial Aquifer, which occurs at or near the soil surface. Confined aquifers in the mainland portion of the study area include the Magothy and Lloyd aquifers, which underlie the Glacial Aquifer.

Precipitation is the sole source of freshwater recharge to Nassau County. In undeveloped areas of Long Island, about 50 percent of the precipitation that falls is lost through evapotranspiration and direct runoff to streams; the other 50 percent infiltrates the soils and enters the ground-water system (Aronson and Seaburn 1974; Franke and McClymonds 1972). In urban areas the infiltration is decreased considerably by impervious surfaces (e.g. paved roads and parking lots).

Shallow groundwater levels are located throughout Nassau County, but are more prevalent in low-lying coastal areas, near surface waterbodies (including wetlands, marshes, and bogs), and along historical drainage ways. Fresh groundwater levels on Long Island fluctuate seasonally and annually in conjunction with precipitation trends (Tetra Tech EMI 2007). However, salt water intrusion into the groundwater aquifers has increased as a result of RSLC and depletion of freshwater within the system, especially in shallower areas of the aquifers (Suffolk County 2007 as cited in USACE 2020).

2.4.2.3 Surface Water

The dominant surface water features in the study area are the Atlantic Ocean, back bays (Hewlett Bay, Middle Bay, Jones Bay, and South Oyster Bay) and the many small channels throughout the smaller barrier islands and dunes. The bay inlets provide hydrologic connectivity between bay and ocean waters, and numerous tidal rivers and creeks located along the northern shore providing freshwater input. Tidal, salt marsh wetlands, and freshwater wetlands are also present in the study area.

There are two inlets in the study area: East Rockaway Inlet and Jones Island Inlet, which are federal navigation projects. Coastal inlets play an important role in nearshore processes. Inlets are the openings in coastal barriers through which water, sediments, nutrients, animals, planktonic organisms, and pollutants are exchanged between the open sea and the protected embayments behind the barriers. These existing inlets contribute to flooding in the back bay that occurs during storm events. Tidal inlets experience diurnal or semidiurnal flow reversals and are characterized by large sand bodies that are deposited and shaped by tidal currents and waves. The ebb shoal is a sand mass that accumulates seaward of the mouth of the inlet. It is formed by ebb tidal currents and is modified by wave action. The flood shoal is an accumulation of sand at the bayward opening of an inlet that is mainly shaped by flood currents (USACE 2002 as cited in USACE 2020). However, not all of the sediment in the littoral transport stream is trapped at these shoals; a large proportion may be bypassed by a variety of mechanisms, particularly at inlets that have already developed mature shoals with a volume approaching equilibrium.

In addition, inlets are important economically because harbors are often located in the back bays, requiring that the inlets be maintained for commercial navigation. At many inlets, the greatest maintenance cost is incurred by periodic dredging of the navigation channel.

Jetties have been constructed at both inlets in the study area. Typically, jetties are built to stabilize a migrating inlet, to protect a navigation channel from waves, or to reduce the amount of dredging required to maintain a specified channel depth. The jetties along with dredging of the navigational channels have resulted in the relative stability of the inlets (USACE 2002 as cited USACE 2020). This stability has led to an increase of bay flushing relative to pre-stabilization conditions because the maintained inlets permit the continual exchange of bay and ocean waters. However, jetties can profoundly affect sand bypassing and other processes at inlets and adjacent shorelines (USACE 2002 cited in USACE 2020). The stabilized inlets do not function as natural inlets in several respects. First, the stabilized inlets maintained by jetties (only one jetty in the case of Fire Island), are periodically dredged, and do not migrate as natural inlets do. Stabilized inlets often serve as more of a sand sink than natural inlets. Natural inlets tend to facilitate bypassing of littoral drift over a series of shallow shoals relatively close to the shore. The jetties act to confine flows within a relatively narrow area compared to natural inlets; they also act to deepen the inlet throat and shift the ebb tidal delta further offshore than a natural inlet. Accordingly, the inlets have acted to trap sand at least during their formative stages.

The back bays of southern Nassau County are characterized by extensive networks of marshlands that serve as a natural defense against coastal storm surge. The study area includes numerous embayments including Bannister Bay, Brosewere Bay, Hempstead Bay, Hewlett Bay, Middle Bay, Baldwin Bay, Jones Bay, Zachs Bay, Merrick Bay, East Bay, and South Oyster Bay, and connected creeks, channels, and minor water bodies. This includes all salt marsh islands and undeveloped sections along Jones Beach barrier islands. The boundary of the habitat complex follows the high tide line from Edgemere on the Rockaway Peninsula in the west along the north shore of the bays into Suffolk County, then south along the Gilgo Cut Boat Channel that separates South Oyster Bay from Great South Bay, and across Jones Beach Island; the southern boundary extends about 400 meters or 1/4 mile offshore of the barrier islands from this point west to East Rockaway Inlet.

The environmental and economic importance of the study area was recognized by the establishment of the SSER. The SSER was established in recognition of the highly productive habitats that support the largest concentration of water-dependent businesses in New York; and the critical need to maintain water quality in the estuary in support of commercial and recreational fishing and shellfishing industries. The SSER protects and manages the system as a single integrated estuary and maritime region of statewide importance. A SSER Comprehensive Management Plan was prepared with recommended implementation actions for partners across a broad range of entities (State, federal, and local governments; NGOs; the private sector; and academic institutions). The five outlined goals are to 1) improve and maintain water quality; 2) protect and restore living resources; 3) expand public use and enjoyment; 4) sustain and expand the estuary economy, and 5) increase education, outreach, and stewardship.

The tidal currents commence flooding at East Rockaway Inlet about 20 minutes before Jones Inlet (NOAA 2015 as cited in Swanson et al. 2017). As the tide moves north into Hewlett Bay, it is amplified from a mean range of 1.24 m at Point Lookout (Jones Inlet) to 1.36 m at Bay Park. It also takes only about 20 minutes for high tide to reach Bay Park relative to Point Lookout. At the USGS Hog Island site, maximum tidal current occurs near mean tide level. These conditions are typical of a standing wave which is significant in regard to flushing within the bay.

The marine intertidal habitat is characterized as oceanic waters from mean high water (MHW) to MLW. Although exposed at low tides, the marine intertidal habitat is generally unvegetated with a sand or rock substrate that does not support areas that would meet the criteria for definition as a wetland under Section 404 of the Clean Water Act. However, these areas would be considered part of the territorial seas subject to regulation under Section 10 of the Rivers and Harbors Act, as well as Section 404 of the CWA. In addition, any area within this habitat type categorized as a Littoral Zone as defined by the New York State Tidal Wetlands Program (i.e., tidal areas seaward to 6 feet deep at MLW) would be regulated under NYSECL Article 25 (tidal wetlands).

The marine offshore habitat is characterized as oceanic waters from 30 to 100 feet deep. These areas do not meet the criteria for definition as a wetland under Section 404 of the CWA or NYSECL Article 25 (tidal wetlands). However, these areas would be considered territorial seas subject to regulation under Section 10 of the Rivers and Harbors Act, as well as Section 404 of the CWA.

Offshore waters in the proximity of the study area have an average temperature of approximately 15 °C (59 °F). The SCDHS data indicate that average ocean temperature increases from east to west (from 12 to 15 °C [53.6 to 59 °F]). The average salinity is approximately 31 parts per thousand (ppt) (SCDHS 1996 as cited in USACE 2020).

2.4.2.4 Water Quality

The town of Hempstead Water Quality Report provides water quality data for much of the study area. Hempstead Bay comprises the western 19,500 acres of the South Shore Estuary. Oyster Bay and the western portion of Great South Bay within Nassau County also occur in the study area (Hempstead 2012).

Hempstead Bay water temperatures showed typical seasonal variation with high temperatures in summer months (July through September) and low in winter months (November through March). Water temperatures generally follow seasonal trends in air temperature. The temperatures of the bays from 1975-2010 ranges from low of 3 °C in January to a high of 25 °C in September (Hempstead 2012). The spatial and temporal distributions of temperature in the bays are dependent upon season, and from the exchange rate of ocean and bay waters through tidal inlets. The temperature is dictated by a balance among ocean water, freshwater, and solar radiation (USACE 2020).

Average salinity in Hepmstead Bay ranged from 26.1 to 32 %. Salinities were generally higher from east to west but not significantly different. Salinities were also higher in the winter months and lowest in spring and early summer. Spatial and temporal salinity distributions in the bays along the south shore of Long Island are dependent upon two major factors: (1) freshwater inflow rates that vary both yearly and seasonally, and (2) exchange rate of sea and bay waters through tidal inlets (Pritchard 1983 as cited in USACE 2020).

Dissolved oxygen (DO) concentration is one of the most universal indicators of overall water quality and is critical for respiration by aquatic life. Adequate DO is necessary for good water quality and is measured in milligrams of oxygen per liter of water (mg/L). DO concentrations generally ranged from 6 mg/l to 12 mg/l. Warmer water holds less DO and can lead to hypoxic events. As expected, DO varied seasonally, with lowest oxygen concentrations in the summer and the highest concentrations in the winter. Some individual readings were below the NYSDEC chronic standard of 4.8 mg/L, which can result in negative effects on aquatic life (Hempstead 2012).

The NYSDEC provides an inventory of all of the waterbodies in the state, including those located in Nassau County, along with an assessment of their impairment status based on available information (NYSDEC 2019b). This list includes the Clean Water Act 303(d) list of impaired waters that require development of a total maximum daily load (TMDL) as well as impaired waters that do not require a TMDL. A TMDL is a strategy to reduce the input of a specific pollutant to a waterbody in order to meet water quality standards. Table 4 provides a list of impaired waterways in the study area. In Nassau County, a majority of the freshwater systems, and many of the estuarine systems, are listed as having impaired segments.

Table 4 - Impaired Waters within the Study Area

Water Index Number	Waterbody Name (WI/PWL ID)	Class	Pollutant	Cause	Year
(MW8.1a) AO-SOB-216 thru 219	Tidal Tribs to South Oyster Bay (1701-0200)	SC	Fecal Coliform	Urban/Storm Runoff	2012
(MW8.1a) AO-SOB-220	Massapequa Cove, and tidal tribs (1701-0391)	SC	Fecal Coliform	Urban/Storm Runoff	2012
(MW8.1a) AO-SOB-221 thru 223	Seafords/Seamans Creeks, and tidal tribs (1701-0389)	SC	Fecal Coliform	Urban/Storm Runoff	2012
(MW8.4) HB (portion 1)	Hempstead Bay, Broad Channel (1701-0032)	SA	Nitrogen	Municpal (Bay Park, other)	2006
(MW8.4) HB (portion 2)	Hewlett Bay (1701-0382)	SA	Nitrogen	Municpal (Bay Park, other)	1998

Water Index Number	Waterbody Name (WI/PWL ID)	Class	Pollutant	Cause	Year
(MW8.4) HB (portion 3)	Browswere Bay (1701-0383)	SA	Nitrogen	Municpal (Bay Park, other)	1998
(MW8.4) HB (portion 4)	HIC Hog Island Channel (1701-0220)	SB	Nitrogen	Municpal (Bay Park, other)	2014
(MW8.4a) HB-232 thru 237	Tidal Tribs to Hempstead Bay (1701-0218)	SC	Nitrogen	Municpl, Urb/Strm Runoff	2014
(MW8.4a) HB-233	East Rockaway Channel (1701-0381)	SC	Nitrogen	Municpl, Urb/Strm Runoff	2014
(MW8.4a) HB-236	Woodmere Channel (1701-0219)	SA	Nitrogen	Municpl, Urb/Strm Runoff	2014
(MW8.4a) HB-237, 237a	Bannister Creek/Bay (1701-0380)	SA	Nitrogen	Municpl, Urb/Strm Runoff	1998
(MW8.1) SOB	South Oyster Bay (1701-0041)	SA	Fecal Coliform	Urban/Storm Runoff	1998
(MW8.2) EB	East Bay (1701-0202)	SA	Fecal Coliform	Urban/Storm Runoff	2002
(MW8.3) MDB (portion 1)	Middle Bay (1701-0208)	SA	Fecal Coliform	Urban/Storm Runoff	2002
(MW8.3) MDB (portion 4)	Garret Lead/East Channel (1701-0386)	SA	Fecal Coliform	Urban/Storm Runoff	2002
(MW8.3) MDB (portion 6)	Middle Bay, Eastern Channel (1701-0387)	SA	Fecal Coliform	Urban/Storm Runoff	2002
(MW8.3) MDB-RC	Reynolds Channel, east (1701-0215)	SA	Fecal Coliform	Urban/Storm Runoff	2002
(MW8.3a) MDB-228	Freeport Cr/East Meadow Br, Lower (1701-0388)	SA	Fecal Coliform	Urban/Storm Runoff	2002
(MW8.4) HB (portion 1)	Hempstead Bay, Broad Channel (1701-0032)	SA	Fecal Coliform	Urban/Storm Runoff	1998
(MW8.4) HB (portion 2)	Hewlett Bay (1701-0382)	SA	Fecal Coliform	Urban/Storm Runoff	1998
(MW8.4) HB (portion 3)	Browswere Bay (1701-0383)	SA	Fecal Coliform	Urban/Storm Runoff	1998
(MW8.4) HB-ERI	East Rockaway Inlet (1701-0217)	SA	Fecal Coliform	Urban/Storm Runoff	2002
(MW8.4a) HB-236	Woodmere Channel (1701-0219)	SA	Fecal Coliform	Urban/Storm Runoff	2002
(MW8.4a) HB-237, 237a	Bannister Creek/Bay (1701-0380)	SA	Fecal Coliform	Urban/Storm Runoff	1998
(MW4.3a) LIS-HH-38	Glen Cove Creek, Lower, and tribs (1702-0146)	SC	Fecal Coliform	Urb/Storm, Mun/Ind	2002

Water Index Number	Waterbody Name (WI/PWL ID)	Class	Pollutant	Cause	Year
(MW8.4) HB-RC (portion 2)	Reynolds Channel, West (1701-0216) 12	SB	Nitrogen	Municpal (Bay Park, other)	2014
(MW8.3) MDB-RC (portion 1)	Reynolds Channel, East (1701-0215) 12	SA	Nitrogen	Municpal (Bay Park, other)	2014

Both macro-algae and harmful algal blooms occur in the Nassau County back bays. Discharge from the Bay Park Wastewater Facility into the western bays (i.e. Hewlett Bay and neighboring bays) led to macro-algae like ULVA or "Sea lettuce" (NYSDEC 2014). Blooms of brown tide algae occur periodically in Great South Bay, and *Aurecoccus anophagefferens* is the species responsible for these harmful algal blooms. Brown tides are considered harmful because they can inhibit sunlight penetration, thus limiting the ability for plants such as eelgrass to photosynthesize. Brown tides can also reduce the amount of DO in the water column and are a poor source of nutrition for suspension feeders. These water quality impacts have resulted in decreased submerged aquatic vegetation biomass and reduced hard clam (*Mercanaria mercenaria*) landings in Long Island bay systems. Brown tide incidence appears to be related to nutrient and dissolved organic matter in the water column.

2.4.3 Physical Oceanography

2.4.3.1 Currents and Circulation

Barrier island systems are dynamic with inlets and breaches connecting the back bay to the ocean. Figure 15 is a conceptual diagram showing the interconnectedness of the coastal system (USACE 2015b). Water levels in the study area are affected by tidal and storm surge propagation through the inlets, local wind-driven surge along the bay-axis, and overwash across the barrier islands.

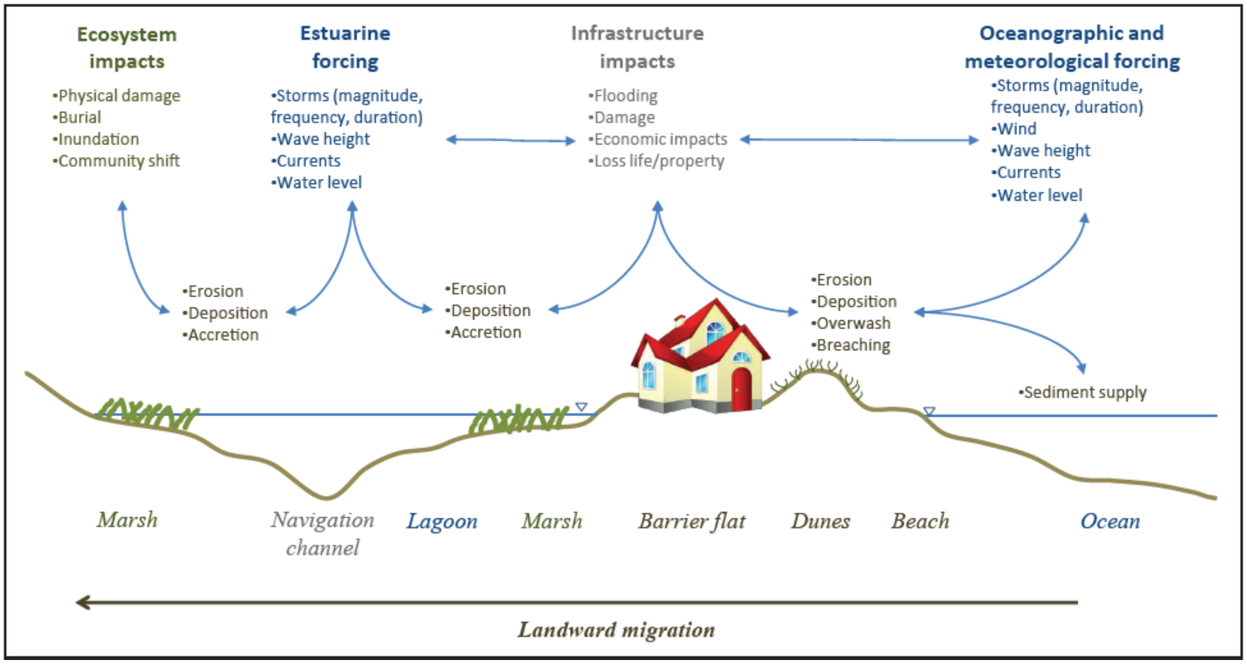


Figure 15 - Conceptual Diagram and Map Showing the Interconnectedness of a Coastal System (Bridges et al. 2015 as cited in USACE 2015b)

Tidal currents in the study are generally weak. Currents at Jones 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 (USACE 2015b).

Wave conditions in the back bays of the NCBB study area are fetch-limited and generated by local wind conditions. In fetch-limited conditions, wave heights are limited by the distance of open water. Wave conditions throughout the bay are also affected by the shallow water depths, marshes and orientation relative to the wind directions. The 100-year wave conditions in the back bays are generally between three and five feet with a peak wave period of three to five seconds. At some back bay locations wave conditions may be dominated vessel wakes.

Wave energy is significantly greater along the ocean coastline and through inlets. Wave conditions offshore may exceed 30 feet during 100-year wave conditions with peak wave periods between nine and 16 seconds. Wave conditions inside the inlets are affected by complex wave transformation processes (wave refraction, shoaling, breaking, diffraction, reflection, and wave-current interactions) associated with the dynamic bathymetry and ebb shoals and rubble mound structures (jetties).

Seasonal and interannual fluctuations in sea level are significant in the study area. The average seasonal cycle of mean sea level is caused by regular fluctuations in coastal temperatures, salinities, winds, atmospheric pressures, and ocean currents and on average causes a 0.5 foot (0.16 m) difference in sea level from September (highest) to January (lowest). Interannual (two or more years) variations in sea level, are caused by irregular fluctuations in coastal ocean temperatures, salinities, winds, atmospheric pressures, and ocean currents (El Niño).

2.4.3.2 Tides

Daily tidal fluctuations in the study area are semi-diurnal, with a full tidal period that averages 12 hours and 25 minutes; hence there are nearly two full tidal cycles per day. The mean tidal range in the study area ranges from 4.5 feet in the west near the City of Long Beach and 1.5 feet in east in Great South Bay. The rise and fall of the tide in the ocean leads to tidal flow through the inlets that causes a corresponding rise and fall of water levels in the back bays. Figure 16 shows the mean tidal range for the study area and surrounding area.

The western half of the study area, from East Rockaway Inlet to Jones Inlet, experiences a mean tide range that is equal to the mean range in the open ocean, typically in the 4 to 5-foot mean range. This is due to the relatively shorter distance along the coast between inlets, and the relatively short distances from the open ocean, through the inlets, to the inland extent of the bays.

East of Jones Inlet the mean tide range in the back bays gradually decreases such that at in Great South Bay, the mean range is less than 1.5 feet. The reduction in mean tide range is due to the long, narrow, and shallow geometry of Great South Bay and the relatively greater distances between inlets.

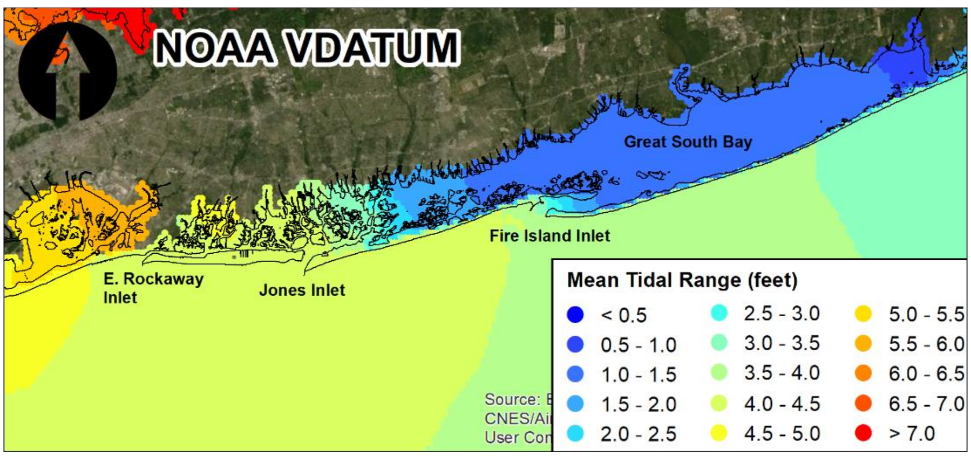


Figure 16 - Mean Tidal Range in the NY Bight and Study Area

2.4.3.3 Storm Surge

Storm surge is the increased water level above the predicted astronomical tide due to storm winds over the ocean and the resultant wind stress on the ocean surface. It is important to note that there are two principle processes that are responsible for back bay flooding in the NCBB study area: storm surge propagation through tidal inlets (East Rockaway Inlet, Jones Inlet and Fire Island Inlet) and local wind-driven storm surge along the east-west bay axis.

Wind blowing over the ocean surface can generate storm surge; however, the largest and most damaging storm surges develop from tropical cyclones (hurricanes and tropical storms) or extra-tropical cyclones (“nor’easters”).

Storm surge propagation into the back bays broadly mirrors the tidal propagation. Storm surge in the study area is highly dependent on wind speed and direction. Strong winds are capable of “pushing” water from Great South Bay in the direction that the wind is blowing.

2.4.3.4 Salinity

Salinity is a measure of the salt concentration of water. It is usually expressed in parts per thousand, abbreviated as ppt. Spatial and temporal salinity distributions in the bays along the south shore of western Long Island are dependent upon two major factors: (1) freshwater inflow rates that vary both yearly and seasonally, and (2) exchange rate of sea and bay waters through tidal inlets (Pritchard 1983 as cited in USACE 2020). Salinity levels are dictated by the balance among the following: (1) saltwater inflow through bay inlets, (2) flow exchange between bays, and (3) freshwater flow entering the bay via major rivers and creeks (Pritchard 1983 as cited in USACE 2020).

Salinity depends on the location and time of year. Generally, salinity decreases by bay from east to west in the back bays of Long Island (USACE 2006a as cited in USACE 2020). Typical salinity values throughout the back bays of south side of Long Island range between 17.3 ppt at Great South Bay (on the western side of the study area) in June to 29.80 ppt.

2.4.4 Air Quality

The Clean Air Act requires that all areas of the country be evaluated and then classified as attainment or non-attainment areas for each of the National Ambient Air Quality Standards (NAAQs). Areas can also be found to be "unclassifiable" under certain circumstances. The 1990 amendments to the act required that non-attainment areas be further classified based on the severity of non-attainment. The classifications range from "Marginal" to "Extreme" and are based on "design values." The design value is the value that actually determines whether an area meets the standard. For example, the 8-hour ozone standard, the design value is the average of the fourth highest daily maximum 8-hour average concentration recorded each year for three years. Ground-level ozone is created when nitrogen oxides (NOx) and volatile organic compounds (VOCs) react in the presence of sunlight. NOx is primarily emitted by motor vehicles, power plants, and other sources of combustion. VOCs are emitted from sources such as motor vehicles, chemical plants, factories, consumer and commercial products, and even natural sources such as trees. Ozone and the pollutants that form ozone (precursor pollutants) can also be transported into an area from sources hundreds of miles upwind.

The study area is part of the Northern New Jersey and New York nonattainment area for 2015 8-hour ozone, the maintenance area for 2006 particulate matter 2.5 (PM2.5), and the maintenance area for the Carbon Monoxide (CO) standard. There is currently not full available data for the 2012 PM 2.5 maintenance areas. (PM 2.5 refers to tiny particles or droplets in the air that are two and one half microns or less in width, and is a measure of pollution by fine inhalable particles.)

2.4.4.1 Greenhouse Gases

Greenhouse gases (GHG) trap heat in the atmosphere. Carbon dioxide is the most abundant GHG and enters the atmosphere through burning fossil fuels (coal, natural gas and oil), solid waste, trees and wood products, and also as a result of certain chemical reactions (e.g. manufacture of cement). Carbon dioxide is removed from the atmosphere (or "sequestered") when it is absorbed by plants as part of the biological carbon cycle. Methane is emitted during the production and transport of coal, natural gas and oil. Methane emissions also result from livestock and other agricultural practices and by the decay of organic waste in municipal solid waste landfills. Nitrous oxide is emitted during agricultural and industrial activities, as well as during combustion of fossil fuels and solid waste. Hydrofluorocarbons, perfluorocarbons, sulfur hexafluoride, and nitrogen trifluoride are synthetic, powerful greenhouse gases that are emitted from a variety of industrial processes. Fluorinated gases are sometimes used as substitutes for stratospheric ozone-depleting substance (e.g., chlorofluorocarbons, hydrochlorofluorocarbons, and halons) (USEPA 2021). The largest source of GHG emissions from human activities in the United States is from burning fossil fuels for electricity, heat and transportation. The USEPA tracks total U.S. emissions and reports the total national GHG emissions and removals associated with human activities.

2.4.5 Hazardous, Toxic and Radioactive Waste

The following inventory of known contaminated sites was developed using information available from USEPA and NYDEC.

The criteria for the EPA databases was:

- National Pollution Discharge Elimination system (NPDES)
- Resource, Conservation, Reclamation Act (RCRA)
- Superfund
- Toxic Release Inventory (TRI)
- Toxic substance Control Act (TSCA)
- Brownfields

The criteria for the NYSDEC databases was:

- Environmental Site Remediation
- Brownfields Cleanup
- State Superfund Program
- Voluntary Cleanup Program
- Environmental Restoration Program
- Resource Conservation Recovery

Within the NYSDEC databases were sub-categories of active, potential, completed or no further action. There is a numbering system the NYSDEC employs to designate the level of concern for the sites. The system ranges from 1 to 5. Sites with a “1” designation are highest concern for threats to public health and environment. Sites with a “5” designation are listed as “no further action” required as the sites are listed as remediated or no longer a threat to public health and environment. The numbers 2, 3 and 4 represent varying levels of concern. For the NYSDEC known sites, many are listed as no further action (NFA), and another group is listed as O&M or operation & maintenance. There are few sites with a designation of high concern (level “1”). The NYSDEC numbers also include sites that have been listed as remediated and no longer a threat to public health and environment.

In some USEPA categories there will be a high number of identified sites. That high number is attributed to the level of commercial/industrial activity within that particular zip code. In some situations, many of the NPDES permits are for local storm water sewer systems discharging into the bay. In some zip codes/towns where there is little commercial activity there may be a high number of RCRA and NPDES permits. The list does not differentiate between current and expired permits. Many RCRA/NPDES permits are expired due to business closure or changes to the activity at that location.

Table 5 summarizes the data contained in the USEPA and NYSDEC databases. The information provides the number of USEPA and NYSDEC known contaminated sites in each of the listed towns. Table 5 does not detail the type(s) of contamination present at each site, but both USEPA and NYSDEC databases contain site information (when listed, type(s) contaminants, type(s) remedial actions taken to date). That site specific information will be reviewed once specific alternatives are developed.

In Nassau County, the RCRA permit holders range from dry cleaners, to auto body shops, to marinas, to medical clinics, power generating stations, to railroad yards to former gasoline stations.

Table 5 - Summary of Contaminated Sites

County	Town	Zip Code	Number of NPDES permits (EPA)	Number of RCRA permits (EPA)	Brownfields (EPA)	Superfund (EPA)	Toxic Substances Control Act	Toxic Release Inventory (releases to water)	Toxic Release Inventory (releases to soil)	Number of sites listed in NYSDEC database
Nassau	Jones Beach	11793	1							
	Long Beach	11561	8	14						5
	Atlantic Beach	11509	3	2						
	Lido Beach	11569	1	3						
	East Massapequa	11758	1	14						5
	Massapequa Park	11762	1	4						
	Seaford	11783	5	14	1					5
	Wantagh	11793	3	23						1
	Bellmore	11710	3	21			2			3
	Merrick	11566	4	22	1					8
	Freeport	11520	15	41			2	2	5	10
	Baldwin	11510	6	43				4		4
	Oceanside	11572	19	31				2	4	11
	Island Park	11558	6	12				1	1	4
	Rockville Center	11570	4	40						
	West Hempstead	11552	5	20	3		2			1
	East Rockaway	11518	8	17			1			1
	Lynbrook	11563	6	10		1	1			2
	Hewlett	11557	5	15						3
	Woodmere	11598	4	15				2	2	
	Cedarhurst	11516	3	10						1
	Lawrence	11559	3	5					1	
	Far Rockaway	11691	3	15					2	
	Inwood	11096	9	23				2	3	11
	Valley Stream	11580	9	17			1			
	West Hempstead	11010								1
Queens Borough	Rosedale	11422		9						
	Springfield Gardens	11413	4	20				1	1	
	Jamaica	11430	2	11				1	1	

County	Town	Zip Code	Number of NPDES permits (EPA)	Number of RCRA permits (EPA)	Brownfields (EPA)	Superfund (EPA)	Toxic Substances Control Act	Toxic Release Inventory (releases to water)	Toxic Release Inventory (releases to soil)	Number of sites listed in NYSDEC database
Suffolk	Bright Waters	11718	8	181				5		24
	Bay Shore/West Bay Shore	11706	5	6						
	West Islip	11795	6	23						3
	Babylon	11702	4	6						25
	Lindenhurst	11757	16	20						9
	Saltaire	11706						2		
	Copaigue	11726	7	9						
	Amityville	11701	7	13						4

Due to the large number of sites noted in the affected towns, the number of sites with NYSDEC category designation “1” located south of State Highway 27 were isolated to identify the sites with the greatest potential of being affected by back bay flooding. Using that method, the number of sites drops to 24. Nine of the 24 sites are located in Oceanside and Island Park, both in Nassau County, of which five are dry cleaner businesses. The other sites are the LIRR service yard, cement plant and machine sales. The 15 remaining sites are dispersed throughout the rest of the study area. The type(s) of contamination issues on these sites include former dry cleaners, manufactured gas plants (MGP), chemical recyclers/manufacturers. Figure 17 depicts these sites plus ten additional sites that are located just outside the immediate area of impact from back bay flooding.

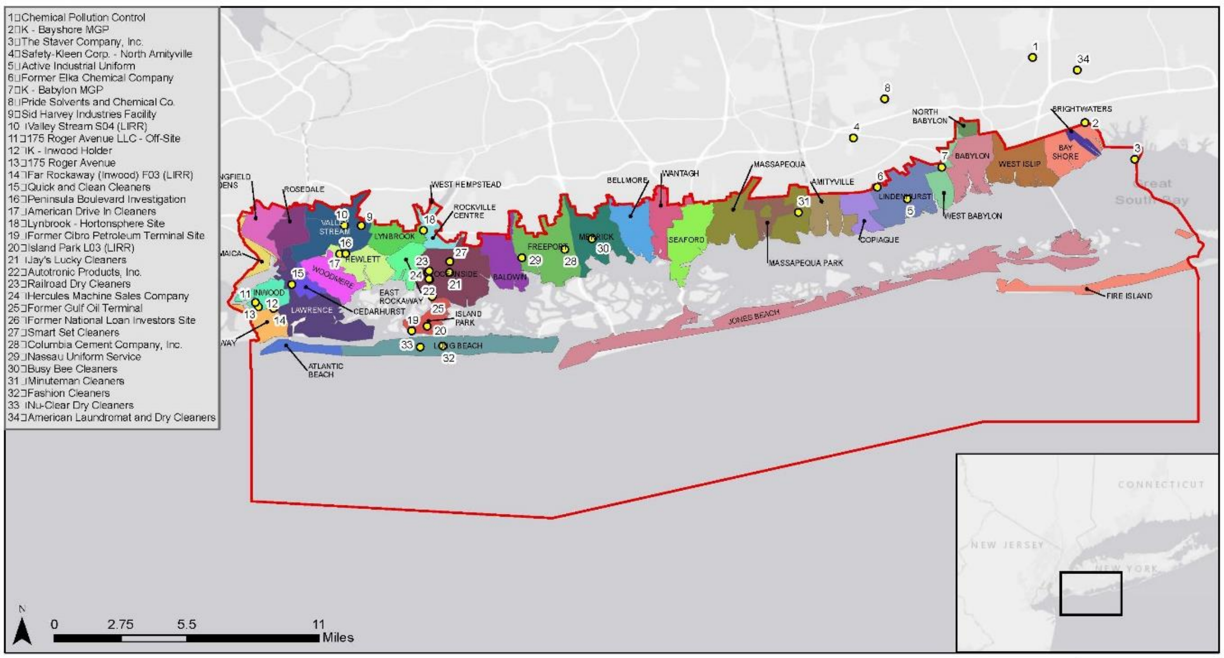


Figure 17 - HTRW Sites at Greatest Risk to Back Bay Flooding

2.4.6 Noise

Noise is defined as unwanted sound that is disruptive and diminishes the quality of the surrounding environment. It is emitted from many sources including airplanes, factories, railroads, power generation plants, and highway vehicles, etc. The magnitude of noise is described by its sound pressure. A logarithmic scale is used to relate sound pressure to a common reference level, as the range of sound pressure varies greatly. This is called the decibel (dB). A weighted decibel scale is often used in environmental noise measurements (weighted-A decibel scale or dBA). This scale emphasizes the frequency range to which the human ear is most susceptible. A 70-dBA sound level can be moderately loud (similar to an indoor vacuum cleaner). A 120 dBA can be uncomfortably loud, as in a military jet takeoff at 50 ft, and a 40-dBA sound level can be very quiet and is the lowest limit of urban ambient sound.

To ensure a suitable living environment, the Department of Housing and Urban Development (HUD) has developed a noise abatement and control policy, as seen in 24 CFR Part 51. According to this policy, noise not exceeding 65 dBA is considered acceptable. Noise above 65 dBA but not exceeding 75 dBA is normally acceptable, but noise above 75 dBA is unacceptable. Normal freeway traffic noise levels range from 70 to 90 dBA.

With regard to noise, the dominant land uses in the study area are low, moderate, and high developed areas including residential housing. These areas generally have outdoor day-night sound levels that range from 59 to 78 A-weighted decibel (USACE 2014a). As development intensity increases, noise levels can also be expected to increase.

The many uninhabited islands have few on-site noise sources and have generally low sound levels. However, substantial noise can be generated from boat traffic in adjacent waters and natural sound sources such as wind, waves, and bird colonies may contribute to measured sound levels. Personal watercraft and powerboats may generate noise levels of 70 to 85 dBA at 50 feet (Noise Unlimited 1995) similar to normal freeway traffic.

Many species use noise to communicate, navigate, breed, and locate sources of food. The sensitivity varies among species, location, and season (e.g., breeding, migration, and roosting). Underwater noise influences fish and other marine animal behavior, resulting in changes in their hearing sensitivity, and behavioral patterns. Sound is important to them when they are hunting for prey, avoiding predators, or engaging in social interaction. Fish can also suffer from acoustically induced stress in their own habitat. Changes in vocalization behavior, breathing and diving patterns, and active avoidance of noise sources by marine life have all been observed in response to anthropogenic noise (Earth Island Institute 2002). Thresholds for affecting behavior of ESA-listed species are 150 dB re (reference pressure) 1 µPA root-mean-square (RMS) for sturgeon and 175 dB re 1 µPA RMS for sea turtles (NMFS pers. comm.).

Underwater ambient noise levels have not been identified for the study area. Underwater noise levels can vary with time of day, weather, tide, season, and other factors. In the study area, ambient underwater noise is expected to be typical of urbanized, industrialized back bay area. Ambient sound sources could include biological sources (e.g., birds, marine mammals) and anthropogenic sources such as from vessels, shore-based industry, maintenance dredging, aircraft overflights, and construction.

2.5 Ecological and Biological Resources

2.5.1 Ecosystems and Habitats

The study area is a complex array of marine, estuarine, coastal, and terrestrial ecosystems. To facilitate a thorough description of conditions, the study area has been partitioned into a series of defined ecosystems and habitats. The ecosystems and habitats have been combined as presented in this section, and are defined in Table 6 and depicted in Figures 18 and 19. These ecosystem and habitat definitions provide the framework for the characterization of the affected environment and for assessing and comparing the impacts of alternatives addressed in this EIS.

Table 6 - NCBB Ecosystem and Habitat Designations

Ecosystem/Habitat	Definition
Marine Offshore Ecosystem	
Marine Offshore	Subtidal marine habitat ranging in depth from 30 to 100 feet; includes pelagic (open water) and benthic (bottom) zones
Atlantic Shores and Inlets Ecosystems	
Marine Nearshore	MLW to depth of 30 feet; includes pelagic and benthic zones
Marine Intertidal	Extends from mean low water (MLW) to mean high water (MHW) with a sandy and/or rocky substrate
Marine Beach	Extends from MHW on the ocean side to the boundary of the primary dunes and swales habitat within the barrier island ecosystem; sandy substrate
Inlets	Areas of water interchange between bay and ocean zones (e.g., Rockaway East Inlet, Jones Inlet, and Fire Island Inlet)
Barrier Island Ecosystems	
Dunes and Swales	Extends from the seaward toe of the primary dune through the most landward primary swale system; includes freshwater ponds, wetlands, and sparsely-vegetated shrub or forested communities found within this zone.
Terrestrial Upland	Extends from the landward boundary of the primary dunes and swales habitat on the ocean side to MHW of the bay intertidal habitat; includes all upland as well as any freshwater wetland habitats within this zone; bayside beach and maritime forested habitats are included in this habitat.
Maritime Forest	Forested communities found within the terrestrial upland habitat. These areas are defined by salt tolerant vegetation, high salinity and salt spray adapted soils and vegetation assemblages such as trees, shrubs, and herbaceous species.
Bayside Beach	Unvegetated sandy areas between MHW and the bayside limit of upland vegetation; included in the terrestrial upland habitat. This habitat is also present in association with the mainland upland habitat where mainland shoreline is adjacent to backbay areas.
Backbay Ecosystems	
Bay Intertidal	Extends from MHW to MLW on the bay side of the barrier island. Habitats such as sand shoals, mud flats, and salt marsh are included in bay intertidal habitat
Sand Shoal and Mud Flat	Unvegetated areas within the bay intertidal habitat exposed at low tide. Sand shoals and mud flats differ on the basis of sediment texture and grain size, providing separate but potentially overlapping infaunal and epifaunal habitats.
Salt Marsh	Bayside vegetation communities found within the bay intertidal habitat that are dominated and defined by salt-tolerant species, predominantly salt marsh cordgrass (*Spartina alterniflora*) and salt meadow cordgrass (*Spartina patens*). Occurs from the landward limit of the high marsh vegetation, sometimes also MHW or slightly landward, to the seaward limit of the intertidal marsh vegetation
Bay Subtidal	Bayside aquatic areas below MLW, including channels and deeper areas of the bay that are always inundated.
Submerged Aquatic Vegetation (SAV)	Bayside submerged aquatic vegetation (SAV) communities found within the bay subtidal habitat
Mainland Upland Ecosystem	
Mainland Upland	Area generally extends from the landward limit of the bay intertidal MHW line to the landward limit of the study area which generally correlates with Sunrise Highway (Route 27). This habitat also includes mainland wetlands and coastal ponds. Along the Atlantic shorefront, mainland upland begins at the landward toe of the primary dune. Along the mainland shoreline adjacent to backbay areas, this habitat also includes bayside beach.

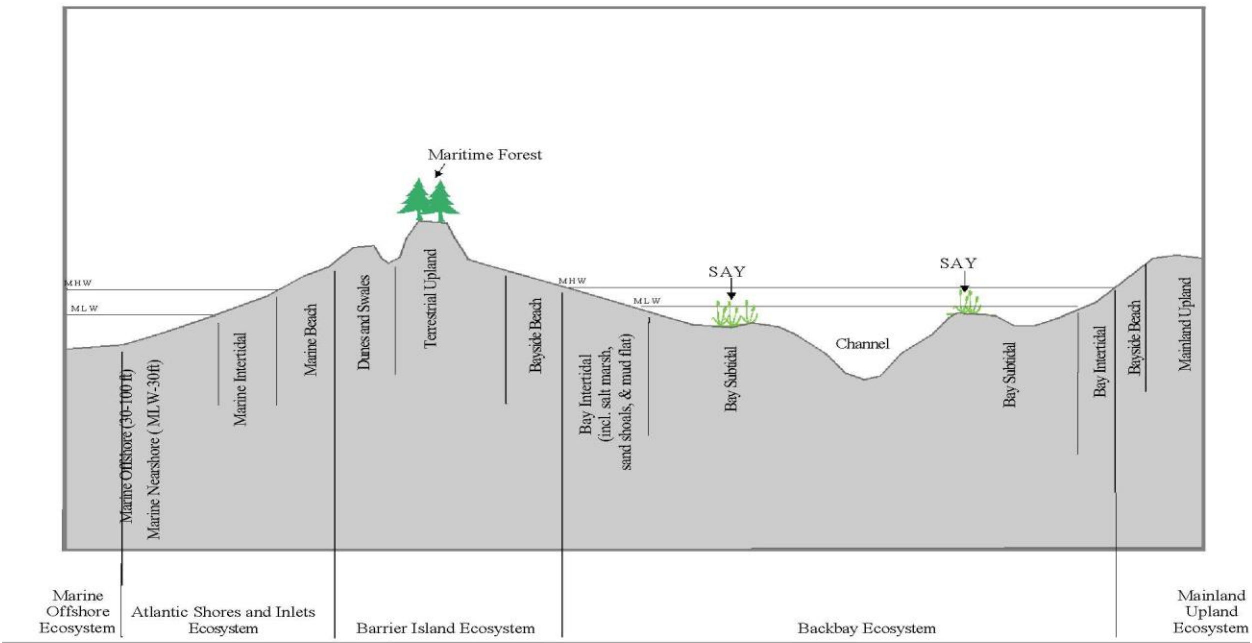


Figure 18 - Transect Showing Ecosystems and Habitats Present in Study Area

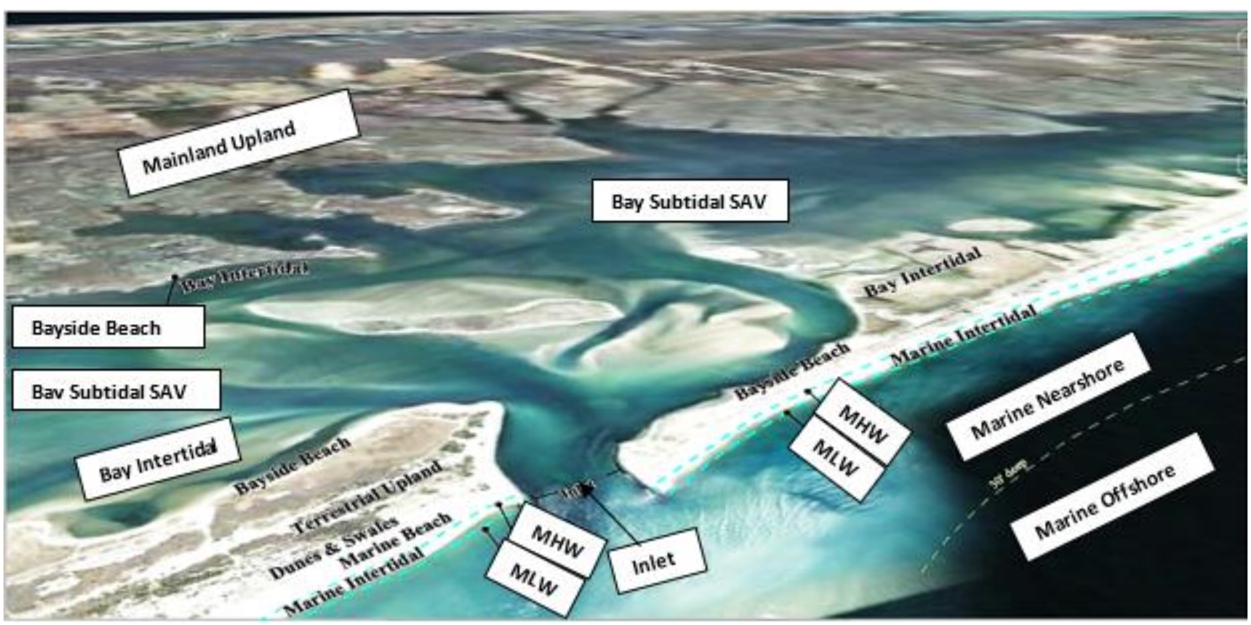


Figure 19 - Birds Eye View Showing Representative Habitats in Study Area

2.5.1.1 Marine Offshore Ecosystem

The marine offshore ecosystem includes habitat that consists of the deep water areas (ranging from 30 to 100 feet) of the Atlantic Ocean. The habitat includes pelagic and benthic zones, which support different assemblages of organisms. The pelagic zone refers to the water column and organisms within it, whereas the benthic zone refers to the bottom or substrate and includes sediments and other material present on the ocean floor. The benthic zone substrate within the study area is primarily sand. The marine offshore zone is relatively homogeneous throughout the entire coastline of southern Long Island. The bottom or benthic zone substrate is primarily a ridge and swale complex and consists of fine to medium grained sand. Typically, ocean wave heights are less than 3 feet (USACE 2006a), although waves between 3 and 10 feet occur roughly 25 percent of the time, and waves exceeding 10 feet occur only about 1 to 3 percent of the time.

2.5.1.2 Atlantic Shores and Inlets Ecosystem

The Atlantic shores and inlets ecosystem includes all oceanic habitats from 30 feet deep to the seaward toe of the primary dune, and includes the Rockaway East, Jones Island, and Fire Island inlets. Habitats within the Atlantic shores and inlets ecosystem include the marine nearshore and intertidal, oceanfront beaches, and inlets.

Marine Nearshore and Intertidal. Marine nearshore habitat is defined as the MLW level to a depth of 30 feet and includes pelagic and benthic zones. The marine intertidal habitat is defined as the oceanic area from MLW to MHW typically having a sandy and/or rocky substrate.

Oceanfront Beach. Oceanfront (marine) beach habitat extends from the MHW line, or upper bound of the marine intertidal habitat, to the seaward toe of the primary dune. The marine beach habitat consists of sand and is typically sparsely vegetated with beach grass, scattered herbs, and sparse low-growing shrub communities associated with the upper beach/dune area and not subject to regular inundation. The oceanfront beaches in the study area are significantly impacted from human use for recreational activities. Significant development that abuts the upper beach zone in most of the study area. The only undeveloped areas in the study area, besides the beach itself, occur at Silver Point, and Lido Beach/Point Lookout.

Inlets. The inlets ecosystem includes the area below MHW within the three barrier island inlets: East Rockaway Inlet, Jones Inlet, and Fire Island Inlet. These inlets are aligned generally perpendicular to the barrier island and mainland shorelines. The inlets are typically rocky at their perimeter edges at the MHW line.

2.5.1.3 Barrier Island Ecosystem

The barrier island ecosystem includes all habitats of the barrier islands from the landward limit of the marine beach habitat to MHW of the bay intertidal habitat. Habitats within the barrier island ecosystem include dunes and swales, and terrestrial upland (which encompasses maritime forest and bayside beach).

Dunes and Swales. The dunes and swales habitat are located between the landward edge of the marine beach and terrestrial upland habitat of the barrier island ecosystem. The dunes and swales habitat typically has a sand substrate and is not regularly inundated by tides. Freshwater ponds, wetlands, and sparsely-vegetated shrubby or forested communities are included in this habitat designation.

Terrestrial Upland. The upland habitat extends from the landward boundary of the dunes and swales habitat on the ocean side to MHW on the bay side of the barrier island. This habitat type includes vegetated upland, developed land, maritime forest, and bayside beach habitat. Also included in the terrestrial upland habitat are areas of residential and commercial development.

Maritime Forest. Maritime forest is a terrestrial upland habitat that is typically located in sheltered hollows landward of dunes and swales. These areas are defined by salt tolerant vegetation, high salinity and salt spray adapted soils and vegetation assemblages dominated by trees and shrubs. Historically, a mosaic of the maritime forests/shrubland/grassland habitats was a large component of the undisturbed Nassau Back Bays 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.

Bayside Beach. The bayside beach extends from MHW on the bay side landward to the upland habitat and is included in the terrestrial upland habitat. Bayside beach habitat is also present in association with the mainland upland habitat where mainland shoreline is adjacent to back bay areas. It is generally characterized as narrow beach areas devoid of vegetation and comprising mostly sand. Within the study area, much of the bayside beach has been eliminated due to bulkhead construction, immediate upland development, and/or severe erosion (USACE 2020).

2.5.1.4 Back Bay Ecosystem

The back bay ecosystem includes all intertidal and subtidal areas below MHW from the bay side of the barrier island to the mainland. Habitats within the back bay ecosystem include bay intertidal (including salt marsh, sand shoals, and mud flats) and bay subtidal (including submerged aquatic vegetation [SAV]).

Bay Intertidal (including salt marsh, sand shoal and mudflats). The bay intertidal habitat extends from MHW to MLW on the bay side of the barrier island and includes salt marsh, sand shoal, and mud flat habitat areas. The substrate is periodically exposed and flooded by semidiurnal tides (two high tides and two low tides per tidal cycle), resulting in alternating periods of inundation and dryness and fluctuating salinity, making this a naturally stressed habitat suitable only for biota that are adapted to these conditions. Sand shoals and mud flats are generally distinguishable from each other on the basis of sediment texture and grain size, providing separate but potentially overlapping infaunal and epifaunal habitats.

Bay intertidal habitat is influenced by hydrology and sediment transport, and includes natural and hardened shoreline areas, such as those associated with bulkheads and riprap revetments.

Bay Subtidal (including SAV). The bay subtidal habitat extends from the MLW boundary of the bay intertidal habitat and includes the channels and deeper areas of the bay that are always inundated. Most subtidal areas are unvegetated. However, some vegetated subtidal areas exist in the form of SAV habitat, where the dominant submerged plant species is eelgrass (*Zostera marina*). SAV habitat areas are included in the bay subtidal habitat definition because SAV generally occurs below MLW.

2.5.1.5 Mainland Upland Ecosystem

The mainland ecosystem extends from the landward limit of the back bay intertidal MHW line to the landward limit of the study area. This habitat also includes mainland wetlands, coastal ponds, and bayside beaches.

The mainland ecosystem contains various upland and wetland habitats occurring in a mosaic with largely residential and commercially developed lands. Natural vegetation on the mainland primarily consists of various pine-oak forests on upland slopes and ridgetops and forested swamps and emergent marsh along stream channels, pond margins, and in low lying depressional areas. Disturbed and densely developed areas occur throughout the study area. Historically, much of the shoreline of the mainland has been subject to extensive clearing and filling to support the development of homes and commercial facilities. Along with this development, ornamental plants and exotic faunal species have been introduced, which compete with native flora and faunal species.

2.5.2 Wetlands

The study area supports an extensive network of wetlands that are primarily located on eroding marsh islands throughout the back bays ecosystem. Within the study area, intertidal wetlands and mudflats are the predominant wetland types. Table 7 provides the composition of wetland resources in the study area based on the 1974 NYSDEC data used for state regulatory decisions. Figure 20 depicts these wetland resources in the area as mapped by NYSDEC. There are 17,155 acres of wetlands within the study area (excluding Littoral Zone shallow water). Low and high marsh comprise over 8,926 acres. Coastal shoals, bars, and mudflats cover 7,687 acres.

Table 7 - Acreage of Wetlands by Type in the Study Area (NYSDEC 1974)

Wetland Category	Acreage
Dredged Spoil (DS)	481
Formerly Connected (FC)	58
Coastal Fresh Marsh (FM)	3
High Marsh (HM)	1,249
Low (Intertidal) Marsh (IM)	7,677
Littoral Zone (LZ)	191,849
Coastal Shoals, Bars and Mudflats (SM)	7,687
Total	**209,004**
Total excluding Littoral Zone	**17,155**
Low and High Marsh Habitat Only	**8,926**

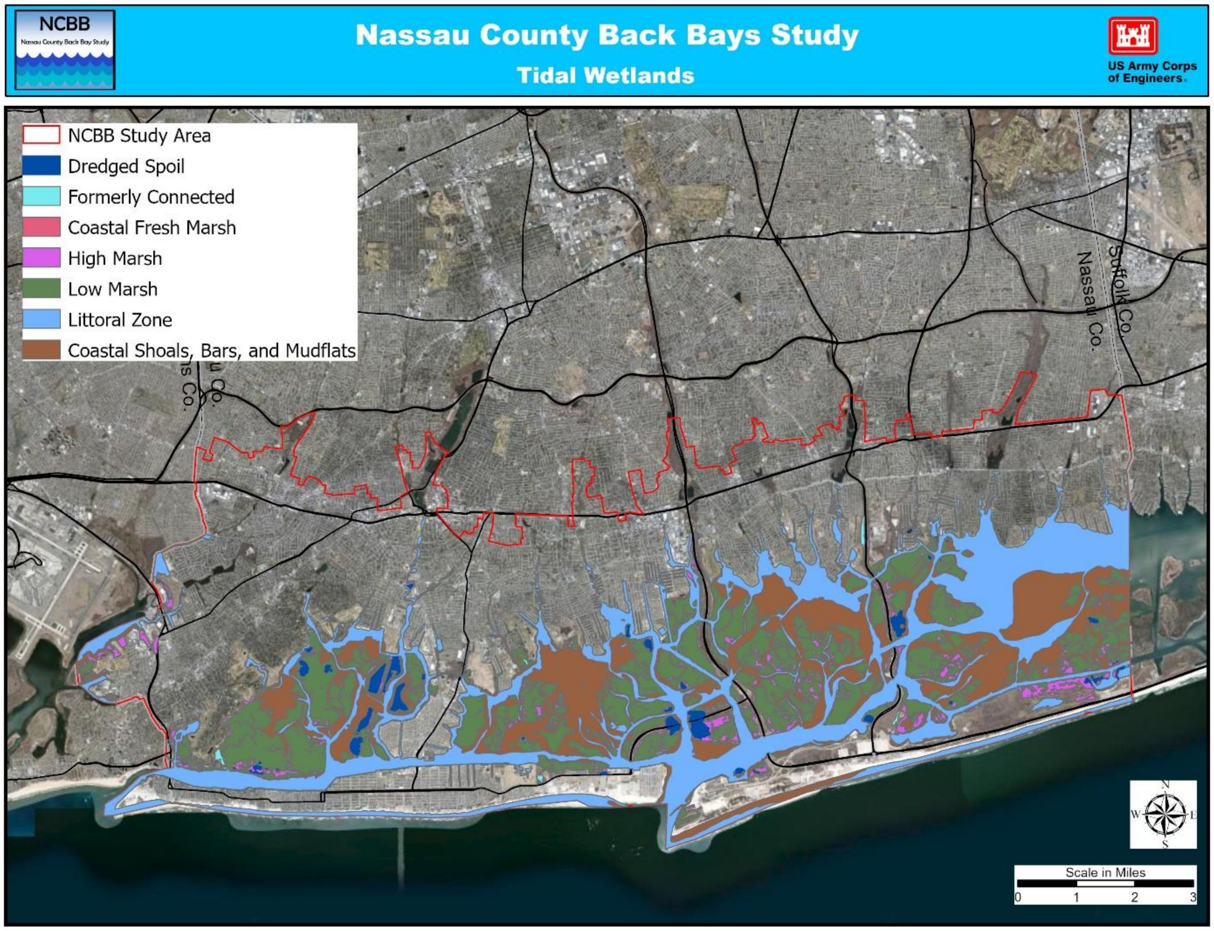


Figure 20 – Wetlands

Intertidal wetlands are vegetated areas tidally influenced and connected to open waters that are inundated or saturated by surface water or groundwater frequently enough to support vegetation that thrives in wet soil conditions. Intertidal wetlands in the back bay estuaries are some of the most important habitats for wintering waterfowl, migratory and resident shorebirds, waterbirds, wading birds, passerines, raptors, and songbirds; and provide nursery grounds and refuge for numerous fish and invertebrates. For example, the network of salt marsh and dredge material islands in the Hempstead Bay – South Oyster Bay complex are important for nesting by herons, egrets, and ibises. The substrate of most bays and sounds are exposed at low tide and the invertebrates present are heavily utilized by shorebirds, wading birds, gulls, terns, and waterfowl. Vegetation assemblages characteristic of the estuarine intertidal subsystem include high and low salt marshes and salt pannes dominated by smooth cordgrass (*Spartina alterniflora*), common glasswort (*Salicornia europea*), salt hay grass (*Spartina patens*), spike grass (*Distichlis spicata*), and perennial salt marsh aster (*Aster tenuifolius*). The predominant vegetation in these wetlands is salt marsh cordgrass, an important species for the production of food chain organisms for fish, shellfish, birds, and other wildlife.

Additionally, wetlands within the terrestrial upland habitat are nontidal, freshwater wetlands that support forested, scrub-shrub, and emergent communities. These wetlands occur primarily in small, isolated depressions within the greater upland terrestrial community. Freshwater forested wetlands are not common in the study area but can be found in the upland interior of the barrier island ecosystem.

Additional wetland data is available from 2008 as provided in Figure 21 that demonstrates the loss of wetlands in the study area since 1974. Low (intertidal) mash remains the primary wetland resource in the study area.

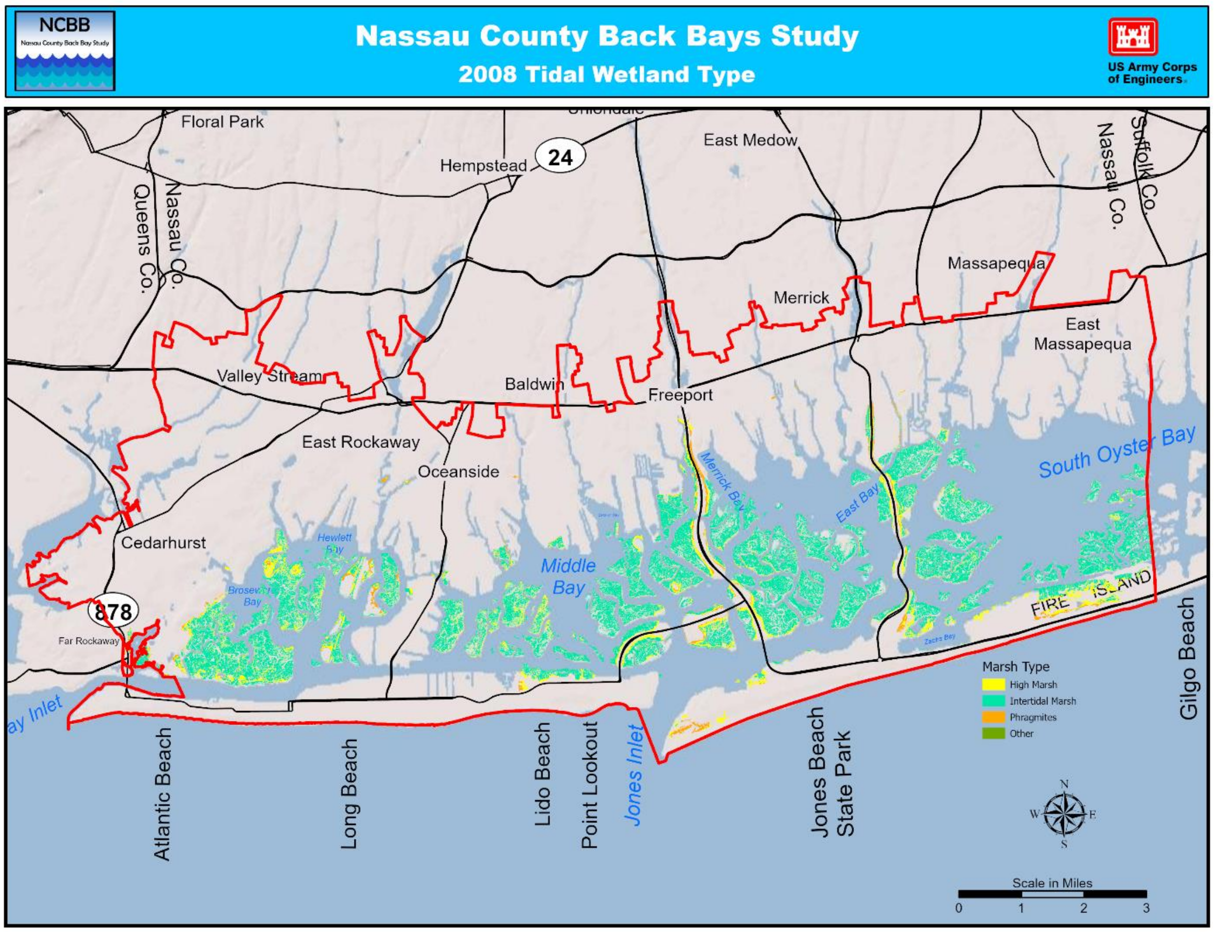


Figure 21 - 2008 Wetlands

2.5.2.1 Historical Wetland Loss

There has been a severe loss of wetlands in the back bays system due to human development in the watershed. Existing wetlands are not only threatened by additional development pressures, but by climate change and RSLC. Wetland loss between 1974 and 2008 was investigated by the Long Island Tidal Wetlands Trends Analysis. Figure 22 illustrates wetland loss in the study period. In general, wetlands are being loss to erosion of the edges of marsh islands throughout the back bays. The loss of low (intertidal) marsh is driving the trend.

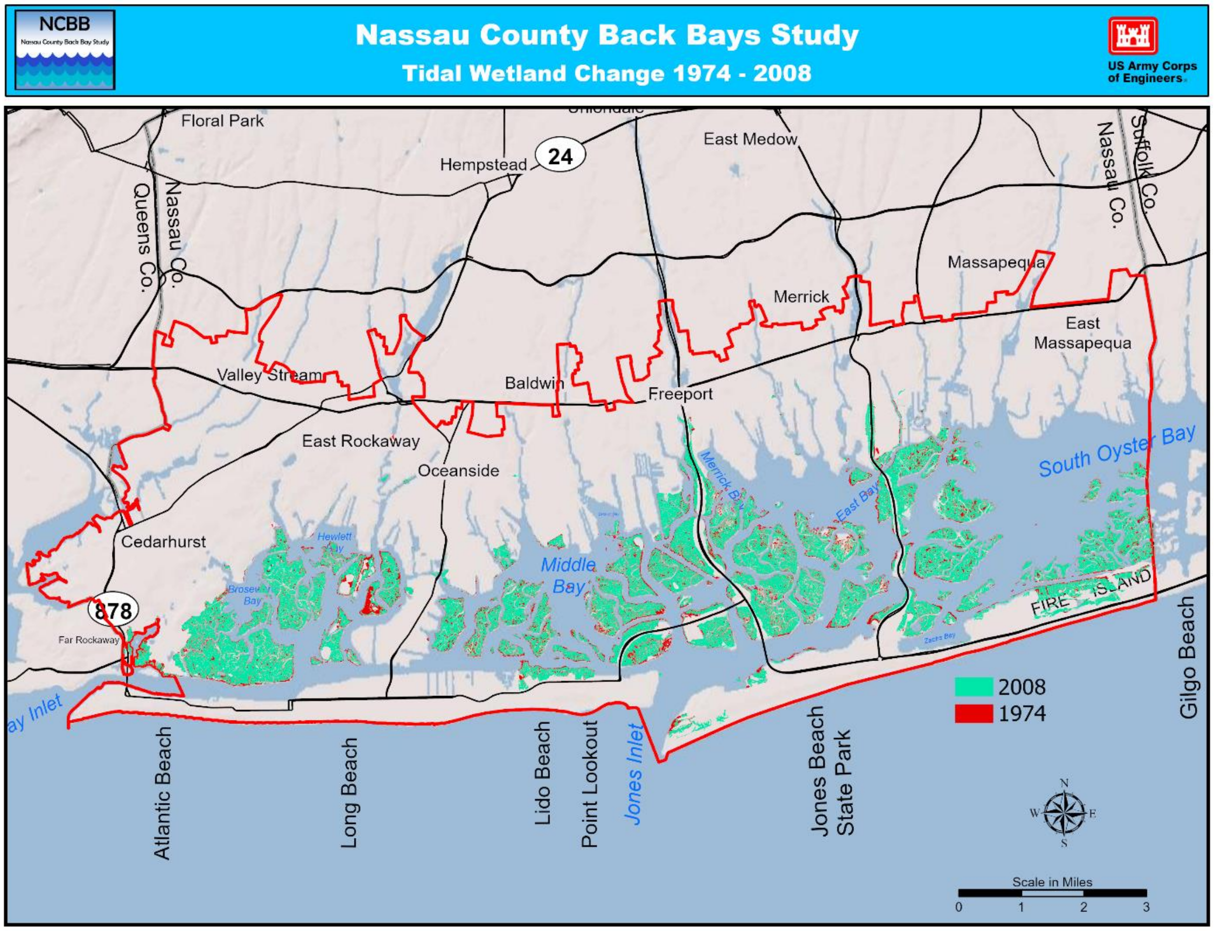


Figure 22 - Wetland Loss in the Study Area Between 1974 and 2008

Table 8 - Wetland Loss by Acreage Between 1974 and 2008

	Tidal Wetland Acreage		
	1974	2008	% Change
Total	7958	6750	-15.2
High Marsh	1106	1059	-4.2
Intertidal Marsh	6574	5473	-16.7
Phragmites	276	218	-21.0
Other	2	0	-100.0

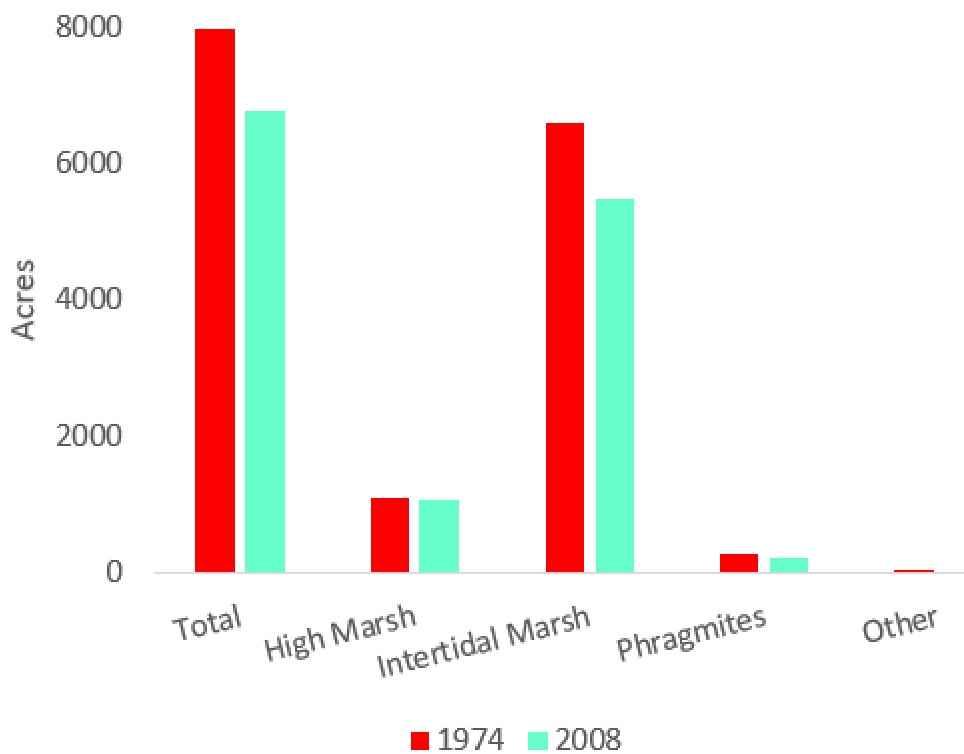


Figure 23 - Comparison of Wetland Loss by Type Between 1974 and 2008

The Trends Analysis only included three wetland categories: high, intertidal (low), and Phragmites. Additionally, there is a discrepancy between the 1974 acreage provided in Table 8 for these wetland types. This is due to exclusion of internal island channels in the Trends Analysis versus inclusion in the complete NYSDEC data set. Additionally, the Trends Analysis does not include an area in East Rockaway in the evaluation. Regardless of the processing differences, low marsh acreage is being loss to edge erosion and RSLC. Due to the urban backdrop of the south shore estuaries, it is unlikely that natural landward migration will occur to accommodate accelerated RSLC.

2.5.3 Vegetation

2.5.3.1 Submerged Aquatic Vegetation (SAV)

Submerged aquatic vegetation (SAV) and/or “seagrass” beds exist in the eastern portion of the back bay estuarine system. Based on 2018 surveys, there are 2,177 acres of SAV habitat within the study area.

SAV are rooted vascular flowering plants that exist within the photic zone of shallow bays, ponds, and rivers. SAV are an essential food for a number of waterfowl species; provide habitat for finfish, shellfish and a number of other invertebrates; and improve water quality and clarity. Further, SAV beds help absorb wave energy, stabilize sediment to reduce erosion, and support shoreline resilience. Eelgrass (*Zostera marina*) is the dominant seagrass within the study area. Widgeongrass (*Ruppia maritime*) can also be found to a lesser extent in some brackish and estuarine waters. Additionally, unattached macrophytes grow in shallow, quiet waters below the spring low tide level. Figure 24 depicts SAV in the study area from the NYSDEC Statewide Seagrass Map. Western Great South Bay supports significant SAV beds near the border of Suffolk and Nassau Counties. There are no SAV beds present in the bays west of Great South Bay, but beds persist through the back bay system to the east outside the study area.

This limited distribution is due to both natural and anthropogenic conditions that characterize this highly urban environment. Currently, seagrass populations in New York State are declining due to threats associated with excess nitrogen (affecting water quality), persistent and sustained algal blooms, and fishing and shellfishing gear impacts (NYS seagrass Task Force 2009). RSLC may pose significant threats to remaining populations due to potential implications of increased water depth such as increased water temperatures and limited light penetration. The South Shore Estuary is the shallowest area where seagrasses are found in New York State and populations in this area are susceptible to RSLC, and increased water temperatures from climate change. Additionally, a hardened shoreline exacerbates the effects of RSLC on seagrass beds by preventing landward migration and causing scour and decreased availability of suitable habitat (NYS seagrass Task Force 2009).

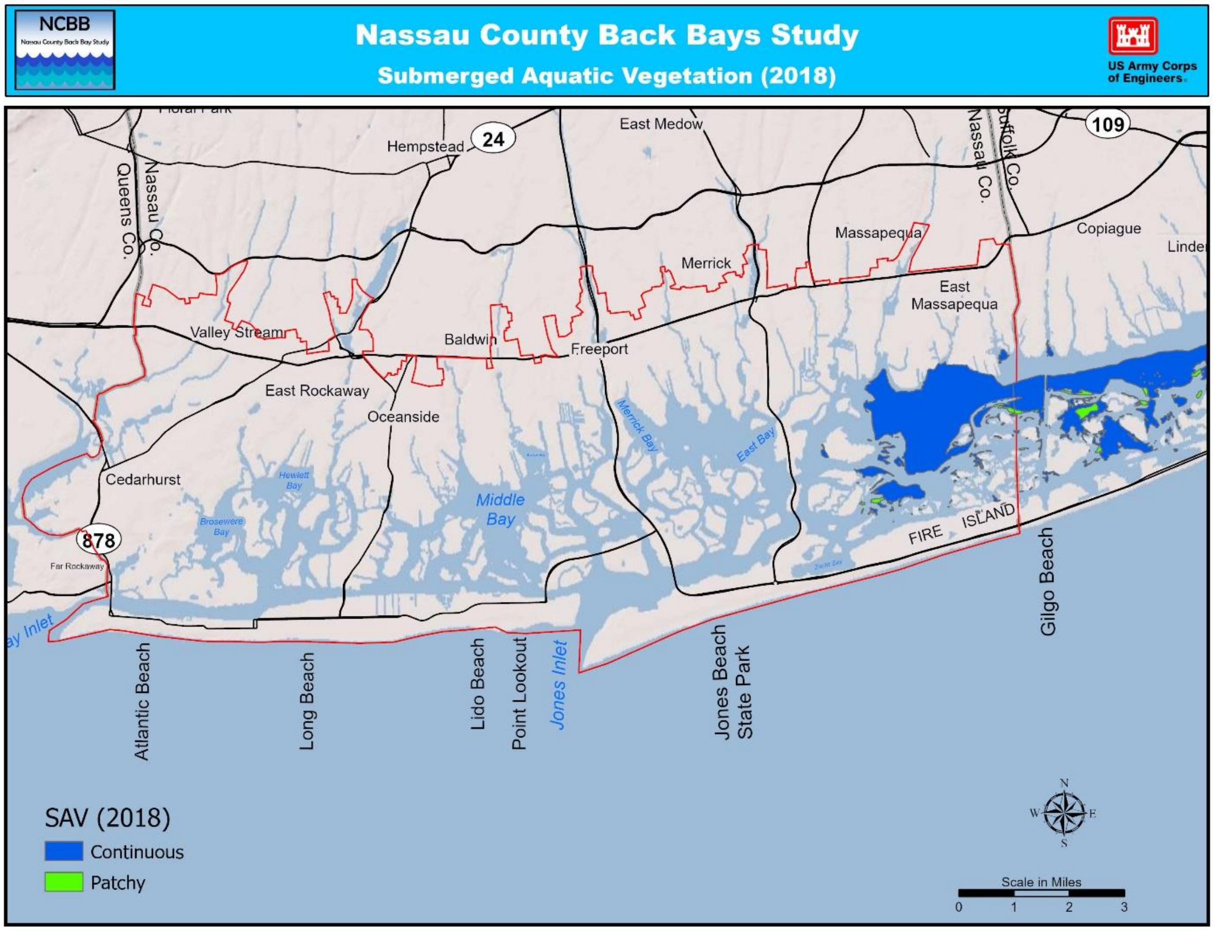


Figure 24 - NYSDEC Statewide Seagrass Map Portraying the Study Area

2.5.3.2 Upland Vegetation

The upland habitat on the barrier island extends from the landward boundary of the dunes and swales habitat on the ocean side to MHW on the bay side of the barrier island. This habitat type includes vegetated upland, developed land, maritime forest, and bayside beach habitat. The upper beach zone and dunes are dominated by sand and beachgrass. Grass lawns, park fields and forested tracks, and urban trees can be found within the vegetated upland behind the back bays.

Dunes and swales provide important microhabitat for vegetation such as beach grasses, other annual herbaceous species, and shrubs. The initial establishment of dune vegetation acts to trap sediment and enhance dune stability, creating suitable conditions for establishment of other biota and later successional vegetation. Dunes and swales can be subdivided into several distinct habitat types, including the foredune and primary dune slopes, crest, and back or stabilized secondary dunes. Vegetation communities are often defined by the dunes' distance from the shoreline (USACE 2016). Wetland communities within this habitat type are generally small and limited to the interdunal swales that may support freshwater and brackish plant species. The most common wetland type is scrub-shrub communities defined as freshwater wetlands with a predominance of woody shrubs adapted for saturated conditions.

2.5.4 Terrestrial and Aquatic Wildlife

The marine offshore and nearshore ecosystems, inlets, bayside intertidal saltmarsh, mudflats, beach, and sand shoals are utilized by a diverse group of birds for various activities, including foraging, nesting, and resting; and fish, shellfish, and marine mammals. NYSDEC has designated a number of areas as Significant Coastal Fish and Wildlife Habitats (SCFWH). The SSER supports more designated SCFWH areas than any other region of the State including Democrat Point, Hempstead Bay (East, Middle, and West), Jones Beach (East and West), Tobay Sanctuary, South Oyster Bay, and Great South Bay (NYSDOS 2008). Many of these areas are significant for their undeveloped salt marsh complex, tidal flats, and open water.

2.5.4.1 Terrestrial

Birds. The National Audubon Society of New York State has recognized nearly the entire study area as Important Bird Areas within two priority areas: West Hempstead/Jones Beach West or Captree Island vicinity. The study area is part of the Atlantic Flyway, a route used by a wide array of avifauna during migrations, and is home to a host of pelagic avifauna species (birds that spend most of their time on the ocean; petrels, shearwaters, gannetts, cormorants, sea ducks, etc.) during certain portions of the year. Piscivorous (fish-eating) species such as the cormorant (Family *Phalacrocoracidae*), are drawn to the area due to the availability of prey fish and benthic invertebrates. The invertebrate-rich feeding grounds of the area also support nesting birds and many migratory shorebirds. Many of the shorebirds and waterbirds may also utilize the Dunes and Swales habitat. Colonial wading and water birds use the island network within the back bays for rookeries; and maritime shrublands support a diverse assemblage of migratory land birds such as warblers, vireos, and thrushes.

A variety of birds use the beach for resting, nesting, and feeding including several state and/or federally listed threatened and endangered species, including the least and common terns, piping plover (*Charadrius melodus*; Federally Threatened and State Endangered), black skimmer (*Rynchops niger*; State Special Concern), and red knot (*Calidris canutus*; Federally Threatened and State Endangered). These birds prefer dry, sandy, open beaches well above the high tide line breeding habitat. Grassless areas in remote beaches are traditionally utilized, although openings in grassy dunes as small as 200 to 300 feet wide may also be used (Wilcox 1959). Piping plover nests have been seen along the southern shore of Long Island in grassy areas at the edges of dunes, and sometimes behind dunes in blowout areas. The bayside intertidal areas of Long Island are utilized by wading birds, shorebirds, and gulls. The primary use of the sand shoal and mudflat areas by birds is for foraging activities, but significant numbers of birds also loaf on these areas when exposed during low tides.

Recreationally important ducks, including the scaup (*Aythya sp.)* and American black duck (*Anas rubripes*), use inlets for the variety of prey items available for forage. South Oyster Bay is a primary waterfowl wintering area on Long Island.

The following species are a sampling of the avian resources supported by the back bay estuarine habitat:

- *colonial water birds* - common terns, Forster's tern, least tern, roseate terns, gull-billed terns, and black skimmer (*Rynchops niger*; State Special Concern);
- *shorebirds* – piping plover (*Charadrius melodus*; Federally Threatened and State Endangered), black-bellied plover (*Pluvialis squatarola*), common tern (*Sterna hirundo*), dunlin (*Calidris alpina*), herring gull (*Larus argentatus*), sanderling (*Calidris alba*), dowitchers, willet (*Catoptrophorus semipalmatus*), red knot (*Calidris canutus*; Federally Threatened and State Endangered), ruddy

turnstone (*Arenaria interpres*), marbled godwit, sandpipers, great black-backed herring gull (*Larus marinus*), ring-billed gulls (*Larus delawarensis*), whimbrel, yellowlegs, and American oystercatcher (*Haematopus palliates*);

- *colonial wading birds* – snowy egret, great egret (*Casmerodius albus*), greater yellowlegs (*Tringa melanoleuca*), great blue heron (*Ardea herodias*), little blue heron, black-crowned night heron, yellow-crowned night herons, tri-colored heron, glossy ibis, American bittern (*Botaurus lentiginosus*; State Special Concern), and green-back heron;
- *raptors* – peregrine falcon (*Falco peregrinus;* State Endangered), short-eared owl (*Asio flammeus*; State Endangered), bald eagle (*Haliaeetus leucocephalus*; State Threatened, as well as being protected under the Golden and Bald Eagle Protection Act of 1940), northern harrier (*Circus cyaneus*; State Threatened), sharp-shinned hawk (*Accipiter striatus*; State Special Concern), cooper's hawk (*Accipiter cooperii*; State Special Concern), common nighthawk (*Chordeiles minor*; State Special Concern), snowy owl (*Bubo scandiacus*), and osprey;
- *passerines* – marsh wren, sharp-tailed sparrow, saltmarsh sparrow (*Ammodramus caudacutus*), vesper sparrow (*Pooecetes gramineus*; State Special Concern), seaside sparrow (*Ammodramus maritimus*; State Special Concern), snow bunting (*Plectrophenax nivalis*); and
- *waterfowl* – greater and/or lesser scaup (*Aythya sp.).* American black duck (*Anas rubripes*), brant (*Branta bernicla*), geese, canvasback, American coot, mergansers, mallards, common goldeneye, bufflehead, ruddy duck, long-tailed duck, blue-winged teal, green-winged teal, northern shoveler, and American widgeon.

Reptiles. Reptiles that may occur in the study area include green sea turtles (*Chelonia mydas*), loggerhead sea turtles (*Caretta caretta*), leatherback sea turtles (*Dermonchelys coriacea*), Kemp's ridley sea turtles (*Lepidochelys kempii*), diamondback terrapins (*Malaclemys terrapin*), eastern wormsnake (*Carphophis amoenus*), northern brown snake (*Storeria d. dekayi*), 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*).

The diamondback terrapin (*Malaclemys terrapin*) is a medium sized turtle species that inhabits brackish waters of estuaries, tidal creeks, and salt marshes along the northeastern coast of North America. Diamondback terrapins are known to forage in the tidal creeks of marshes and even in the open bays of the back bay ecosystem. They feed on marine snails, clams and worms. Typically, diamondbacks come ashore to lay their eggs in June, which hatch later in the summer. Sea turtles often use sheltered estuaries and bays, as well as other important habitats such as SAV during their juvenile years (CRESLI 2006, USACE 2016).

Amphibians. Amphibians 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 (*Ambystoma maculatum)*, and redback salamander (*Plethodon cinereus*). The sparsely vegetated terrestrial habitat along the beach and dunes are not expected to support amphibian habitat. No amphibians are associated with the deeper portions of the backbay.

Mammals. The majority of the study area is urbanized. Mammals typical of these urban areas and adjacent natural areas include includes year-round habitat for terrestrial mammals such as the gray squirrel (*Sciurus carolinensis*), house mouse (*Mus musculus*), Norway rat (*Rattus norvegicus*), Eastern cottontail (*Sylvilagus floridanus*), and feral cat (*Felis catus*) (USACE 1998, 2003, and USFWS 1992 as cited

USACE 2015a). Some of the marsh and upland areas provide natural habitat for resting and feeding activities.

Marine mammals are discussed under Section 2.5.5.3.

2.5.4.1 Aquatic

Finfish. Finfish inhabit all aquatic habitats in the study area: back bay intertidal, sand shoals, mudflats, bay subtidal, marine nearshore, and marine offshore waters.

The pelagic zone of the marine offshore habitat generally contains schools of adult and juvenile fish populations that occupy the mid- to upper areas of the water column (USFWS 1997b as cited in USACE 2020) including several species of skate (predominantly *Raja* and *Leucoraja* spp.), and commercially and recreationally valuable fish species including, but not limited to, hake species (*Gadidae* spp.), scup (*Stenotomus chrysops*), bluefish (*Pomatomus saltatrix*), Atlantic butterfish (*Peprilus triacanthus*), striped bass (*Morone saxatilis*), herring species (Clupeidae spp.), and Atlantic mackerel (*Scomber scombrus*). The marine offshore habitat is also frequented by benthic finfish species such as American sandlance (*Ammodytes americanus*), winter flounder (*Pseudopleuronectes americanus*), summer flounder (*Paralichthys dentatus*), windowpane (*Scophthalmus aquosus*), and monkfish (*Lophius americanus*) as documented by USACE (2006a).

The back bay intertidal habitat extends from MHW to MLW on the bay side of the barrier island, and includes sand shoals, sand/mud flats, and salt marsh habitats. Common finfish within the bay intertidal habitat include the forage/bait species Atlantic silverside (*Menidia menidia*), killifish (various species from the Genus *Fundulus*), and cunner (*Tautogolabrus adspersus*) (USACE 2006a). Commercially and recreationally important indicator finfish of the bay intertidal habitat include tautog (blackfish) (*Tautoga onitis*), common weakfish (Cynoscion regalis), bluefish (*Pomatomus saltatrix*), black sea bass (*Centropristis striata*), striped bass (*Morone saxitilis*), and herring species.

Species found in the study area associated with sand shoal and mudflat habitat include various species of juvenile fish, killifish, and the commercially and recreationally important winter flounder (*Pseudopleuronectes americanus*), summer flounder (*Paralichthys dentatus*), and bluefish (*Pomatomus saltatrix).*

The bay subtidal habitat includes bayside aquatic areas located below the MLW, and includes channels and the deeper areas of the bay that are always inundated. A variety of finfish utilize bay subtidal waters that retreat from the bay intertidal habitat on ebb tides, as many species are attracted to different subtidal depths and substrate types (e.g., shallow unvegetated sand and mud, vegetated areas, mid-depth, etc.). Forage and bait species such as cunner, killifish, Atlantic silverside, northern puffer (*Sphoeroides maculatus*), northern pipefish (*Syngnathus fuscus)*, and sticklebacks are common finfish species of the bay subtidal habitat. Winter flounder, American eel (*Anguilla rostrata*) and tautog, are all considered to be commercially and recreationally important species of the bay subtidal habitat (USACE 2006a).

The back bays are critical nurseries for yearling striped bass, summer flounder, and bluefish; and reef-associated species such as tautog, cunner, and black sea bass; and important spawning ground for winter flounder, Atlantic menhaden, Atlantic silverside, bay anchovy, weakfish, American sandlance, pipefish, sticklebacks, and killifish.

Epiphytic invertebrates that inhabit SAV beds provide a food source for a variety of fish. USACE has identified the following species associated with SAV habitats within the study area: cunner, Atlantic silverside, killifish, northern puffer, pipefish, fourspine sticklebacks (*Apeltes quadracus*), tautog, common weakfish, bluefish, black sea bass, striped bass, herring species, winter flounder, and American eel (USACE 2016). The USACE surveyed backbay habitats with beach seines as part of a SAV study conducted within the bay habitat in 2004 and 2005. A total of 16,413 finfish representing 49 species were collected from June through October of 2004, and a total of 4,691 finfish representing 41 species were collected from May through November of 2005 (USACE 2004 and USACE 2006). The dominant species collected within the SAV beds in the 2004 study was the fourspine stickleback which represented 32 percent of the total catch. Atlantic silverside was the next most abundant species, followed by tautog and grubby (*Myoxocephalus aenaeus*). In 2005 Atlantic silverside was the most abundant species collected, representing 26 percent of the total catch, followed by bay anchovy, and Atlantic tomcod.

Shellfish. Shellfish present within the subtidal habitat of the backbays include the hard clam (*Mercenaria mercenaria*), blue mussel (*Mytilus edulis*), soft shell clam (*Mya arenaria*), eastern oyster (*Crassostrea virginica)*, and bay scallop (*Argopecten irradians*). Hard clams and other shellfish such as bay scallop and soft shell clam play a critical role in the bays, filtering water and serving as an important link in the food web. The hard clam population peaked in the 1970s. Since 1976, the hard clam harvest has declined 100 fold (Hinga 2005). The shellfish stocks have been declining steadily since the 1960s. The causes of the decline are still not proven, but poor natural recruitment, over-harvesting, increased predation, long-term climatic changes in temperature and salinity, and toxic algal blooms, such as brown tide, have been discussed as possible factors. High abundances of hard clams are found in sediments with a larger fraction of course-grained materials, especially shell fragments, which appear to provide a more diverse habitat community of suspension feeders and carnivores (Hinga 2005, USACE 2016).

Aquatic Invertebrates. The coastal habitats along Long Island including the back bays are home to a wide variety of both benthic and free swimming and floating invertebrates. Marine benthic invertebrates are bottom-dwelling species that can be grouped into two categories: infaunal, or benthic invertebrates that live within the substrate, and epifaunal or epibenthic invertebrates, which live on the surface of the substrate. In particular, benthic invertebrates make up the primary food source for both juvenile and adult fish species in shallow water environments found in estuarine habitats. Benthic invertebrate communities vary spatially and temporally as a result of factors such as sediment type, water quality, depth, temperature, predation, competition, and season. Thus, benthic invertebrate communities differ between habitat types. For example, the community within fine grain sediment found in deep water, low energy environment is likely to be dominated by a higher percentage of sessile organisms, while a shallow, high energy environment consisting of larger grain sediment may contain a higher percentage of mobile filter feeding invertebrates. Other invertebrates discussed in this section include pelagic forms of invertebrates, or those that swim and move freely within the water column, and commercial and recreationally important invertebrates that occur within the marine offshore habitat of the study area.

Invertebrate groups found in various coastal habitats include Cnidaria (hydra, corals, anemones, jellyfish), Platyhelminthes (flatworms), *Nemertinea* (ribbon worms), Nematoda (roundworms), Polychaetes (bristle worms), Oligochaetes, *Bryozoa*, Mollusca (chitons, bivalves, snails, squids, etc.), Crustaceans (crabs, shrimp, amphipods), insects (Dipterans), Echinodermata (sea urchins, sea cucumbers, sand dollars, starfish), Urochordata (tunicates), and zooplankton, which may represent a number of different phyla at various life stages.

The benthic invertebrates of the marine offshore habitat include a variety of taxa common to generally clean, well-oxygenated, coarse sandy marine habitats (USACE 2020). 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 bottom feeding fish (Waldman 2008 as cited in USACE 2019). Blue crab (*Callinectes sapidus*) and American lobster (*Homarus americanus*) are food resources for predatory fish and birds (Bain et al. 2007, Waldman 2008, and USACE 2009 as cited in USACE 2019), and commonly found in subtidal bottom and oyster reef habitats. Epifaunal biota include amphipods, crabs, horseshoe crabs, echinoderms (e.g., sea stars, sand dollars), and bivalves (e.g., surf scallops [*Aequipecten sp*.], Atlantic surfclams [*Spisula solidissima*]). 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 (USACE 2019).

Surf clams inhabit relatively shallow waters of the surf zone to a depth of about 180 feet (National Oceanic and Atmospheric Administration [NOAA] National Marine Fisheries Service [NMFS] 2000 as cited in USACE 2020), but most commonly occur at depths less than 240 feet in well-sorted, medium-sized sand in turbulent areas beyond the breaker zone (Jacobson et al. 2006). Off the coast of Long Island, surf clam beds extend from the marine beach habitat to marine offshore depths of approximately 150 feet (USFWS 2007d as cited in USACE 2020). Commercial landings of surf clams in the State of New York exceeded $1,240,000 in 2017 and this species is considered a valuable resource to the state (NOAA 2017 and NYSDEC 2008b as cited in USACE 2020). Several surf clam stock assessments conducted by NYSDEC and USACE determined higher concentrations of surf clam can be found within waters west of Fire Island Inlet in comparison to waters east of the inlet (USACE 2002b as cited in USACE 2020), however surf clam densities can be expected to fluctuate in space and time as evidenced by historical data (NOAA NMFS 2000 as cited in USACE 2020). Site-specific densities cannot be assumed to remain constant, and it is not uncommon to find extremely patchy and localized distributions of this species. Surf clams collected in three USACE reference studies often included juvenile representatives (USACE 2000, 2004a, 2008 as cited in USACE 2020), however, these densities were often low.

In general, the ocean quahog (*Arctica islandica*) is considered a marine offshore species with adults most commonly occurring in dense beds of waters ranging from 26 feet to a depth of 200 feet (USFWS 1997b as cited in USACE 2020).

The bay intertidal habitat of the study area extends from MHW to MLW on the bay side of the barrier island, and includes sand shoals, sand flats, mud flats, and salt marsh habitats. Benthic invertebrates of the bay intertidal habitat must be adapted to life in regularly changing conditions of alternating submersion in salt water and then exposure to air. Benthic invertebrates of the bay intertidal habitat can be attached to hard structures or live on top of sediment (epifauna), or live in association with sediments (infauna). Epifauna typically feed on particulate matter associated with the attached biota. Examples of attached forms of epifauna include barnacles, mussels and limpets, and free-living forms include amphipods, crabs, and sea stars. Commercially and recreationally important invertebrates of the bays intertidal habitat include blue mussel, Atlantic ribbed mussel, blue crab, and softshell clam. The estuaries are an important spawning ground for blue crab (USFWS 1991 as cited in USACE 2020). Blue crab also spawns in the shallow salt marsh areas located along the fringes of the study area estuaries.

Sand shoal and sand/mud flat habitats support many of the species described for the bay intertidal habitat, and include horseshoe crab, fiddler crabs (*Uca pugilator* and *U. pugnax*), and the commercially and recreationally important blue mussel, Atlantic ribbed mussel (*Geukensia demissa*), and softshell clam (*Mya arenaria*) (USACE 2006a as cited in USACE 2020).

Two invertebrate surveys have been conducted by USACE in both marine intertidal and bay intertidal areas of the study area. In general, a higher density of invertebrates within the bay intertidal habitat was found in comparison to samples collected from similar marine intertidal habitats (USACE 1999d and 2005c as cited in USACE 2020). Sediment cores collected within the bay intertidal habitat were dominated by oligochaete worms and nematode representatives, with blue mussel dominating one of the wrack line samples in the 1998 study (USACE 1999d as cited in USACE 2020). Pitfall fall traps set out within the bay intertidal habitats generally had a higher catch per unit effort in comparison to pitfall traps located within similar marine intertidal habitats.

Benthic invertebrates of the bay subtidal habitat are those adapted to fine-grained sediments typical of this habitat. These include the crab species Say mud crab (Dyspanopeus sayi), green crab (*Carcinus maenas*), and other crab species, comb jelly (phylum Ctenophora), sea star, polychaetes, jellyfish, shrimp species, zooplankton, the hard clam (*Mercenaria mercenaria*), blue crab, and scallop (USACE 20020). Great South Bay is important spawning grounds for hard clam (USFWS 1991 as cited in USACE 2020). Further, polychaetes (segmented worms with bristles) are an important component of the benthic infaunal community.

SAV beds are one of the most important features of the bay subtidal habitat, because they provide nursery areas for finfish and a niche for colonization of epiphytic algae and invertebrates. Epiphytic algae attach to other algae, plants, and rocks, and can outcompete certain SAV species such as eelgrass for light (USACE 2020). They also provide unique habitat for a diverse assemblage of invertebrates, including habitat for the commercially and recreationally important blue mussel (*Mytilus edulis*), Atlantic ribbed mussel and blue crab (USACE 2004). Other species associated with SAV habitats include horseshoe crab, barnacles, eastern mudsnail (*Tritia obsoleta*), Say mud crab, hermit crab, green crab, other crab species, amphipods, isopods, softshell clam, hard clam, sea star, comb jelly, scallop, polychaetes, jellyfish, and shrimp species.

Benthic macroinvertebrate communities are commonly used as indicators of overall quality of water and benthic habitats due to their sensitivity to pollution and changes in water quality. Indices measuring such parameters as abundance and species composition are well developed and often used in describing quality of habitats and also the potential food sources for higher consumers, of which many species are considered commercially and recreationally important.

Common benthic invertebrates classified as indicator species within the marine offshore environment include polychaete worms (phylum Annelida), amphipods (phylum Arthropoda), sand dollars and sea stars (phylum Echinodermata), horseshoe crabs, and *Yoldia* species of mollusc (phylum Mollusca). Common epibenthic species of invertebrates include various species of shrimp belonging to the Decapoda order of the subphylum Crustacea. Pelagic species of invertebrates common to the marine offshore environment include jellyfish (phylum Cnidaria) and zooplankton (e.g. radiolarians and foraminerans). Commercially and recreationally important invertebrates of the marine offshore environment include bivalve clams and scallops (phylum Mollusca, class Bivalvia), including Atlantic surf clam and ocean quahog, American lobster, squid species such as long-finned squid (*Loligo pealeii*) and short-finned squid (*Illex illecebrosus*), and various crab species (phylum Arthropoda).

2.5.5 Protected Species

2.5.5.1 Threatened and Endangered Species

The Endangered Species Act (ESA) of 1973 describes several categories of federal status for plants and animals and their critical habitat, as designated by the U.S. Fish and Wildlife Service (USFWS) or the National Marine Fisheries Service (NMFS). The regulations for the designations are contained in 50 CFR 17. An "endangered species" is defined as any species in danger of extinction throughout all or a large portion of its range. A "threatened species" is defined as any species likely to become an endangered species in the foreseeable future. The USFWS has jurisdiction over terrestrial and freshwater species; NMFS is responsible for any endangered or threatened marine species found in the study area. Under Section 7 of the ESA, any federal agency that is sponsoring or assisting a project must coordinate with the USFWS and/or the NMFS for a determination of impacts on protected plants and animals. Federal and state agencies independently list species based on the ESA. Each state's endangered and threatened species program is subject to approval by the U.S. Secretary of the Interior. Under New York State Environmental Conservation Law, the NYSDEC maintains a list of plant and animal species that are considered rare, threatened, endangered, or of special concern in the state of New York. NYSDEC has authority under the State Endangered Species Act (ECL Section 11-0535) and associated regulations (6 NYCRR Part 182) to review projects for potential impacts on State threatened and endangered species and provide recommendations to avoid or reduce impacts. Take (i.e., "direct harm to listed species or the adverse modification of the occupied habitat") of State threatened and endangered animal species requires an incidental take permit.

Information on threatened, endangered, or otherwise protected species was compiled from USFWS, NMFS, and NYSDEC. Additionally, a literature search was conducted to determine which of these species would likely occur in the study area.

Federally-Listed Species. The USFWS Information for Planning and Conservation and NMFS ESA mapper databases were queried on May 2021 to determine which species protected under the ESA have the potential to occur in the NCBB Study Area. A total of 12 federally-listed species occur in the study area, and one species is proposed for listing (Table 9). Federally-listed species include birds, mammals, reptiles, fish, and plants. No critical habitat has been designated in the study area.

Table 9 - Federal Threatened and Endangered Species in the Study Area

Common Name	Scientific Name	Federal Status
INSECTS		
Northeastern Beach Tiger Beetle	*Cicindela [Habroscelimorpha] dorsalis dorsalis*	Threatened, Extirpated
BIRDS		
Piping plover	*Charadrius melodus*	Threatened
Roseate tern	*Sterna dougallii dougallii*	Endangered
Red knot	*Calidris canutus rufa*	Threatened
Eastern Black Rail	*Laterallus jamaicensis spp. jamaicensis*	Threatened
PLANTS		
Sandplain gerardia	*Agalinis acuta*	Endangered
Seabeach amaranth	*Amaranthus pumilus*	Threatened
TERRESTRIAL MAMMALS		

Northern long-eared bat	*Myotis septentrionalis*	Threatened
REPTILES		
Loggerhead sea turtle	*Caretta caretta*	Endangered
Leatherback sea turtle	*Dermochelys coriacea*	Endangered
Kemp's ridley sea turtle	*Lepidochelys kempii*	Endangered
Green sea turtle	*Chelonia mydas*	Endangered
MARINE MAMMALS		
North Atlantic right whale	*Eubalena glacialis*	Endangered
Fin whale	*Balaenoptera physalus*	Endangered
FISH		
Atlantic Sturgeon	*Acipenser oxyrinchus oxyrinchus*	Endangered
Shortnose Sturgeon	*Acipenser brevirostrum*	Endangered

Tables 10 and 11 provide an initial screening of the threatened and endangered species that have the potential to occur in the study area based on a suitable habitat. Species potentially affected were carried forward in the biological assessment for consideration. The initial screening indicates that the following species would not be affected by the project because of they would not occur in the action area based on a lack of habitat or known occurrences or their habitat would not be disturbed by the project.

- Shortnose sturgeon (*Acipenser brevirostrum*)
- Northeastern beach tiger beetle (*Cicindela dorsalis dorsalis*)
- Piping plover (*Charadrius melodus*)
- Sandplain gerardia (*Agalinis acuta*)
- Seabeach amaranth (*Amaranthus pumilus*)

These species are eliminated from further consideration in this biological assessment. All other species were carried forward for a detailed assessment. Additionally, saltmarsh sparrow (*Ammospiza caudacuta*) is a USFWS species of concern, also considered in this assessment.

Table 10. Potential Impacts of the TSP and Options on Threatened and Endangered Species

Species	Habitat in NCBB	Potential for Impact	Carried Forward for Consideration
Northern Long-Eared Bat	Summertime roosts beneath the bark of live and dead trees.	Impacts to occupied habitat would be avoided to the maximum extent practicable.	Yes
Piping plover	Ocean beaches, inlets, washover areas, tidal flats	No expected disturbance to nests/foraging areas on beaches and inlet dunes or disruptions in food chain.	No
Eastern Black Rail	Salt and freshwater marshes	Direct habitat impacts/losses are likely on breeding in higher saltmarshes. Indirect impacts through disruptions in food chain.	Yes

Species	Habitat in NCBB	Potential for Impact	Carried Forward for Consideration
Roseate Tern	Beaches w/ vegetated dunes	No breeding population currently in NJ. Potential disturbance to foraging areas. Indirect impacts through disruptions in food chain.	Yes
Red Knot	Foraging and resting habitat on gently sloping, sandy beaches.	Potential disturbance to foraging areas. Indirect impacts through disruptions in food chain.	Yes
Northeastern Beach Tiger Beetle	Coastal beaches. Extirpated from the study area.	No expected disturbance to beach habitat.	No
Sandplain gerardia	Grassland habitat along the coastal plain. This species is only known to occur in Nassau County at Hempstead Plains, which is not in the study area.	Not expected in the study area.	No
Seabeach amaranth	Upper sandy beaches, accreting ends of inlets	No expected disturbance to habitat on beaches and inlet dunes.	No

Table 11. Potential Impacts of TSP and Options on Threatened and Endangered Species under NMFS Jurisdiction

Species	Habitat in NCBB	Potential for Impact	Carried Forward for Consideration
Fin Whale	Marine pelagic	There is no marine construction proposed in or adjacent to open ocean waters.	No
North Atlantic Right Whale	Marine pelagic	There is no marine construction proposed in or adjacent to open ocean waters.	No
Atlantic Loggerhead	Marine/Estuarine Pelagic	Construction/noise vibrations could disturb migrating/feeding habits of adults and juveniles. Indirect impacts through disruptions in food chain.	Yes
Kemp's Ridley	Marine/Estuarine Pelagic	Construction/noise vibrations could disturb migrating/feeding habits of adults and juveniles. Indirect impacts through disruptions in food chain.	Yes
Atlantic Green Sea Turtle	Marine/Estuarine Pelagic	Construction/noise vibrations could disturb migrating/feeding habits of	Yes

(Chelonia mydas)		adults and juveniles. Indirect impacts through disruptions in food chain.	
Leatherback Sea Turtle	Marine/Estuarine Pelagic	Construction/noise vibrations could disturb migrating/feeding habits of adults and juveniles. Indirect impacts through disruptions in food chain.	Yes
Atlantic Sturgeon	Anadromous, marine/estuarine Demersal/pelagic	Construction/noise vibrations could disturb migrations/feeding habits of adults and subadults. Indirect impacts through disruptions in food chain.	Yes
Shortnose Sturgeon	Amphimodrous, freshwater/brackish tidal Demersal/pelagic	This species is not expected to occur in the action area.	No

Eastern Black Rail. The subspecies, eastern black rail was listed as a threatened species on November 2020. The species black rail (*Laterallus jamaicensis*) is listed as endangered by the state of New York. Threats for eastern black rail include habitat fragmentation, altered hydrology, effects of climate change and RSLC, disease, altered food webs, and oil and chemical spills, as well as other environmental contaminants.

The eastern black rail occupies portions of the eastern United States (east of the Rocky Mountains), Mexico, Central America, the Caribbean, and occasionally in Brazil. In the United States, eastern black rails primarily from coastal sites, but can also be found in inland areas. The eastern black rail has been historically present during breeding months from Virginia to Massachusetts, with 70 percent of historical observations (773 records from 1836 to 2010) in Maryland, Delaware, and New Jersey (Watts 2016).

The eastern black rail can typically be found in salt and brackish marshes with dense cover but can also be found in upland areas of these marshes. The habitat can be tidally or non-tidally influenced, and with a wide range in salinity (salt to brackish to fresh), tidal range, and tidal volume (USFWS 2020). The last breeding record of black rail in Nassau County, NY occurred in 1940 (NYNHP 2021a).

Roseate Tern. The northeastern breeding population of the roseate tern was designated as endangered in Northeastern North America in the 2 November 1987 (52 FR 42064-42068). This species is listed as endangered by the state of New Jersey. Threats to roseate terns include habitat loss, climate change, collisions, and predation.

The roseate tern is a coastal species that occurs in both temperate and tropical areas throughout the world. The North Atlantic breeding population is located from Nova Scotia to Long Island, New York, with historic nesting records south to Virginia (USFWS 1998).

Roseate tern is nest on barrier islands and salt marshes and forage over shallow coastal waters, inlets, and offshore seas. Nesting colonies are located above the high-tide line, often within vegetated dunes. Roseate terns do not currently nest in New Jersey and typically nest at sites with more vegetative cover than the terns that nest in New Jersey (USFWS 1998).

The roseate tern is not known to breed in the study area but has been observed in Nassau County (NYNHP 2021b, eBird 2020).

Red Knot. The red knot was listed as threatened under ESA on 12 January 2015 (79 FR 73705-73748). Threats to red knot include beach stabilization (beach armoring, sand fences, sea walls, groins, jetties, and riprap); habitat loss; and intensive recreational use (USFWS pers. com.).

Red knots fly up to 9,300 miles from south to north every spring and reverse the trip every autumn, making the red knot one of the longest-distance migrating animals. Migrating birds break their spring migration into non-stop segments of 1,500 miles or more, ending at stopover sites called staging areas (USFWS 2021).

Red knots prefer unimproved tidal inlets for nonbreeding habitat. Dynamic and ephemeral (lasting only briefly) features are important red knot habitats along the Atlantic Coast; these include sand spits, islets, shoals, and sandbars, features often associated with inlets (several authors cited in 86 FR 37415). In New York, the red knots occur along the salt meadows and mudflat of the South Shore of Long Island in both spring and fall, numbering more than 1,000 individuals (NYSDEC 2014).

Red knot migrants are common in Long Island in the spring and fall and some may be observed in the winter as well. Jamaica Bay serves as important habitat for red knot. They also congregate at Long Beach and Jones Beach (NYSDEC 2014).

Northern Longeared Bat. The northern long-eared bat was listed as threatened by the USFWS on 16 February 2016 (81 FR 1900-1922). The primary threat to this species is the disease white-nose syndrome.

The northern long-eared bat occurs in the midwest and northeast of the United States, and all Canadian provinces west to the southern Yukon Territory and eastern British Columbia.

During the summer, NLEB typically roost singly or in colonies underneath bark, crevices, or hollows of both live and dead trees and/or snags (typically ≥ 3 inches diameter at breast height [dbh]). The NLEB bat is opportunistic in selecting roosts, selecting varying roost tree species throughout its range. During the winter, NLEBs predominately hibernate in caves and abandoned mine portals. Maternity colonies generally consist of 30 to 60 females and young. Males and non-reproductive females may occur within the breeding and foraging range of maternity colonies, but some individuals are solitary in the summer and may roost in cooler places such as caves and mines. Roosting NLEBs have also been observed in man-made structures, such as buildings, barns, sheds, cabins, under eaves of buildings, and in bat houses (USFWS pers. com.).

The proposed study area is located within the summer range of the northern long-eared bat. There are no known hibernacula in Nassau County (USFWS 2019). While known maternity roosts occur in Nassau County in the municipalities of Brookville, Muttontown, Oyster Bay, Oyster Bay Cove, and Upper Brookville, these are outside of the study area (USFWS Undated).

Sea Turtles. Four species of Endangered Species Act (ESA) listed threatened or endangered sea turtles under our jurisdiction could be seasonally present in the study area, the threatened Northwest Atlantic Ocean distinct population segment (DPS) of loggerhead and North Atlantic DPS of green sea turtles, and the endangered Kemp's ridley and leatherback sea turtles. Sea turtles typically forage in New York waters from May to November, with the highest concentration of sea turtles present from June through October. Sea turtles are unlikely to nest in New York.

The loggerhead turtle was first listed under the ESA as threatened throughout its range in 1978. In 2011, NmFS and the USFWS determined that the loggerhead sea turtle was composed of nine DPSs[1]. On 24 October 2011, the Western North Atlantic DPS of loggerhead turtles was listed as threatened (76 FR 58868-58952). Threats to loggerhead turtles include bycatch in fishing gear, intentional killing, and entanglement in marine debris. Loggerhead turtles forage in the New York (NYSDEC Undated, NYSDEC 2020). Typically, juveniles are found in Long Island Sound and bays, while adults are found offshore with immature turtles (NYSDEC 2013). Loggerheads frequently forage around coral reefs, rocky places and old boat wrecks; they commonly enter bays, lagoons and estuaries (Dodd 1988).

The Kemp's ridley sea turtle has been listed as endangered since 1970 (35 FR 18319-18322). Kemp's ridley turtles inhabit sheltered coastal areas and frequent larger estuaries, bays and lagoons in the temperate, subtropical and tropical waters of the Atlantic Ocean and Gulf of Mexico (Mager 1985). The foraging range of the adult Kemp's ridley sea turtle appears to be restricted to the Gulf of Mexico. However, juveniles and subadults occur throughout the warm coastal waters of the U.S. Atlantic coast (Hopkins and Richardson 1984, Pritchard and Marquez 1973). On a seasonal basis, Kemp ridleys are common as far north as the Canadian portions of the Gulf of Maine (Lazell 1980), but during cooler months of the year they shift to the south (Morreale et al. 1988). Juveniles are typically found in nearshore shallow waters and typically occur in Long Island Sound, Block Island Sound, Gardiners Bay and the Peconic Estuary, but have also been observed in Jamaica Bay, lower New York harbor and Great South Bay (NYSDEC Undated-a). Kemp's ridleys are omnivorous and feed on crustaceans, swimming crabs, fish, jellyfish and mollusks (Pritchard and Marquez 1973). This species does not nest in New York.

The green turtle was listed under the ESA in the on 28 July 1978 (43 FR 32800-32811). Breeding populations of the green turtle in Florida and along the Pacific Coast of Mexico were listed as endangered; all other populations were listed as threatened. Green turtles are circumglobally distributed mainly in waters between the northern and southern 20°C isotherm (Mager 1985). Juvenile and adults adults have been observed in sea grass beds off the eastern side of Long Island and free-swimming in pelagic environments (NYSDEC Undated-a).

The leatherback turtle was listed as endangered on 2 June 1970 (35 FR 8491-8498). Leatherbacks have a circumglobal distribution and occur in the Atlantic, Indian and Pacific Oceans. They range as far north as Labrador and Alaska to as far south as Chile and the Cape of Good Hope. They are found farther north than other sea turtle species, probably because of their ability to maintain a warmer body temperature over a longer period of time. In New York, leatherbacks have been observed the south shore of Long Island, in the NY Bight region, and within the Long Island Sound (NYSDEC Undated-a).

Atlantic Sturgeon. Five Atlantic sturgeon DPSs were listed as endangered or threatened under the ESA on 6 February 2012 (77 FR 5913-5982). These are the endangered New York Bight, Chesapeake Bay, South Atlantic, and Carolina DPSs, and the threatened Gulf of Maine DPS. The primary threats to Atlantic sturgeon include bycatch in some commercial fisheries, dams that block access to spawning areas, poor

[1] A DPS is the smallest division of a species permitted to be protected under the ESA.

water quality (which harms the development of sturgeon offspring), dredging of spawning areas, water withdrawals from rivers, and vessel strikes (NMFS 2020a).

In New York, Atlantic sturgeon migrate into the Hudson River in the spring to spawn. The adults return to the Atlantic Ocean while the juveniles remain in the Hudson River estuary for at least two years before emigrating to the ocean to mature (NMFS pers. comm., NYSDEC Undated-b).

There is limited information on the marine and coastal movements of Atlantic sturgeon; therefore they have not been removed from consideration. Sub-adult and adult Atlantic sturgeon could be present within the study area (NMFS pers. comm.). Early (eggs, larvae, young-of-year) and juvenile life stages are found in large rivers and their estuaries and will not be present as they are not able to tolerate the high salinity of marine and coastal waters (NMFS pers. com.).

State-Listed Species. State listed species in the study area include birds, insects, plants, reptiles, and mammals. Endangered species are defined as any native species in imminent danger of extirpation or extinction in New York State. Threatened is defined as any native species likely to become an endangered species within the foreseeable future in New York State. A special concern listing is made for any native species for which a welfare concern or risk of endangerment has been documented in New York State. Table 12 presents the state threatened, endangered, and special concern species in the study area.

Table 12 - State Threatened , Endangered, and Special Concern Species in the Study Area

Common Name	Scientific Name	NY State Status
PLANTS		
Annual saltmarsh aster	*Symphyotrichum subulatum var. subulatum*	Threatened
Atlantic white cedar	*Chamaecyparis thyoides*	Threatened
Barratt's Sedge	*Carex barrattii*	Endangered
Brown Bog Sedge	*Carex buxbaumii*	Threatened
Bushy Rockrose	*Crocanthemum dumosum*	Threatened
Button sedge	*Carex bullata*	Endangered
Carolina clubmoss	*Pseudolycopodiella caroliniana*	Endangered
Coastal carrion flower	*Smilax pseudochina*	Endangered
Coast flatsedge	*Cyperus polystachyos*	Endangered
Coastal goldenrod	*Solidago latissimifolia*	Endangered
Collins' sedge	*Carex collinsii*	Endangered
Cut-leaved evening primrose	*Oenothera laciniata*	Endangered
Downy lettuce	*Lactuca hirsuta*	Endangered
Dune sandspur	*Cenchrus tribuloides*	Threatened
Dwarf glasswort	*Salicornia bigelovii*	Threatened
Few-flowered Nut Sedge	*Scleria pauciflora*	Endangered
Fringed boneset	*Eupatorium torreyanum*	Threatened
Globe-fruited Ludwigia	*Ludwigia sphaerocarpa*	Threatened
Golden dock	*Rumex fueginus*	Endangered
Green Parrot's Feather	*Myriophyllum pinnatum*	Endangered
Hyssop Skullcap	*Scutellaria integrifolia*	Endangered
Leggett's pinweed	*Lechea pulchella*	Endangered
Little-leaf Tick Trefoil	Desmodium ciliare	Threatened

Common Name	Scientific Name	NY State Status
Long-tubercled Spike Rush	Eleocharis tuberculosa	Threatened
Low St. John's wort	*Hypericum stragulum*	Endangered
Lowland Yellow Loosestrife	Lysimachia hybrida	Endangered
Marsh straw sedge	*Carex hormathodes*	Threatened
Midland Sedge	Carex mesochorea	Threatened
Narrow-leaved Bush Clover	*Lespedeza angustifolia*	Threatened
Oakes evening primrose	*Oenothera oakesiana*	Threatened
Pale Duckweed	*Lemna valdiviana*	Endangered
Persimmon	Diospyros virginiana	Threatened
Prairie Wedge Grass	*Sphenopholis obtusata*	Endangered
Red pigweed	*Oxybasis rubra var. rubra*	Threatened
Retrose flatsedge	*Cyperus retrorsus*	Endangered
Salt-meadow grass	*Diplachne fusca ssp. fascicularis*	Endangered
Sandplain gerardia	*Agalinis acuta*	Endangered
Sea pink	*Sabatia stellaris*	Threatened
Seabeach amaranth	*Amaranthus pumilus*	Threatened
Seaside bulrush	*Bolboschoenus maritimus ssp. paludosus*	Threatened
Side-oats Grama	*Bouteloua curtipendula var. curtipendula*	Endangered
Slender Crab Grass	*Digitaria filiformis var. filiformis*	Endangered
Small floating bladderwort	*Utricularia radiata*	Threatened
Soapwort Gentian	*Gentiana saponaria*	Endangered
Southern Yellow Flax	*Linum medium var. texanum*	Threatened
Stiff Cowbane	*Oxypolis rigidior*	Endangered
Swamp Lousewort	*Pedicularis lanceolata*	Threatened
Swamp Smartweed	*Persicaria setacea*	Endangered
Swamp Sunflower	*Helianthus angustifolius*	Threatened
Velvet Panic Grass	*Dichanthelium scoparium*	Endangered
Velvety Bush Clover	*Lespedeza stuevei*	Threatened
Weak rush	*Juncus debilis*	Endangered
Whip nut sedge	*Scleria triglomerata*	Endangered
Woodland Agrimony	*Agrimonia rostellata*	Threatened
Yellow flatsedge	*Cyperus flavescens*	Endangered
INSECTS		
Hessel's hairstreak	*Callophrys hesseli*	Endangered
BIRDS		
Black skimmer	*Rynchops niger*	Special Concern
Bald eagle	*Haliaeetus leucocephalus*	Threatened
Black tern	*Chlidonias niger*	Endangered
Common tern	*Sterna hirundo*	Threatened
Least tern	*Sterna antillarum*	Threatened
Least bittern	*Ixobrychus exilis*	Threatened
Piping plover	*Charadrius melodus*	Endangered
Roseate tern	*Sterna dougallii dougallii*	Endangered
Peregrine falcon	*Falco peregrinus*	Endangered
Red knot	*Calidris calidris rufa*	Threatened

Common Name	Scientific Name	NY State Status
Seaside sparrow	*Ammospiza maritimus*	Special Concern
Short-eared owl	*Asio flammeus*	Endangered
Pied-billed grebe	*Podilymbus podiceps*	Threatened
Northern harrier	*Circus cyaneus*	Threatened
Upland sandpiper	*Bartramia longicauda*	Threatened
REPTILES		
Eastern mud turtle	*Kinosternon subrubrum*	Endangered
Green sea turtle	*Chelonia mydas*	Threatened
Leatherback sea turtle	*Dermochelys coriacea*	Endangered
Loggerhead sea turtle	*Caretta caretta*	Threatened
Kemp's ridley sea turtle	*Lepidochelys kempii*	Endangered
Eastern wormsnake	*Carphophis amoenus*	Special concern
MAMMALS		
Northern long-eared bat	*Myotis septentrionalis*	Threatened
Fin whale	*Balaenoptera physalus*	Endangered
Humpback whale (West Indies Distinct Population Segment)	*Megaptera novaeangliae*	Endangered
Harbor Porpoise	*Phocoena phocoena*	Special Concern

Source: EAF Mapper (NYSDEC 2020); NYNHP Explorer (NYNHP 2020)

2.5.5.2 Migratory Birds

Migratory birds are protected by the Migratory Bird Treaty Act (MBTA) 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 majority of the birds discussed in Section 2.12.1 are protected under MBTA. Additionally, a subset of these are on the 2008 Birds of Conservation Concern 2008 list and represent high conservation priorities that have the potential to become candidates for listing under the ESA. The following are birds are Birds of Conservation Concern occur in the study area (USFWS pers. comm.).

- Red-throated Loon – *Gavia stellata*
- Pied-billed Grebe (on state threatened list) – *Podilymbus podiceps*
- Horned Grebe – *Podiceps auritus*
- Greater Shearwater – *Puffinus gravis*
- American Bittern – *Botaurus lentiginosus*
- Snowy Egret – *Egretta thula*
- Bald Eagle (on state threatened list) – *Haliaeetus leucocephalus*
- Peregrine Falcon (on state endangered list) – *Falco peregrinus*
- Eastern Black Rail (on federal threatened and state endangered lists) – *Laterallus jamaicensis*
- American Oystercatcher – *Haematopus palliatus*
- Solitary Sandpiper – *Tringa solitaria*
- Lesser Yellowlegs – *Tringa flavipes*
- Whimbrel – *Numenius phaeopus*
- Marbled Godwit – *Limosa fedoa*
- Red Knot (on federal and state threatened lists) – *Calidris canutus rufa*
- Semipalmated Sandpiper – *Calidris pusilla*
- Purple Sandpiper – *Calidris maritima*

- Short-billed Dowitcher – *Limnodromus griseus*
- Least Tern (on state threatened list) – *Sterna antillarum*
- Gull-billed Tern -*Gelochelidon nilotica*
- Black Skimmer – *Rynchops niger*
- Red-headed Woodpecker – *Melanerpes erythrocephalus*
- Wood Thrush – *Hylocichla mustelina*
- Blue-winged Warbler – *Vermivora cyanoptera*
- Prairie Warbler – *Dendroica discolor*
- Worm-eating Warbler - *Helmitheros vermivorum*
- Kentucky Warbler – *Oporornis formosus*
- Nelson's Sparrow – *Ammodramus nelsoni*
- Saltmarsh Sparrow – *Ammospiza caudacuta*
- Seaside Sparrow – *Ammodramus maritimus*
- Rusty Blackbird – *Euphagus carolinus*

2.5.5.3 Marine Mammals

All marine mammals are protected under the Marine Mammal Protection Act (MMPA). As discussed under Section 2.5.5.1, the fin whale and North Atlantic Right whale are all protected under the ESA. Marine mammals within the study area use marine offshore, nearshore, and intertidal habitats as well as intertidal backbay areas. Harbor seals are the most common marine mammal in the marine nearshore and inlets habitats. Gray seals and bottlenose may also be found in these habitats. Harbor seal, makes occasional use of bay intertidal areas as well as deeper bay areas in winter, and are likely the only mammal typically occurring in the back bay subtidal areas (USFWS 1991 and USACE 2006a as cited in USACE 2020). Bottlenose dolphins, common dolphins, pilot whales, and Risso's dolphins can often be seen off the south shore of Long Island.

Cetaceans that may occur in the nearshore marine waters of the Atlantic Ocean in the study area include humpback whale (*Megaptera novaeangliae*), finback (*Balaenoptera physalus*), minke (*B. acutorostrata*), and pilot (*Globicephala melaena*) whales; the ESA-listed North Atlantic right and fin whales; and several dolphin species, including common (*Delphinus delphis*), bottle-nosed (*Tursiops truncatus*), white-sided (*Lagenorhynchus acutus*), and striped (*Stenella coeruleoalba*), and harbor porpoise (*Phocoena phocoena*) (Edinger et al. 2014). Seals are also found in nearshore marine waters (USACE 2019).

2.5.5.4 Essential Fish Habitat

In accordance with the Magnuson-Stevens Fishery Conservation and Management Act, the back bays and coastal waters of New York have been designated as essential fish habitat (EFH) for a variety of life stages of fish and shellfish managed by the New England and Mid-Atlantic Fishery Management Councils and the National Marine Fisheries Service. Twenty-seven species have EFH designated in the study area; these include Mid-Atlantic, New England, coastal migratory pelagic, highly migratory, and shark species (Table 13). Additionally, submerged aquatic vegetation is designated as habitat area of particular concern (HAPC) in the study area.

Table 13 - Species with Designated Essential Fish Habitat within the Study Area

Species	Lifestage Present
Black Sea Bass	Juvenile, Adult
Longfin Inshore Squid	Eggs, Juvenile

Species	Lifestage Present
Atlantic Mackerel	Eggs, Larvae, Juvenile, Adult
Bluefish	Juvenile. Adult
Atlantic Butterfish	Juvenile
Spiny Dogfish	Sub- Female, Adult Male
Atlantic Surfclam	Juvenile, Adult
Ocean Quahog	Juvenile, Adult
Scup	Juvenile, Adult
Summer Flounder (SAV Is HAPC for juveniles)	Juvenile, Adult
Bluefin Tuna	Juvenile
Sandbar Shark	Juvenile, Adult
Common Thresher Shark	Neonate, Juvenile, Adult (all)
Skipjack Tuna	Adult
Dusky Shark	Neonate
White Shark	Neonate, Juvenile, Adult
Smoothhound Shark Complex (Atlantic Stock)	All
Sand Tiger Shark	Neonate, Juvenile
Winter Flounder	Eggs, Larvae, Juvenile, Adult
Little Skate	Juvenile, Adult
Ocean Pout	Eggs, Adult
Atlantic Herring	Juvenile, Adult
Atlantic Cod	Eggs, Larvae, Adult
Pollock	Juvenile
Red Hake	Adult
White Hake	Juvenile
Yellowtail Flounder	Eggs, Adult
Monkfish	Eggs, Larvae, Adult
Windowpane Flounder	Eggs, Larvae, Juvenile, Adult
Winter Skate	Juvenile, Adult

Source: EFH Mapper (NMFS 2020b) and NMFS pers. comm.

2.6 Cultural Resources

2.6.1 Nassau County Context

Nassau County is composed of three distinct towns: Hempstead, North Hempstead, and Oyster Bay. Hempstead makes up approximately 200 square miles of land in the southwestern portion of the County, in the western half of Long Island. It is comprised of 22 villages and 37 hamlets and collectively it is known as the South Bay. The town was first settled in 1644 after a treaty between the English and the Lenape Indians. In 1784 following the Revolution, conflict between British loyalists in the south and American sympathizers in the north caused Hempstead to be broken up into two separate townships, North Hempstead and South Hempstead with the latter becoming simply known as Hempstead. The harvesting of wild salt hay, known as "marshing" for animal feed, became important early on and was supplemented by clamming in the adjacent bays and islands. The south shore of Hempstead further expanded in the 19th Century with the rise of the oyster industry and the beginnings of a thriving commercial waterfront (Loorya and Rutigliano 2020).

The town of North Hempstead comprises the northwest portion of Nassau County, and is made up of 30 individual villages and 20 hamlets totaling about 69 square miles. The establishment of the Long Island Railroad through the town and the rise of steamboats for the transportation of goods and people contributed to an increasingly affluent population. According to the town's webpage, "for over 200 years, the harbors and bays of North Hempstead and the Long Island Sound supported a thriving maritime economy of fisherman, boat-builders and sail makers." Shellfishing and commercial oyster farming were important to the economy into the 20th Century (Town of North Hempstead 2021).

Oyster Bay is the easternmost of the three Nassau County towns and is comprised of 18 villages and another 18 hamlets. It is also the only town that extends completely from the north shore to the south shore of Long Island and has a total area of roughly 169 square miles. Throughout the 19th Century, Oyster Bay was predominantly an agricultural town. Theodore Roosevelt was an Oyster Bay resident and his home Sagamore Hill served as the summer White House from 1902 to 1908. Later in the 20th Century, Oyster Bay's agricultural economy began to shift towards industry and business, especially aeronautics, and the farmlands were transformed into factories, businesses, and housing developments (Town of Oyster Bay 2021).

2.6.2 Historic Properties including Archaeological Resources

Archaeological site data for recorded sites within the NCBB study area was obtained from the NY SHPO CRIS GIS database (NYSHPO 2021) along with site forms, spreadsheets, and reports provided by Nicole Minnichbach, Archaeologist of the USACE. Site files for each site are available and can be provided separately by the author upon request.

Along with the location of archaeological sites, submerged resources, historic buildings, historic building and archaeological districts, archaeological and building surveys, and consultation projects, the CRIS Database contains a layer of archaeologically sensitive areas within Nassau County (NYSHPO 2021). Due to the sensitive nature of site locational data, which is exempt from Freedom of Information Act requests, the sensitivity maps and specific locations of sites are not reproduced here.

The recorded historic properties within the NCBB study area are presented as follows:

- Table 14 – Archaeological Sites
- Table 15 – National Register Archaeological Sites
- Table 16 – National Register Listed Building Sites
- Table 17 – National Register Listed Building and Historic Districts

Table 14 - Archaeological Sites

USN	Name	NRHP Status
5901.00004	Seaford Park Site NCM #55	Undetermined
5901.000082	Unknown Tug Boat Wreck Site	Not Eligible
5901.00045	Marble Wreck	Eligible
5901.001366	Long Beach Underwater Anomaly 18	Undetermined
5901.001367	Long Beach Underwater Anomaly 29	Undetermined
5901.001368	Mexico Shipwreck Site (Possible)	Eligible
5901.003482	Abraham Hewlett historic site	Not Eligible
5903.000001	Fort Massapeag/Fort Neck Site	Listed

5920.000006	Raynor Gristmill & Sawmill Sites and House	Undetermined
5941.000135	Rock Hall Museum grounds	Undetermined
5947.000004	Site of Smith's Pond Pump Station (FEATURE 24)	Undetermined

Table 15 - National Register Listed Archaeological Sites

NR Number	Name	Municipality
93NR00516	Fort Massapeag Archeological Site	Oyster Bay

Table 16 - National Register Listed Building Sites within APE (Nassau County)

NR Number	Name	Municipality
90NR01701	United States Post Office-Freeport	Freeport
90NR01723	Grace Church Complex	Massapequa
90NR01769	Pagan-Fletcher House	Valley Stream
97NR01169	Haviland-Davison Grist Mill	East Rockaway
90NR01715	Granada Towers	Long Beach
90NR01714	Rock Hall	Lawrence
90NR01716	United States Post Office-Long Beach	Long Beach
90NR01770	Wantagh Railroad Complex	Wantagh
90NR01732	United States Post Office-Rockville Centre	Rockville Centre
04NR05378	Felix, Pauline, House	Long Beach
04NR05380	Vaisberg, Samuel, House	Long Beach
04NR05404	Jones Beach State Park, Causeway and Parkway System	Towns of Hempstead and Oyster Bay
07NR05778	73 Grove Street, House at	Lynbrook
07NR05779	House at 251 Rocklyn Avenue (Brower House)	Lynbrook
07NR05780	House at 474 Ocean Avenue (Luning House)	Lynbrook
08NR05887	House at 226 West Penn (Long Beach Historical Museum)	Long Beach
14NR06578	Denton Homestead	East Rockaway
14NR06602	Cobble Villa	Long Beach
14NR06604	Barkin House	Long Beach
15NR00059	Rockville Cemetery and Mariners Monument	Lynbrook
17NR00024	390 Ocean Avenue	Massapequa
17NR00025	George Sumner Kellogg House	Baldwin

Table 17 - National Register Listed Building and Historic Districts within APE (Nassau County)

USN	Name	Status
5901.001769	Stevenson Estate Tract Historic District	Eligible
5901.002668	Merrick Gables Historic District	Eligible
5901.002795	Lido Guest Houses Historic District	Eligible
5901.003386	Bristol Homes Historic District	Eligible
5901.00339	Meadowbrook Park Gardens Study Area	Undetermined
5901.003394	Narwood Court Study Area	Undetermined
5903.001165	Jones Beach State Park, Causeway & Parkway System	Listed
5903.00126	Ocean Parkway	Eligible
5903.001288	Harbour Green Historic District	Eligible
5903.001493	Spanish Revival Homes of Biltmore Shores	Eligible
5909.000176	Cedarhurst Park Survey District	Undetermined
5930.000133	Hempstead Lake State Park	Eligible
5941.000402	Rockaway Hunt Historic District	Eligible
5941.000403	Isle of Wight Historic District	Eligible
5941.000455	West Lawrence Historic District	Eligible
5941.00049	Weston Place Historic District	Eligible
5941.000507	Causeway-Herrick Historic District	Eligible
5941.000535	Waverly Place Historic District	Eligible
5941.000536	Jorgen Street Historic District	Eligible
5941.000545	Rosalind Place Historic District	Eligible
5946.001508	Seaside Homes Inc. on Lindell	Eligible
5946.0016	Estates of Long Beach Historic District	Eligible
5948.000024	Malverne Historic District	Eligible
5993.000005	Flower Streets Historic District	Eligible

2.6.3 Shipwrecks

NOAA Coast Survey's Automated Wreck and Obstruction Information System (AWOIS) was utilized to provide an initial assessment of the presence of shipwrecks in the study area. There are nearly 150 wrecks in the study area identified in Figure 25 (NOAA 2018).

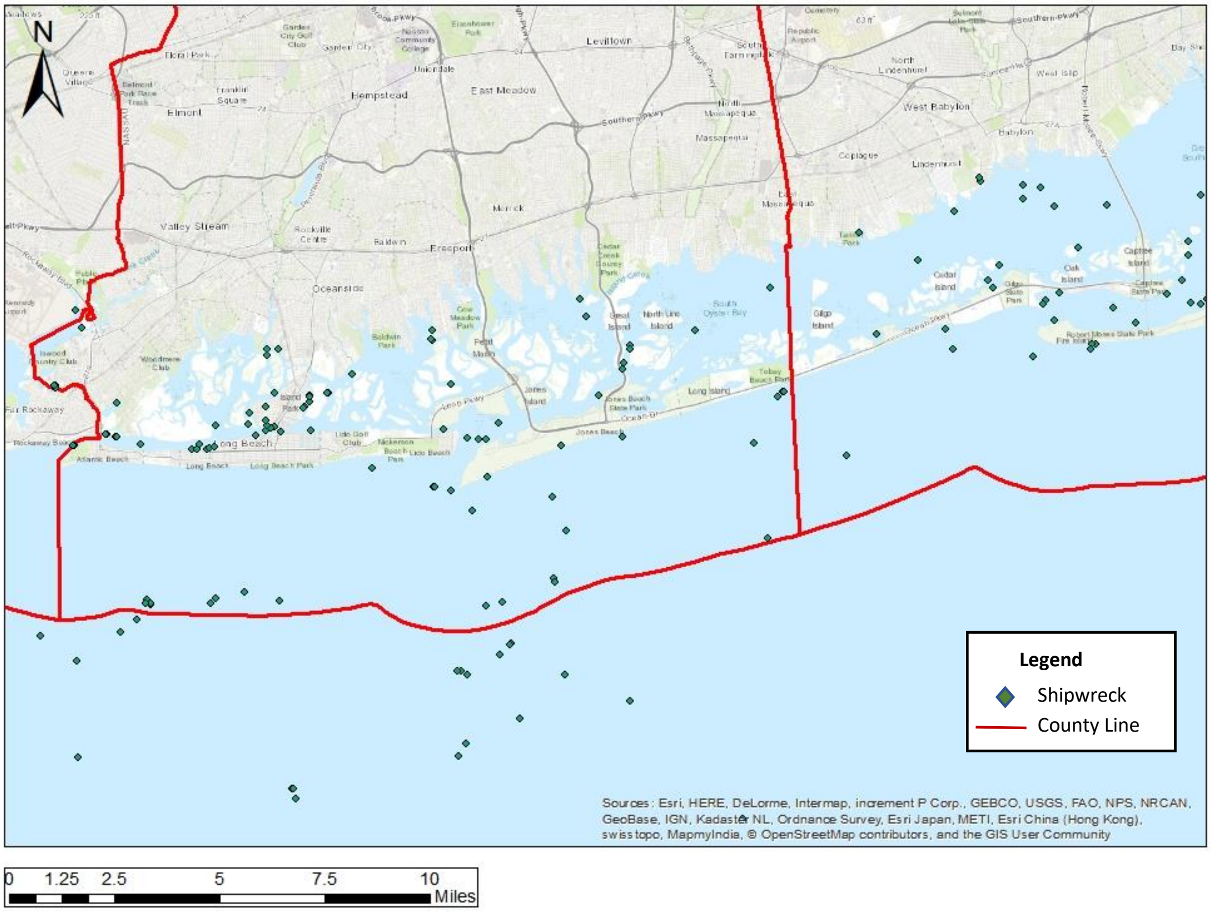


Figure 25 – Shipwrecks

2.7 Recreational Resources

There are abundant recreational resources within the study area. A number of public parks are located in the study area that offer both land-based and water-based recreational opportunities as well as private recreational facilities. Public resources include but are not limited to: Grant Park, Bay Park, Hewlett Point Park, Nickerson Beach Park, Ocean Beach Park, Long Beach Municipal Fishing Pier, Shell Creek Park, Lido Beach West Town Park, Lido Beach Wildlife Management Area, Oceanside Park, Marine Nature Study Area, Baldwin Park, Waterfront Park, Sea Breeze Park, Cow Meadow Park, Point Lookout Beach, Jones Beach Energy and Nature Center, Theodore Roosevelt Nature Center, Wantagh Park, Newbridge Road Park, Jones Beach State Park, and Cedar Creek Park. Additionally, the waterways of the study area are part of the South Shore Estuary Reserve. The Reserve provides shoreline recreation facilities, open space, and maritime history and culture. Recreational opportunities include swimming, boating, sailing, paddling, fishing, shellfishing, hiking, biking, photography, and visiting vineyards farmstands, and cultural heritage and historic landmarks sites (NYSDOS 2021a).

2.8 Aesthetics

The study area is a mix of urban centers, residential communities, and natural areas. Aesthetics and viewshed will vary depending on location. The South Shore Estuary Reserve is characterized by shallow, interconnected bays, island marshes, and tidal tributaries that provide open views of the estuarine system.

2.9 Population and Socioeconomic Conditions

The study area is a heavily populated, largely urbanized environment within the New York metropolitan area. Tables 18 and 19 summarize population census data for Nassau County and within the study area (US Census Bureau 2021). Table 20 provides socioeconomic data for Nassau County. The population of the study area is 424,352. The study area is estimated to have a minority population slightly over 35%. The per capita income of Nassau County is $51,422.

The study area has deep roots in maritime activities. Commercial fishing, island bay houses, recreational boating, marinas, yacht clubs, boat repair shops, ferries and shoreline parks are some of the facilities and activities that manifest the region's maritime heritage and contribute to its present-day culture. The study area has large concentrations of water-dependent businesses. Long Island is one of the two largest concentrations of commercial and recreational vessels, marines, and other water-dependent businesses in the State of New York. The local economy has a strong dependency on commercial and recreational fishing, beach and boating activities and the continued transportation and service activities on which they depend (NYSDOS 2021b).

Table 18 - Nassau County Population Data

Nassau County Population Data (2019 estimate)	
Population (2019 Estimate)	1,356,924
Population (Census April 1, 2010)	1,339,532
Age and Sex	
Persons under 5 years, percent	5.50%
Persons under 18 years, percent	21.40%
Persons 65 years and over, percent	18.20%
Female persons, percent	51.20%
Race and Hispanic Origin	
White alone, percent	73.40%
Black or African American alone, percent	13.10%
American Indian and Alaska Native alone, percent	0.50%
Asian alone, percent	10.90%
Native Hawaiian and Other Pacific Islander alone, percent	0.10%
Two or More Races, percent	2.00%
Hispanic or Latino, percent	17.50%
White alone, not Hispanic or Latino, percent	58.50%

Table 19 - Demographics Within the Study Area (Census 2010)

Demographics Within Study Area (Census 2010)		
	Count	**Percent**
Total Population	424,352	
Population 25 years and over	295,840	
Households	145,208	
Minority Population	151,835	35.78%
Low-income Population	61,593	14.51%
Count of individuals age 25 or over with less than high school degree	23,030	7.78%
Count of individuals under age 5	23,263	5.48%
Count of individuals over age 64	71,615	16.88%
Housing units	155,797	
Count of housing units built before 1960	102,212	

Table 20 - Nassau County Socioeconomic Data (2109 Estimate)

Nassau County Socioeconomic Data (2019 estimate)	
Housing	
Housing units	474,165
Owner-occupied housing unit rate, 2015-2019	80.70%
Median value of owner-occupied housing units, 2015-2019	$493,500
Families & Living Arrangements	
Households, 2015-2019	446,977
Persons per household, 2015-2019	2.99
Language other than English spoken at home, percent of persons age 5 years+, 2015-2019	28.70%
Education	
High school graduate or higher, percent of persons age 25 years+, 2015-2019	91.40%
Bachelor's degree or higher, percent of persons age 25 years+, 2015-2019	46.00%
Economy	
In civilian labor force, total, percent of population age 16 years+, 2015-2019	65.10%
In civilian labor force, female, percent of population age 16 years+, 2015-2019	59.20%
Total accommodation and food services sales, 2012 ($1,000)	2,938,830
Total health care and social assistance receipts/revenue, 2012 ($1,000)	13,166,206
Total manufacturers shipments, 2012 ($1,000)	5,196,698
Total merchant wholesaler sales, 2012 ($1,000)	27,959,054
Total retail sales, 2012 ($1,000)	24,105,610
Total retail sales per capita, 2012	$17,866
Income & Poverty	
Median household income (in 2019 dollars), 2015-2019	$116,100
Per capita income in past 12 months (in 2019 dollars), 2015-2019	$51,422
Persons in poverty, percent	5.60%
Businesses	
Total employer establishments, 2019	48,915
Total employment, 2019	580,276
Total annual payroll, 2019 ($1,000)	32,239,561
Geography	
Population per square mile, 2010	4,704.80
Land area in square miles, 2010	284.72

2.9.1 Environmental Justice

On February 11, 1994, President Clinton issued Executive Order 12898, Federal Actions to Address Environmental Justice in Minority and Low-Income Populations. This order requires that “each federal agency make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities, on minority populations and low-income populations” (Executive Order 12898, 59 Federal Register 7629 [Section 1-201]).

The NYSDEC follows guidance established in DEC Commissioner Policy 29 on Environmental Justice and Permitting (CP-29), to identify Potential EJ Areas (PEJAs) as U.S. Census block groups of 250 to 500 households each that, in the Census, had populations that met or exceeded at least one of the following statistical thresholds:

- 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 Nassau County (NYSDEC 2016) as depicted in Figure 26. Within the study area in Nassau County, there are six PEJA identified: multiple locations within the Town of Hempstead (north and west of Valley Stream, Inwood, and Island Park), northcentral Long Beach, Freeport, and East Massapequa. Figures 27 and 28 provide the percent minority and low income populations, respectively. The PEJA contain populations that exceed both the minority and low income population percentages for environmental justice concerns.

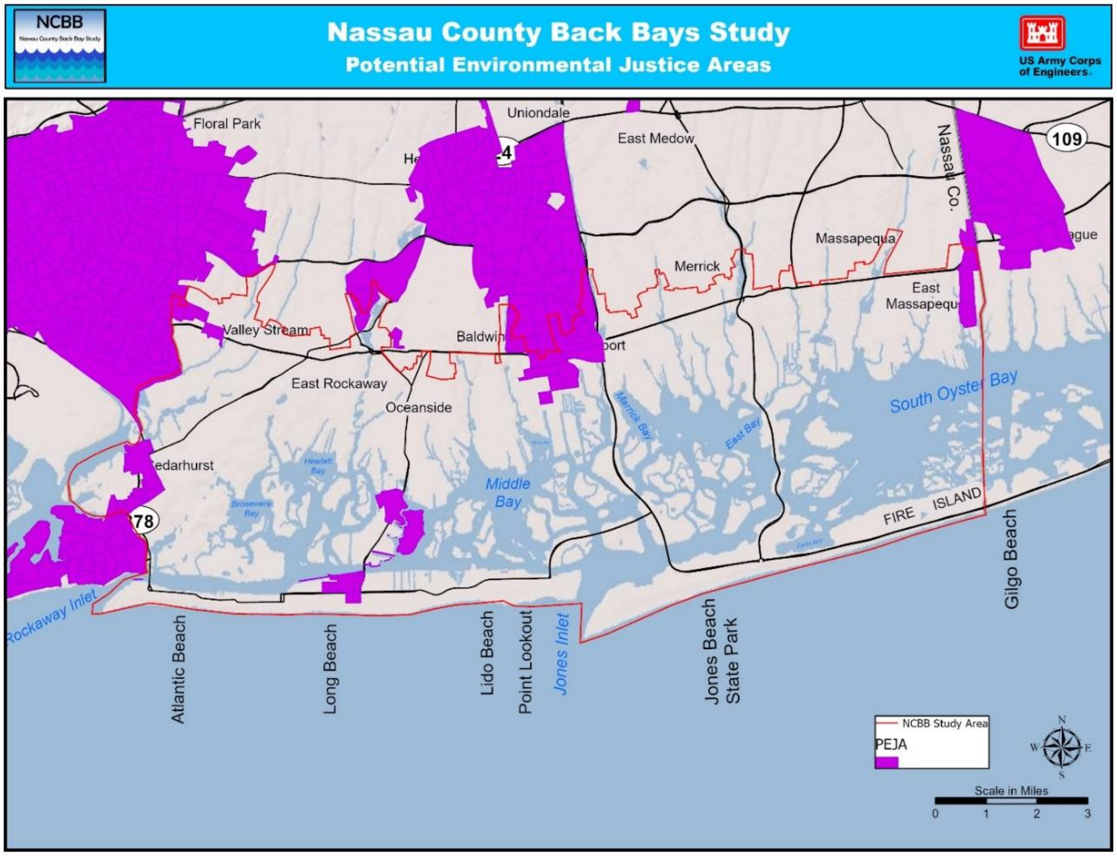


Figure 26 – Potential Environmental Justice Census Block Groups (as determined by NYSDEC)

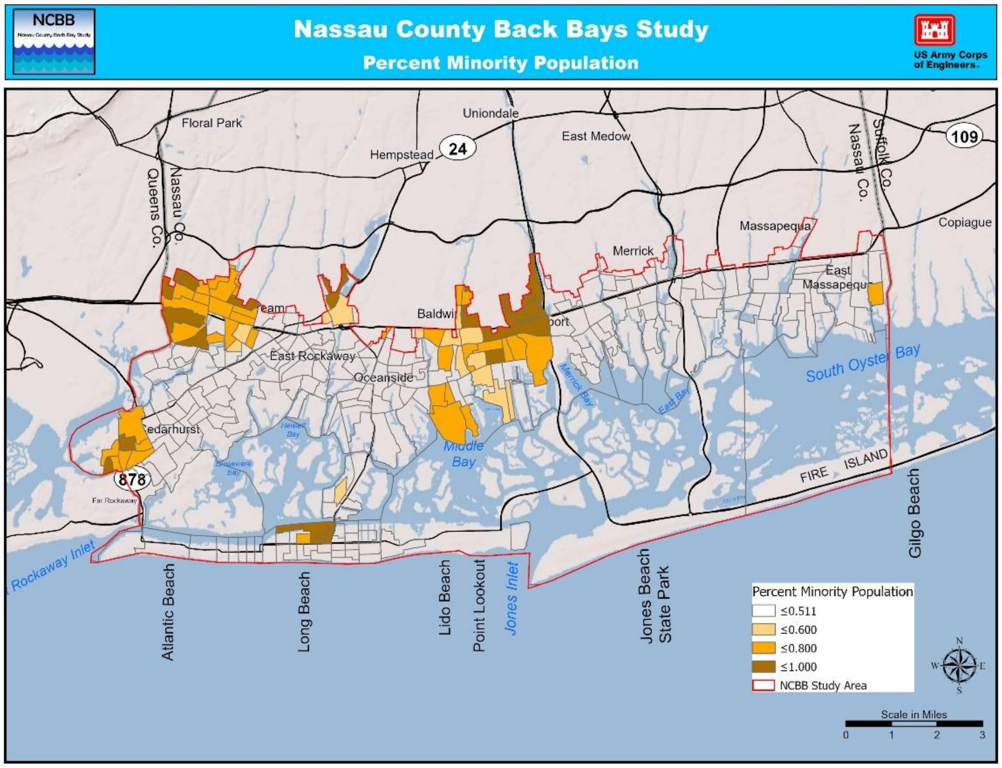


Figure 27 - Percent Minority Population within the Study Area

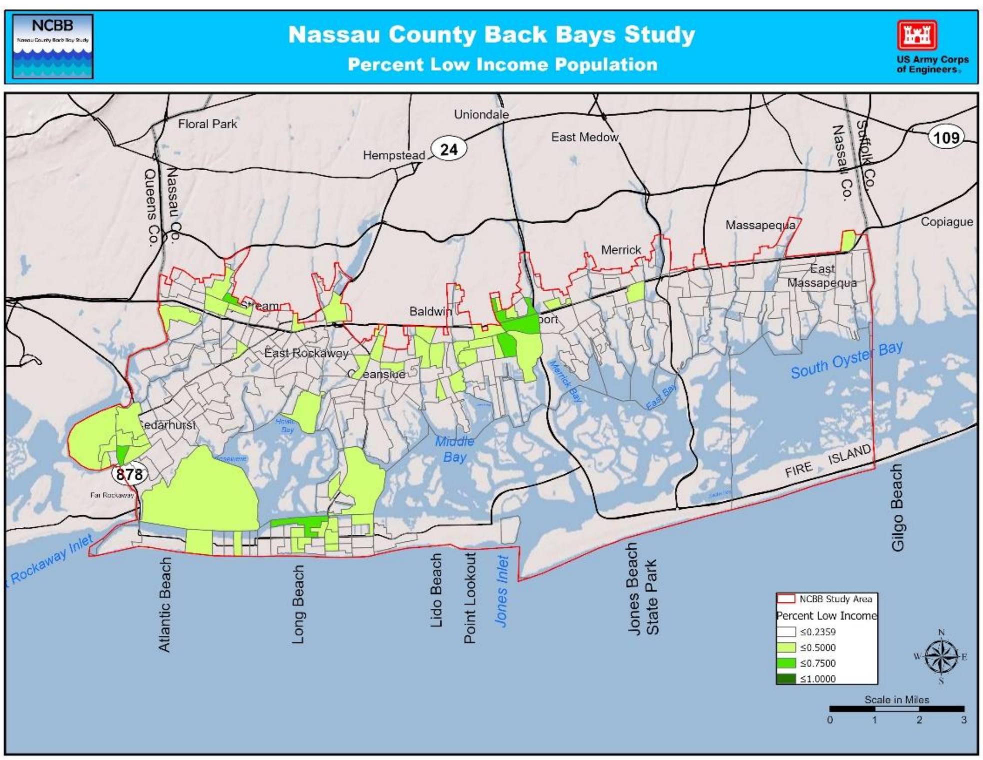


Figure 28 - Percent Low Income Population within Study Area

Based on 2019 projections, non-Hispanic Whites made up 58.5 percent of the population of Nassau County (USCB 2019). The largest minority group in the county is Hispanic, with 17.5 percent of the population in 2019; Black or African Americans represented 13.1 percent of the population, Asians represented 10.9 percent of the population, and Native American Indians represented less than one percent (USCB 2019).

2.10 Navigation

The back bays ecosystem is a relatively shallow body of water, primarily navigable only by shallow draft vessels. The South Shore Estuary Reserve shallow, interconnected bays and tidal tributaries support the largest concentration of water-dependent businesses in the State (NYSDEC 2021).

There are two ocean inlets in the study area: East Rockaway Inlet and Jones Island Inlet, which are federal navigation projects. East Rockaway Inlet is at the western end of Long Beach Barrier Island, between Far Rockaway, Queens County, NY and Atlantic Beach, Nassau County, NY and provides for a channel 12 feet deep and 250 feet wide. It is the only entrance into Jamaica Bay (outside of the study area) from the Atlantic Ocean/New York Harbor. Jones Inlet is located in the Town of Hempstead, Nassau County, NY, between the Atlantic Ocean and Hempstead Bay, extending from the outside of the east jetty to the Loop Causeway Bridge over Long Creek; and provides for a channel 12 feet deep and 250 feet wide, from deep water in the Atlantic Ocean to the Loop Causeway Bridge over Long Creek, and also for the east jetty. The total length of the channel is 2.3 miles. In 2017, the annual commercial tonnage transported through Jones Inlet was 10,000 tons, and consisted of fuel oil. The inlet supports U.S. Coast Guard Station Jones Beach, NY Search & Rescue (SAR) missions, and provides access from the Atlantic Ocean to the protected non-federal inner channels of the Middle Bay. The channel also supports approximately ten commercial marinas.

Automatic Identification System Analysis Package (AISAP) was used to determine average vessel characteristics in the study area, particularly within the back bays adjacent to the HVAs. AISAP is a real-time shipboard broadcast system sending signals to other ships and shore-based receivers. The system was designed as a collision avoidance system. Broadcasted data includes information such as time stamps, latitude and longitude, vessel ID, vessel type, and vessel dimensions. AIS is mandatory for almost all commercial vessels and is also used by some recreational vessels. The Nationwide Automatic Identification System (NAIS) is run by the U.S. Coast Guard and is a network of land-based receivers and transmitters that listen for AIS broadcasts. NAIS collects and archives AIS signal data. USACE developed AISAP, enabling users to pull data from the NAIS archive into the USACE database. AISAP is a web-based tool for acquiring, analyzing and visualizing near-real-time and archival data from the U.S. Coast Guard. Users can search for all vessels in an area during a specific time or limit their search to specific vessels during a given time range. Data is limited by the number of vessels using the Automated Identification System (AIS), the sampling rate used to collect AIS data in a particular area, and the accuracy of the vessel information inputted into the system. The goal of this analysis was not to report every single vessel traversing through an inlet and its exact location, but rather to generate a general representation of vessels active in the four highly vulnerable areas (HVAs).

AIS data was collected and evaluated in the Back Bay area adjacent to HVAs from May 21, 2018 to September 9, 2018, representing a total of 111 days. Figure 29 provides the heat map of the vessel transit data captured during this timeframe.

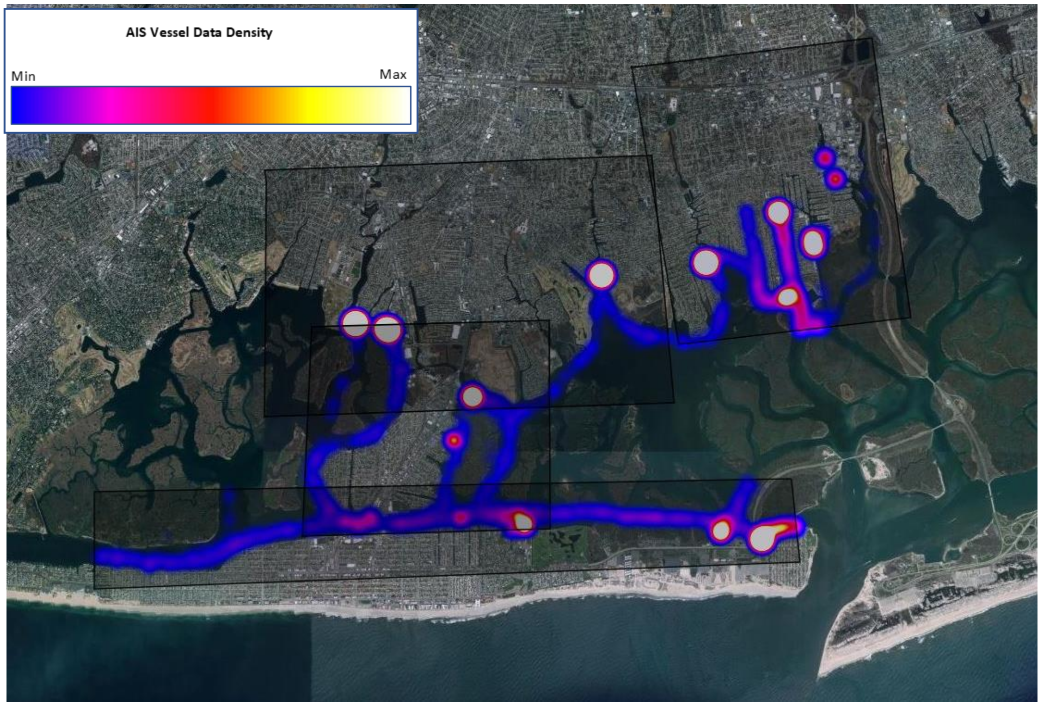


Figure 29 - Heat Map of Vessel Transit Data

Raw results of the vessel data statistics for each HVA has been included in Exhibit D of Appendix C (Civil App) titled "AISAP Vessel Data Results". A total of 21,000+ vessel reports with 7,000+ transits were recorded during this timeframe for the four HVAs. A summary of the recorded vessel data for each HVA has been included in Table 21 below. The far-right column is the averaged value of each notable vessel characteristic.

The majority of the vessels reported through the NCBB area were smaller recreational vessels (pleasure crafts). Recreational navigation includes motor, sail, and paddle boats, but it is unlikely that all these types of vessels are included in the AISAP data. The Long Beach area recorded the highest number of unique vessels at 29 while East Rockaway had the highest number of transits. The average mean vessel draft was 1.6 ft. Considering the standard deviation, vessels drafts were under 6.27 ft. A more extensive discussion of the AISAP data and how it was incorporated into formulation is provided in Appendix C (Civil Appendix).

Table 21 – Summary of Recorded Vessel Data for each HVA from AISAP

VESSEL TRAFFIC SAMPLE STATISTICS						
Report Date Range: 5/21/2018 12:05:00 AM to 9/9/2018 12:50:00 PM						
Description	**Unit**	**East Rockaway**	**Long Beach**	**Island Park**	**Freeport**	**Average**
Number of Reports	EA	8328	3884	4423	5009	5411
Number of Unique Vessels	EA	15	29	20	17	20
Number of Transits	EA	3286	1362	877	2139	1916
Vessel Draft (Mean)	FT	1.75	2.06	2	0.39	1.6
Vessel Draft (Std. Deviation)	FT	3.68	4.21	4.27	1.6	3.4
Vessel Length (Mean)	FT	43.74	46.83	47.73	46.32	46.2
Vessel Length (Std. Deviation)	FT	28.35	29.05	27.08	33.47	29.5
Vessel Width (Mean)	FT	13.77	15.16	14.11	13.69	14.2
Vessel Width (Std. Deviation)	FT	8.43	11.59	7.83	7.98	9.0
Vessel Speed (Mean)	KN	0.14	1.84	1.35	0.58	1.0
Vessel Speed(Std. Deviation)	KN	0.04	0.7	0.58	0.2	0.4

EA = each, FT = feet, KN = knot

3.0 No-Action/Future Without-Project Conditions (*NEPA Required)

The forecast of the FWOP condition reflects the conditions expected during the 50 period of analysis (2030-2080) if none of the alternatives described in this report are implemented. The FWOP condition is the No Action Alternative and provides the basis from which alternative plans are formulated and impacts are assessed. Since impact assessment is the basis for plan evaluation, comparison and selection, clear definition and full documentation of the FWOP condition are essential. Gathering information about historic and existing conditions requires an inventory. Gathering information about potential future conditions requires forecasts, which should be made for selected years over the period of analysis to indicate how changes in economic and other conditions are likely to have an impact on problems and opportunities.

The FWOP Condition includes a characterization of CSRM projects and features, socio-economic, environmental, and cultural conditions if the NCBB action is not taken. This is the baseline from which the NCBB measures will be evaluated for reducing coastal storm risk and promoting resilience. The FWOP serves as the baseline for evaluating the anticipated performance of the NCBB alternatives. It documents the need for Federal action to address the water resources problem.

3.1 Climate Change

Several trends have been identified for the NCBB Region which are projected to continue into the future and will likely affect the FWOP for this study. It is anticipated that the study area will continue to experience damages from coastal storms, and that the damages may increase from more intense storm events. These coastal storm events will likely continue to effect areas of low coastal elevations within the study area with pronounced localized effects in some areas.

In the FWOP Condition climate change trends are expected to continue,. Since 1970, the annual average temperature in New York State has risen about 2.4°F and annual average temperatures have increased in all regions of the state. Since 1900 average annual precipitation has increased across New York State, although the state is getting more rain and snow in the winter and less in the summer. Increased precipitation is expected to continue, with more frequent storm events and heavier downpours.

Climate change may lead to increased ocean temperatures, ocean acidification, sea level rise, changes in currents, and upwelling and weather patterns, and has the potential to cause changes in the nature and character of the estuarine ecosystem (USACE 2017). Climate change is expected to result in more intense and frequent extreme precipitation events by the end of the century, which would cause flooding, streambank erosion, and increases in the rate and amount of nutrients and sediments entering the estuary (IPCC 2013). Cumulative losses of saltmarsh habitat due to sea level rise and other factors may reduce the ability to capture and hold carbon. Saltmarshes are considered to be carbon sinks. When these habitats are damaged or lost, carbon (i.e. CO2) is emitted back into the atmosphere where it can contribute to climate change (NOAA 2021).

In the FWOP Condition, it is anticipated that sea level will increase throughout the study area, that shorelines will change in response to RSLC, and historic erosion patterns will continue and accelerate. It is anticipated that there will continue to be significant economic assets within the NCBB study area and that population and development will continue to increase The Nassau County Back Bay study area would experience a total of $1.01 billion in FWOP Average Annual Damages (AAD) over the 50-year period of analysis with Intermediate SLC (see Appendix F).

Due to the likelihood of increasing water levels resulting from the rise in sea level over time, erosion rates will increase and impact the shorelines in the NCBB study area. Increased erosive forces have the potential to undermine shorelines protected with structural measures such as bulkheads having direct negative impacts on residents in bayfront communities. Unprotected shorelines could also be degraded, reducing the ability to attenuate waves, erosive forces, and resulting in the loss of valuable habitat. To maintain the shallow tidal marshes and islands, increases in sediment inflow into the back bays would be required to offset the increases in water levels. It is more likely that over time, increased water levels in the back bays will create more open water, reduce tidal marshes, inundate barrier islands, and steepen slopes near bulkheads and other back bay structures.

The FWOP Condition would see no additional federal involvement in CSRM as outlined within this study. Current projects and programs that the USACE conducts in conjunction with other Federal and non-Federal entities would continue and would be constructed by 2030.

The FWOP Condition does consider those projects that have been completed (existing), are under construction, or have been authorized for construction and are anticipated to be constructed by 2030. Any proposed projects, which are not yet authorized for construction, are not considered part of the FWOP conditions for analysis.

3.1.1 Sea Level Change

In accordance with ER 1100-2-8162, Incorporating Sea Level Change in Civil Works Programs, potential effects of RSLC were analyzed over a 50-yr economic analysis period and a 100-yr planning horizon. Research by climate science experts predict continued or accelerated climate change for the 21st century and possibly beyond, which would cause a continued or accelerated rise in global mean sea level. ER 1100-2-8162 states that planning studies will formulate alternatives over a range of possible future rates of SLC and consider how sensitive and adaptable the alternatives are to SLC.

ER 1100-2-8162 requires planning studies and engineering designs consider three future sea level change scenarios: low, intermediate, and high. The historic rate of SLC represents the “low” rate. The “intermediate” rate of SLC is estimated using the modified National Research Council (NRC) Curve I. The “high” rate of SLC is estimated using the modified NRC Curve III. The “high” rate exceeds the upper bounds of IPCC estimates from both 2001 and 2007 to accommodate the potential rapid loss of ice from Antarctica and Greenland, but it is within the range of values published in peer-reviewed articles since that time.

USACE low, intermediate, and high SLC scenarios over the 100-yr planning horizon at Sandy Hook, NJ are presented in Table 22 and Figure 30. Water level elevations at year 2030 are expected to be between 0.5 and 1.0 feet higher than the current National Tidal Satum Epoch (1983-2001)(NTDE). Water elevations at year 2080 are expected to be between 1.1 and 4.0 feet higher than the current NTDE.

Hydrodynamic modeling performed for this study was completed in the current NTDE. Therefore, the modeled water levels represent MSL in 1992. Future water levels are determined by adding the SLC values in Table 22. For example, a water level elevation of 10 feet NAVD88 based on the current NTDE will have an elevation in the year 2080 of 11.13, 11.82, and 14.0 feet NAVD88 under the USACE low, intermediate, and high SLC scenario respectively.

Table 22 - USACE Sea Level Change Scenarios (Derived from Sandy Hook, NJ)

Year	USACE - Low (ft, MSL[1])	USACE - Int (ft, MSL[1])	USACE - High (ft, MSL[1])
1992	0.00	0.00	0.00
2000	0.10	0.11	0.13
2021	0.37	0.45	0.68
2030	0.49	0.62	1.02
2050	0.74	1.04	1.99
2080	1.13	1.82	4.00
2100	1.38	2.42	5.71
2130	1.77	3.46	8.83

[1]Mean Sea Level based on National Tidal Datum Epoch (NTDE) of 1983-2001

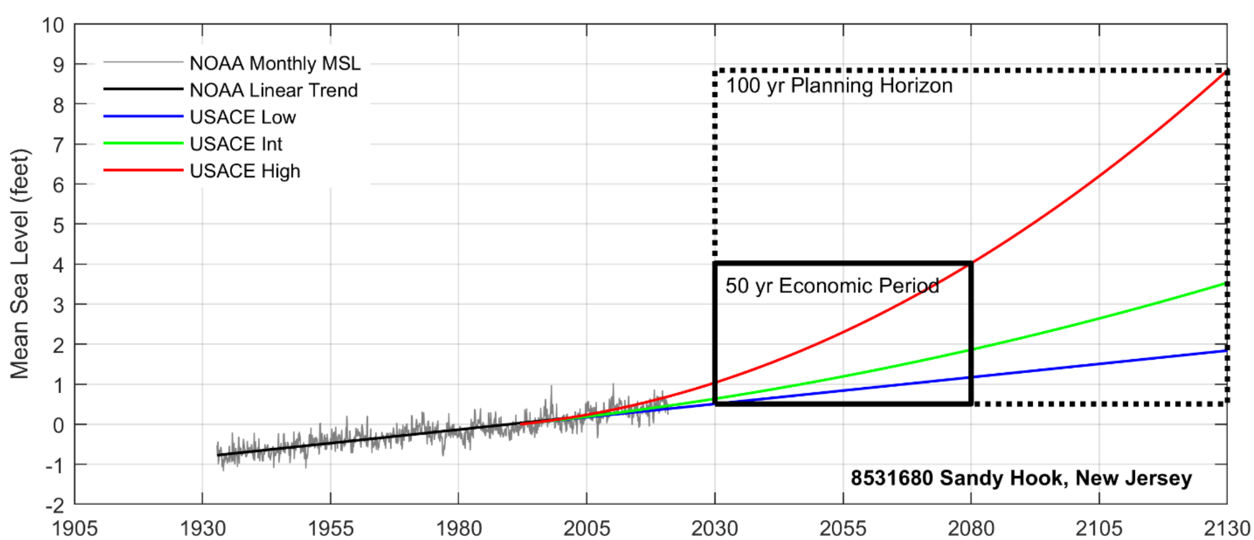


Figure 30 - Relative Sea Level Change Projections at Sandy Hook, NJ

3.1.2 High Frequency Flooding

The number of high-frequency flood days is accelerating in the study area in response to RSLC. The frequency and impact of rainfall flooding will increase as the probability of the tide level exceeding storm drains will increase in response to RSLC. Some municipalities are addressing this problem by installing pump stations that are capable of draining water during elevated water levels. NWS major flood stage could eventually occur at frequency consistent with high-frequency flooding in the future in response to RSLC.

Section 2.1.1 showed the dramatic impact RSLC has had on frequency of flooding over the last 100 years. This section shows how the rate of high-frequency flooding will be affected by future RSLC. To complete this analysis a recent 25 year period of the NOAA tidal record (1992-2016) was assumed to repeat over and over again until 2130. However, the three USACE SLC projections were added to the observed water levels. An example of the approach using the USACE Low SLC scenario is shown in Table 23 with historical and future projected hourly water levels and a color-coded dot for any day in which the NWS flood stages were exceeded. Appendix B provides additional detail on the methods and results for each SLC scenario.

Annual NWS flood days from the analyses are tabulated in Table 23. It is difficult to say or know what the tipping point (days per year) is for NWS minor, moderate, and major flooding before the impacts to roads and infrastructure are unacceptable. However, the analysis shows that major investments in bulkheads and storm water systems (i.e. pump stations) are likely to be required in the future for the portions of the study area to be inhabitable.

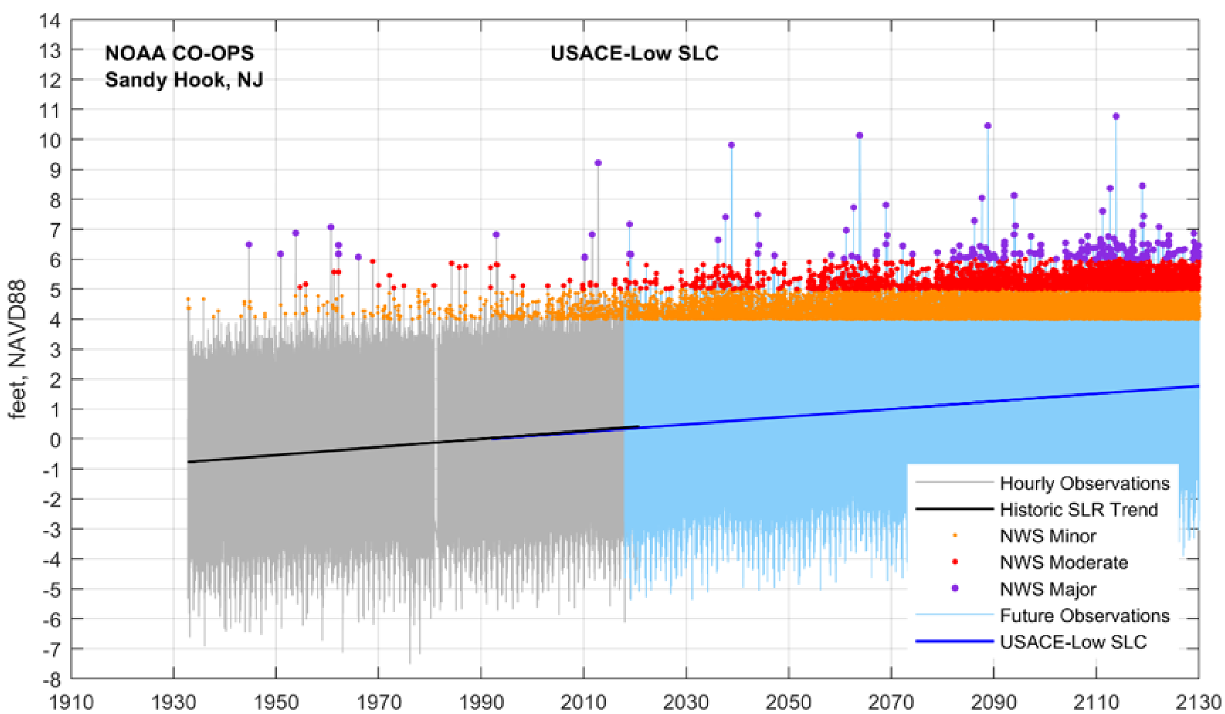


Figure 31 - Historical and Future High Frequency Flooding with USACE Low SLC

Table 23 - High-Frequency Flood Occurrences (Per Year)

Year	NWS Minor Flood			NWS Moderate Flood			NWS Major Flood		
	Low	Int	High	Low	Int	High	Low	Int	High
1935	0.8	0.8	0.8	0.0	0.0	0.0	0.0	0.0	0.0
1960	2.5	2.5	2.5	0.5	0.5	0.5	0.3	0.3	0.3
1985	3.4	3.4	3.4	0.4	0.4	0.4	0.0	0.0	0.0
2010	17.0	17.0	17.0	1.1	1.1	1.1	0.4	0.4	0.4
2020	26.2	30.7	49.6	2.1	2.3	3.1	0.3	0.3	0.4
2030	39.4	51.8	108.3	3.1	4.5	13.6	0.0	0.0	1.1
2055	70.5	127.5	315.0	6.5	17.7	151.2	0.2	1.3	25.8
2080	117.6	248.1	363.3	15.2	71.7	352.7	1.2	6.9	271.4
2105	172.0	339.6	363.6	33.2	201.5	363.6	2.6	47.1	363.4
2130	215.5	359.2	362.5	51.6	316.7	362.5	2.9	140.2	362.5

Note: 10-year running mean filter applied to determine annual flood occurrences

3.1.3 Economic and Social Without Project Condition

The Nassau County Back Bays study area would experience a total of $1.01 billion in FWOP Average Annual Damages (AAD) over the 50-year period of analysis with Intermediate SLC. Table 24 provides the breakdown of AAD across each category type for each of the three USACE SLC curves.

Figure 32 provides a map of the study area that highlights structures with significant coastal storm risk in the FWOP Condition under the Intermediate SLC curve. Markers depict structures that receive at least $195,000 in damages from the Year 2080 1% Annual Exceedance Probability (AEP) event. This threshold denotes the 90th percentile of structures in terms of coastal storm damages estimated.

Table 24 – FWOP Average Annual Damages (in thousands)

	Low SLC	Intermediate SLC	High SLC
VEHICLE	$27,000	$37,000	$104,000
COMMERCIAL	$61,000	$80,000	$195,000
CRITICAL INFRASTRUCTURE	$34,000	$45,000	$119,000
INDUSTRIAL	$86,000	$113,000	$250,000
MULTI-USE	$15,000	$19,000	$53,000
PUBLIC	$12,000	$15,000	$33,000
RESIDENTIAL	$574,000	$702,000	$1,402,000
TOTAL	**$808,000**	**$1,012,000**	**$2,156,000**
RELATIVE TOTAL INCREASE	**-**	**25.3%**	**113.0%**

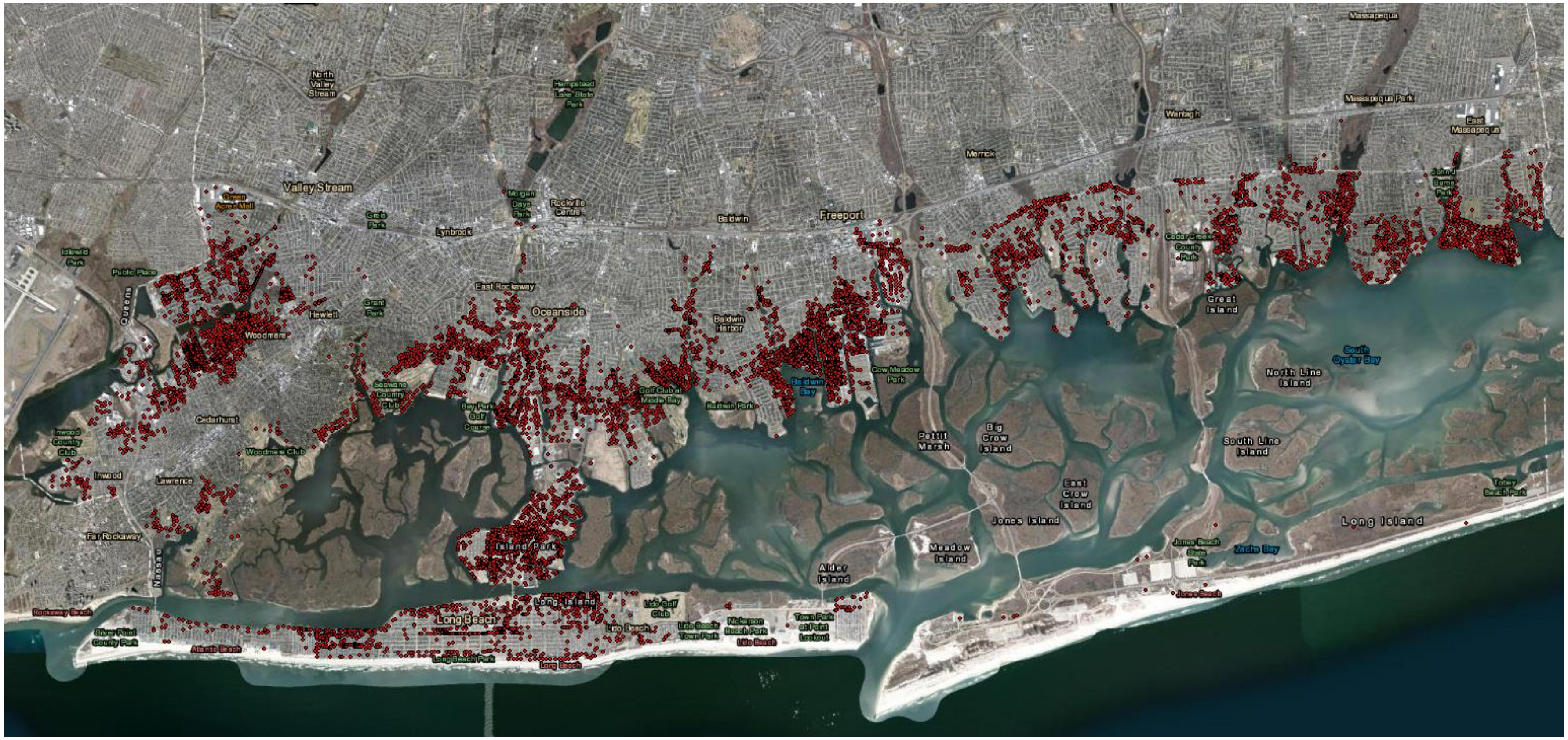


Figure 32 - Nassau County Back Bays High Damage Assets

Across all USACE SLC curves, residential structures provide the majority of estimated FWOP coastal storm damages. Under the Low SLC scenario, residential structures comprise over 71% of total quantified damages. As the SLC rate projection increases, the relative contribution to total damages drops for residential structures as more commercial, industrial, and critical infrastructure facilities become vulnerable to inundation. The total projected average annual damages increase in line with SLC projected rates.

Under the High SLC curve, the 1% AEP event stage is approaching +14.9ft NAVD88 for certain parts of the study area by the end of the 50-year period of analysis. This introduces structures into the damage pool that may otherwise have not been vulnerable under the Low and Intermediate SLC rates and places them at significant risk from coastal storm events.

For context, Figure 31 provides the anticipated RSLC for the study area across the 100-year planning horizon as calculated using the USACE Sea-Level Change Curve Calculator (Version 2021.12) and in accordance with ER 1100-2-8162 *Incorporating Sea Level Change in Civil Works Programs*. By 2080, the end of the 50-year period of analysis, RSLC in this area under the High SLC curve is projected at just under 4ft. By 2130, the end of the 100-year planning horizon, High SLC projections are reaching close to 9ft.

The Low (Historic) and Intermediate SLC rates are fairly linear for this study area across both the 50-year period of analysis and 100-year planning horizon. The projections increase at a relatively uniform rate with the Intermediate SLC curve only projecting 0.8ft more sea level rise than the Low (Historic) SLC curve. This corresponds with the data in Table 24**Error! Reference source not found.** that displays only a modest 25.3% increase in FWOP NED damages under then Intermediate SLC in comparison to the Low SLC curve.

FWOP AAD are distributed across the study area but do cluster in a few locations. Particularly in the City of Long Beach, Village of Freeport, and the Village of Island Park. Smaller clusters of higher-value, high-vulnerability structures are also evident in the area north of the Village of Island Park, the far western edge of Nassau County and in East Massapequa.

3.2 Land Use

In the FWOP Condition, there could be changes to land use. Low-lying areas would be increasingly susceptible to flooding, making these locations inaccessible at times to residents and visitors. Table 25 and Figure 33 show the expected changes to land cover over the study period based on SLAMM Data. More than 700 acres of developed dry land under the intermediate RSLC scenario and more than 4,000 acres of developed dry land would become flooded under the high RSLC scenario. This has the potential to affect communities, tourist areas, transportation, and commercial and industrial areas, which could potentially have significant effects on land use. It is expected that some localized measures (structural or non-structural) would be implemented by residents, businesses, local municipalities or at the state level to mitigate flooding. However, areas left unprotected over time may be uninhabitable following a major storm event or recurrent flooding.

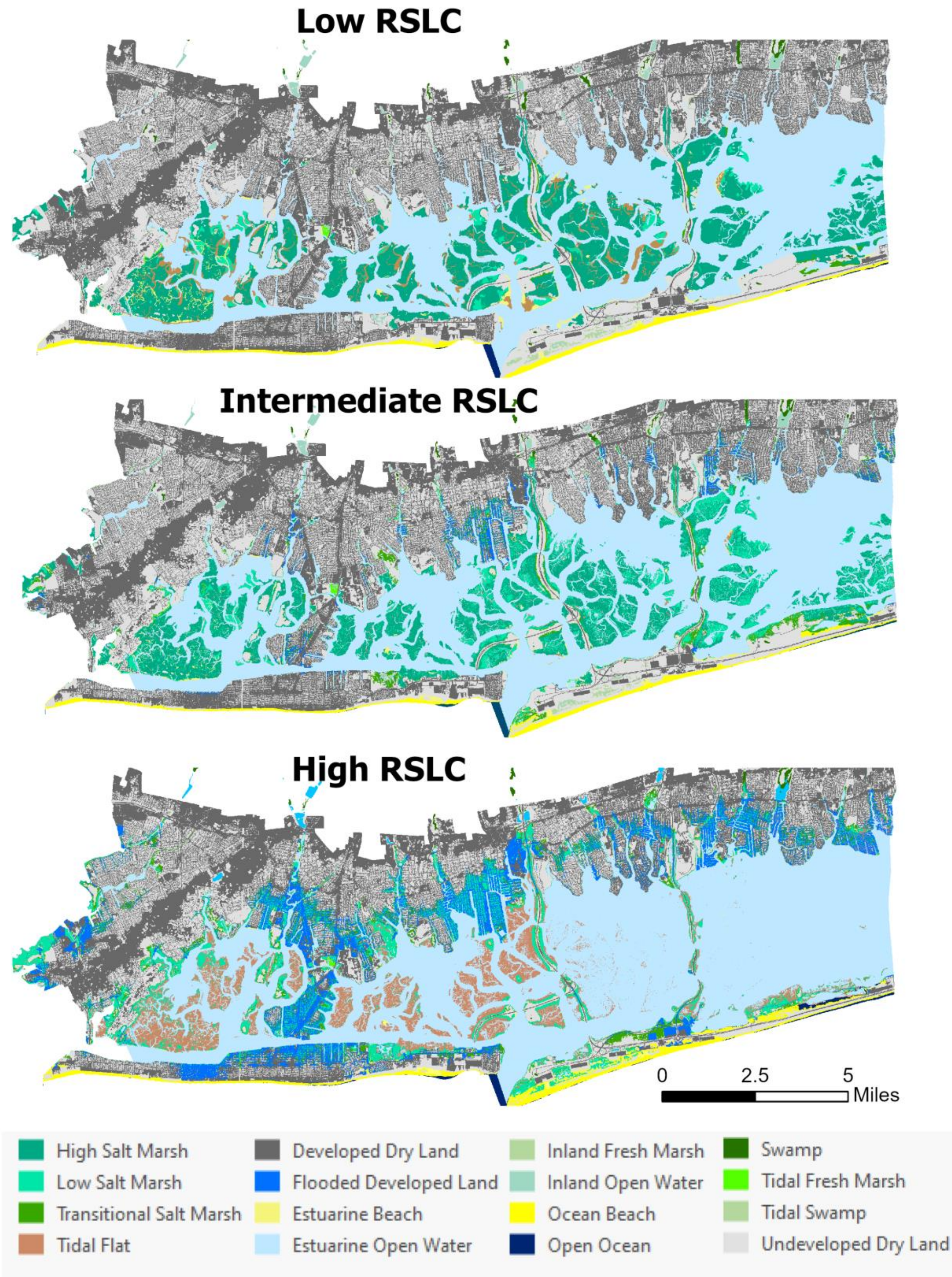
As shown in Table 25, as the RSLC rate projection increases, the relative contribution to total damages for residential structures decreases as more commercial, industrial, and critical infrastructure facilities become vulnerable to inundation. The total projected AAD increase in line with SLC projected rates. See Appendix F for additional details.

Table 25 - Changes in Land Covers Based on Low, Intermediate, and High RSLC Scenarios

	Low/ Baseline[1]	**Intermediate**	**High**
Land Cover Type	***Acres***	***Change in Acres***	
High Salt Marsh (Irregularly Flooded)	7,461	-2,349	-7,388
Low Salt Marsh (Regularly Flooded)	612	2,087	2,610
Transitional Salt Marsh	124	735	1,546
Tidal Fresh Marsh	22	-2	-10
Inland Fresh Marsh	138	-36	-124
Tidal Flat	916	-696	2,370
Estuarine Beach	419	-216	-344
Tidal Swamp	12	-5	-11
Ocean Beach	628	42	309
Swamp	256	-26	-67
Inland Open Water	333	-46	-105
Estuarine Open Water	15,715	1,715	6,196
Open Ocean	87	37	105
Undeveloped Dry Land	15,130	-1,241	-5,087
Developed Dry Land	16,408	-719	-4,193
Flooded Developed Land	0	719	4,193

Source: Clough et al. 2014

[1] The low SLC scenario assumes that salt marsh accretion keeps pace with SLC and wetland area would be similar to existing conditions. This is used as the baseline to determine losses under the intermediate and high SLC scenarios.



Source: Clough et al. 2014

Figure 33 - Changes in Land Covers Based on Low, Intermediate, and High RSLC Scenarios

3.3 Floodplains

Structures that are not protected by flood protection or elevation with appropriate freeboard will continue to be at risk of flooding or could become more at risk due to RSLC and climate change in the FWOP Condition. Without local or non-Federal interventions, nuisance flooding in low-lying areas will continue. Potential impacts from tidal and/or rainfall flooding will likely increase and worsen over time with climate change and RSLC and would also become more susceptible to catastrophic flooding from storm surges.

3.4 Physical Resources

3.4.1 Geological Resources

In the FWOP Condition, continued RSLC would likely increase flooding and wave attack are likely to increase soil erosion particularly on tidal marshes and mudflats in vulnerable locations. RSLC may also exceed normal sediment accretion rates in the saltmarshes resulting in increased inundation and subsidence. Additionally, groundwater may become more susceptible to saltwater intrusion.

3.4.2 Water Resources

It is reasonable to expect that current water quality trends will continue without any significant interventions, such as changes in land use or improvements or implementation of water quality improvement programs such as TMDLs, administered by Federal, State, and local agencies. Climate change and RSLC introduce greater uncertainty of continued trends where changes in temperature, precipitation and flooding patterns, and chemical changes such as ocean acidification and increases in salinity could impose synergistic effects on the NCBB water quality. In the future, climate change and RSLC may have profound effects on the NCBB water quality (NYS SLR Task Force 2010, USACE 2014b).

3.4.3 Physical Oceanography

In the FWOP Condition, climate change and RSLC introduce greater uncertainty of continued trends in localized circulation. At the highest rates of RSLC, salt marsh accretion and barrier retreat may not keep pace with inundation, significantly increasing overwash and breaching of new inlets and potentially changing the physical and environmental characteristics of the bays such as, lagoon flushing rates, salinity, light penetration and nutrient dynamics (NYS SLR Task Force 2010, USACE 2014b).

3.4.4 Air Quality

In the FWOP Condition, it is expected that current air quality trends would continue. The primary pollutant of concern in the study area is ground level ozone. It is expected that no action will continue the trends in ground level ozone, which are influenced by many factors including emissions of NOx and VOCs (ozone precursors), weather conditions and emission reductions brought about by control measures. Short term fluctuations are most likely due to weather conditions. With no action, no impacts to air quality in the region are expected as described in the Affected Environment section and current trends will continue in the study area.

3.4.4.1 Greenhouse Gases

It is expected that current greenhouse gas trends will continue. New York has been working to reduce emissions from the power and transportation sectors, buildings, and food waste. New York adopted Statewide Greenhouse Gas Emission Limits (6 NYCRR Part 496) which adopts limits on the emission of greenhouse gases in 2030 and 2050, as a percentage of 1990 emissions. While this rule applies to all emission sources in the State, it does not impose compliance obligations.

3.4.5 Hazardous, Toxic and Radioactive Waste

In the FWOP Condition, the inventory of known contaminated sites would be expected to persist. Cleanup of these sites would continue under various Federal and State programs. Facilities would continue to be at risk due to coastal storms. The risk that storm damage could affect these sites, resulting in additional threats to human populations and the ecosystem, would increase with climate change over time. Where NPDES permits are required for local storm water sewer systems discharging into the bay, discharges may increase or that additional permits may be required to address increased discharges.

3.4.6 Noise

In the FWOP Condition, no changes to noise as described in the Affected Environment section are expected. Assuming no significant changes in land use or the introduction of new activities that emit noise, it is expected that noise levels in the communities and wetland bay habitats would remain the same as current conditions. Climate change and RSLC are not expected to be a significant factor in future above water or underwater noise impacts.

3.5 Ecological and Biological Resources

3.5.1 Ecosystems and Habitat

In the FWOP Condition, the NCBB shorelines will likely have a varying response to RSLC. In areas with adequate sediment supply and no artificial or natural barriers, shoreline habitat will be able to migrate landward. However, at increased rates of RSLC and in cases of inadequate sediment supplies, the effects are difficult to assess and will likely include more significant loss of habitat, accelerated erosion and limited landward migration of beach dune systems (NYS SLR Task Force 2010, USACE 2014b). As sea levels rise, many beaches on the barrier island/back bay system will erode to the point in front of shoreline protection structures and would be eventually lost without continual beach nourishment (USACE 2014b).

Short-term changes in sea level caused by storms are much larger than those associated with long-term trends such as relative sea level rise, therefore the greatest impact to barrier islands over the 50 year planning period can be expected from storms and disruption of sediment transport by human activity (Tanski 2007, NYS SLR Task Force 2010). High rates of projected RSLC may lead to increased overwash, breaching of new inlets, and the eventual disappearance of barrier islands altogether if the system cannot supply a sufficient amount of sand (Tanski 2007, NYS SLR Task Force 2010, USACE 2014b).

In the FWOP Condition, some changes to to terrestrial habitats may occur. It is assumed that continued beach nourishment along the Atlantic Coast beaches would maintain terrestrial habitats such as the upper beach, dunes and lands behind these features along the developed barrier islands. Existing land use trends may continue with conversions of some upland habitats to urban lands within areas zoned for development. RSLC may convert some lower lying upland areas into transitional wetlands and may result in die-back of low-lying forests by creating “ghost forests”.

3.5.2 Wetlands

Existing wetland/marsh loss trends would continue or worsen under the FWOP Condition. Predicted climate change impacts such as increased RSLC or increased risk of severe coastal storms can change the nature and character of the wetlands in the NCBB study area. In general, wetlands are at increased risk of degradation and loss from RSLC. Wetlands may erode further or be at increased risk of becoming inundated while not keeping up with sediment accretion rates. Inundation may result in a change in vegetation community or habitat type or loss (i.e. inundation too severe to support wetlands). The low, intermediate, and high RSLC scenarios used for marsh modeling (i.e., Sea Level Affecting Marshes Model [SLAMM]) are similar to the USACE low, intermediate, and high RSLC scenarios. The low scenario assumes that salt marsh accretion keeps pace with RSLC and wetland area would be similar to existing conditions. This is used as the baseline to determine losses under the intermediate and high SLC scenarios. Table 25 provides changes in wetlands and other landcover types based on modeling under low, intermediate, and high SLC scenarios (Clough et al. 2014). Eventually, RSLC may cause estuarine and freshwater wetlands to retreat inland (USACE 2017). However, wetland retreat may not be possible in a lot of locations due to exiting heavy development and structures that would halt this process.

3.5.3 Vegetation

3.5.3.1 Submerged Aquatic Vegetation

Seagrass populations in the study area would continue to decline in the FWOP Condition unless significant interventions were implemented (as described under Water Quality). Climate change and RSLC introduce greater uncertainty of continued trends where changes in temperature, precipitation, flooding patterns, along with chemical changes, could impose synergistic effects on the NCBB water quality, algal blooms, and SAV/macroalgae distribution and abundance. Additionally, sea level rise could potentially impact seagrass beds as increasing water depths will result in reductions in light penetration, photosynthesis, and productivity (USACE 2014b).

The South Shore Estuary is the shallowest area where seagrasses are found in New York State, and populations in this area are susceptible to RSLC and increased water temperatures from climate change. The proliferation of docks and hardened shorelines in response to sea level rise will decrease seagrass coverage further by preventing migration and shading seagrass habitat (NYS Seagrass Task Force 2009, USACE 2014b).

3.5.3.2 Upland Vegetation

In the FWOP Condition approximately 1,241 acres of undeveloped dry land would be lost under an intermediate sea level rise scenario and 5,087of undeveloped dry land a would be lost under a high sea level rise scenario during the 2030 - 2080 study period.

3.5.4 Terrestrial and Aquatic Wildlife

3.5.4.1 Terrestrial

In the FWOP Condition changes to wildlife are expected as described in the Affected Environment section. RSLC, as projected, has the potential to adversely affect wildlife species by causing losses of irregularly flooded marshes, freshwater wetlands, and some upland habitats. In locations where marshes and transitional areas have room to migrate, conversions of irregularly flooded marshes to regularly flooded marshes and regularly flooded marshes to intertidal mudflats may not necessarily adversely affect the species that depend on these habitats, because these conversions may more or less offset each other. However, irregularly flooded marshes, regularly flooded marshes, and intertidal mudflats and beaches that abut hardened shoreline structures in the back bays may be lost and converted to subtidal open water due to the inability of these habitats to retreat against a hardened shoreline. Conversion of intertidal mudflats and sandy shorelines to open water may have impacts on bird species.

The extensive shallow water habitat and tidal flats along Long Island's southern shoreline are a diverse and productive ecosystem that are heavily used as nursery and foraging habitat by many species of shorebirds, raptors, colonial waterbirds and waterfowl. If shoreline waters become too deep for foraging on these flats, migrating shorebirds could have insufficient foraging areas to support their long-distance migrations (Titus and Strange 2008). USFWS scientists have asserted that loss or degradation of key sites could devastate shorebird populations as populations utilize few areas during migration (Titus and Strange 2008, USACE 2014b). For example, the network of salt marsh and dredge material islands in the Hempstead Bay–South Oyster Bay complex are important for nesting by herons, egrets, and ibises (Titus and Strange 2008, USACE 2014b).

3.5.4.2 Aquatic

Existing conditions and trends for aquatic resources would persist under the FWOP Condition. Climate change and RSLC introduce greater uncertainty of continued trends where changes in temperature, precipitation and flooding patterns, along with chemical changes, could impose synergistic effects on the NCBB water quality (salinity, nutrients, DO) and algal blooms, which could adversely impact fish and shellfish habitat. Changes in salinity and flow patterns could disrupt migratory fish patterns, recruitment of fish and shellfish, and predator and forage distribution. Some fish such as Atlantic silverside, mummichog, and bay anchovy, as well as commercial species that prey on these species or that also use marsh as spawning, nursery, or foraging habitat could benefit from SLC as high marshes along protected shorelines convert to low marsh, with increased tidal flooding and a deepening and widening of tidal creeks. However, continued RSLC may adversely affect these species in marshes along hardened shorelines that convert to open water by decreasing protection from predators, nursery habitat and foraging areas (USACE, 2014).

Reductions in SAV/seagrass would have similar impacts on fisheries. The global importance of seagrasses as essential habitat for fish and invertebrates has been established for decades (Heck et al. 1997 as cited in USACE 2014b). Their ecosystem contributions include nutrient cycling, reductions in flow regimes and particulate removal, sediment stabilization and reduced erosion, and dissipation of storm energy to coastal communities (USACE 2014b). The importance of eelgrass beds in the south shore estuary has been documented for the productivity of fisheries resources, in a study where 23 of 40 recorded fish species clearly preferred naturally vegetated bottom to unvegetated areas (Briggs and O'Connor 1971 as cited in Titus and Strange 2008). Additionally, SAV and macroalgae are designated as habitat area of particular concern for summer flounder.

Shellfisheries which depend on tidal flats for habitat, including soft clam, northern quahog (hard clam), bay scallop, and blue mussel, would lose habitat under the intermediate SLC scenario. Under the high SLC scenario, habitat for these species would increase (Titus and Strange 2008).

Existing conditions for invertebrates (as described in the Affected Environment section) and continuation of existing trends would continue under the FWOP Condition without interventions. Climate change and RSLC introduce greater uncertainty of continued trends where changes in temperature, precipitation and flooding patterns, along with chemical changes, could impose synergistic effects on the NCBB water quality (salinity, nutrients, DO) and algal blooms, which could adversely impact benthic invertebrate communities and cause shifts in benthic community structure (diversity, abundance, etc.). RSLC is not expected to have significant effects on benthic invertebrates inhabiting subtidal habitat as this habitat would likely increase. Permanent losses of intertidal mudflats, sandy beaches, regularly flooded and irregularly flooded marshes due to RSLC are more likely to affect the invertebrates that inhabit these areas through their entire lifecycle as well as those that depend on these habitats for a portion of their life cycle such as spawning horseshoe crabs (Titus and Strange 2008).

3.5.5 Protected Resources

In the FWOP Condition, changes to Federal and State listed threatened and endangered species are likely. Climate change and RSLC may exacerbate conditions for some of these species. The loss of estuarine beach habitat associated with RSLC may contribute to loss of intertidal foraging habitat critical for red knots by converting them to open water. For piping plovers and seabeach amaranth, RSLC may directly impact beach habitats in areas where beach erosion is persistent, while at the same time beach migration and overwash are curtailed by human development which limits available nesting and foraging habitat. Continued implementation of beach nourishment projects may lessen this effect when implemented in accordance with measures to protect this species. Seabeach amaranth is highly susceptible to the effects of RSLC but has survived episodic sea level rise in the past (Cooper et al. 2005 as cited in USACE 2014a; USFWS 1996). The Federally threatened eastern black rail favors high marsh/irregularly flooded habitats for nesting and would experience significant losses due to conversion to low marsh habitat. RSLC could also affect freshwater wetland systems by making them more vulnerable to saltwater intrusion, especially from major storm events that may push saline water further into freshwater systems. NMFS (2014) considered the effects of climate change on Atlantic sturgeon, and concluded that projections of rising sea temperatures of 3-4^{o} C by 2100 could, "over the long term, affect Atlantic sturgeon by affecting the location of the salt wedge in rivers, distribution of prey, water temperature and water quality. However, there is significant uncertainty, due to a lack of scientific data, on the degree to which these effects may be experienced and the degree to which Atlantic sturgeon will be able to successfully adapt to any such changes." NMFS (2014) further concludes that for sea turtles, "the temperature changes are unlikely to be enough of a change to contribute to shifts in the range or distribution of sea turtles even though, theoretically, it is expect that as waters in the action area warm, more sea turtles could be present or sea turtles could be present for longer periods of time." Additionally, it is uncertain that long-term habitat changes to SAV beds would have any indirect effects on species like green sea turtles that venture into the shallow areas to feed on marine algae and eelgrass.

3.6 Cultural Resources

Climate change-driven RSLC and the potential for more frequent coastal storms, are expected to continue over the next 50 years and into the future in the FWOP Condition. Predicted climate change impacts, such as erosion of beaches and extended storm surge inundation would continue and worsen over time. Climate change and associated RSLC would increase the depth and extent of storm surge inundation, as well as increase potential for more frequent nuisance flooding and increase the depth of water during nuisance flood events. It would be expected that RSLC and coastal storms would continue to increase along with population growth in the APE, potentially impacting historic properties.

As sea level continues to rise and inland marshes and barrier islands erode or subside, cultural resources existing on them or behind them could be exposed to the elements or inundated, putting them at a greater risk of damage or destruction. Resources could also be adversely impacted over time by an increased risk of storm damage. Cultural resources would continue to be affected in coastal areas where there is no protection against storm events (USACE 2014b). Effects upon historic properties would be cumulative and are expected to continue over time without further action or project implementation. Additional historic properties and archaeological sites would potentially be added to the county database with new investigations associated with future development and with buildings and structures reaching 50 years of age.

3.7 Recreational Resources

Under the FWOP Condition, water-based recreation activities are not expected to change significantly even with climate change and RSLC. However, RSLC may increase vulnerability of land-based recreational facilities such as athletic fields to flooding. RSLC would subject the communities in the study area to increased vulnerabilities to coastal storms, and thus, any damages experienced by the communities from coastal storms would result in temporary and possibly long-term degraded tourism opportunities. Lesser known would be the potential for indirect losses of ecotourism opportunities resulting from diminishing wetland habitats due to RSLC.

3.8 Aesthetics

With no action, RSLC would subject the communities in the study area to increased vulnerabilities to coastal storms, and thus, any damages experienced by the communities from coastal storms would result in temporary and possibly long-term degraded aesthetics.

3.9 Socioeconomic Conditions

The FWOP Condition would leave the communities within the study area more vulnerable to coastal storm risks from storm surge, inundation, and future economic damages. Coastal storm risks coupled with RSLC have the potential to devastate communities, tourist areas, associated transportation, commercial, industrial, health–related and educational activities. Low-lying areas would be increasingly susceptible to flooding, making these locations inaccessible at times to residents and visitors. It is expected that some localized measures (structural or non-structural) would be implemented by residents, businesses, local municipalities or at the state level to mitigate flooding. However, areas left unprotected over time may be uninhabitable following a major storm event or recurrent flooding.

3.10 Navigation

Under the FWOP Condition, it is anticipated that navigational use within the study area would not change.

4.0 Formulation and Evaluation of Alternative Plans

4.1 Plan Formulation Synopsis

A CSRM plan for the NCBB study area has been developed to address the previously identified (Chapter 1) problems, opportunities, study objectives and avoid the constraints where possible. Plan formulation has focused on meeting the Federal objective of water resources project planning which is to contribute to NED consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements. Plan formulation also considers the effects to each of the four evaluation accounts identified in the Principles and Guidelines (ER 1105-2-100) which include the NED, RED, EQ, and OSE. The four Planning Criteria including effectiveness, efficiency, acceptability and completeness identified in the Principles and Guidelines (ER 1105-2-100) were also considered in plan formulation.

The NCBB study is guided by the principle of iterative planning, which encourages risk-informed decision making and the appropriate levels of detail for each round of alternative formulation. The Principles and Guidelines (ER 1105-2-100) 6-step planning process is integrated throughout the study process, including the following steps:

- Step 1 – Identifying Problems and Opportunities

- Step 2 – Inventorying and Forecasting Conditions
- Step 3 – Formulating Alternative Plans
- Step 4 – Evaluating Alternative Plans
- Step 5 – Comparing Alternative Plans
- Step 6 – Selecting a Plan

The focused array of alternative plans identified as part of this DIFR-EIS is consistent with the findings and recommendations of the NACCS. The NACCS risk management framework is 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 sustainable coastal landscape systems that take into account, future sea level and climate change scenarios wherever possible. The process used to identify the focused array of alternative plans herein utilized the NACCS framework that included evaluating alternative solutions and also considering future sea level change and climate change.

4.2 Management Measure Summary

The NACCS full array of CSRM measures was used as the starting point for this study. Although many of the categories generally correspond to standard CSRM strategies, specific applications are not constrained to the usual solutions. Opportunities for innovative designs, technologies, materials, and combinations of standard measures are expected to be key to managing coastal risks and promoting resilience.

No actions to reduce storm damage to the study area will result in $1 billion in storm damages over the 50 year period of analysis.

4.2.1 Overview of Potential CSRM Measures

The No Action plan provides no additional measures to provide CSRM in the study area. The No Action plan represents the FWOP Condition against which alternatives plans will be evaluated. No actions to reduce storm damage to the study area will result in $1 billion in storm damages over the 50 year period of analysis.

4.2.1.1 Non-Structural Measures

Non-structural CSRM measures are divided into two primary categories, physical and non-physical. Physical non-structural measures include: buyout/acquisition, dry flood proofing, wet flood proofing, elevation and relocation. Non-physical non-structural measures include: evacuation plans, flood emergency preparedness plans, floodplain mapping, land use regulation, risk communication, zoning, flood Insurance and flood warning systems. A detailed discussion of each type of non-structural measure is provided in the Plan Formulation Appendix (Appendix A).

4.2.1.2 Structural Measures

Structural measures considered during this study include: floodwalls (permanent, deployable or crown walls), levees, bulkheads, storm surge barriers (inlet surge barriers and cross bay barriers), beach nourishment, seawalls and revetments. Structural measures are intended to physically limit flood water inundation from causing damage. The Plan Formulation Appendix (Appendix A) provides a detailed discussion of each each type of structural measure considered.

4.2.1.3 Natural and Nature-Based Features

Natural Features are created and evolve over time through the actions of physical, biological, geologic, and chemical processes operating in nature. Natural coastal features take a variety of forms, including reefs (e.g., coral and oyster), barrier islands, dunes, beaches, wetlands, and maritime forests. The relationships and interactions among the natural and built features comprising the coastal system are important variables determining coastal vulnerability, reliability, risk, and resilience. Conversely, nature-based features are those that may mimic characteristics of natural features, but are created by human design, engineering, and construction to provide specific services such as CSRM. The built components of the system include nature-based and other structures that support a range of objectives, including erosion control and storm risk management, as well as providing economic and social functions. NNBF considered during this study include: living shorelines, reefs, wetland restoration, submerged aquatic vegetation (SAV) restoration and green stormwater management. Each NNBF measure is discussed in greater detail in the Plan Formulation Appendix (Appendix A).

4.3 Formulation of Management Measures in the Study Area

Based on the aforementioned planning constraints, including but not limited to the extensive CBRA System Unit, the USACE formulated the study to focus on more complete, effective, efficient, and acceptable measures that would improve CSRM in the study area. Specifically, the feasibility study focused on critical infrastructure and HVAs in Nassau County, NY with an overall study goal to promote resilience and sustainability of communities in the study area by reducing risk to life safety and reducing potential structure/content damage while allowing solutions to be adaptable to RSLC.

The study utilized data from the NACCS, which ranked the value and density of critical infrastructure in Nassau County. Per the NACCS, the Department of the Army Field Manual (FM) 3-34.170 was utilized to rank infrastructure that supports populations and communities. The sewage, water, electricity, academics, trash, medical, safety and other considerations (SWEAT-MSO) assessment process provided immediate feedback concerning the status of the basic services necessary to sustain population, as detailed in the FM. The SWEAT-MSO assessment represents a complete evaluation of assets susceptible to direct exposure from storm damage as well as the indirect damages that would follow by identifying the assets within and support to a community. In addition, Average Annual Damage (AAD) outputs from Hydrologic Engineering Center-Flood Damage Reduction Analysis (HEC-FDA) were evaluated and mapped to identify highly vulnerable areas (HVAs) with a high AAD potential.

Based on this analysis, four HVAs (encompassing approximately 29% of the study area) with a combination of dense critical infrastructure and high AAD (and little or no geographic overlap with the CBRA System Units) were identified: The Village of Freeport, Oceanside & East Rockaway Villages, Island Park Village and City of Long Beach.

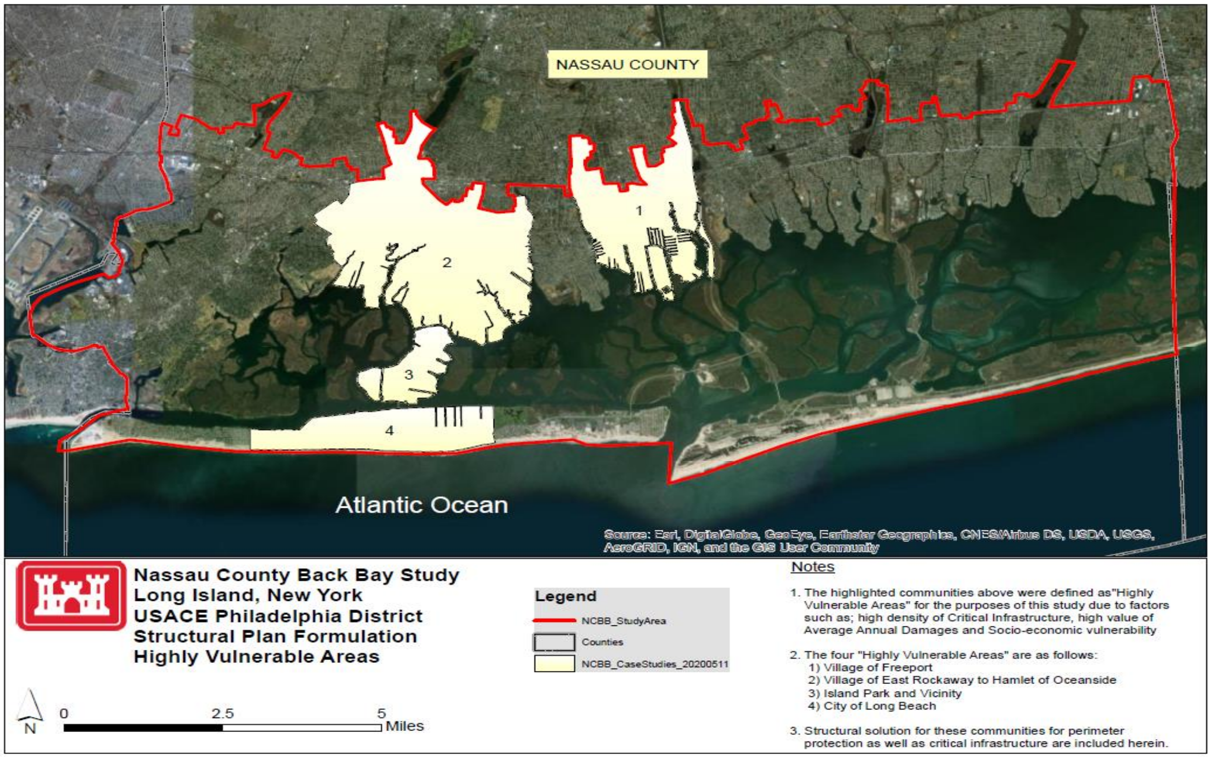


Figure 34 - Highly Vulnerable Areas in Nassau County

The highly urbanized (and in some cases industrial) HVAs were less constrained by the presence of the CBRA System Unit, when compared to the rest of the study area; therefore, structural, non-structural and NNBF measures were formulated in these areas. While the formulation in the remainder of the County was more constrained, the USACE was still able to formulate extensive non-structural and NNBF measures in these areas, as well as localized structural measures.

4.4 Initial Management Measure Screening

Initially, all measures were compared against the study objectives to see if they were in line with the study purpose. In order for measures to be carried forward for further analysis, they must have met at least two of the three study objectives (Table 26).

Table 26 - Objectives/Measures Matrix

Management Measure	**Objective 1:** Manage potential life loss related to coastal flooding in the study area through 2080.	**Objective 2:** Manage the risk of coastal storm damage to public infrastructure & important societal resources, as well as highly vulnerable portions of Nassau County through 2080.	**Objective 3:** Contribute to the long-term sustainability & resilience of coastal communities in Nassau County through 2080.	**Management Measure Carried Forward for Further Analysis (Y/N)?**
Non-Structural				
Buyout/Acquisition	X	X	X	Y
Dry Flood Proofing	X	X	X	Y
Wet Flood Proofing	X	X	X	Y
Elevation	X	X	X	Y
Relocation	X	X	X	Y
Evacuation Plans	X	X	X	Y
Flood Emergency Preparedness Plans	X	X	X	Y
Floodplain Mapping	X	X	X	Y
Land Use Regulation	X	X	X	Y
Risk Communication	X	X	X	Y
Zoning	X	X	X	Y
Flood Insurance	X	X	X	Y
Flood Warning Systems	X	X	X	Y
Structural				
Floodwalls	X	X	X	Y
Bulkheads				N
Storm Surge Barriers	X	X	X	Y
Levees	X	X		Y
Beach Nourishment*	X	X	X	Y
Seawalls	X	X	X	Y
Revetments	X	X	X	Y
NNBF				
Living Shorelines	X	X	X	Y
Reefs	X	X	X	Y
Wetland Restoration	X	X	X	Y
SAV Restoration	X	X	X	Y
Green Stormwater Management			X	N

**Also may be considered as NNBF management measure*

Non-Structural Measures. Each non-structural measure type has a varying level of CSRM function/adaptive capacity. Because each non-structural measure potentially reduces risk to life safety and structure content/damage and ultimately increases community resilience, each non-structural measure was initially carried forward for further analysis.

Structural Measures. During the initial stages of measure screening, the USACE determined that storm surge barriers (inlet barriers and interior bay surge barriers) met all the planning objectives. Floodwalls (permanent, deployable, crown walls) and levees were also carried forward because they met two of three planning objectives, including reducing risk to life safety and reducing structure/content damage in Nassau County.

Seawalls, revetments and beach nourishment were all carried forward because they met each of the planning objectives. Specifically, seawalls were considered potentially applicable to low lying areas, such as beaches, that are still susceptible to waves and erosion. In addition, seawalls were also considered to potentially tie storm surge barriers into high ground or existing adjacent oceanfront projects. Revetments are sloped structures that help mitigate shoreline erosion. Beach nourishment was possibly applicable at existing beach locations to reduce risk related to storm surge flooding, waves, and erosion.

During the initial stage of screening, bulkheads were the only structural measures that were not carried forward for further analysis because bulkheads (unlike floodwalls and levees) are generally constructed at or near the existing grade and CSRM is of secondary importance.

Natural and Nature-Based Features (NNBF). Four (living shorelines, reefs, wetland restoration, SAV restoration) of the five NNBF measures were initially carried forward for further analysis because they met each of the objectives. The USACE recognizes that land development and traditional stormwater infrastructure has altered the historic interaction between surface water and groundwater. However, while green stormwater infrastructure can increase infiltration, improve water quality and capture the "first flush" from frequent storm events, it is not as efficient and effective at providing a large volume or peak flow rate reduction. These particular measures do not typically store large volumes of runoff and effectively mitigate potential life loss and damages for less frequent storm events; therefore, they were not carried forward for further analysis.

Living shoreline creation involves the placement of sand, planting marsh flora, and if necessary, construction of a rock structure on the shoreline or in the near shore (VIMS 2013 as cited in USACE 2015a). Per the NACCS, living shoreline materials may include sand fill, clean dredged material, tree and grass roots, marsh grasses, mangroves, natural fiber logs, concrete, filter fabric, seagrasses, etc. (Maryland DNR 2007 as cited in USACE 2015a). They are generally applicable to relatively low current and wave energy environments in estuaries, rivers and creeks. Reefs can enhance the resilience of coastal areas by reducing the degradation and shoreline erosion that would occur during a storm event. Reef sites may be developed using natural materials such as oyster shells, clam shells, or rock. Wetlands can increase shoreline resiliency by contributing to coastal CSRM wave attenuation and sediment stabilization. The magnitude of these effects depends on the specific characteristics of the wetlands, including the type of vegetation, its rigidity and structure, as well as the extent of the wetlands and their position relative to the storm track. Sandy sediment is preferred in wetlands so that plant roots develop more effectively; however, wetlands can contain a higher percentage of fines than the beach region in front of them. SAV can also increase shoreline resiliency by contributing to CSRM via wave attenuation and shoreline buffering by stabilizing sediments with plant roots.

4.5 Additional Management Measure Screening

As referenced above, seawalls, revetments and beach nourishment were originally carried forward because they met each of the planning objectives; however, further analysis indicated that these measures did not avoid all the planning constraints. Specifically, these measures would likely be formulated within the limits of a CBRA System Unit, as the USACE intended to evaluate these measures along the open ocean coast. That being said, they have been eliminated from further consideration and will not be evaluated within the back bay environment of Nassau County, as they are typically more effective at providing CSRM benefits in high wave energy and erosive environments analogous to the open ocean coastline. Further, within the back bay environment the USACE determined that floodwalls and levees provide a more efficient approach to CSRM as they do not have the potential real estate and environmental impacts associated with seawalls and revetments. Also, beach nourishment is generally more applicable at existing beach locations (i.e. the open ocean coastline) to reduce risk related to storm surge flooding, waves, and erosion.

4.5.1 Storm Surge Barrier Measures

Storm surge barriers (inlet barriers and interior bay surge barriers) met each of the planning objectives and were modeled by the USACE Engineer Research and Development Center (ERDC) with various combinations to evaluate their effectiveness in this study area. It is important to note that there are two principle processes that are responsible for back bay flooding in the NCBB study area: storm surge propagation through tidal inlets (East Rockaway Inlet, Jones Inlet and Fire Island Inlet) and local wind-driven storm surge along the east-west bay axis. As a result, four inlet barrier/interior bay surge barrier combinations were evaluated and modeled.

- Combination 1A – This combination included three storm surge barriers at each of the three inlets.
- Combination 1B, 1C and 1D – The three additional storm surge barrier/interior bay surge barrier combinations added differing locations of interior bay surge barriers to reduce flooding from the local wind-driven surge along the bay.

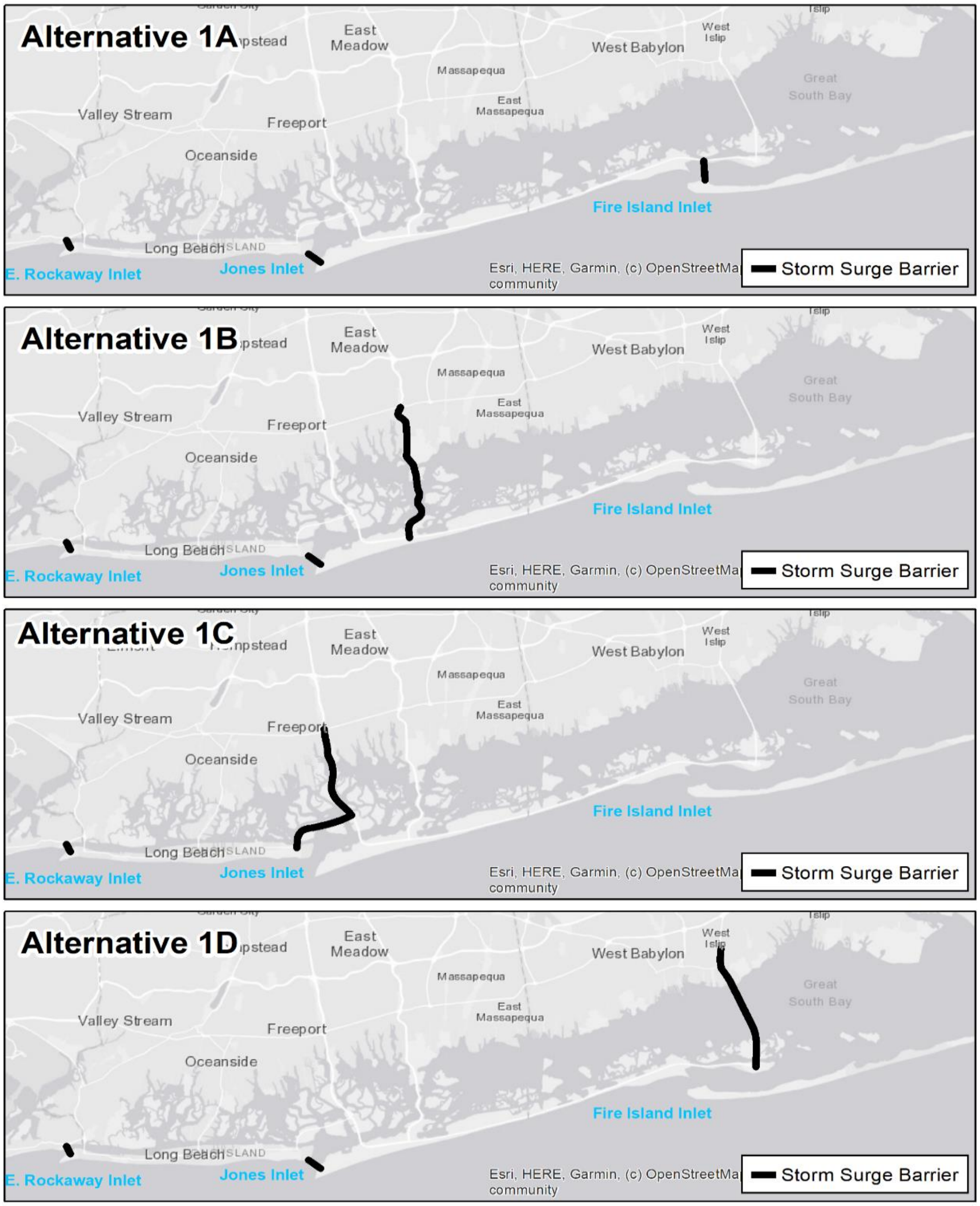


Figure 35 - Storm Surge Barrier Combinations

Model results for Combination 1A indicated that inlet surge barriers alone were only able to reduce the 1% AEP water elevation by approximately one foot, from 10 feet NAVD88 to 9 feet NAVD88. Even with the three inlets closed during storm events with a surge barrier, predominant winds push water in Great South Bay westward into the study area limiting the effectiveness of Combination 1A. Therefore, based on the limited water surface reduction and associated damage reduction, it is highly likely that the proposed storm surge barrier combination would have low economic efficiency when calculating net benefits.

Even with the three inlets closed during storm events with a surge barrier, predominated winds push water in Great South Bay westward into the study area limiting the effectiveness

In order to reduce the surge of water traveling from east to west across the bay, a series of interior bay surge barriers was evaluated as Combinations 1B, 1C and 1D. The model results for Combinations 1B, 1C, and 1D indicated that the combination of storm surge barriers and interior bay surge barriers was successful at reducing water elevations inside the inlet barrier/interior bay surge barrier system by 1 to 2 feet. However, outside the system, specifically east of the bay surge barriers in Great South Bay, the modeled 1% AEP water elevations increase by 2 to 4 feet over extensive areas (10 to 20 miles). An increase in water elevations is the result of local wind-driven storm surge "piling up" at the interior bay surge barriers. From an economic feasibility perspective, the increase in modeled storm damages to communities east of the interior bay surge barrier would have negated many of the damage reduction benefits within Nassau County and greatly reduced the net benefits of the storm surge barrier combinations. Additionally, inducing flooding to communities may not constitute an acceptable nor complete plan. It is also likely that the addition of expensive CSRM measures to alleviate induced flooding impacts (extending 10 to 20 miles into Great South Bay) would have further reduced economic feasibility.

These combinations were also evaluated against potential impacts to CBRA System Units managed by the US Fish and Wildlife. Combinations 1A through 1D have at least one storm surge barrier and/or interior bay surge barrier located entirely within the footprint of a CBRA System Unit. Figure 35 includes a figure of the four Combinations 1A through 1D relative to the CBRA System Unit. Eliminating storm surge barrier and/or interior bay surge barriers located in the CBRA System Units will render these storm surge barriers even less effective at reducing storm surge by severely limiting their ability to block storm surge from both of the principle processes responsible for NCBB back bay flooding. Therefore, given the limited effectiveness and efficiency of the storm surge barriers and the large geographic presence of the CBRA System Unit, the USACE screened storm surge barriers from further consideration.

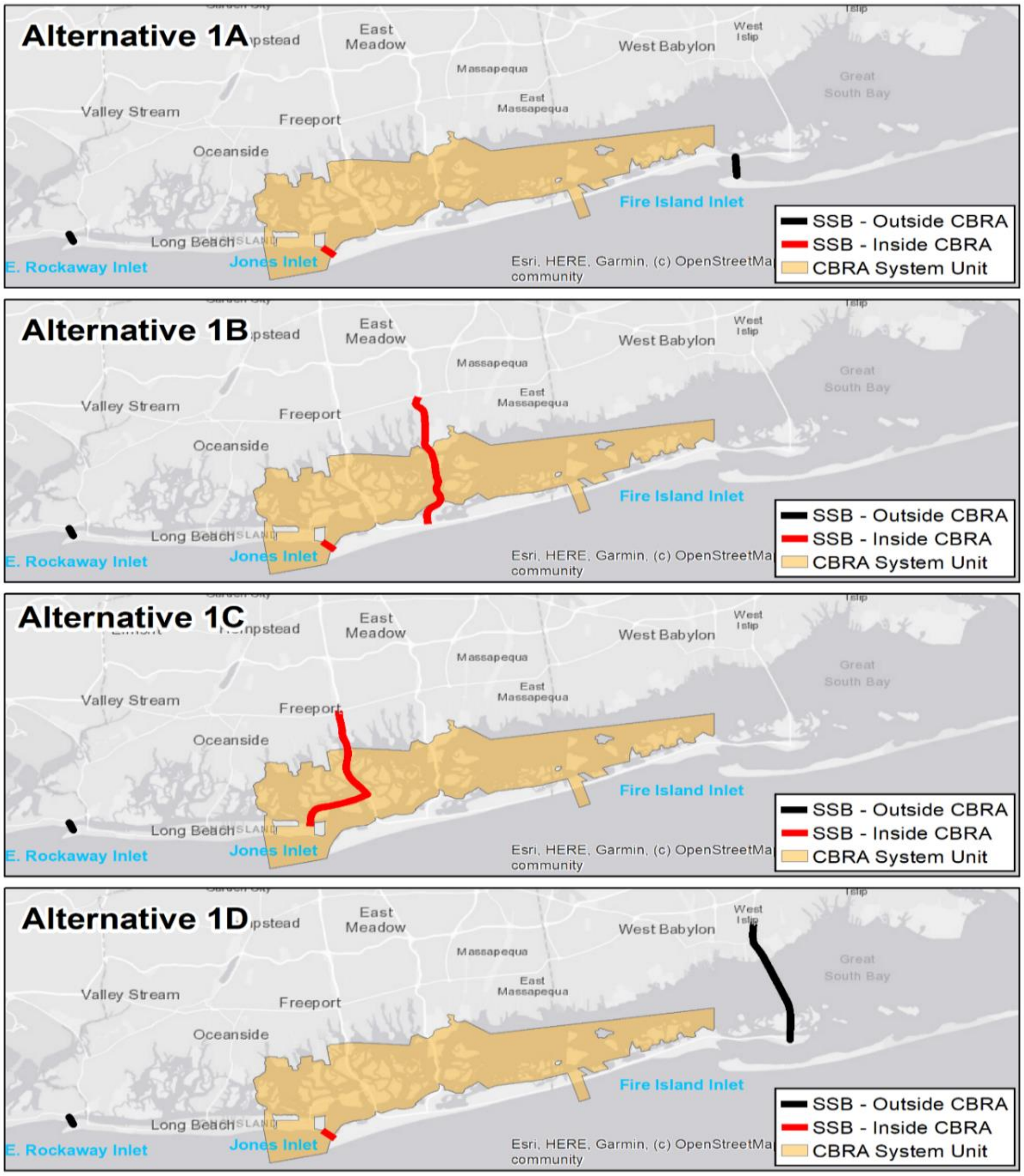


Figure 36 - Storm Surge Barrier Combinations Relative to CBRA System Unit

4.5.2 Other Structural Measures

After additional measure analysis screened out seawalls, revetments, beach nourishment and storm surge barriers, floodwalls and levees were the only structural measures carried forward for further analysis. Given the highly urbanized and in some cases industrial nature of the HVAs, comprehensive floodwalls were formulated as the primary structural measure in these areas based on their ability to reduce flood inundation without requiring a large structural footprint (as compared to other larger CSRM measures). Levees were proposed in isolated sections of the comprehensive floodwall footprints, depending on available open space and topography. In addition, localized floodwalls were formulated as complementary measures to manage risk to critical infrastructure throughout the entirety of Nassau County.

4.5.3 Non-Structural Measures

While each non-structural measure potentially reduces risk to life safety and structure content/damage and ultimately increases community resilience, at this stage of the analysis, detailed non-structural measure analysis has only been performed for elevation of residential structures and dry flood proofing of non-residential and public structures. That being said, none of the non-structural measures have been screened out at this point because they will be further analyzed during feasibility-level design to ensure a complete non-structural alternative is formulated.

4.5.4 NNBF Measures

Natural Features, such as salt marshes, have an ability to reduce wave energy and coastal erosion. Initial NNBF measure analysis utilized modeling efforts and results conducted for the New Jersey Back Bays (NJBB) CSRM feasibility study. For the NJBB study, NNBF measures were modeled as stand-alone and complementary measures to structural measures (such as storm surge barriers or floodwalls) to see if the NNBF improved the effects on water surface elevation reduction. The results indicated the majority of simulated water level reduction was attributable to the structural measures, rather than the NNBFs. The addition of NNBFs to the structural measures provided some further reductions or increases, depending on the pattern of water level response, but those changes are lesser in magnitude than those induced by the structural measures. While water level change attributable to NNBF for most of the NJBB domain was relatively modest (on the order of 4 to 12 inches with some areas up to 20 inches), for many storms, the reductions in water levels occurred over a several-hour time span. In areas protected by other structural measures such as levees or floodwalls, the duration of the reduction of peak water levels can lead to reductions in flooding due to overtopping of structures as well as the load stress by shortening the duration of the highest water levels.

Applying lessons learned from the NJBB study to the NCBB study area, NNBF was initially evaluated as a systemic approach utilizing smaller/targeted creation of NNBF where appropriate to compliment other CSRM measures. Given this approach and the presence of marsh across the study area, marsh conservation and restoration (including wetlands and SAV) showed the greatest potential as a strategy for leveraging existing NNBF to further manage flood risk within the back bay environment as a whole. In addition, the above-referenced modeling associated with the consideration of storm surge barriers illustrated the significant hydraulic impact of north/south oriented structures on wind driven water surface elevations towards the west within the study area. Along the lines of the theoretical barriers, the distribution of marsh within the study area likely reduces the east to west wind-driven flow of water across the back bays relative to their deterioration into open water. Their loss may allow greater volumes of water to accumulate as greater uninterrupted fetch was opened up.

Given the extensive distribution of marsh alongside limited resources, study-wide NNBF consideration therefore focused on determining what marshes to prioritize conserving and/or restoring. The USACE developed an approach to identify which marsh complexes to prioritize in terms of protecting. A basic index assessment approach utilized existing data to classify past wetland trends, current marsh health based on vegetation extent, and likely future tidal marsh conditions. Data utilized for the Long Island Tidal Wetlands Trends Analysis Report (NEIWPCC 2015) was used to identify portions of marsh complexes lost between 1974 and 2008. Recent calculated unvegetated to vegetated marsh ratio (UVVR) values from USGS were used assigned a range of 0 -1 as an indicator of marsh health and stability. Finally, data from Sea Level Affecting Marshes Model (SLAMM) run based on intermediate sea level change conducted for the state of New York were used to add a future element of future marsh condition. A first order analysis *of these data at the marsh complex scale used by the Long Island Tidal Wetlands Trends Analysis highlights the concentrated priority of conserving and/or restoring marsh in central study area, in between where Meadowbrook State Parkway and Wantagh State Parkway cross the bay to Jones Beach (Figure 37 -* Unweighted Index Considering Past Marsh Loss (1974 – 2008),

In addition to being along an evacuation route, this position is east of the HVAs identified by the study. If justified, further evaluation of marsh conservation and restoration in this area in order to leverage NNBF strategies will be considered during feasibility-level design and optimization.

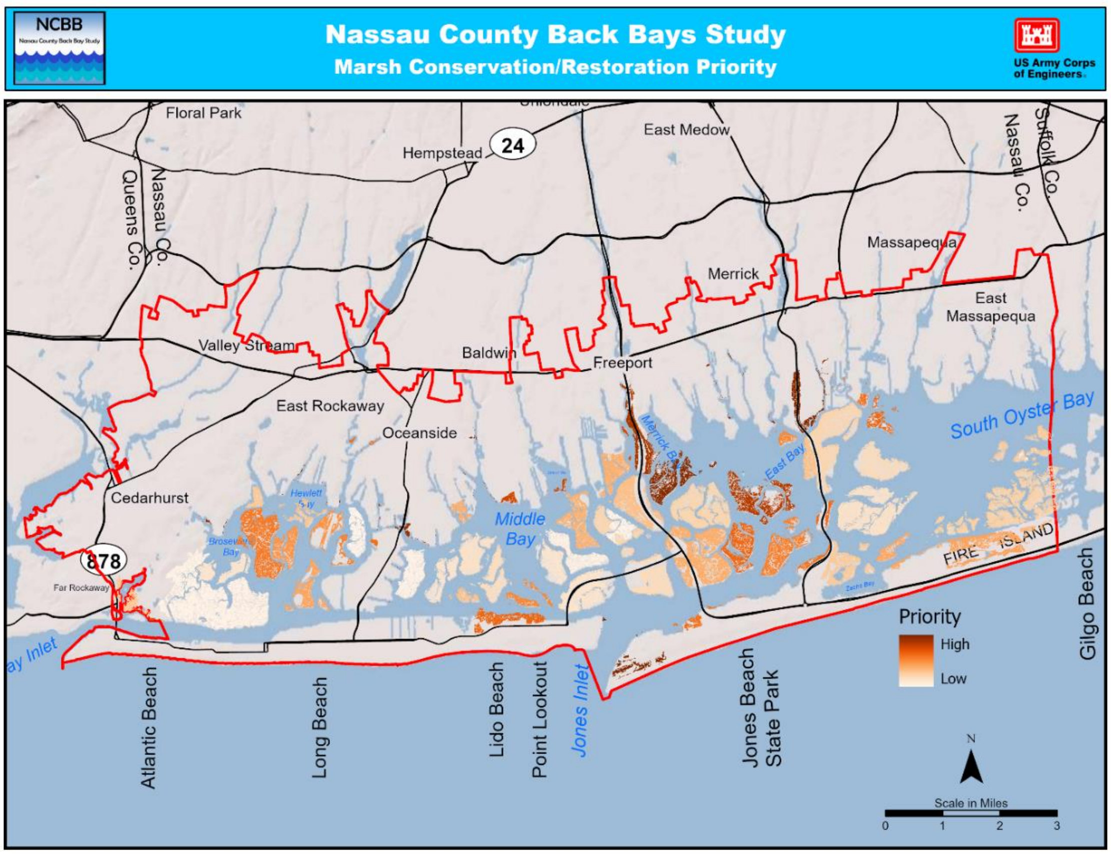


*Figure 37 - U*nweighted Index Considering Past Marsh Loss (1974 – 2008),

4.6 Alternative Development

As referenced above, floodwalls (and levees in select areas), non-structural measures and NNBF (with the exception of green stormwater infrastructure) were carried forward to develop the array of alternatives. All other structural measures; including bulkheads, storm surge barriers, beach nourishment, seawalls and revetments; were screened from further consideration.

Initially in the HVAs, alternative plan development began with the formulation of non-structural elevation of residential structures and dry flood proofing of industrial/commercial structures, as well as comprehensive floodwalls. Non-structural plans were also formulated throughout the remainder of Nassau County. NNBF features were formulated throughout Nassau County as complementary measures to be further analyzed during plan optimization.

Within the HVAs, comprehensive floodwalls were formulated with varying scales of risk management in the Village of Freeport, Oceanside & East Rockaway Villages, Island Park Village and the City of Long Beach. Based on lessons learned from the NJBB feasibility study, the USACE looked at floodwall alignments that provided risk management associated with the 5% AEP (20-year storm equivalent) and 1% AEP (100-year storm equivalent). In addition, the team also incorporated the 20% AEP (5-year storm equivalent) into the formulation to evaluate impacts related to high frequency flooding. The modeled floodwall crest elevations for the 1% AEP, 5% AEP and 20% AEP were +16 feet NAVD88, +13 feet NAVD88 and +9 feet NAVD88, respectively. It is important to note that due to the spatial variability in water levels, wave conditions and wave overtopping the required crest elevation of the floodwalls could be higher or lower than the preliminary crest elevations. The average annual net benefits (AANB) of each risk management scale were incrementally compared against each other in each HVA. The incremental analysis indicated that the risk management scale associated with the 1% AEP had the highest net benefits in each of those areas. Figure 37 provides a potential 1% AEP comprehensive floodwall alignment for the City of Long Beach; additional alignments for the highly vulnerable areas can be found in the Plan Formulation Appendix (Appendix A) as well. In addition, renderings of the potential impact of the City of Long Beach floodwall alignment are shown on Figures 38 and 39.

Figure 38 - Comprehensive Floodwall for the City of Long Beach (1% AEP Alignment)

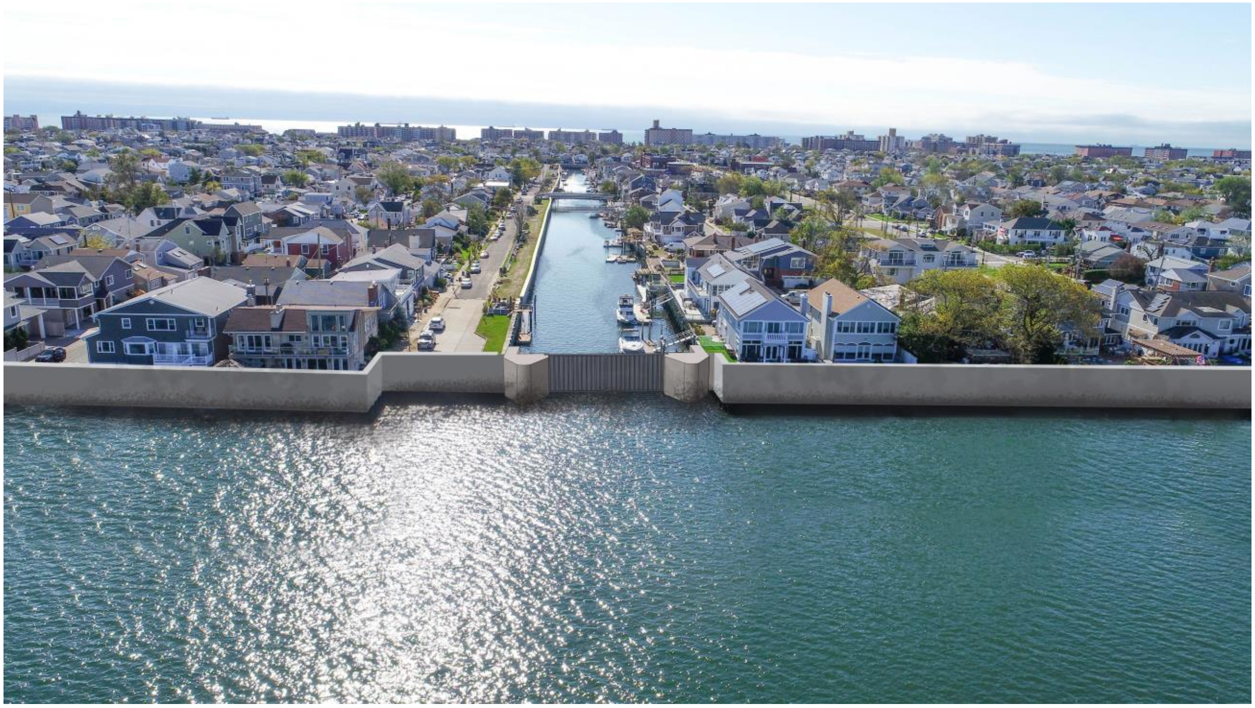


Figure 39 - Rendering of Bayside View of Floodwall Around Long Beach

Figure 40 - Rendering of Barrier Island Side View of Floodwall Around Long Beach

For the non-structural formulation, structures that had a first floor elevation (FFE) at or below the 5% AEP (predicted to occur at the end of the 50-year period of analysis – 2080) were considered at-risk structures eligible for non-structural alternatives. At this point in the study, non-structural analysis focused on the previously defined at-risk structures.

As at-risk structure threshold is dependent upon the SLC rate, non-structural alternatives were formulated for Low (Historic), Intermediate, and High SLC scenarios in accordance with ER 1100-2-8162 *Incorporating Sea Level Change in Civil Works Programs*.

The current non-structural economic analysis outlines a precautionary approach to SLC risk management. Using the Year 2080 5% AEP event stage (for each USACE SLC curve), at-risk structures are identified and elevated or flood proofed by the base year. All non-structural costs are incurred by the base year and benefits start accruing in the base year for all retrofitted structures (depending on their relative vulnerability over the period of analysis). Additionally, industrial and commercial structures are eligible based on their vulnerability to the 1% AEP flood event by the Year 2080.

For the at-risk residential structures, structure elevation was formulated to the modeled 1% AEP non-structural design water surface elevation, which includes intermediate sea level change projected to 2080. If elevation requirements are greater than 12 feet above ground level, structure acquisition and relocation would likely be considered instead because such a height introduces additional structure risk factors (i.e. hydrodynamic forces and wind). However, the combined 2080 non-structural design water surface elevation at 1% AEP with the intermediate SLR projection is not anticipated to be greater than 12 feet above ground level; therefore, it is highly likely that acquisition and relocation of residential structures will not need to be considered based on those constraints. That being said, acquisition and relocation is still being considered based on repetitive losses, value and vulnerability.

For at-risk industrial and commercial facilities, dry flood proofing, consisting of sealing all areas from the ground level up to approximately three feet of a structure, is being formulated to reduce the risk of damage from storm surge. Such dry flood proofing measures will help make walls, doors, windows and other openings resistant to penetration by storm surge waters. For example, walls may be coated with sealants or waterproofing compounds, while plastic sheeting can be placed around the walls and covered. In addition, dry flood proofing includes prevention mechanisms (such as drain plugs, standpipes, grinder pumps and back-up valves) for back-flow from water and sewer lines. Openings, such as doors, windows, sewer lines and vents, may also be closed temporarily, with sandbags or removable closures.

Recognizing that the initial non-structural formulation will inherently have residual risk, none of the other non-structural measures have been screened out at this point because they will be further analyzed during feasibility-level design to ensure a complete plan is formulated.

Localized structural floodwall alignments targeting risk management at large-scale critical infrastructure (supporting populations and communities throughout Nassau County) were also formulated to reduce residual risk and increase community resilience. While the non-structural formulation targeted all critical infrastructure in the study area, the USACE evaluated larger structural floodwalls at select large-scale critical infrastructure, based on the criteria listed below:

- Must meet Army SWEAT-MSO guidelines for critical infrastructure.
- Must fall within the 1% AEP floodplain limits.
- Risk management must maintain the functionality of the facility.
- No adverse impacts to surrounding properties/facilities.
- Cannot be within the CBRA System Unit.

Per the criteria listed above and the USACE priority to manage risk to critical infrastructure without negatively impacting the functionality of the facility and the surrounding properties, localized floodwalls were only formulated for select large-scale critical infrastructure. In many locations that were highly developed, localized floodwalls were not formulated because the USACE determined that the floodwalls would not only impact the functionality of the critical facility, but also impact other properties in terms of stormwater conveyance, property encroachment and viewshed impacts.

4.7 Focused Array of Alternatives

The development and analysis of alternatives that included structural, non-structural and NNBF measures helped shaped the focused array of alternatives that were ultimately evaluated and compared. The focused array of alternatives included the following:

1. No Action Plan
2. Non-Structural (NS) Countywide Plan
   - Elevation of 14,183 residential structures to the modeled 1% AEP non-structural design water surface elevation (which includes intermediate sea level change projected to 2080).
   - Dry flood proofing of 2,667 industrial and commercial (non-residential) structures from the ground surface up to 3 feet above ground.

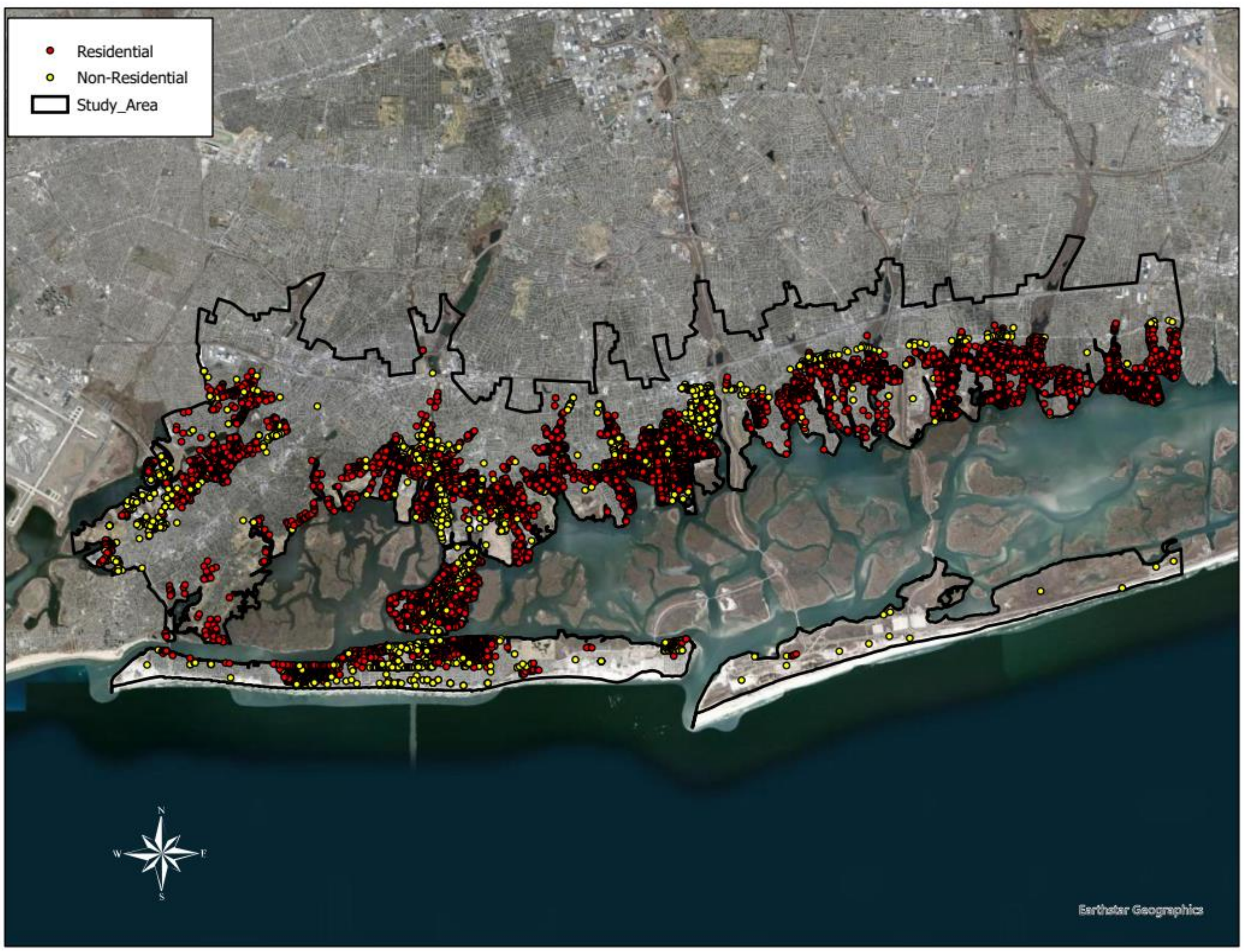


Figure 41 - Non-Structural Countywide Plan

3. Comprehensive Structural Highly Vulnerable Area (HVA) & NS Plan
    - Comprehensive Floodwall at the City of Long Beach
        - 46,400 linear feet of floodwall construction at elevation +16 feet NAVD88
        - Floodwall Type – Type B & Type C

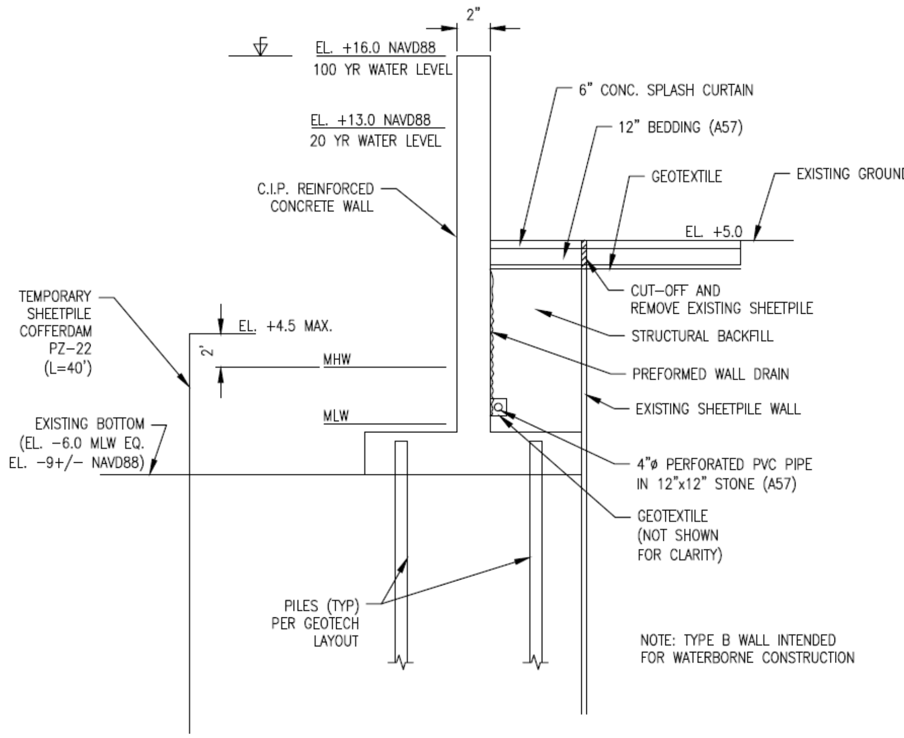


Figure 42 - Typical Section - Concrete Cantilever Wall on Piles - Type B

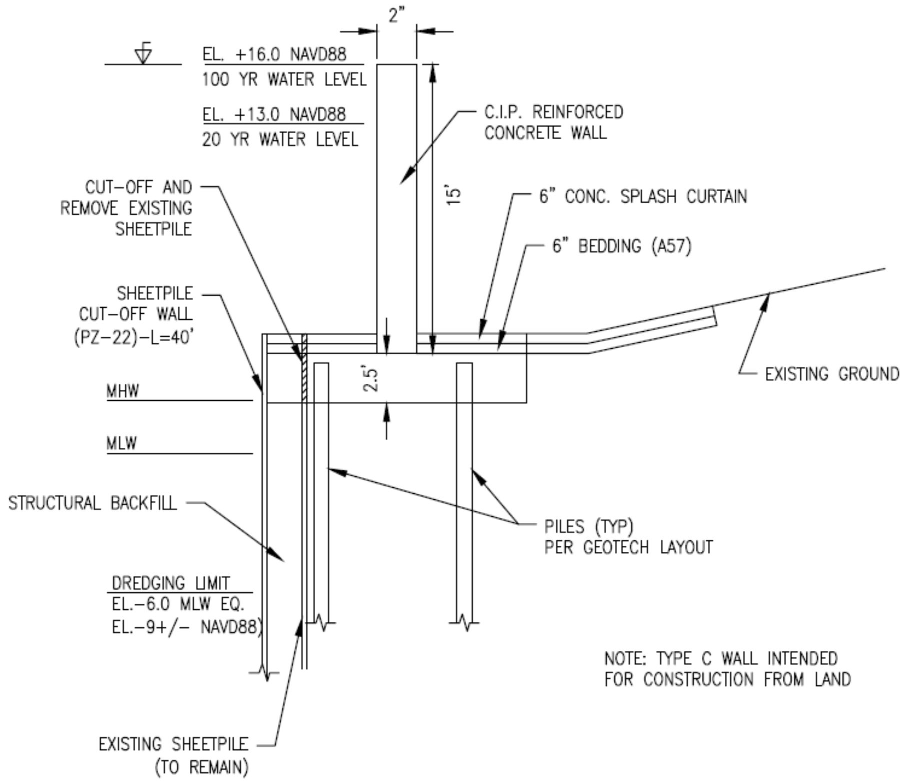


Figure 43 - Typical Section - Concrete Cantilever Wall on Piles - Type C

    - 5 miter gates at elevation +16 feet NAVD88
    - 4 road & 1 rail closure gate at elevation +16 feet NAVD88
  - Elevation of 12,251 residential structures to the modeled 1% AEP non-structural design water surface elevation (which includes intermediate sea level change projected to 2080).
  - Dry flood proofing of 2,140 industrial and commercial structures from the ground surface up to 3 feet above ground.
4. Localized Structural Critical Infrastructure (CI) & NS Plan
  - Elevation of 14,159 residential structures to the modeled 1% AEP non-structural design water surface elevation (which includes intermediate sea level change projected to 2080).
  - Dry flood proofing of 2,427 industrial and commercial structures from the ground surface up to three feet above ground.
  - Protection of evacuation routes: Evacuation routes were evaluated as a critical facility within the “Other” category of the SWEAT-MSO guidance. Figure 44 shows the four (4) major evacuation routes within Nassau County. Portions of Evacuation Routes No. 1 and No. 4 that were within the 1% AEP floodplain are presented for consideration for a localized floodwall.

Figure 44 - Nassau County Evacuation Routes

a. Far Rockaway

- Localized floodwall around Evacuation Route No. 1 (Far Rockaway, NY) (Figure 45):
  - 7,000 linear feet of floodwall construction at elevation +16 feet NAVD88
  - Floodwall Type – Type C
  - 4 road closure & 1 sluice gate at elevation +16 feet NAVD88

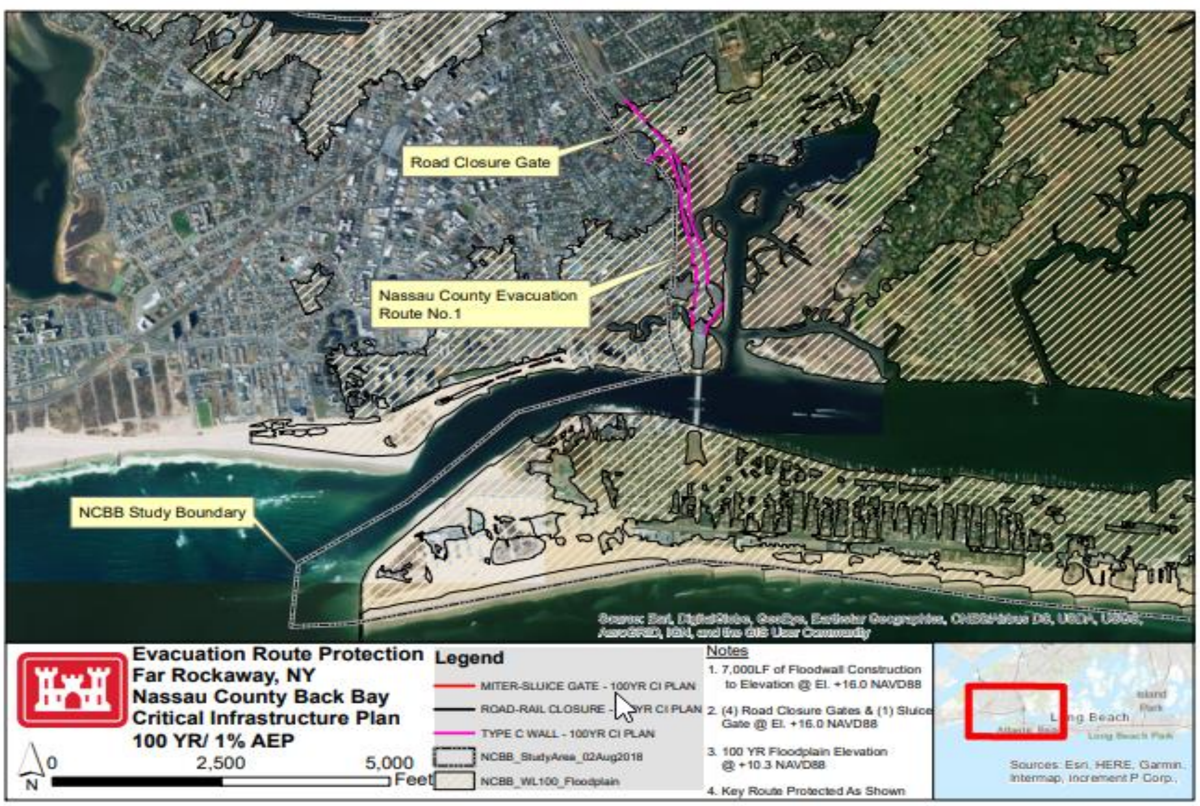


Figure 45 - Localized Floodwall for Evacuation Route No. 1

b. Village of Freeport

- Localized floodwall around critical infrastructure in the Village of Freeport (Figure 46)
  - 12,250 linear feet of floodwall construction at elevation +16 feet NAVD88
  - Floodwall Type – Type B & Type C
  - 3 road closure gates at elevation +16 feet NAVD88

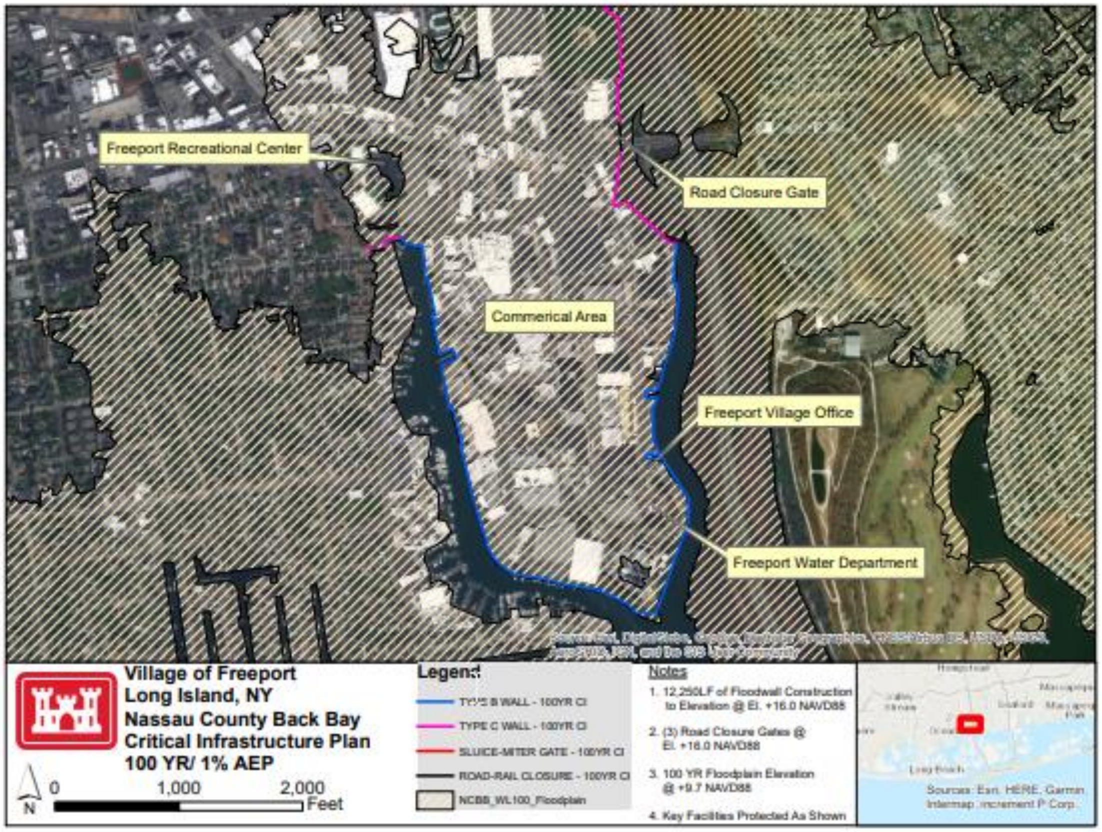


Figure 46 - Localized Floodwall for the Village of Freeport

c. Island Park

- Localized floodwall around critical infrastructure in Island Park & Vicinity (Figure 47)
  - 6,950 linear feet of floodwall construction at elevation +16 feet NAVD88
  - Floodwall Type – Type C
  - 2 road closure gates at elevation +16 feet NAVD88
  - 2 sluice gates at elevation +16 feet NAVD88

Figure 47 - Localized Floodwall for Island Park & Vicinity

d. City of Long Beach
   - Localized floodwall around critical infrastructure in the City of Long Beach (Figure 48)
     - 10,280 linear feet of floodwall construction at elevation +16 feet NAVD88
     - Floodwall Type – Type C
     - 3 road & 1 rail closure gates at elevation +16 feet NAVD88

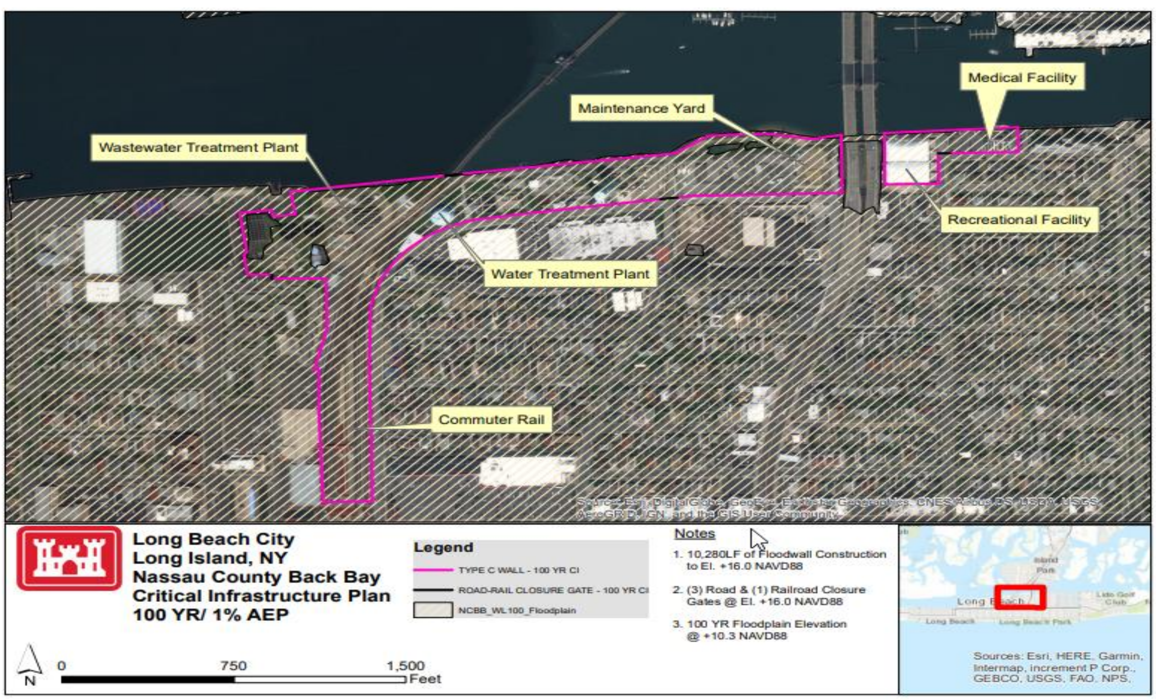


Figure 48 - Localized Floodwall in the City of Long Beach

The three localized floodwalls discussed above were formulated in the HVAs and preliminary cost/benefit analysis was conducted for them. However, the USACE did not limit localized floodwall for critical facilities just to HVAs. The team reached out to the Non-Federal Sponsor and coordinated a site visit to identify any additional areas that would meet the established criterion. From that visit, the Cedar Creek Wastewater Treatment Plant (WWTP) in Wantagh, NY was identified as another location.

e. Hamlet of Wantagh
    - Localized floodwall around Cedar Creek Wastewater Treatment Plant (Figure 49)
        - 6,000 linear feet of floodwall construction at elevation +16 feet NAVD88
        - Floodwall Type – Type C
        - 1 road closure gate at elevation +16 feet NAVD88

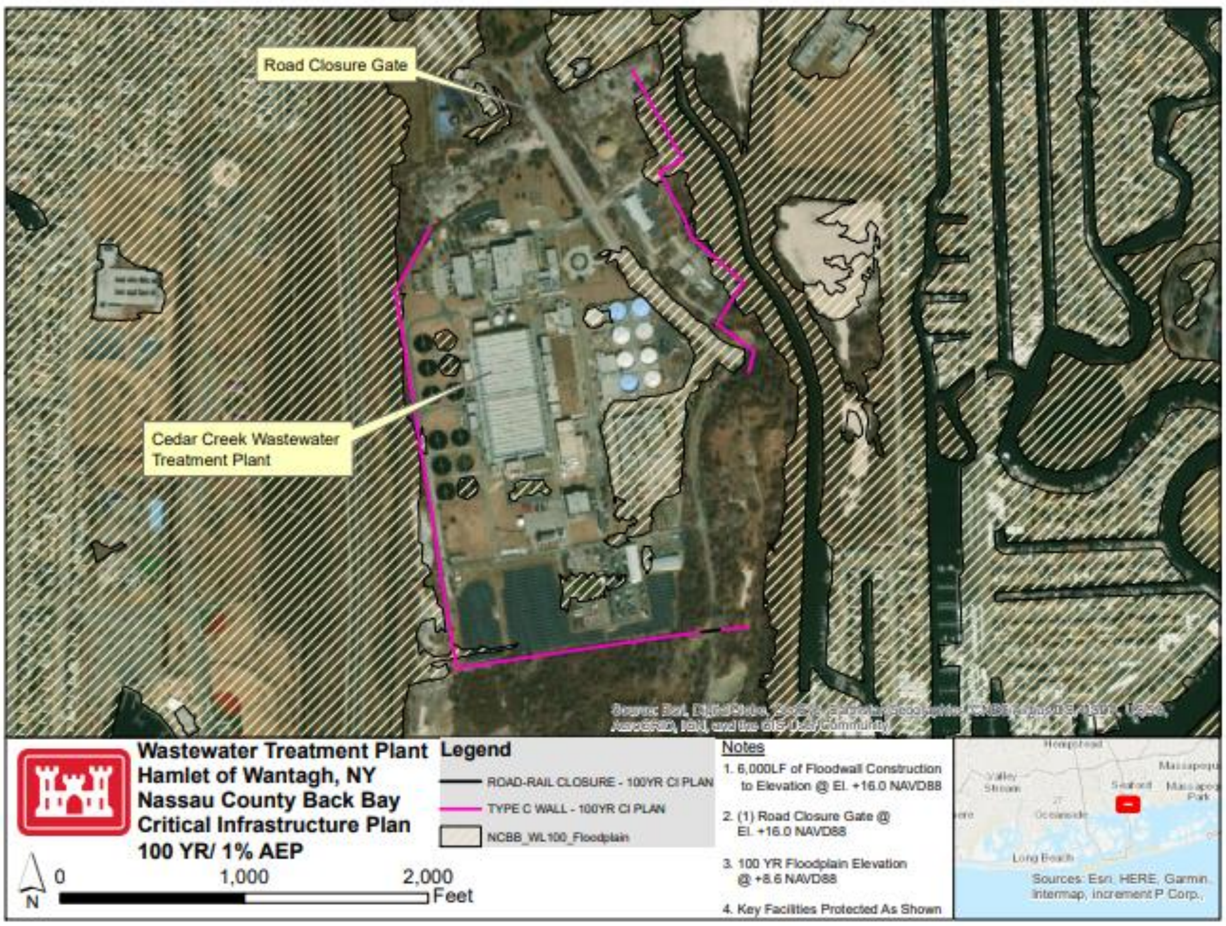


Figure 49 - Localized Floodwall for Cedar Creek Wastewater Treatment Plant

- Localized floodwall around Evacuation Route No. 4 (Figure 50)
    - 800 linear feet of floodwall construction at elevation +16 feet NAVD88
    - Floodwall Type – Type C

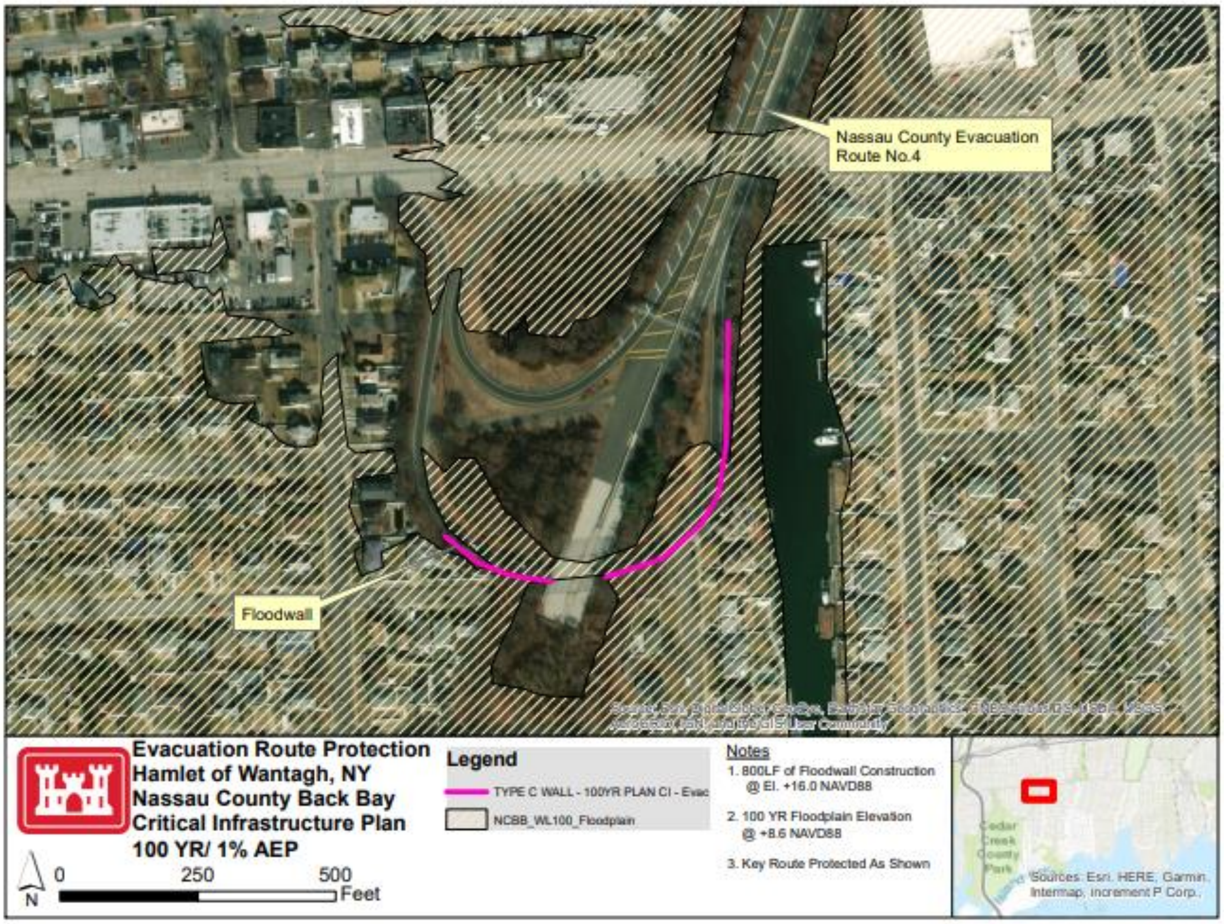


Figure 50 - Localized Floodwall for Evacuation Route No. 4

While the Cedar Creek WWTP localized floodwall and the Evacuation Routes 1 and 4 floodwalls have not gone through a cost/benefit analysis to date, their potential impacts are evaluated in this DIFR-EIS as they will be further analyzed as the study progresses.

5. Locally Preferred Plan – Not Applicable. The local sponsor decided to pursue plans that maximized storm damage reduction benefits.

Each alternative will potentially include NNBF measures as complementary features to be evaluated further during plan optimization.

The focused array of alternative plans is also consistent with the requirements of the policy directive issued by the Assistant Secretary of the Army for Civil Works (ASA – CW) on 05 January 2021. Specifically, this policy directive reiterated the USACE priority for "Comprehensive Documentation of Benefits in Decision Documents." The directive stipulated that, at a minimum, the focused array of alternatives must include the following plans:

- The No Action Plan
- A plan that maximizes total benefits across all benefit categories
- A plan that maximizes net benefits consistent with the study purpose

- For flood-risk management studies, a non-structural plan, which includes modified floodplain management practices, elevation, relocation, buyout/acquisition, dry flood proofing and wet flood proofing
- A Locally Preferred Plan (LPP) if requested by the non-Federal sponsor

Specifically, the requirements to identify the No Action Plan and LPP (if applicable) have been addressed. In addition, the TSP meets both the requirement to identify the non-structural plan and the plan that maximizes net benefits consistent with the study purpose (NED Plan). Per the quantitative NED analysis and the qualitative RED, OSE and EQ analysis, the Localized Structural Critical Infrastructure (CI) & NS Plan maximizes total benefits across all benefit categories.

4.8 Focused Array of Alternatives Evaluation & Comparison

After the focused array of alternatives was formulated, the first task was to forecast the most likely with-project condition expected under each alternative plan. The criteria used to evaluate the alternative plans included: contributions to the Federal objective and the study planning objectives, compliance with environmental protection requirements, and the Principles & Guidelines' (P&G's) four evaluation criteria (completeness, effectiveness, efficiency and acceptability). The second task was to compare each with-project condition to the without-project condition and document the differences between the two. The third task was to characterize the beneficial and adverse effects of magnitude, location, timing and duration. The fourth task was to identify the plans that will be further considered in the planning process, based on a comparison of the adverse and beneficial effects and the evaluation criteria. The System of Accounts (National Economic Development, Environmental Quality, Regional Economic Development and Other Social Effects) was used to facilitate the evaluation and display of effects of alternative plans.

4.8.1 Alternative Comparison

National Economic Development (NED) – Contributions to the NED Account (increases in the net value of the national output of goods and services, expressed in monetary units) through the reduction in wave, erosion and inundation damages were measured with the following considerations: project cost, average annual cost (AAC), average annual benefits (AAB), average annual net benefits (AANB), benefit to cost ratio (BCR) and residual risk.

Table 27 - NED Alternative Comparison

Alternative	Initial Const.	AAC	AAB	AANB	BCR	Residual Risk
No Action Plan	N/A	N/A	N/A	N/A	N/A	N/A
NS Countywide Plan	$3,849,693,000	$135,733,000	$610,571,000	**$474,839,000**	4.5	40%
Comprehensive Structural HVA & NS Plan	$4,785,719,000	$180,345,000	$649,545,000	$469,200,000	3.6	36%

Localized Structural CI & NS Plan	$4,789,373,000	$176,411,000	$622,893,000	$446,481,000	3.5	38%
Locally Preferred Plan	N/A	N/A	N/A	N/A	N/A	N/A

Regional Economic Development (RED) – The RED account registers changes in the distribution of regional economic activity that result from each alternative plan. Two measures of the effects of the plan on regional economies are used in the account: regional income and regional employment.

Table 28 - RED Alternative Comparison

Alternative	Employment	Income
No Action Plan	While there is no project cost, the No Action Plan does not provide RED benefits and will allow for increasing coastal storm risk, thereby providing little or no employment benefits to the area.	While there is no project cost, the No Action Plan does not provide RED benefits and will allow for increasing coastal storm risk, thereby providing little or no employment benefits to the area.
NS Countywide Plan	Regionally, this plan could benefit the local economy by providing consistent CSRM benefits to residential and industrial/commercial structures. This plan may be less effective at minimizing economic disruption from storm-related impacts to large-scale CI (i.e. treatment plants and generating stations).	Regionally, this plan could benefit the local economy by providing consistent CSRM benefits to residential and industrial/commercial structures. This plan may be less effective at minimizing economic disruption from storm-related impacts to large-scale CI (i.e. treatment plants and generating stations).
Comprehensive Structural HVA & NS Plan	Regionally, this plan could benefit the local economy by providing consistent CSRM benefits to the area. The presence of comprehensive floodwalls in HVAs with large-scale CI will also minimize economic disruption by reducing storm-related impacts to large-scale CI (i.e. treatment plants and generating stations) and allowing communities to recover quicker from storms.	Regionally, this plan could benefit the local economy by providing consistent CSRM benefits to the area. The presence of comprehensive floodwalls in HVAs with large-scale CI will also minimize economic disruption by reducing storm-related impacts to large-scale CI (i.e. treatment plants and generating stations) and allowing communities to recover quicker from storms.
Localized Structural CI & NS Plan	Regionally, this plan could benefit the local economy by providing consistent CSRM benefits to the area. In addition, this plan has a higher likelihood to reduce disruption to the local economy by	Regionally, this plan could benefit the local economy by providing consistent CSRM benefits to the areas. In addition, this plan has a higher likelihood to reduce disruption

Alternative	Employment	Income
	reducing damage large-scale CI (at a lower cost than the Comprehensive HVA/NS Plan) and allowing communities to recover quicker from storms.	to the local economy by reducing damage to large-scale CI (at a lower cost than the Comprehensive HVA/NS Plan) and allowing communities to recover quicker from storms.
Locally Preferred Plan	N/A	N/A

Other Social Effects (OSE) – The OSE account is a means of displaying and integrating into water resource planning information on alternative plan effects from perspectives that are not reflected in the other three accounts. As discussed above, the feasibility study formulation focused on critical infrastructure and highly vulnerable areas. The highly vulnerable areas identified in the array of alternatives are very consistent with the Socially Vulnerable Areas that the Center for Disease Control (CDC) identified in Nassau County. Given that the CDC emphasizes the impacts of socioeconomic status, household composition/disability, race/ethnicity/language/minority status and housing/transportation on social vulnerability, the USACE believes the focused array of alternatives align with the intent of Executive Order 12989 (dated February 11, 1994). Specifically EO 12989 stipulates the importance of Environmental Justice, as defined by the USEPA: "the fair treatment and meaningful involvement of all people regardless of race, color, national origin or income with respect to the development, implementation and enforcement of environmental laws, regulations and policies."

Table 29 - OSE Alternative Comparison

Alternative	Social Risk & Vulnerability	Community Cohesion	Quality of Life
No Action Plan	While there is no project cost, the No Action Plan does not provide OSE benefits and will allow for increasing coastal storm risk, thereby providing little or no social benefits to the area.	While there is no project cost, the No Action Plan does not provide OSE benefits and will allow for increasing coastal storm risk, thereby providing little or no community cohesion benefits to the area.	While there is no project cost, the No Action Plan does not provide OSE benefits and will allow for increasing coastal storm risk, thereby providing little or no quality of life benefits to the area.
NS Countywide Plan	While countywide non-structural measures would reduce damages to structure/content during low and higher frequency events, there is risk that elevating structures might create a false sense of security during a storm event reducing compliance	While countywide non-structural measures would reduce damages to structure/content during low and higher frequency events, residual risk to infrastructure and properties that don't qualify for elevation could reduce the robustness of coastal communities. Additionally, there	Countywide non-structural measures would reduce damages to structure/content during low and higher frequency events.

	with evacuation orders. People sheltering in place will increase their personal risk and could also increase risk to emergency responders. Also, residual risk (approximately 40%) remains with this alternative in place. The residual risk varies throughout different regions of the study area.	might be community opposition to selective elevating of structures and the needed real estate easements.	
Comprehensive Structural HVA & NS Plan	Potential for reduction in bayside views and access by floodwalls and levees. Real estate easements required to construct walls could be difficult to obtain. In addition, there is a high potential for increased with-project incremental life loss potential with overtopping or failure of the community-wide floodwall.	Potential for reduction in bayside views and access by floodwalls and levees. Real estate easements required to construct walls could be difficult to obtain. Also, portions of communities may be cut off from each other, especially on the western and eastern portions of the project where the floodwall cuts into neighborhoods and streets.	Floodwalls and levees would reduce inundation to communities during low and higher frequency events.
Localized Structural CI & NS Plan	While the risk still remains that elevating structures might create a false sense of security during a storm event, the localized floodwall measures will reduce damages to CI that will allow communities to be more resilient and recover quicker from storms. In addition, reducing damages to CI promotes a more socially equitable solution that benefits a wide range of citizens with varying socioeconomic conditions.	There might be community opposition to selective elevating of structures and the needed real estate easements; however, the added components of localized floodwalls will reduce damages to CI and allow communities to be more resilient and recover quicker from storms.	Non-structural measures would reduce damages to structure/content during low and higher frequency events and localized floodwall measures will reduce damages to CI that will allow communities to be more resilient and recover quicker from storms.
Locally Preferred Plan	N/A	N/A	N/A

Environmental Quality (EQ) – Beneficial effects in the EQ account are favorable changes in the ecological, aesthetic, and cultural attributes of natural and cultural resources. Adverse effects in the EQ account are unfavorable changes in the ecological, aesthetic, and cultural attributes of natural and cultural resources.

Table 30 - EQ Alternative Comparison

Alternative	Physical Effects		Chemical Marine Effects		Biological Effects				
	Back Bay Circulation	Back Bay Sedimentation	Back Bay Water Quality	Air Quality	T&E Species	Fisheries/EFH	Aquatic Life	Wetlands/Aquatic Habitats	Terrestrial Habitats
No Action Plan	Sea level rise will continue but will not affect circulation	No change in sedimentation.	Climate change forecasts potential for increased temperature and precipitation - this could result in higher water temps that would deplete DO, increased run-off, which could increase nutrient levels in the estuaries.	No change in air quality.	Global climate change, sea level rise, and invasive species would continue to affect T&E species. Stressors include changes in distribution, prey distribution, habitat, etc.	Water quality, climate change, sea level rise, and invasive species will continue to be stressors on fisheries.	Water quality, climate change, sea level rise, and invasive species will continue to be stressors on aquatic life.	Climate change and sea level rise will result in conversion of intertidal and terrestrial habitat.	Climate change and sea level rise will result in conversion of terrestrial habitat to wetlands or aquatic habitat.
NS Countywide Plan	No effect on circulation. Sea level rise, as described under No Action would continue.	No change in sedimentation. On land construction will follow all erosion and sediment control requirements.	No impacts on water quality. Construction would comply with all applicable regulatory requirements. Changes as a result of climate change, as described under No Action/FWOP would continue.	Temporary adverse impacts from construction with unknown magnitude (minor, moderate, major). Construction would comply with all applicable regulatory requirements.	On land construction expected to occur within footprint of existing structures. Impacts on T&E species/habitat are expected to be minimal. Some potential for temporary negligible disturbance if present during construction. Impacts associated with climate change and sea level rise would continue, as described under No Action. Complementary NNBF measures would be incorporated to provide additional CSRM while improving ecosystem services. Structural measures may protect T&E species habitat (e.g. wetlands) from sea level rise.	No impacts. Construction would comply with all applicable regulatory requirements. Stressors as described under No Action would continue	No impacts. Construction would comply with all applicable regulatory requirements. Stressors as described under No Action would continue	No impacts. On land construction expected to occur within footprint. Impacts associated with climate change and sea level rise would continue, as described under No Action. Complementary NNBF measures would be incorporated to provide additional CSRM while improving ecosystem services Structural measures may protect intertidal and freshwater wetlands from the effects of sea level rise.	No impacts. On land construction expected to occur within footprint. Impacts associated with climate change and sea level rise would continue, as described under No Action.
Comprehensive Structural HVA & NS Plan	No net change on bay wide circulation. May be some negligible local impacts on circulation at bay surge barriers. Sea level rise, as described under No Action would continue.	Temporary minor changes in sedimentation during construction. Construction would comply with all applicable regulatory requirements. May be some localized scour or sedimentation at gate structures.	Temporary localized adverse impacts from construction associated with increases in turbidity from sediment disturbance. Magnitude is unknown magnitude (minor, moderate, major). Construction would comply with all applicable regulatory requirements. Changes as a result of climate change, as described under No Action would continue.	Temporary adverse impacts from construction (intensity – minor, moderate, major, unknown). Construction would comply with all applicable regulatory requirements.	Construction footprint uses existing footprint to the maximum extent possible. Marine habitat is primarily disturbed habitat. Impacts on T&E species/habitat are expected to be minimal. Some potential for temporary negligible impacts, if marine T&E species are present during construction. Impacts associated with climate change and sea level rise would continue, as described under No Action. Complementary NNBF measures would be incorporated to provide additional CSRM while improving ecosystem services. Structural measures may protect T&E species habitat (e.g. wetlands) from sea level rise.	Minimal temporary and long-term impacts on fisheries and EFH. Construction would comply with all applicable regulatory requirements. Stressors as described under No Action would continue	Minimal temporary impacts on aquatic life. Construction would comply with all applicable regulatory requirements. Stressors as described under No Action would continue	Minor temporary and long-term impacts on estuarine intertidal and subtidal wetlands and freshwater wetland. Construction footprint uses existing footprint to the maximum extent possible. Impacts associated with climate change and sea level rise would continue, as described under No Action. Complementary NNBF measures would be incorporated to provide additional CSRM while improving ecosystem services Structural measures may protect intertidal and freshwater wetlands from the effects of sea level rise.	Minor temporary and long-term impacts on terrestrial habitat. Construction footprint uses existing footprint to the maximum extent possible. Structural measures may protect habitat from effects of sea level rise.

Localized Structural CI & NS Plan	No effect on circulation. Sea level rise, as described under No Action would continue.	No change in sedimentation. On land construction will follow all erosion and sediment control requirements.	No impacts to water quality. Construction would comply with all applicable regulatory requirements. Changes as a result of climate change, as described under No Action would continue.	Temporary adverse impacts from construction (intensity – minor, moderate, major, unknown). Construction would comply with all applicable regulatory requirements.	On land construction expected to occur within footprint of existing structures. Impacts on T&E species/habitat are expected to be minimal. Some potential for temporary negligible disturbance if present during construction. Impacts associated with climate change and sea level rise would continue, as described under No Action. Complementary NNBF measures would be incorporated to provide additional CSRM while improving ecosystem services.	No impacts fisheries. Construction would comply with all applicable regulatory requirements. Stressors as described under No Action would continue.	No impacts. Construction would comply with all applicable regulatory requirements. Stressors as described under No Action would continue.	No impacts. On land construction expected to occur within footprint. Impacts associated with climate change and sea level rise would continue, as described under No Action. Complementary NNBF measures would be incorporated to provide additional CSRM while improving ecosystem services.	No impacts. On land construction expected to occur within footprint. Impacts associated with climate change and sea level rise would continue, as described under No Action.
Locally Preferred Plan	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

As indicated on the EQ comparison table, the NS Countywide Plan has little or no mitigation required, while the Localized Structural CI & NS Plan and Comprehensive Structural HVA & NS Plan will likely require mitigation related to the floodwall construction. That being said, the USACE qualitatively determined that the mitigation required for Localized Structural CI & NS Plan would be potentially offset by the plan's potential to minimize damage and associated environmental impacts related to critical infrastructure damage. For example, during Hurricane Sandy, the Bay Park Sewage Treatment Plant (Nassau County) was damaged resulting in the following:

- Pumping system was flooded under 9 feet of water
- Sewage backed up and overflowed into low-lying homes and streets
- Plant shut down ~2 days (44 hours) ~100 million gallons of raw sewage poured into Hewlett Bay
- Additional 2.2 billion gallons of partially treated sewage flowed into Rockaway Channel (from October 29th to December 21st)
- Electrical system was destroyed
- $730 million to help rebuild the Bay Park Sewage Treatment Plant

4.8.2 Alternative Evaluation

After alternatives were compared using the NED, RED, EQ and OSE system of accounts criteria, the remaining alternatives were evaluated against the four planning criteria. Table 31 provides analysis and screening of the focused array of alternatives against the four planning criteria (effectiveness, efficiency, acceptability and completeness):

- Effectiveness is the extent to which an alternative plan alleviates the specified problems and achieves the specified opportunities
- Efficiency is the extent to which an alternative plan is the most cost-effective means of alleviating the specified problems and realizing the specified opportunities, consistent with protecting the Nation's environment
- Acceptability is the workability and viability of the alternative plan with respect to acceptance by State and local entities and the public and compatibility with existing laws, regulations, and public policies.
- Completeness is the extent to which a given alternative plan provides and accounts for all necessary investments or other actions to ensure the realization of the planned effects.

Table 31 - Planning Criteria Alternative Evaluation

NCBB Alternative Evaluation	**Planning Criteria**			
	Effectiveness	**Efficiency**	**Acceptability**	**Completeness**
No Action Plan	This does not meet the effectiveness criteria because the No Action Plan does not provide CSRM benefits and will allow for increasing erosional impacts and coastal storm risk to the study area.	This does not meet the efficiency criteria. While there is no project cost, the No Action Plan does not provide CSRM benefits and will allow for increasing erosional impacts and coastal storm risk to the study area.	This does not meet the acceptability criteria as State and local entities are generally supportive of improved CSRM.	This does not meet the completeness criteria because the No Action Plan does not provide CSRM benefits and will allow for increasing erosional impacts and coastal storm risk to the study area.

NCBB Alternative Evaluation	Planning Criteria			
	Effectiveness	Efficiency	Acceptability	Completeness
NS Countywide Plan	Medium - will reduce damages to buildings (i.e. structure and content). At this point in the analysis, this plan includes dry flood proofing measures to reduce damage to CI; however, that may not be effective for large-scale CI (treatment plants, generating stations, etc.).	High (BCR>1) – Plan currently has highest AANB.	High – Since Hurricane Sandy hit this area, extensive non-structural (predominantly elevation) efforts have been undertaken in Nassau County; therefore, it appears that is a highly acceptable CSRM approach in this area.	Medium – Complements ongoing NS and CI risk management in the study area.
Comprehensive Structural HVA & NS Plan	Medium – will reduce damages to highly vulnerable areas; however, floodwalls are not adaptable to RSLC and potentially increase life loss consequences in the case of a structure failure.	Medium (BCR>1)	Low - there is risk that the project may not be implementable due to environmental laws. This risk is based on the very high uncertainty whether the high direct impacts of a floodwall would be acceptable to resource agencies.	Low – NS portion compliments ongoing NS and CI risk management in the study area; however, comprehensive floodwalls may be duplicative considering ongoing efforts to manage risk to CI in communities.
Localized Structural CI & NS Plan	High - will reduce damages to buildings (i.e. structure and content) and also provide more effective risk management to large-scale CI (treatment plants, generating stations, etc.) that allow communities to recover quicker from storms.	Medium (BCR>1) – The efficiency of this plan will likely increase as the analysis continues and secondary NED benefits (such as the number of customers served by different CI) are factored into the net benefit and BCR calculations.	High – since Hurricane Sandy struck this area, extensive non-structural (predominantly elevation) and CI risk management efforts have been undertaken in Nassau County; therefore, it appears that is a highly acceptable CSRM approach in this area.	Medium – Complements ongoing NS and CI risk management in the study area.
Locally Preferred Plan	N/A	N/A	N/A	N/A

4.9 Plan Selection

The TSP is the Non-Structural (NS) Countywide Plan. The TSP does not include the critical infrastructure and NNBF measures but they are measures that will continue to be evaluated.

4.9.1 Description of the TSP

The NS Countywide Plan includes the following:

- Elevation of 14,183 residential structures to the modeled 1% AEP non-structural design water surface elevation (which includes intermediate sea level change projected to 2080).

- Dry flood proofing of 2,667 industrial and commercial (non-residential) structures from the ground surface up to three feet above ground.

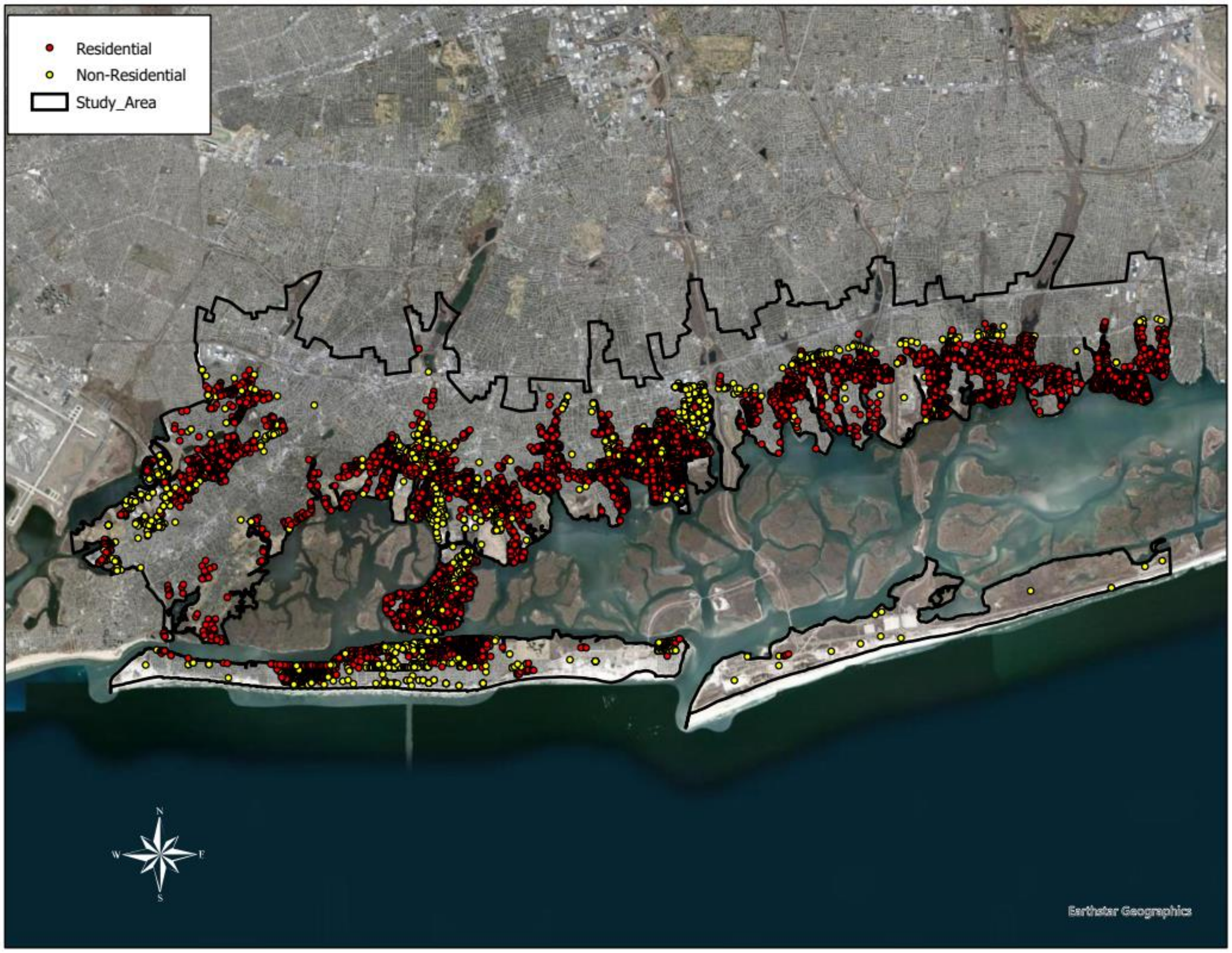


Figure 51 - TSP Location

4.9.1.1 TSP Components

At this stage of the analysis, at-risk structures identified in the TSP were selected based on their potential to incur damages from the 5% AEP (predicted to occur at the end of the 50-year period of analysis – 2080). For the at-risk residential structures, structure elevation was formulated to the modeled 1% AEP non-structural design water surface elevation, which includes intermediate sea level change projected to 2080. If elevation requirements are greater than 12 feet above ground level, structure acquisition/relocation would likely be considered instead because such a height introduces additional structure risk factors (i.e. hydrodynamic forces and wind). However, the combined 2080 non-structural design water surface elevation at 1% AEP with the intermediate RSLC projection is not anticipated to be greater than 12 feet above ground level; therefore, it is highly likely that acquisition and relocation of residential structures will not need to be considered based on those constraints, but acquisition and relocation is still being considered based on repetitive losses, value and vulnerability. Based on the variability of structure type and condition in the study area, the USACE identified three potential methodologies for residential structure elevation: Elevation with Piles, Elevation with Posts/Columns and Elevation with Extended Foundations.

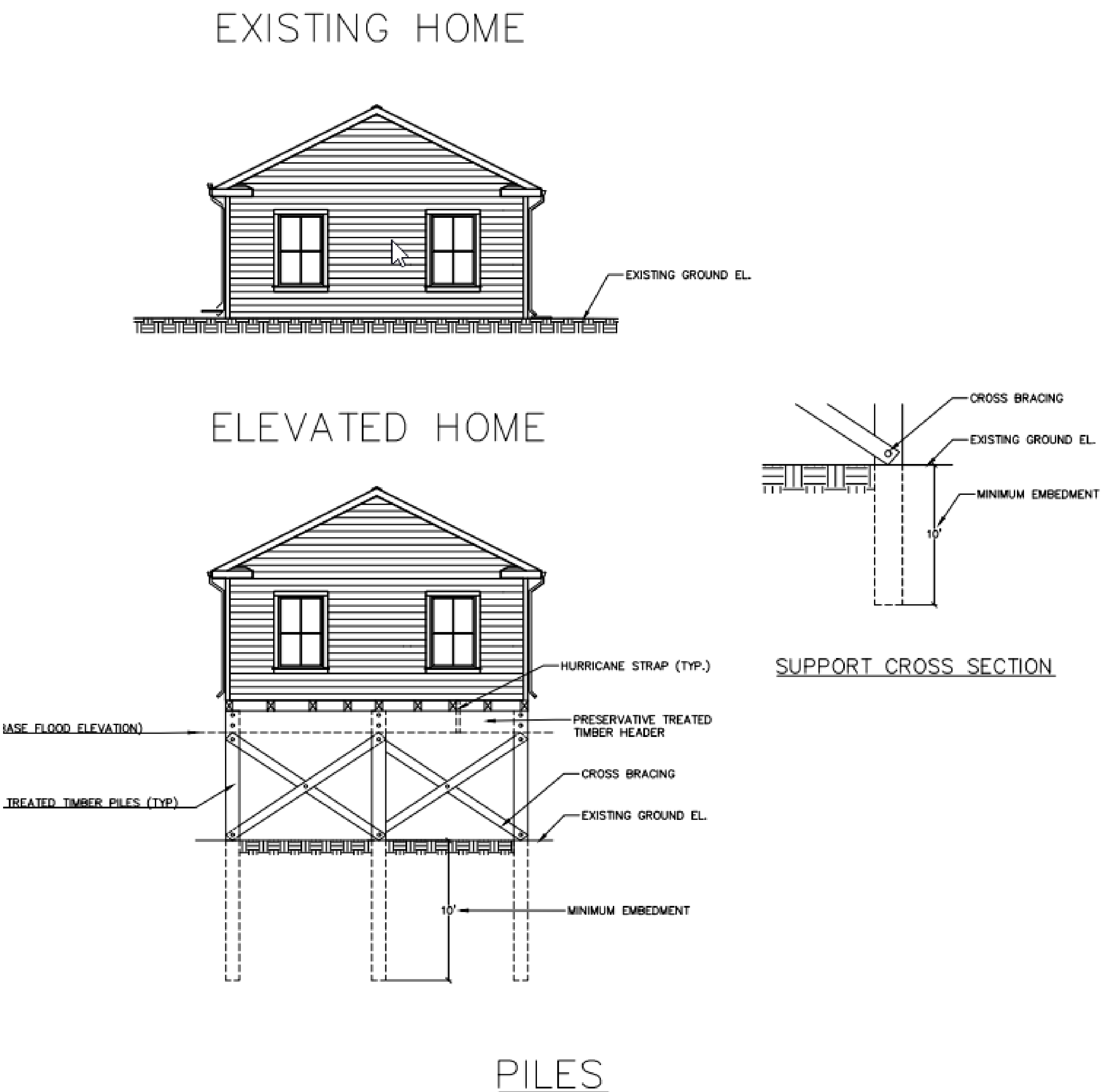


Figure 52 - Residential Elevation Concept with Piles

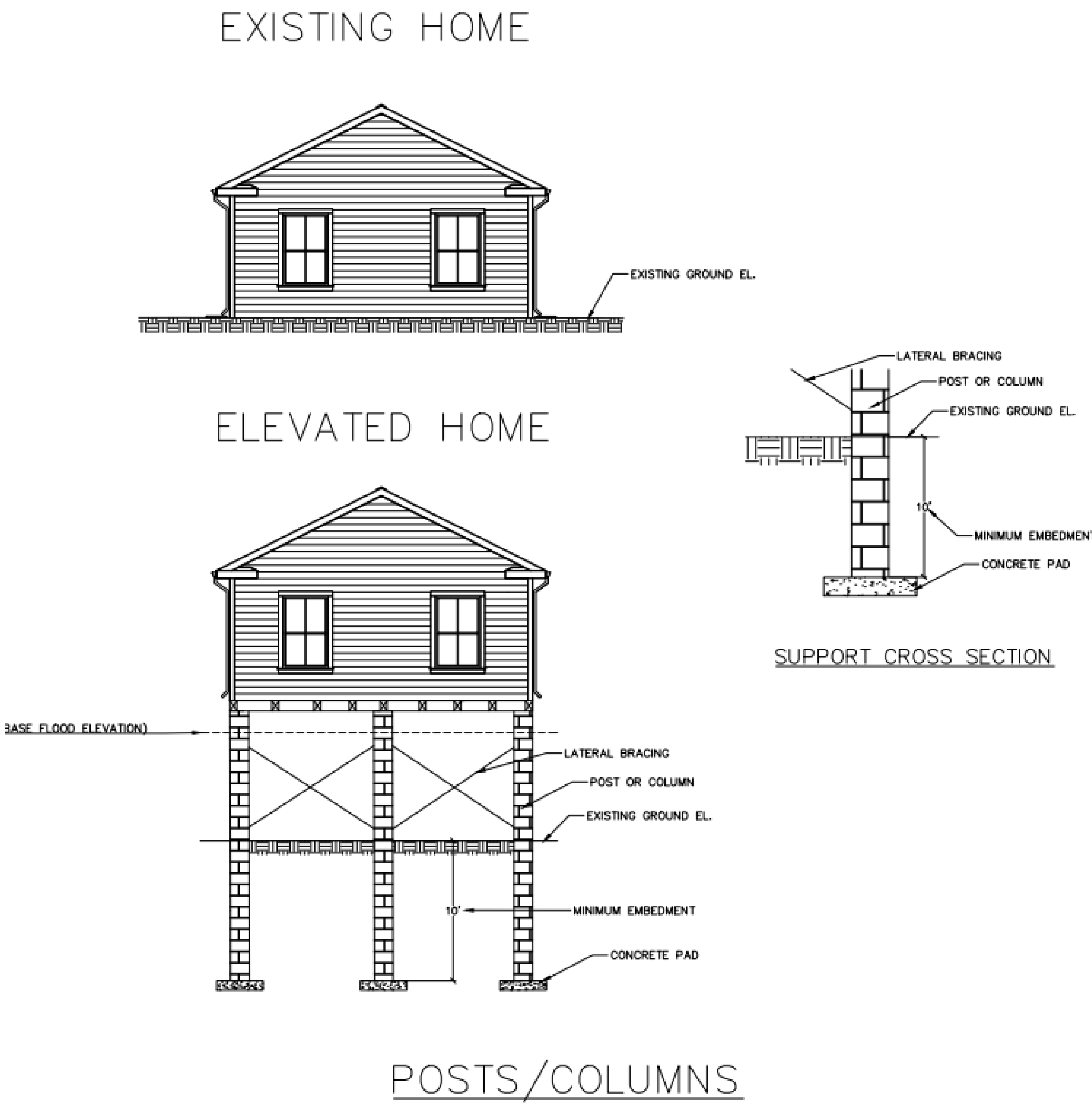


Figure 53 - Residential Elevation Concept with Posts/Columns

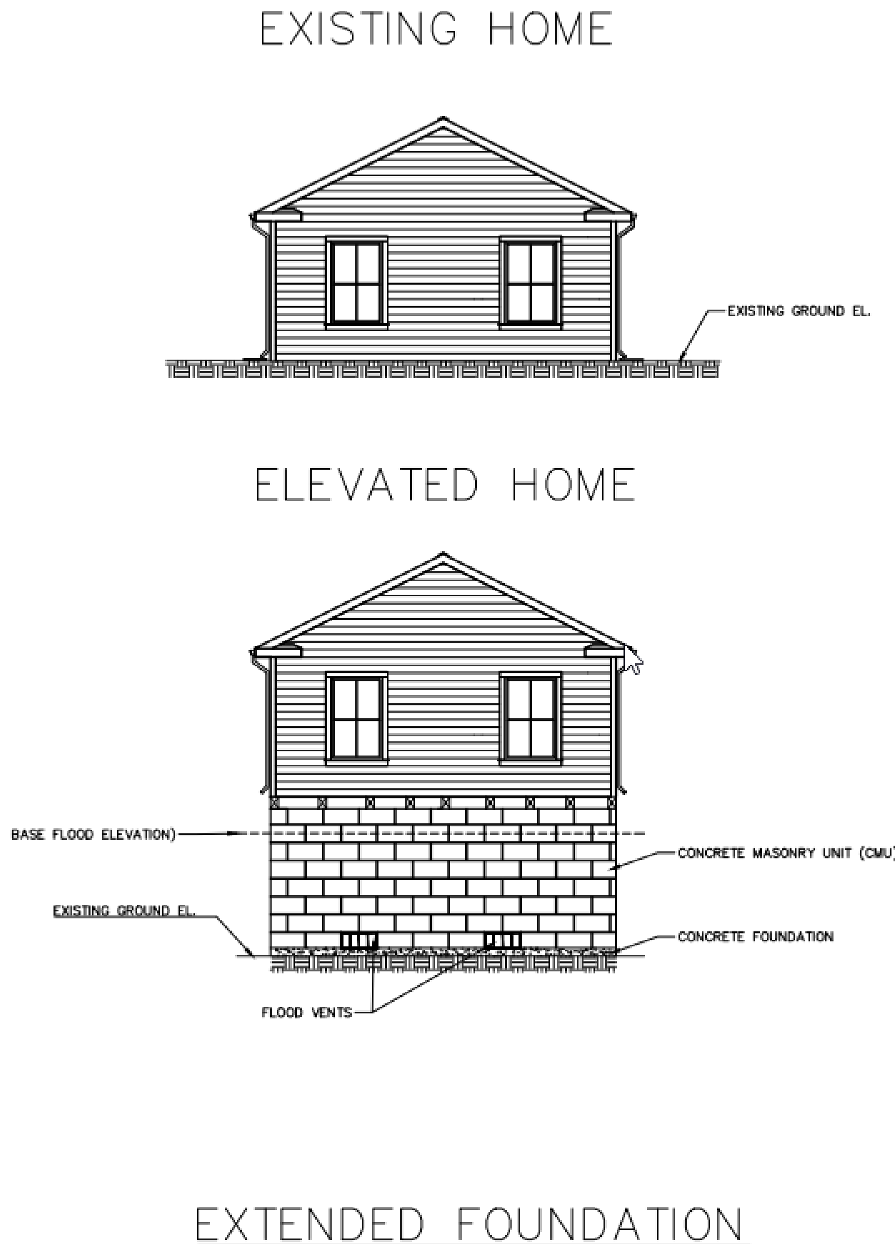


Figure 54 - Residential Elevation Concept with Extended Foundation

For at-risk industrial and commercial facilities, dry flood proofing generally consists of sealing all areas from the ground level up to approximately three feet of a structure. Such dry flood proofing measures will help make walls, doors, windows and other openings resistant to penetration by storm surge waters. Water and sewer back-flow prevention mechanisms (such as drain plugs, standpipes, grinder pumps and back-up valves) are also included in dry flood proofing. Openings, such as doors, windows, sewer lines and vents, may also be closed temporarily, with sandbags or removable closures.

Figure 55 - Dry Flood Proofing Rendering @ Island Park Fire Department

Recognizing that the initial non-structural formulation will inherently have residual risk (storm risk that would still exist with a projet in place) none of the other non-structural measures have been screened out at this point because they will be further analyzed during feasibility-level design to ensure a complete plan is formulated.

4.9.1.2 TSP Consistency with the USACE Environmental Operating Principles

The USACE Environmental Operating Principles were developed to ensure that Corps of Engineers missions include totally integrated sustainable environmental practices. The Principles provided corporate direction to ensure the workforce recognized the Corps of Engineers role in, and responsibility for, sustainable use, stewardship, and restoration of natural resources across the Nation and, through the international reach of its support missions.

Since the Environmental Operating Principles were introduced in 2002 they have instilled environmental stewardship across business practices from recycling and reduced energy use at Corps and customer facilities to a fuller consideration of the environmental impacts of Corps actions and meaningful collaboration within the larger environmental community.

The concepts embedded in the original Principles remain vital to the success of the Corps and its missions. However, as the Nation's resource challenges and priorities have evolved, the Corps has responded by close examination and refinement of work processes and operating practices. This self-examination includes how the Corps considers environmental issues in all aspects of the corporate enterprise. In particular, the strong emphasis on sustainability must be translated into everyday actions that have an effect on the environmental conditions of today, as well as the uncertainties and risks of the future. These challenges are complex, ranging from global trends such as increasing and competing demands for water and energy, climate and sea level change, and declining biodiversity; to localized manifestations of these issues in extreme weather events, the spread of invasive species, and demographic shifts. Accordingly, the Corps of Engineers is re-invigorating commitment to the Environmental Operating Principles in light of this changing context.

The Environmental Operating Principles relate to the human environment and apply to all aspects of business and operations. They apply across Military Programs, Civil Works, Research and Development, and across the Corps. The Principles require a recognition and acceptance of individual responsibility from senior leaders to the newest team members. Re-committing to these principles and environmental stewardship will lead to more efficient and effective solutions, and will enable the Corps of Engineers to further leverage resources through collaboration. This is essential for successful integrated resources management, restoration of the environment and sustainable and energy efficient approaches to all Corps of Engineers mission areas. It is also an essential component of the Corps of Engineers' risk management approach in decision making, allowing the organization to offset uncertainty by building flexibility into the management and construction of infrastructure.

The **Environmental Operating Principles** are:

- Foster sustainability as a way of life throughout the organization.
- Proactively consider environmental consequences of all Corps activities and act accordingly.
- Create mutually supporting economic and environmentally sustainable solutions.
- Continue to meet our corporate responsibility and accountability under the law for activities undertaken by the Corps, which may impact human and natural environments.
- Consider the environment in employing a risk management and systems approach throughout the life cycles of projects and programs.
- Leverage scientific, economic and social knowledge to understand the environmental context and effects of Corps actions in a collaborative manner.
- Employ an open, transparent process that respects views of individuals and groups interested in Corps activities.

As referenced above, existing wetland/marsh loss trends will continue and/or worsen under the FWOP/No Action Alternative. Predicted climate change impacts, such as increased sea level rise or increased risk of severe coastal storms, have the potential to change the nature and character of the wetlands in the NCBB study area. In general, wetlands are at increased risk of degradation and loss from sea level rise. Wetlands may erode further or be at increased risk of becoming inundated while not keeping up with sediment accretion rates. Therefore, the USACE has not screened out NNBF measures (specifically marsh restoration measures) from further consideration, as these measures may provide improved CSRM and potential enhanced resiliency and sustainability of the natural environment by complementing the current TSP. Thus, the current plan supports the Corps Environmental Operating Principles by providing an economic and environmentally sustainable solution that enhances community resilience and sustainability.

4.9.1.3 TSP Contributions to the USACE Campaign Plan

The USACE Campaign Plan is comprised of four separate goals: 1 – Supporting the Warfighter, 2 – Transforming Civil Works, 3 – Reducing Disaster Risks, and 4 – Preparing for Tomorrow.

Transforming Civil Works will enable the Corps to deliver essential water resource solutions using effective transformation strategies through a systems-based watershed approach. The NCBB TSP enhances resiliency and sustainability of the NCBB area by improving CSRM consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements.

Reducing Disaster Risk will be achieved through the reduction in coastal storm risk offered by TSP.

Preparing for Tomorrow contributions are through maintaining a commitment to the project through project operation & maintenance and life cycle adaptive management while mitigating for increases in water levels and storm frequency.

4.9.1.4 TSP Consistency with the NACCS

The NACCS 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 incorporatings sustainable coastal landscape systems and taking 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 SLC and climate change.

Recognizing the Federal government's commitment to ensure no inducement of development in the floodplain pursuant to Executive Order 11988, this project will identify in the Project Partnership Agreement (PPA) the need for the non-Federal sponsor to develop a floodplain management plan and a requirement for the sponsor to certify that measures are in place to ensure that the project does not induce development within the floodplains.

4.9.1.5 TSP Resiliency & Sustainability/Adaptabliity

As economic modeling results indicate, the study area is sensitive to RSLC. According to current USACE guidance (ER 1110-2-8162) relative sea level change has an equal probability of occurring at any rate between the Low (Historic) and High SLC rates. Per ER 1110-2-8162, the USACE compared all alternatives against each of the three USACE SLC curves to investigate the resiliency of proposed alternatives in terms of project performance and possible decision-timing strategies. As discussed in the Economics Appendix (Appendix F), decision-timing strategies are different approaches in managing sea level change risk over the period of analysis (or over the planning horizon). Decision-timing strategies include: Anticipatory (i.e. Precautionary), Managed Adaptive, and Reactive.

If the Anticipatory Strategy was applied to the TSP, all eligible structures (using the Year 2080 5% AEP stage height with SLC) would be retrofitted prior to the Base Year (2030). Figure 56 shows the structure retrofits (elevation and floodproofing) per SLC scenario.

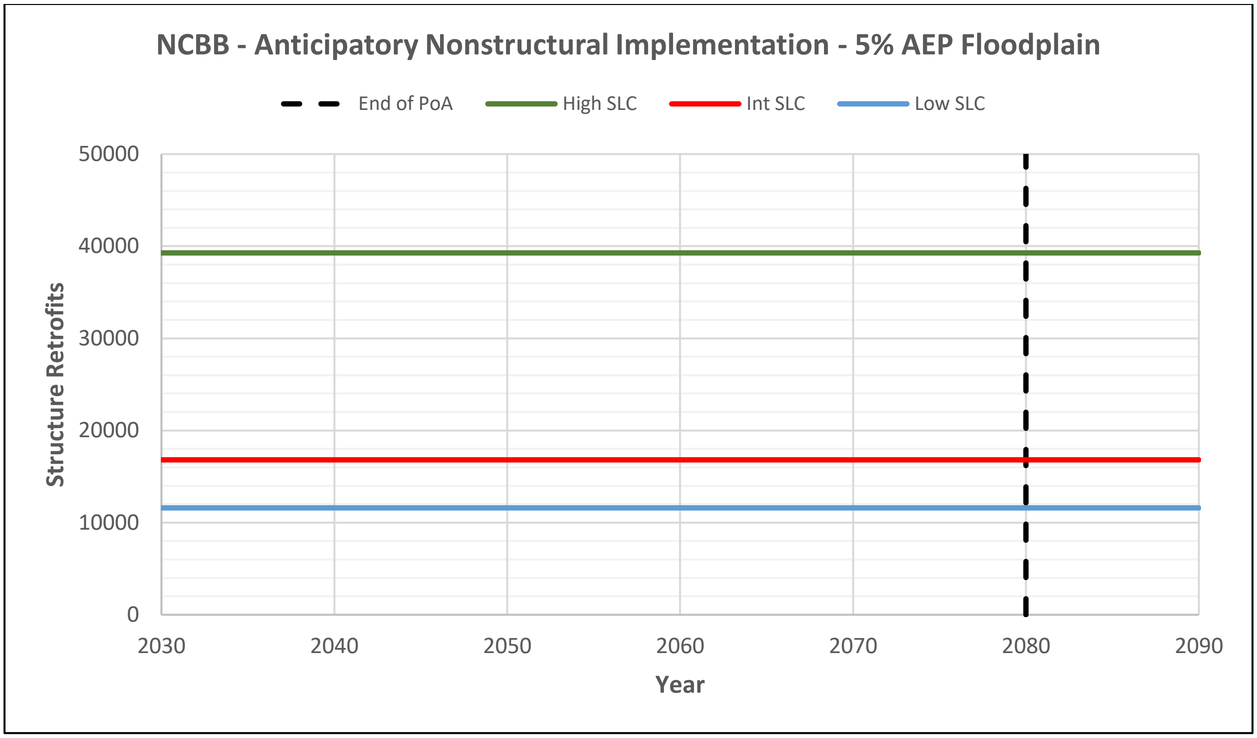


Figure 56 - TSP Anticipatory Strategy Retrofits

The main disadvantage of an Anticipatory approach is the potential to either unnecessarily overspend on project implementation (if SLC is less than expected) or the potential to leave significant residual risk in the study area (if SLC is higher than expected).

The Managed Adaptive Strategy would include periodically returning to the study area and retrofitting structures that are now vulnerable to coastal storm hazards based on the experienced SLC curve. This strategy requires active management over the 50-year period of analysis, but offers numerous advantages in terms of cost efficiency and improving plan resiliency. With a Managed Adaptive approach, plan formulation no longer needs to predict SLC rates and then attempt to fit nonstructural implementation to an uncertain curve. Rather, implementation of nonstructural retrofits can be accomplished incrementally to optimize measure resiliency.

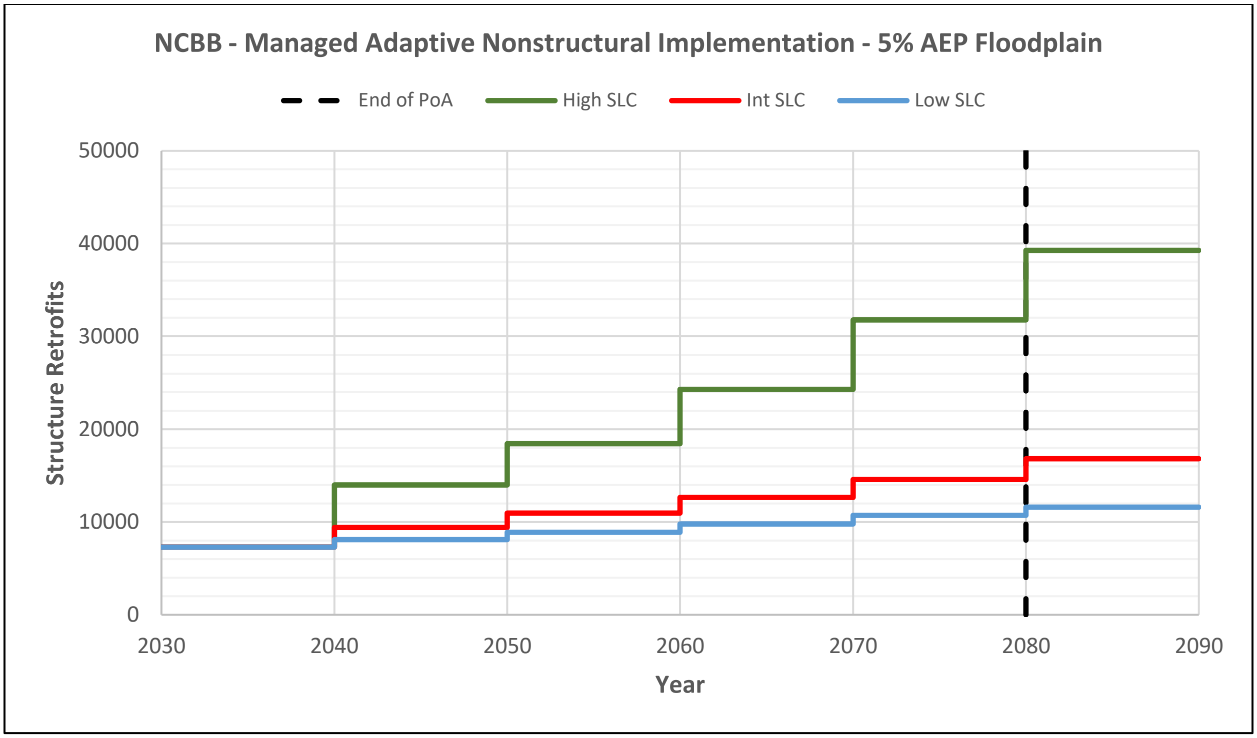


Figure 57 - TSP Managed Adaptive Strategy Retrofits

A Reactive strategy for the TSP is also possible, but not recommended for this study area. The approach would include elevating or floodproofing the 7,300 vulnerable structures by the Base Year (2030) without including any plans or procedures for re-evaluating coastal storm risk over the period of analysis. While this approach is the least expensive, the risk of significant residual damages is very high and the proposed measure is neither resilient nor robust for addressing SLC. As a nonstructural plan is inherently adaptable to SLC due to the flexibility in assigning eligibility, there are few benefits to a nonstructural Reactive strategy for this study area.

4.9.2 TSP Risk Analysis

4.9.2.1 TSP Residual Risk

Residual risk is the coastal storm risk that remains in the floodplain even after a proposed coastal storm risk management project is constructed and implemented. Physical damages, as well as potential life loss consequences, can remain even after the project is implemented due to a variety of causes. For the TSP, residual risk across the study area is approximately 40% with varying levels throughout different regions of the study area. In the four HVAs, residual risk ranges from ~20% in the Village of Freeport to ~46% in the City of Long Beach, while it is approximately 48% throughout the remainder of County located outside of the HVAs.

The next phase of the study will investigate the necessity for a comprehensive life safety risk assessment based on the proposed measures of the TSP. The comprehensive life safety risk assessment would investigate estimated statistical life loss in the FWOP and the effectiveness of the various alternatives in reducing this life loss.

4.9.2.2 TSP Risk & Uncertainty

Future Without Project Conditions Assumptions

For the FWOP conditions and the TSP (future with project) conditions, the structure inventory and assigned values are considered static throughout the 50-year period of analysis. Though this approach may ignore future condemnations of repeatedly damaged structures or, conversely, increases in the number or value of structures in the inventory due to future development, the variability and limitations of projecting future inventory changes over 50 years across such a wide study area are too significant to assign any reasonable level of certainty to the predicted inventory alterations. FWOP damages are used as the base condition and the potential project alternatives (including the TSP) are measured against this base to evaluate the project effectiveness and cost efficiency.

The FWOP modeling results are based on estimated structure damages, content damages, and vehicle damages. Additional benefit categories such as emergency costs foregone or indirect (non-physical) damages are not currently quantified in HEC-FDA.

Non-Structural Formulation Assumptions

For the non-structural TSP, it is important to note that non-structural implementation is applied on a house-by-house basis; thus, a true building retrofit (elevation and flood proofing) cost would also be developed for each structure individually based on their characteristics such as foundation type, wall type, size, condition, and available workspace. Individually surveying each structure to capture this data, however, is prohibitively time and resource intensive. In compliance with Planning Bulletin 2019-03 *Further Clarification of Existing Policy for USACE Participation in Nonstructural FRM and CSRM Measures*, “nonstructural analyses will formulate and then evaluate measures and plans using a logical aggregation method.”

FFE is the addition of ground elevation and foundation height to measure the absolute elevation of the main floor of the structure. In addition to FFE, each structure occupancy type is assigned a begin-damage point to account for vulnerable entry points above (or below) the FFE. The economic model (HEC-FDA) begins to assign damage to structures when flood stage heights reach the first floor +/- the begin-damage point value. While the ground elevation is derived with a high degree of certainty via NOAA Digital Coast Bare Earth Light Detection and Ranging (LiDAR)-derived DEM, the foundation height is more difficult to measure and attribute for each individual structure. Techniques such as field surveys or mobile LiDAR can theoretically calculate foundation height for every structure with a high degree of certainty; however, the size of the study area and associated structure inventory makes these methods prohibitively time and resource consuming. Therefore, to calculate the FFE for structures within the model inventory, a stratified random sample was collected of structures within each occupancy type to assign a typical foundation height per structure type. The average foundation height for a given occupancy type was then added to the structure’s unique ground elevation to calculate final FFE.

While this method of assigning average foundation height by occupancy type, and then selecting a certain volume of residential structures as “elevated,” provides reasonable accuracy for estimating FFE across a large population, it does not allow for knowing the true FFE for each individual structure within the inventory; only the assigned FFE for a typical structure of a given occupancy type at that location. This has some impact on later plan formulation and evaluation, particularly for non-structural measures.

Cost Estimating Assumptions

Due to the size of the study area, elevation and flood proofing costs were developed for a "typical" structure in each of the HVAs and rest of county locations. Both a "typical" residential structure and "typical" non-residential structure were identified for each location using a stratified random sample. A per unit cost was then developed based on the dimensions and characteristics of those "typical" structures. More information on nonstructural cost estimation can be found in the Plan Formulation Appendix (Appendix A), Cost Engineering Appendix (Appendix D) and Economics Appendix (Appendix F).

For aggregated cost summaries, current analysis assumes a 100% participation rate in the nonstructural alternative. In compliance with National Nonstructural Committee (NNC) Best Practice Guide (BPG) 2020-02 *Considerations for Estimating Participation Rates in Voluntary Nonstructural Measures*, further analysis will be conducted to estimate the participation rate of the study area.

Identifying structures eligible for elevation and flood proofing focused on isolating structures with the highest coastal storm damage risk levels. Residential and non-residential structures with high vulnerability to coastal storm damage, whether due to geographic conditions or first floor elevation, are considered prime candidates for such building retrofits.

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Non-structural analysis was focused on at-risk structures within the 5% AEP event floodplain. As this floodplain threshold is dependent upon the SLC rate, non-structural alternatives were formulated for Low (Historic), Intermediate, and High SLC scenarios in accordance with ER 1100-2-8162 *Incorporating Sea Level Change in Civil Works Programs*. As the eligibility threshold stage for each SLC scenario is different, the number of structures (both residential and non-residential) eligible under each SLC scenario is also different. Additionally, the 5% AEP event stage changes over the 50-year period of analysis depending on the modeled SLC curve scenario.

The current non-structural economic analysis outlines a precautionary approach to SLC risk management. Using the Year 2080 5% AEP event stage (for each USACE SLC curve), vulnerable structures are identified and elevated/flood proofed by the base year. All non-structural costs are incurred by the base year and benefits start accruing in the base year for all retrofitted structures (depending on their relative vulnerability over the period of analysis).

Critical Infrastructure Formulation Assumptions

Additionally, critical infrastructure assets are eligible based on their vulnerability to the 1% AEP flood event by the Year 2080. Non-structural measures are applicable for the majority of critical infrastructure assets such as hospitals, police stations, and medical offices. For large-scale infrastructure facilities such as wastewater treatment plants and electric power plants, it is uncertain whether non-structural measures alone are effective in mitigating coastal storm risk. At this stage of the analysis, non-structural measures are not applied to those facility types in the future with-project condition. The analysis to confirm whether non-structural measures are effective for large-scale critical infrastructure will occur prior to release of the final Integrated Feasibility Report/EIS.

For this study, critical infrastructure is divided into three broad categories:

- traditional building types (e.g. medical offices, hospitals),
- large scale infrastructure that resembles an entire industrial complex (e.g. wastewater treatment plants, natural gas power station),

- infrastructure that does not resemble buildings in any way (e.g. evacuation routes, ports, utility lines).

At this point in the study, only the direct (physical) damages for the first traditional and large-scale infrastructure types are quantified within HEC-FDA and currently contribute to NED damage estimates. None of the three critical infrastructure types are currently quantified for indirect (non-physical) coastal storm damages. In addition to physical and non-physical NED damages, critical infrastructure disruptions may also cause severe RED, OSE and EQ impacts due to regional business impacts and catastrophic health & safety and environmental concerns. RED, OSE and EQ impacts are currently handled qualitatively for all three infrastructure types.

Real Estate Costs

At this point in the analysis, LERRD costs are not included in the total project cost for the non-structural TSP. The study team assumed a 100% participation rate for project implementation; thus, acquisition costs were assumed to be negligible. In the event that additional study analysis indicates that a structure identified for elevation would likely be a candidate for acquisition instead, the study team believes acquisition costs would be lower than elevation costs in such cases. As the study continues, further analysis of the participation rate will be conducted to reduce data uncertainty. In addition where necessary, costs for acquisition will be evaluated in greater detail. From an engineering standpoint, a sampling of structures in the study area will be evaluated to support the refinement of LERRD costs. Specifically, FFEs will be further evaluated to verify a structure's eligibility for elevation and structure conditions will be analyzed to confirm the applicability of elevation to those structures. That being said, the study team recognizes that the current LERRD cost underestimates the potential for relocation assistance costs associated with elevation of residential properties occupied by renters. Therefore, a sensitivity analysis was conducted to account for this risk and associated uncertainty. Based on typical relocation costs applied on similar feasibility efforts, the study team assumed a $20,000/per structure relocation assistance cost for each residential structure in the TSP. This approach is considered conservative as the temporary rehousing cost would actually only apply to rental properties; however, the current structure inventory does not yet distinguish between rental and non-rental properties. This conservative sensitivity analysis indicated that the current TSP remains the plan with the highest AANB even with the added relocation assistance cost.

The real estate impact costs (Land, Easements, Rights-Of-Way, Relocation, and Disposal Areas – LERRD) for the floodwall measures were estimated as a percentage of construction costs. The percentages used for the NCBB study followed the methodology utilized to develop a floodwall cost per linear foot in the NJBB study. Specifically, a portion of the proposed NJBB floodwall(s) in Long Beach Island (LBI), New Jersey was selected as the sample to develop an approximate LERRD cost per linear foot of floodwall. For this sample set, the USACE estimated that there were 1,126 structures located behind the proposed floodwall in the LBI sample section. Rough order of magnitude LERRD costs ($93,002,000) were developed for 140 representative residential structures in the inventory of structures behind the wall. The stretch of floodwall in the sample section was approximately 100,658 feet long.

The unit cost of a representative structure or parcel can be determined by dividing the LERRD sample cost by the number of structures. Using the below equation, the LERRD unit cost for a representative structure located within the study area is $664,300.

Calculation: $93,002,000 / 140 structures = $664,300 per structure (LERRD Unit Cost)

Based on the projected 1,126 structures behind the floodwall, the total LERRD cost for the floodwall was estimated at $748,001,800, per the calculation below:

Calculation: 1126 structures * $664,300/structure = $748,001,800

Assuming the aforementioned floodwall length of 100,658 feet, the LERRD cost per linear foot of floodwall was calculated by dividing the total LERRD cost by the total length of floodwall, per the calculation below:

Calculation: $748,001,800 / 100,658-feet = $7431.12 / foot (Linear foot cost)

For non-structural measures, the USACE assumed a 100% participation rate and no LERRD costs as this point in the analysis. However, moving forward the USACE will further analyze the number of renters and owners in the study area to determine the applicability of adding relocation costs to the LERRD calculation.

5.0 Impacts of TSP (*NEPA Required)

5.1 Climate Change

Under the TSP, RSLC and high frequency flooding would continue to increase, as described in Section 3.1.1 and 3.1.2. While non-structural measures in the TSP will have minimal impact on the overall hydraulics associated with storm-related or high frequency flooding, they will change the position and vulnerability of structures relative to the water surface elevation. Therefore, as RSLC and high frequency flooding continue to change at the rates described in Section 3.1.1 and 3.1.2, the TSP will remove structures from damageable water surface elevations. There would be a reduction of $610,571,000 average annual damages to structures (including residences, commercial and industrial structures, and critical infrastructure) as compared to the FWOP Condition.

5.2 Land Use

Where structures are elevated or dry flood proofing is completed, the TSP would enable current developed land uses to continue with reduced risk to storm damages. If buyouts/relocations occur it can be expected that those structures would be demolished and the land returned to an undeveloped condition, which ultimately may become permanently flooded (see Section 3.2).

5.3 Floodplains

The TSP is not expected to affect floodplains. Recognizing the Federal government's commitment to ensure no inducement of development in the floodplain pursuant to Executive Order 11988, this project will identify in the Project Partnership Agreement (PPA) the need for the non-Federal sponsor to develop a floodplain management plan and a requirement for the sponsor to certify that measures are in place to ensure that the project does not induce development within the floodplains.

5.4 Physical Resources

5.4.1 Geological Resources

Construction activities associated with non-structural measures such as elevation (including raising a structure on fill or foundation elements such as solid perimeter walls, pier, posts, columns, or pilings) or buyout/ relocations (such as demolition, grading, and soil stabilization/revegetation) could have minor, localized effects on soils and other local geological resources. However, these activities are not expected to have broadscale impacts on regional geological resources. Most activities would occur within existing footprints; therefore, prime farmland soils would not be impacted.

5.4.2 Water Resources

The TSP would have no effect on water resources. Construction activities would occur on land within existing footprints.

5.4.3 Physical Oceanography

Construction activities associated with the TSP would occur on land and would not directly or indirectly affect physical oceanography.

5.4.4 Air Quality

Implementation of the TSP would produce emissions from construction equipment. Impacts are expected to be direct and short-term. The magnitude of impact would range from minor to moderate depending on the level to which the elevations and floodproofing are implemented. Once the construction is complete, emissions would cease, and there would be no further direct impacts. As the Study Area is a nonattainment area for ozone, and maintenance area for 2006 PM-2.5 and carbon monoxide, further coordination would be undertaken with NYSDEC to ensure the project is consistent with the State Implementation Plan.

5.4.5 Hazardous, Toxic and Radioactive Waste

Implementation of the TSP is not anticipated to affect HTRW sites within the county. USACE will undertake no activity that could result in liability as a potentially responsible party (PRP). Any Civil Works project proposed to be carried out in areas impacted by HTRW should be preceded by response action addressing the contamination acceptable to EPA and state regulatory agencies. If HTRW is encountered during construction, the non-Federal sponsor will be responsible for all HTRW response costs and solely responsible for ensuring that required HTRW response actions are accomplished in accordance with applicable requirements of Federal, state and local regulations. Any HTRW costs incurred by the non-Federal sponsor shall not be credited toward the non-Federal sponsor’s share of the total project costs. This does not limit any rights the sponsor may have to recover HTRW costs from responsible parties.

5.4.6 Noise

It is anticipated that there would be short-term, negative impacts to above water noise during construction. The TSP calls for a significant amount of construction associated with elevations, demolition, and flood-proofing. Although construction impacts would cease once the project is complete and would be short-term at an individual site, the extensive amount of construction would be expected to have a prolonged duration throughout the county. Noise levels from construction equipment can range between 74 to 113 dBA (at 50 ft) depending on the equipment. The area is a highly developed environment that typically experiences noise from traffic (70 dBA at 50 ft) and boats (75 to 90 dBA). It can be expected that construction-related noise would be a temporary and direct effect of TSP implementation. Construction would be restricted to daytime operations and comply with local noise ordinances and is therefore expected to be a moderate impact to the study area communities. The construction noises would be typical of common construction activities, but would be more frequent and widespread than the community is accustomed to experience.

Because the TSP occurs completely on land in residential and industrial areas, no impacts to ambient underwater noise are expected.

5.5 Ecological and Biological Resources

5.5.1 Ecosystems and Habitat

The non-structural measures associated with the TSP involve a significant construction effort whether from building retrofits such as elevation (including raising a structure on fill or foundation elements such as solid perimeter walls, pier, posts, columns, or pilings) or buyout/ relocations that are likely to involve demolition, grading, and soil stabilization/revegetation. The majority of the construction would occur within the footprint of the existing structure and would most likely be in upland urbanized settings and would not affect natural marine offshore, Atlantic shores and inlets, barrier island, back bay or mainland upland ecosystems.

5.5.2 Wetlands

Non-structural measures would have no direct or indirect effects on vegetated or unvegetated wetlands.

5.5.3 Vegetation

5.5.3.1 Submerged Aquatic Vegetation

Non-structural measures would have no direct or indirect effects on submerged aquatic vegetation or natural upland vegetation.

5.5.3.2 Upland Vegetation

There is some potential for minor effects on landscape vegetation. Vegetated areas on the landscape could increase where buyout/relocations occur. In those situations, the property could be demolished and replanted with upland vegetation.

5.5.4 Terrestrial and Aquatic Wildlife

5.5.4.1 Terrestrial

Construction activities associated with elevating and flood proofing structures may have minor effects from noise on urban-adapted wildlife.

5.5.4.2 Aquatic

Construction activities would not directly or indirectly affect aquatic habitats; therefore no direct or indirect effects on aquatic resources are expected.

5.5.5 Protected Resources

5.5.5.1 Threatened and endangered species

The residential and industrial areas where the TSP would be implemented do not provide suitable habitat for federally listed threatened and endangered species. Therefore, the USACE has determined that the TSP would have no effect on the following federally listed species. Additional analysis is provided in the Biological Assessment in Appendix G2.

- Shortnose sturgeon
- Northeastern Beach Tiger Beetle
- Piping plover
- Seabeach amaranth
- Northern longeared bat
- Eastern black rail
- Roseate tern

- Red knot
- Atlantic loggerhead
- Kemp's ridley
- Atlantic green sea turtle
- Leatherback sea turtle
- Atlantic Sturgeon

No direct impacts on state-listed species are expected. The TSP would be constructed in footprints of existing structures. Sensitive plants and wildlife are not expected to occur there. There is some potential for minor, temporary disturbance of terrestrial wildlife in smalls pockets of adjacent habitat.

5.5.5.2 Migratory Birds

Noise from the construction activities associated with nonstructural measures has the potential to disturb migratory birds. The residential and industrial areas where these activities would occur provide marginal habitat for nesting birds and most of construction would occur within existing footprints. Therefore, no impacts to migratory birds are expected.

5.5.5.3 Marine Mammals

Construction activities associated with non-structural measures would have no direct or indirect effects on open ocean or estuarine waters. Therefore, there would be no impacts to marine mammals.

5.5.5.4 Essential Fish Habitat

Construction activities associated with non-structural measures would have no direct or indirect effects on estuarine or marine habitats. Therefore, there would be no impacts to essential fish habitat.

5.6 Cultural Resources

5.6.1 Historic Properties including Archaeological Resources

Elevation and flood proofing of structures have the potential to cause adverse effects to the structures as well as to associated outbuildings and archaeological sites that may exist within the surrounding APE. Impacts to historic districts are also possible should the non-structural measures result in the loss of contributing resources or alter the historic character and viewshed of a neighborhood.

Documented archaeological sites, historic buildings and districts, shipwrecks, and archaeologically sensitive areas are all located within the APE for non-structural measures associated with the proposed undertaking. Information collected from archaeological sites recorded within the study area and from cultural resources surveys indicates that the study area possesses a rich past with both Native American and later Euro-American communities who heavily utilized the shoreline, bays, and barrier islands. Lands on Long Island were used as pasture with the harvesting of salt marsh grasses as fodder for livestock during the 17th Century. Barrier beaches across Long Island were also used for maritime activities including the early development of the whaling industry in the 17th Century, with one documented whaling station on Long Beach from around 1721. The harvesting of fish, shellfish, and migratory waterfowl were also common activities for both colonists and Indians during this period (Pelletier et al. 2007:13).

Portions of the study area designated as historic districts should be considered particularly sensitive to impacts. Of particular note is the 17th Century Fort Massapeag/Fort Neck archaeological site (Oyster Bay) which is listed on the State and National Registers and is also a National Historic Landmark.

Outside of the identified historic districts, numerous historic properties are recorded throughout the Nassau County study area and in the vicinity of the properties selected for non-structural measures. Some of these properties may be listed on or eligible for the NRHP; additional properties may require evaluation and historic or architectural survey. There are a great deal of additional survey data available on the NYS CRIS database (NYSHPO 2021) which should be properly researched and reviewed, and which will assist in developing the nature and extent of required surveys for a more complete survey of historic properties (buildings and districts) and Phase 1B archaeological investigations, if required. The configuration and integrity of the existing historic districts should be re-evaluated to determine the status of their contributing resources and to better define their physical and viewshed boundaries within the APE.

5.6.2 Shipwrecks and Submerged Historic Properties

Shipwrecks and submerged historic properties are located within the APE for non-structural measures associated with the proposed undertaking. Eleven USACE archaeological investigations have been conducted within the Nassau County Back Bays study area. These studies were in support of the five different projects: East Rockaway Inlet Dredging, Jones Inlet to Freeport Channel Navigation Improvements, Long Beach Erosion Control, Fire Island to Montauk Point, and Jamaica Bay Ecosystem Restoration. These investigations located one eligible resource, which is the Marble Wreck near Jones Inlet. Ten potentially significant resources were noted around Jamaica Bay and recommended for future 1B surveys, of which two were conducted and found to not be eligible. Additionally, a magnetic anomaly was found that may be the historically NRHP eligible wreck of the Mexico, along with six other anomalies that were recommended for avoidance. Future study may determine if these sites are eligible for the National Register of Historic Places and to identify other properties if any offshore improvements are proposed with the TSP in the future.

5.6.3 Conclusions and Programmatic Agreement

Archaeological studies and investigations will be necessary to complete identification of all significant resources within the APE, including shipwrecks and submerged historic properties, if necessary. Additional investigations will be required to determine the level of adverse effect from the proposed non-structural measures of the overall NCBB study.

In accordance with Section 106 of the NHPA of 1966, as amended and its implementing regulations, 36 CFR 800, it is recommended that a Programmatic Agreement (PA) be prepared as part of the Final Feasibility Report and Environmental Impact Statement. A PA is a binding agreement between the NY SHPO and the USACE and that outlines the activities and tasks that must be carried out to conclude identification of significant resources, determine adverse effects, and mitigate for those adverse effects. These activities include carrying out additional archaeological assessments and investigations based on the locations of project elements; coordination and consultation with the NY SHPO, interested parties and federally recognized Tribes; and preparation of NRHP nomination forms.

The PA should also stipulate that, depending upon the results of surveys, treatment plans or a standard mitigation agreement will be prepared to outline the specific mitigation measures that will be taken to address adverse effects on structures and archaeological sites that cannot be avoided. Treatment plans or mitigation agreements would include but not be limited to, specialized design guidelines for shipwrecks and submerged historic properties and the scope of data recovery for archaeological sites that cannot be avoided.

5.7 Recreational Resources

The TSP would not affect recreational resources in the study area.

5.8 Visual Resources

The TSP would result in direct and permanent alterations to the viewshed of the developed areas within the study area. The non-structural plan for residential structures will result in these buildings being elevated on pilings 10 feet high. This will change the aesthetics of neighborhoods and urban centers. However, these changes to the aesthetics are typical of elevations that have occurred within the Study Area since Superstorm Sandy and are within the character of the existing communities. The changes would be more widespread than they currently are within the area. No changes are expected to the aesthetics of natural areas.

5.9 Socioeconomic Conditions

By reducing coastal storm risk damages and adding resiliency to the residential and commercial structures within the study area, the TSP is expected to have permanent, long-term and positive impacts on the socioeconomic resources of the study area. However, there would be initial investments needed to implement the TSP that could have negative, short-term impacts on the resources of the study area.

5.10 Navigation

The TSP would not affect navigation.

5.11 Cumulative Impacts

The Council on Environmental Quality regulations (40 CFR 1508.7) that implement the *National Environmental Policy Act of 1969* (NEPA; 42 U.S.C. §§ 4321 *et seq.*) define cumulative impact as the "impact on the environment which results from the incremental impact of the action when added to past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. A cumulative impact assessment requires consideration of impacts beyond the site-specific direct and indirect impacts and consideration of effects that expand beyond the geographical extent of the proposed project. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time." This cumulative impact analysis is based on the TSP and other activities in the surrounding region with the potential to contribute to cumulative environmental impacts and is in accordance with the Council on Environmental Quality NEPA regulations and handbook, "Considering Cumulative Effects Under the National Environmental Policy Act" (CEQ 1997b as cited in USACE 2020).

An important step in cumulative impacts analysis is identification of resources that could be impacted by the TSP. Resources deemed to have no impacts from the TSP were eliminated from the cumulative impacts analysis. Based on the impacts analysis, resources with minor adverse impacts from the TSP 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 TSP would have a minor adverse impact on the resource and could contribute to cumulative regional impacts:

- Land use
- Air Quality
- Noise
- Upland Vegetation

- Visual Resources

Section 1.8 summarizes other related projects and storm risk management activities within the study area. Dozens of regional projects were identified, and those with a potential to introduce cumulative impacts in conjunction with potential effects of the Proposed Action were included in the analysis.

USACE has a series of navigation and CSRM projects within the region (Section 1.8): East Rockaway Inlet Dredging; Jones Inlet to Freeport Channel Navigation Improvements; The Atlantic Coast of New York, Jones Inlet to East Rockaway Inlet, Long Beach Island, New York Storm Damage Reduction Project; East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Project; Long Beach Erosion Control; The Fire Island Inlet to Montauk Point, New York Combined Beach Erosion Control and Hurricane Protection Project; and Jamaica Bay Ecosystem Restoration; Shinnecock Inlet Navigation Project, the Westhampton Interim Project, the Moriches Inlet Navigation Project, and the West of Shinnecock Project. The NCBB TSP would provide storm risk management measures along Long Island between the East Rockaway Inlet to Rockaway Inlet to Jamaica Bay Project and the Fire Island to Mantauk Point Project. The area is currently not comprehensively addressed for CSRM.

Minor, direct impacts could be experienced in the study area due to increased noise and air emissions during construction. The TSP would contribute to these impairments in the study area, but impacts are expected to be noticeable only on a local basis, and not provide any cumulative impacts.

Cumulatively, the TSP would contribute to a change in the landscape of the developed areas where non-structural measures would be implemented. Broad-scale elevation of residential structures would alter the elevations and aesthetics throughout the study area, but this would be a continuance of trends in elevating structures that has occurred since Superstorm Sandy through other initiatives. Non-structural measures area included in the FIMP Project, but were screened out of the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Project. Although not expected, if a substantial number of properties undergo a buyout and are returned to an undeveloped condition, land use could be affected resulting in more open space and upland vegetation in flood-prone areas. The TSP would partially break the cycle of storm damage in the Study Area that has built up over the years under the cumulative effect of natural processes acting on an environment altered by human' intervention. The additive damages to homes, businesses, the area’s recreational resources, and its economy would be reduced. The use of natural and non-renewable resources in the salvage, repair, and reconstruction in the aftermath of storm damage would also be reduced.

6.0 Impacts of Complementary Critical Infrastructure Measures (*NEPA Required)

6.1 Climate Change

Complementary localized floodwalls are being considered in addition to the nonstructural measures. Complementary critical infrastructure measures will have minimal impact on the overall hydraulics for the study area related to RSLC and high frequency flooding; however, they will reduce localized damage associated with large-scale critical facilities. The current assessment indicates that implementation of these measures would result in a reduction of $45M average annual damages. The USACE has only quantified the direct (physical) damages reduced to critical facilities; however, indirect (non-physical) coastal storm damages will be evaluated as the study progresses. For example, by mitigating or eliminating indirect damages such as downtime for certain critical infrastructure systems, post-storm recovery time and impacts to regional economic will be improved. Critical infrastructure support also significantly reduces health and safety concerns during and after storm events, particularly for socially vulnerable populations that rely on public utilities and infrastructure stability for vital health services.

6.2 Land Use

Impacts on land use would be the same as the TSP if the complementary critical infrastructure measures are used in conjunction with the TSP (see Section 5.2). Current developed land uses would continue with reduced risk to storm damages. If buyouts/relocations occur it can be expected that those structures would be demolished and the land returned to an undeveloped condition, which ultimately may become permanently flooded (see Section 3.2).

6.3 Floodplains

The complementary critical infrastructure measures are not expected to affect floodplains in the surrounding communities, as they are being tailored to address flood damages to isolated infrastructure and the impacts of the measures to the floodplain would be limited to the critical infrastructure itself.

6.4 Physical Resources

6.4.1 Geological Resources

The complmentary critical infrastructure measures will have permanent and temporary minor impacts on local geology and soil. Construction of floodwalls, levees, sluice/mitre gates, and road/railroad closures require pile driving and excavation and would have minor, localized effects on soils and other local geological resources. However, these activities are not expected to have broadscale impacts on regional geological resources. Because most of the localized floodwalls would be built within the footprint of existing bulkhead, no long-term increases in sediment suspension from scour would be expected. Most activities would occur immediately adjacent to existing bulkheads or in subtidal or intertidal habitat; therefore, prime farmland soils would not be impacted.

6.4.2 Water Resources

The complementary critical infrastructure measures will have temporary, minor localized impacts on water quality. Construction of floodwalls, levees, sluice/mitre gates, and road/railroad closures would require excavation of subtidal or intertidal habitat or construction and dewatering of temporary cofferdams. The majority of the floodwalls are Type C floodwalls and would be built from land. The Type B flood wall in Freeport would be built within dewatered cofferdams. These construction methods will help to minimize impacts, disturbance of sediment, increases in turbidity, decreases in dissolved oxygen, and other water quality impacts. Activities such as excavation, fill, and construction and dewatering of temporary cofferdams could result in localized increases in turbidity and decreases in dissolved oxygen. Increases in turbidity and decreases in dissolved oxygen would be localized and temporary and would be expected to dissipate within a tidal cycle.

Because most of the localized floodwalls would be built within the footprint off existing bulkhead, no long-term increases in turbidity from scour are expected. Sluice and mitre gates would remain open during normal conditions and would be closed during significant storm events. Some temporary, localized, but minor changes in hydrodynamics might occur while the gate is closed. These would dissipate once it is open again.

6.4.3 Physical Oceanography

Because most of the localized floodwalls will be built within the footprint of existing bulkhead, no changes such as scour are expected. Sluice and mitre gates would remain open during normal conditions and would be closed during significant storm events. Future analysis will be conducted to evaluate potential temporary, localized, but minor changes in hydrodynamics anticipated to occur while the gate is closed. These would dissipate once it is open again.

6.4.4 Air Quality

Implementation of the critical infrastructure measures will produce emissions from construction equipment. Impacts are expected to be minor, direct, and short-term, and dispersed throughout the study area at the five independent sites. Once the construction is complete, emissions would cease, and there would be no further direct impacts. As the study area is a non-attainment area for ozone, and maintenance for for 2006 PM-2.5 and carbon monoxide, further coordination would be undertaken with NYSDEC to ensure the project complies with the State Implementation Plan.

6.4.5 Hazardous, Toxic and Radioactive Waste

Implementation of the critical infrastructure measures is not anticipated to affect HTRW sites within the county. USACE will undertake no activity that could result in liability as a potentially responsible party (PRP). Any Civil Works project proposed to be carried out in areas impacted by HTRW should be preceded by response action addressing the contamination acceptable to EPA and state regulatory agencies. If HTRW is encountered during construction, the non-Federal sponsor will be responsible for all HTRW response costs and solely responsible for ensuring that required HTRW response actions are accomplished in accordance with applicable requirements of Federal, state and local regulations. Any HTRW costs incurred by the non-Federal sponsor shall not be credited toward the non-Federal sponsor's share of the total project costs. This does not limit any rights the sponsor may have to recover HTRW costs from responsible parties.

6.4.6 Noise

It is anticipated that there would be short-term, negative noise impacts during construction of the complementary critical infrastructure measures. Although construction impacts would cease once the construction is complete and would be short-term at an individual site, the size of the critical infrastructure measures to be implemented would lead to varying levels of noise impacts. The critical infrastructure measures for the Village of Freeport and City of Long Beach are the most expansive, including 9,100 to 12,250 ft of floodwall with two and four gates, respectively. Noise impacts from construction would be expected to be highest at those sites. However, both sites are in developed areas with elevated noise levels now due to traffic and human activities. The Island Park and Far Rockaway critical infrastructure measures include approximately 7,000 lf of floodwall construction. These measures would protect a generation station and evacuation route. Additionally, the Wantagh component would protect the evacuation route. In all these locations, existing noise levels are characteristic of highways and developed landscapes. Noise levels from construction equipment can range between 74 to 113 dBA (at 50 ft) depending on the equipment. These areas are highly developed environments that typically experiences noise from traffic (70 dBA at 50 ft) and boats (75 to 90 dBA). It can be expected that construction-related noise would be a temporary and direct effect of critical infrastructure measure implementation. Construction would be restricted to daytime operations and will comply with local noise ordinances, and therefore, would be expected to be a moderate impact to the study area communities. The construction noises would be typical of common construction activities.

The critical infrastructure measures would have temporary minor effects on underwater noise. Sources of noise could include vessels and vibratory sheet pile driving in Emory Creek in Freeport only and excavation at the other floodwalls. All impact pile driving would occur on land or in dewatered cofferdams and will have no underwater noise impacts. Impacts from excavation and vessels are expected to be similar to ambient noise levels in the study area. The construction of temporary cofferdams in Emory Creek in Freeport might require the use of vibrating sheet pile into sediments. Vibratory driving is typically quieter than impact hammering. Noise levels associated with vibratory driving of sheet pile are presented in Table 32. These measurements were taken in water that that is much deeper than the study area. The shallower water of the study area might reduce the sound propagation.

Table 32 - Noise levels associated with vibratory driving of sheet pile

Pile	Water Depth	Noise Levels (dB)[1]		
		Peak	RMS	SEL
24-inch section of steel sheet pile	~50 ft	175	160	160
24-inch section of steel sheet pile	~50 ft	182	165	165

Notes: [1] Reference for Peak and RMS is 1 µPa. Reference for SEL is 1 µPa 2 -sec. Sources: Rodkin and Pommerenck 2014,

6.5 Ecological and Biological Resources

6.5.1 Ecosystems and Habitat

The critical infrastructure measures would not affect the Marine Ecosystem within the study area. They would have minor effects on the Barrier Island, Mainland Upland Ecosystems, and Offshore and Atlantic Shores and Inlets. The majority of the permanent habitat impacts are within the Mainland Upland Ecosystem and split between subtidal habitat in Freeport, trees/woodland habitat in Island Park, and undeveloped grasslands and shrubs in Far Rockaway. The Long Beach floodwall is the only floodwall that would be constructed on a barrier island and would have impacts on unvegetated intertidal benthic habitat.

Within the Offshore and Atlantic Shores and Inlets, estuarine open waters would be affected by the Long Beach floodwall. Construction of floodwalls, levees, and miter gates have the potential to result in minor and temporary increases in turbidity and total suspended solids in the vicinity during construction. These would result from activities such as the installation and removal of temporary cofferdams, temporary excavations, fill and rock placement. Other activities such as earth disturbances resulting from construction access activities, staging/storage areas, and upland excavations and soil stockpiles have the potential to generate turbidity as a non-point source. In accordance with Section 402 of the Clean Water Act, a sediment/erosion control plan will be submitted to the county conservation districts for their review and approval. The plan will include measures to avoid these effects, such as rock entrances, silt fencing, physical runoff control, as well as other best management practices. Compliance with the approved sediment/erosion control plan and earth disturbance permit will result in minimal sedimentation/turbidity. Areas disturbed during construction would be subsequently stabilized upon completion of construction activities and turbidity is expected to return to normal levels.

Vessels transiting open estuarine waters and noise and vibrations during the pile driving have the potential to disturb sea turtles. Measures would also be employed to avoid impacts from noise and collision with construction equipment during construction of the Long Beach floodwall in estuarine open waters.

The critical infrastructure measures will likely require pump stations to collect interior drainage from significant precipitation events. These pump stations would generally receive urban run-off from impermeable surfaces such as buildings, streets, and parking lots that may contain typical urban non-point source pollutants such as sediments, bacteria, nutrients, and oil and grease. The pumps would not necessarily increase these stormwater discharge but might focus stormwater at fewer locations based on the pump station location, rather than the current stormwater drainage systems. Currently, stormwater drainage systems might discharge directly into the bays at the street ends or through combined sewers. Stormwater drainage systems vary by community and would require further investigation to determine the appropriate locations and design for the interior drainage pumps and outfalls.

Miter gates will be installed and operated across smaller channels. These gates would remain open during normal conditions and would be closed during significant storm events. Some temporary, localized, but minor changes in hydrodynamics around the gates are expected, however, no significant changes in water quality are expected while the gates are open. Miter gate closures during storms may temporarily affect water quality in a localized area by inhibiting circulation and mixing.

Table 33 and Table 34 provide preliminary estimates of permanent and temporary habitat impacts of the critical infrastructure measures, respectively. Figure 58, provides an overview of the critical infrastructure measures' footprints relative to habitat impacts; however, design details, including alignments are limited at this time.

Table 33 - Nassau County Back Bay Wetlands and Undeveloped Uplands Permanent Impacts (06/24/2021)

Location	Beach	Unvegetated Estuarine Subtidal Benthic Habitat (LZ)	Unvegetated Estuarine Intertidal Benthic Habitat (Shoals, Bars, and Mudflats - SM)	Vegetated Wetland Habitat (Intertidal Marsh - IM, E2EM1P, FC)	Palustrine Forested (PFO1Ad)	Undeveloped Upland: Trees	Undeveloped Upland: Grassland and Shrubs
Long Beach	0.00	0.09	0.41	0.00	0.00	0.00	0.00
Island Park	0.00	0.19	0.04	0.07	0.00	0.00	3.54
Freeport	0.00	2.64	0.00	0.04	0.00	0.00	0.00
Far Rockaway	0.00	0.03	0.01	0.06	0.00	0.00	3.45
Wantagh	0.00	0.00	0.00	0.00	0.00	0.41	0.00
Total Impacts	**0.00**	**2.97**	**0.46**	**0.17**	**0.00**	**0.41**	**6.99**

Table 34 - Nassau County Back Bay Wetlands and Undeveloped Uplands Temporary Impacts (06/24/2021)

Location	Beach	Unvegetated Estuarine Subtidal Benthic Habitat (LZ)	Unvegetated Estuarine Intertidal Benthic Habitat (Shoals, Bars, and Mudflats - SM)	Vegetated Wetland Habitat (Intertidal Marsh - IM, E2EM1P, FC)	Palustrine Forested (PFO1Ad)	Undeveloped Upland: Trees	Undeveloped Upland: Grassland and Shrubs
Long Beach	0.00	0.17	0.70	0.00	0.00	0.00	0.00
Island Park	0.00	0.11	0.04	0.06	0.00	0.00	4.15
Freeport	0.00	2.64	0.00	0.08	0.01	0.00	0.00
Far Rockaway	0.00	0.02	0.01	0.11	0.00	0.00	4.05
Wantagh	0.00	0.00	0.00	0.00	0.00	0.43	0.00
Total Impacts	**0.00**	**2.94**	**0.75**	**0.25**	**0.01**	0.43	8.2

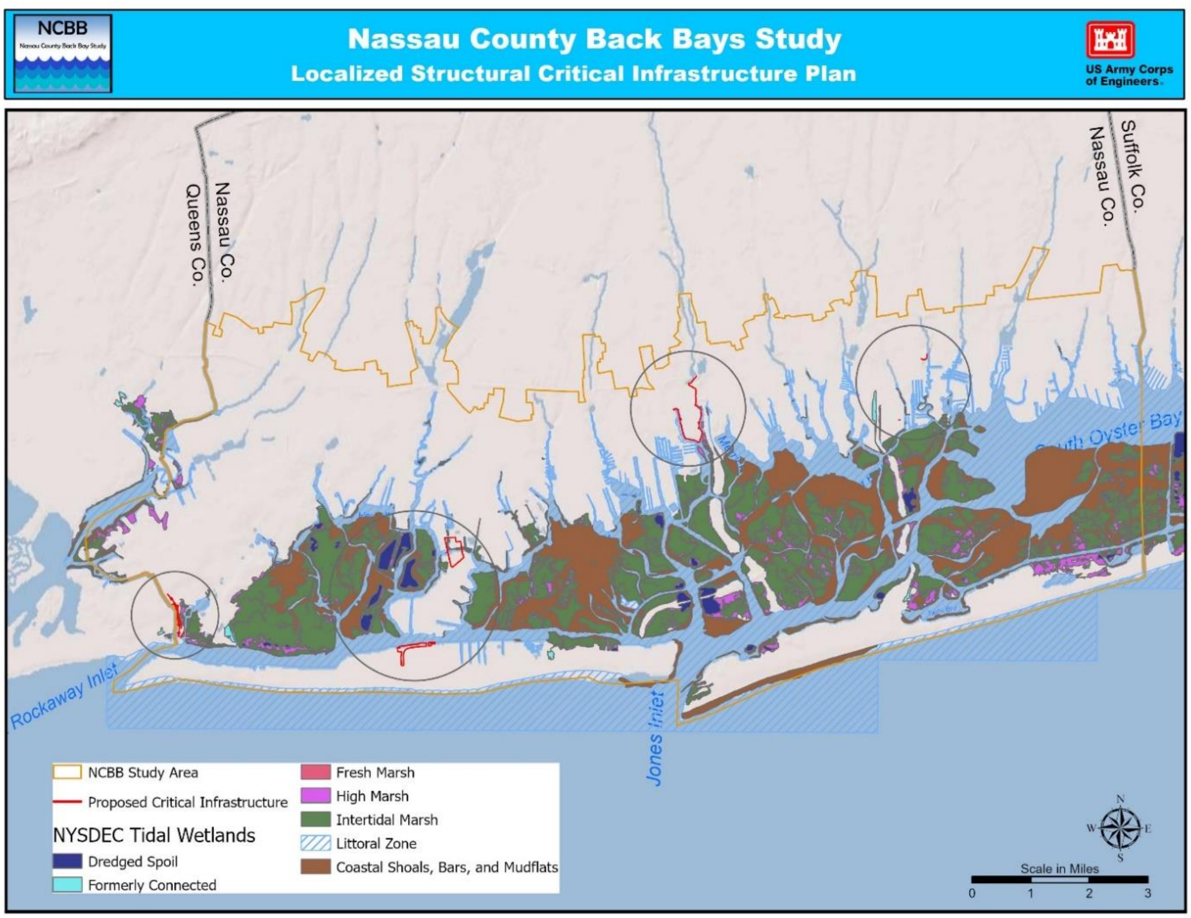

Figure 58 - Critical Infrastructure Measures Footprints

Most of the action area affected by the perimeter plan options are urbanized or industrialized areas, with bulkheads lining the back bays and lagoons. Most of the floodwalls associated with the critical infrastructure measures are being constructed on existing bulkheads and hardened shorelines. Therefore, impacts to the Mainland Upland and Barrier Island Ecosystems are expected to be minor.

6.5.2 Wetlands

Construction of the floodwalls, levees and miter gate structures within coastal wetlands and shallow bay waters result in the impacts on small pockets off vegetated and unvegetated wetlands scattered throughout industrial/residential areas in the study area.

The critical infrastructure measures would result in the permanent impact of 0.17 acre of intertidal marsh, approximately in 0.46 acres of unvegetated estuarine intertidal benthic wetlands, and 2.95 acres of estuarine subtidal benthic habitat. The unvegetated subtidal habitat in Freeport is in Emory Creek/Stadium Park Canal in an industrialized area along what appears to be a hardened shoreline. Most of the unvegetated intertidal benthic habitat that would be affected is along the backbay shoreline of Long Beach. This is the only section that is directly adjacent to estuarine open water. Losses would result from either their removal from excavations or burial from fill placement.

Additionally, a temporary impact to 0.25 acres of intertidal marsh could be experienced through the placement of de-watering structures and either temporary fills or excavations for temporary access points to the work segment.

No jurisdictional wetland delineations have been conducted along the critical infrastructure measure alignments. Preliminary estimates of the affected wetland and shallow water habitats are based on existing mapping (NYSDEC 1974), the current (preliminary) alignments, and an assumed width of the disturbance offset from the structure. Therefore, these impact estimates may be modified and refined based on a higher level of design detail that include surveyed wetland jurisdictional lines and mitigation measures that first employ avoidance and minimization. It is assumed that for unavoidable wetland and aquatic habitats, compensatory mitigation will be required.

Temporary indirect impacts from construction of the critical infrastructure measures on vegetated wetlands are expected to be minimal to moderate and are related to impacts such as sedimentation during construction. Long-term indirect impacts are related to hardened structures potential halting landward migration of marshes, particularly with sea level rise. However, this effect is not expected to be significant since the majority of the shorelines along the back bays already are hardened with bulkheads, concrete revetments and riprap.

6.5.3 Vegetation

6.5.3.1 Submerged Aquatic Vegetation

Construction of floodwalls and miter gate associated with the critical infrastructure measures are not expected to have direct or indirect impacts on SAV. SAV only occurs on the eastern side. Surveys as recent as 2018 and no SAV occurs near critical infrastructure.

6.5.3.2 Upland Vegetation

Woodlands are not common in the study area. The critical infrastructure measures would result in approximately 4.5 acres of permanent impacts and less than an acre of temporary impacts of wooded edge habitat. The majority of the trees/woodland at Island Park are at the edge of an industrialized area.

The critical infrastructure measures would result in approximately 3.8 acres of permanent impacts and approximately 8 acres of temporary impacts to undeveloped grassland and shrubland habitat. The majority of this undeveloped habitat at Far Rockaway is edge habitat along the State Route 878.

6.5.4 Terrestrial and Aquatic Widllife

6.5.4.1 Wildlife

The construction of floodwalls, sluice and miter gates, and road/railroad closures will have direct and indirect, minor, temporary, and permanent impacts on wildlife. Impacts would include habitat loss and disturbance from noise and construction equipment.

Noise impacts would be temporary and minor. The urban adapted wildlife present at the construction area would be temporarily displaced. Most of the wildlife are expected to return to the vicinity of the work areas once construction activities cease and the areas are stabilized.

Construction would result in permanent and temporary impacts on habitat as shown in

Table 33 and Table 34. Most of the habitat occurs in small pockets throughout the highly developed study area and is not expected to be high quality habitat. Wildlife inhabiting these areas are expected to be habituated to a certain amount of noise and disturbance.

The critical infrastructure measures would result in approximately 0.41 acres of permanent impacts and 0.43 acres of temporary impacts to wooded habitat in Wantagh. These impacts would occur along the ramp onto the Seaford-Oyster Bay Expressway. The critical infrastructure measures would result in approximately 7 acres of permanent impacts and approximately 8 acres of temporary impacts to undeveloped grassland and shrubland habitat. These impacts are split between Island Park and Far Rockaway. The habitat at Island Park adjacent to an industrialized area. That habitat at Far Rockaway is along the State Route 878. Although design details are limited at this time, removal of potential roost trees would be avoided to the extent practicable.

Wildlife species such as shorebirds and wading birds that feed in intertidal mudflats and saltmarshes would permanently lose approximately 0.17 acres of vegetated intertidal habitat and 0.46 acres of unvegetated intertidal habitat. Most of the impacted unvegetated intertidal benthic habitat is along the backbay shoreline of Long Beach adjacent to an industrial area. The shoreline appears to be stabilized with riprap. The impact to shorebirds and wading birds is expected to be minor because the quality of the habitat is expected to be marginal, the area of impacted habitat is small relative to similar available habitat, and all wetland impacts would be mitigated.

Vertical barriers such as floodwalls will be constructed in highly developed areas on hardened shorelines. Therefore, they are not expected to cut-off access between aquatic and terrestrial habitats for species such as diamondback. In some locations, a floodwall may act as a barrier that prevents diamondback terrapins from crossing roads thereby, preventing mortalities resulting from vehicle strikes.

6.5.4.2 Aquatics

Construction of floodwalls, sluice and miter gates, and road/railroad closures will have direct and indirect, minor, temporary, and permanent impacts on aquatic species. The majority of the floodwalls are Type C floodwalls and would be built from land. The Type B flood wall in Freeport would be built within dewatered cofferdams. These construction methods will help to minimize impacts including noise, displacement from habitat, increases in turbidity, decreases in dissolved oxygen, sediment disturbance, and direct injury of fish and shellfish from construction equipment.

Impacts of underwater noise on aquatic species is expected to be minor. Sources of noise could include vessels and vibratory sheet pile driving in Emory Creek in Freeport only and excavation at the other floodwalls. All impact pile driving would occur on land or in dewatered cofferdams. Impacts from excavation and vessels are expected to be similar to ambient noise levels in the study area. The construction of temporary cofferdams in Emory Creek in Freeport might require the use of vibrating sheet pile into sediments. Vibratory driving is typically quieter than impact hammering. Noise levels associated with vibratory driving off sheet pile are presented in Table 32. These measurements were taken in water that that is much deeper than the study area. The shallower water of the study area might reduce the sound propagation. While these noise levels could result in behavioral effects on marine species, vibratory driving to construct cofferdams would only occur in Emory Creek and sensitive species such as sea turtles, marine mammals, and Atlantic sturgeon are not expected to occur in this area. Other fish that might be affected by this sound are highly mobile and are expected to move away from this sound source.

While increases in turbidity and decreases in DO can adversely affect fish and shellfish, these effects are expected to be minimized by proposed construction methods from land and in dewatered cofferdams. The generation of turbidity can adversely affect fish respiration, sight feeding, and could smother eggs/larvae. The generation of turbidity can also affect dissolved oxygen levels that can result in either mortalities or heavily stressed fish. The generation of turbidity and low DO could also result in lethal or sub-lethal effects on shellfish. All impacts are expected to be localized and local shellfish and invertebrate communities should recover quickly in areas of temporary disturbance.

Construction activities could result in direct injury to fish and shellfish. Most mobile fish and shellfish (e.g., blue crabs) would be able to move out of active construction areas. This may not be possible for smaller species and egg and larval stages and sessile shellfish (e.g., hard clams). More mobile fish and shellfish may become trapped in a construction segment, such as a temporary cofferdam. Most of the critical infrastructure measures would be constructed from onshore, which would minimize the potential for injury. Approximately 8,220 linear feet of floodwall in Freeport is type B floodwall and would involve marine construction; however, this construction would occur within temporary cofferdams.

The critical infrastructure measures would also result in loss and disturbance of aquatic habitat including vegetated estuarine intertidal habitat and unvegetated estuarine tidal and intertidal habitat (see

Table 33 and Table 34). However, most of this habitat is adjacent to existing bulkheads and other hardened shoreline features. The habitat loss is based on the width of a proposed floodwall in these areas that would be wider than the existing structure. The highest permanent loss of aquatic habitat is unvegetated subtidal soft bottom habitat in Freeport near Emory Creek. In total, approximately 2.9 acres of subtidal habitat would be permanently lost and another 2 acres of subtidal habitat would be temporarily disturbed. Less than an acre of vegetated and unvegetated intertidal habitat would be permanently lost or temporarily disturbed (see

Table 33 and Table 34). These habitats are in pockets throughout residential and industrial areas. The impact to fish and shellfish is expected to be minor because the quality of the habitat is expected to be marginal, the area of impacted habitat is small relative to similar available habitat, and all wetland impacts would be mitigated.

Operation of floodwalls along intertidal and subtidal areas might require pumps to dewater the areas inside the walls during storms. Pumps would not increase discharge of storm water during a storm but concentrate it in one location. This would result in localized water quality impacts (i.e., increases in turbidity and decreases in dissolved oxygen). This would result in localized long-term intermittent adverse effect on fish and shellfish communities, but these impacts are expected to be minor.

6.5.5 Protected Resources

6.5.5.1 Threatened and Endangered Species

Construction of floodwalls, sluice and miter gates, and road/railroad closure will have direct and indirect, minor, temporary, and permanent impacts on state and federal species. Impacts species would be similar to the impacts on wildlife and aquatic species described in Section 5.5.4. Impacts on federally listed species are fully described in the Biological Assessment in Appendix G2 and summarized here.

Because critical infrastructure measures would not affect the habitat of the following species, the USACE has determined that the critical infrastructure measures would have no effect on the following listed species.

- Shortnose sturgeon
- Northeastern Beach Tiger Beetle
- Piping plover
- Seabeach amaranth
- Northern long eared bat

Northern Longeared Bat. The critical infrastructure measures would result in approximately 0.41 acres of permanent impacts and 0.43 acres of wooded habitat in Wantagh. These impacts would occur along the ramp onto the Seaford-Oyster Bay Expressway. Although design details are limited at this time, removal of potential roost trees would be avoided to the extent practicable. If potential roost trees cannot be avoided, the USFWS would be consulted as appropriate under the ESA 4(d) rule.

Eastern Black Rail. Eastern black rails have the potential to forage, rest, and migrate through the study area. Construction of floodwalls directly adjacent to vegetated marshes has the potential to affect eastern black rails. Construction of floodwalls would result in the total loss of 0.17 acres of intertidal marsh. Construction would take place in small patches of habitat within industrial or developed areas, which is not expected to provide optimal habitat for eastern black rail. Additionally, nesting is not expected; the last known breeding record in Nassau County was in 1940. Therefore, impacts on black rail are not expected.

Roseate Tern. Roseate terns have the potential to forage, rest, and migrate through the study area. Noise associated with construction and maintenance of floodwalls has the potential to result in minor impacts on roseate flight and foraging behaviors, including flushing from these activities. These disturbances could occur from upland or aquatic construction or maintenance activities. These impacts are expected to be temporary and localized. The only floodwall adjacent to estuarine open waters (which roseate terns use for foraging) is the Long Beach floodwall. Because this is a residential/industrialized area, impacts are expected to be minimal.

Red Knot. Red knots have the potential to forage, rest, and migrate through the Study area. Noise associated with construction and maintenance of floodwalls has the potential to result in minor impacts on red knot flight and foraging behaviors, including flushing from these activities. Noise and sediment disturbances caused by aquatic construction activities have the potential to indirectly affect red knot by disturbing benthic invertebrates (food source for red knot) in intertidal habitat. Because this is a residential/industrialized area, impacts are expected to be minimal.

Atlantic Loggerhead, Kemp's Ridley, Atlantic Green, and Leatherback Sea Turtle. Construction, operation, and maintenance of the floodwalls have the potential to result in negligible effects on sea turtles. Atlantic Loggerhead, Kemp's Ridley, Atlantic Green, and leatherback sea turtles have the potential to occur in the study area, typically from May through November. Leatherback sea turtles generally occur further offshore than the other sea turtles. Construction of the Long Beach floodwall would have temporary impacts on estuarine open waters and unvegetated intertidal and subtidal benthic habitat, where sea turtles may occur. All other construction would occur at tidal creeks. Construction of floodwalls is not expected to impact SAV, which serves as sea turtle forage habitat.

Minor and temporary increases in turbidity and noise from construction activities such as the installation and removal of temporary cofferdams, temporary excavations, and fill and rock placement could disturb sea turtles. However, these impacts would be localized. Temporary disturbances of unvegetated intertidal and subtidal habitats (potential sea turtle forage habitat) may be experienced through the placement of de-watering structures and either temporary fills or excavations for temporary access points to the work segment. Because, these impacts would be localized they are expected to be negligible.

All other cofferdams would be built and dewatered in a tidal creek, where sea turtles are not expected to be present. Temporary habitat impacts could also result from sedimentation caused by sediment disturbance. Benthic habitats are expected to recover quickly. Because these impacts are temporary and localized, impacts are expected to be insignificant.

Underwater noise impacts on sea turtles are expected to be insignificant . Sources of noise could include vessels and vibratory sheet pile driving in Emory Creek in Freeport only and excavation at the other floodwalls. All impact pile driving would occur on land or in dewatered cofferdams. Noise impacts from excavation and vessels are expected to be similar to ambient noise levels in the study area. The construction of temporary cofferdams in Emory Creek in Freeport might require the use of vibrating sheet pile into sediments. Sea turtles are not expected in Emory Creek. Therefore, impacts from vibratory driving are not expected. If onshore construction and pile driving in dewatered cofferdams cannot be avoided when sea turtles are present in the study area, BMPs would be implemented to avoid and minimize impacts on sea turtles; examples include:

- Develop a protected marine species monitoring and shut down plan.
- For pile driving, use a vibratory hammer instead of an impact hammer, to the maximum extent practicable.
- Use cushion blocks or other noise attenuation devices when using an impact hammer for pile driving.
- Limit pile driving activities to no more than 12 hours per day.
- Use a "soft start" for a pile driving activities where driving does not occur at full power at first.
- Pile driving should be carried out in a way that avoids exceeding noise thresholds identified for the protected marine species that occur in the study area.

Interactions between vessels and sea turtles in open estuarine waters are also expected to be minimal based on the current construction plan. When vessels are needed, NMFS vessel operation BMPs would be implemented to the maximum extent practicable to avoid and minimize potential vessel interactions; these include:

- Shallow draft vessels that maximize the navigational clearance between the vessel and the estuary bottom should be used where possible.
- Vessels should operate at speeds of less than 10 knots. Whenever operating in areas where whales or sea turtles or marine mammals are present. A look out should be posted and measures taken to slow down and avoid any whales or sea turtles spotted.

Construction, operation, and maintenance of the critical infrastructure floodwalls is expected to result in negligible impacts on sea turtles. Habitat losses would be minimal. Noise and vessel and construction equipment interaction would be avoided using onshore construction and BMPs when necessary.

Atlantic Sturgeon. Atlantic sturgeon might use the Nassau County Back Bay and the nearshore coastal waters off Nassau County, NY during their adult marine lifestage, but typically occur further offshore than the study area. While this species has the potential to be affected by noise and vessel operations associated with construction, operation, and maintenance of the Long Beach floodwall, the potential for these impacts is negligible because this species occur further offshore than the impacts.

6.5.5.2 Migratory Birds

Construction of floodwalls, sluice and miter gates, and road/railroad closure will have direct and indirect, minor, temporary, and permanent impacts on migratory birds. As described in Section 5.5.5, impacts would occur in terrestrial and woodland habitats and would result in habitat loss. However, habitat is not expected to be high quality habitat. BMPs would be employed to avoid takes under the Migratory Bird Treaty Act (MBTA). These could include seasonal restrictions or monitoring for nests and nesting behavior.

6.5.5.3 Marine Mammals

Harbor seals, gray seals and bottlenose dolphins have the potential to occur in the study area. Construction of the Long Beach floodwall would have temporary impacts on estuarine open waters and unvegetated intertidal and subtidal benthic habitat, where marine mammals may be present. Construction of the Long Beach floodwall could result in minor and temporary increases in turbidity in open estuarine waters where marine mammals could occur. These impacts are expected to be extremely localized and would not be expected to affect marine mammals. All other floodwalls would be constructed in tidal creeks.

Underwater noise impacts on marine mammals are not expected. Sources of noise could include vessels and vibratory sheet pile driving in Emory Creek in Freeport only and excavation at the other floodwalls. All impact pile driving would occur on land or in dewatered cofferdams. Impacts from excavation and vessels are expected to be similar to ambient noise levels in the study area. The construction of temporary cofferdams in Emory Creek in Freeport might require the use of vibrating sheet pile into sediments. Marine mammals are not expected in Emory Creek. Therefore, impacts from vibratory driving are not expected. If onshore construction and pile driving in dewatered cofferdams cannot be avoided when marine mammals are present in the study area, BMPs would be implemented to avoid and minimize impacts; examples include:

- Develop a protected marine species monitoring and shut down plan.
- For pile driving, use a vibratory hammer instead of an impact hammer, to the maximum extent practicable.
- Use cushion blocks or other noise attenuation devices when using an impact hammer for pile driving.
- Limit pile driving activities to no more than 12 hours per day.
- Use a "soft start" for a pile driving activities where driving does not occur at full power at first.
- Pile driving should be carried out in a way that avoids exceeding noise thresholds identified for the protected marine species that occur in the study area.

Vessel use in open estuarine waters and therefore the potential for marine mammal-vessel interactions are also expected to be minimal based on the current construction plan. When vessels are needed, NMFS vessel operation BMPs would be implemented to the maximum extent practicable to avoid and minimize potential vessel interactions; these include:

- Shallow draft vessels that maximize the navigational clearance between the vessel and the estuary bottom should be used where possible.
- Vessels should operate at speeds of less than 10 knots. Whenever operating in areas where whales or sea turtles or marine mammals are present. A look out should be posted and measures taken to slow down and avoid any whales or sea turtles spotted.

Construction, operation, and maintenance of the critical infrastructure floodwalls is expected to result in negligible impacts on marine mammal habitat. Habitat disturbance and losses would be minimal. Noise and vessel and construction equipment interaction would be avoided using onshore construction and BMPs when necessary.

6.5.5.4 Essential Fish Habitat

Within the project area, there is a diversity of species with EFH designations. These species utilize a broad array of habitats and include pelagic and benthic species as well as those that inhabit multiple types of habitats.

Construction of the complementary critical infrastructure measures would result in minor temporary and permanent effects on EFH. Impacts from construction would result in minor disturbance and loss of tidal, intertidal, and wetland habitats. Those species utilizing intertidal and shallow subtidal benthic habitats (flounders, ocean pout, scup, pollock, and skates) have the most potential to be affected by the proposed critical infratrusture plan. However, those impacts would be expected to be low to moderate due to their mobility, the extent of construction, and the current quality of the habitat.

More specifically, a total 2.97 acres of unvegetated subtidal shallow areas would be permanently impacted, with an additional 2.94 acres of temporary impacts as well due to cofferdams, excavation, etc. These impacts would occur in tidal creeks and would be adjacent to existing bulkheads and hardened shoreline. This habitat is marginal, and the impact would constitute a small impact relative to the similar available habitat in the study area.

A total of 0.46 acres of unvegetated intertidal areas including bars, shoals, and mudflats would be permanently impacted, with an additional 0.75 acre of temporary impacts. Most of these impacts would occur at the Long Beach floodwall in open estuarine waters in an industrialized area and are adjacent to shoreline that is heavily riprapped. This habitat is marginal and the impact would constitute a small impact relative to the similar habitat in the study area.

Permanent impacts to intertidal vegetated wetlands could impact prey species for some species. These impacts include 0.17 acre of permanent impacts to intertidal marsh (0.25 acre of temporary impact during construction), and 0.01 acre of temporary impacts to forested wetland during construction. These impacts would occur in tidal creeks and would be adjacent to existing bulkheads and hardened shoreline. This habitat is marginal, and the impact would constitute a small impact relative to the similar available habitat in the study area.

The impacts would primarily occur in EFH 10 minute x 10 minute square 2, which covers the waters within the central section of Hempstead Bay, Reynolds Channel, Middle Bay, East Bay, Jones Inlet and Long Beach. Critical infrastructe measure work locations within this square include the majority of the Long Beach critical infrastructure measures, the Island Park critical infrastructure measures, and the Freeport critical infrastructure measures. The Freeport critical infrastructure measures would have the greatest potential to directly affect EFH for this species and would result in a loss of 2.64 acres of shallow subtidal habitat and 0.04 acres of intertidal marsh habitat. There would be no effects in EFH 10 x 10 square 3 (Wantagh critical infrastructure measures). Except for the minimal impacts in EFH 10 x 10 square 1 associated with the Far Rockaway critical infrastructure measures (0.1 acres across habitats) and a small portion of the Long Beach critical infrastructure measures, impacts are limited to EFH 10 x 10 square 2 (2.94 ac of shallow subtidal habitat; 0.45 acres of shoals, bars, and mudflats; and 0.11 acres of intertidal marsh).

While construction would be conducted from shore or within a cofferdam, some minor localized increases in turbidity would occur, but these are expected to dissipate within a tidal cycle. While increases in turbidity have the potential to interfere with foraging, and potentially smother certain species temporarily, impacts occur in marginal habitat and would be extremely localized. Impacts would be minimized through use of cofferdams, onshore construction and erosion and sediment control BMPs. Further, undertaking the project in the winter would minimize interactions with or impacts to some species.

6.6 Cultural Resources

6.6.1 Historic Properties including Archaeological Resources

Far Rockaway. No historic properties are noted within the proposed floodwall location. The Rockaway Hunt and Isle of Wight Historic Districts are located east of Bannister Bay, while the West Lawrence Historic District is located to the north. The Rock Hall and Rock Hall Museum Grounds archaeological site are located northeast of the evacuation route area. Due to the archaeological sensitivity of the overall area, an assessment of the floodwall footprint would be required to assess for archaeological potential.

Island Park. According to the CRIS database, there are two historic properties (buildings) within the footprint of the Island Park area, of which one is not eligible (Barrett Substation) for the National Register and one is undetermined (2-story administration building on McCarthy Road) (NYSHPO 2021). However, this entire area is designated as archaeologically sensitive and would require an assessment of the floodwall and gate footprint and configuration for impacts upon historic properties.

City of Long Beach. This area of Long Beach does not have any recorded historic or archaeological sites within the footprint of the proposed floodwall configuration. Numerous properties on the south side of Water Street have been designated as not eligible for the National Register; several are noted as undetermined. However, as this entire area is designated archaeologically sensitive, an assessment of the floodwall and gate footprint and configuration for impacts upon historic properties would be required.

Freeport. The Freeport Commercial Area does not have any recorded historic properties within its area for a proposed floodwall and gate system; however, just to the north is the archaeological site for the Raynor Gristmill and Sawmill Sites and House, and the National Register eligible Hewlett-Raynor House. On the eastern side, the proposed floodwall would be located on the boundary of the Jones Beach State Park, Causeway and Parkway System. Additionally, the entire area is designated as archaeologically sensitive and would require an assessment of impacts to the above historic properties as well as any others that may be present and not yet identified in the floodwall configuration.

Wantagh. The area surrounding the Wantagh Wastewater Treatment Plant does not have any recorded historic properties within its area. The Cedar Creek Water Pollution Control Plant building (east of Wantagh State Parkway) was determined not eligible for the National Register. However, on the western side, the proposed floodwall would be located on the boundary of the Jones Beach State Park, Causeway and Parkway System. Additionally, the entire area is designated as archaeologically sensitive and would require an assessment of impacts to Jones Beach as well as any other sites or properties that may be present and not yet identified within the floodwall configuration.

The area surrounding the evacuation route (No. 4) for the Hamlet of Wantagh does not have any recorded historic properties within the area of potential effect. However, as the overall area is designated as archaeologically sensitive, an assessment of the footprint for the floodwall would be required to determine if there is the potential for unidentified properties to be present.

6.6.1 Shipwrecks and Submerged Historic Properties

Construction of the floodwalls as part of the critical infrastructure measures have the potential to cause adverse effects to shipwrecks and submerged historic properties along and adjacent to the walls' footprint. However, the extent of adverse effects is not known at this time. Archaeological assessments and surveys, if needed, along the footprint of the floodwall configurations and any offshore areas should be conducted to identify all historic properties that may be impacted by construction.

6.6.2 Conclusions

In general, construction of the critical infrastructure floodwalls have the potential to cause adverse effects to nearby historic districts and numerous historic properties or archaeological sites along and adjacent to its footprint. However, the extent of adverse effects is not known at this time. Archaeological and architectural assessments and surveys, if needed, along the footprint of the floodwall configurations should be conducted to identify all historic properties that may be impacted by construction.

Historic, architectural and archaeological studies and investigations will be necessary to complete identification of all significant resources within the APE (study area). Additional evaluation of known historic districts and properties may be required to update their resource inventories and boundaries and confirm current integrity. Additional investigations will be required to determine the level of adverse effect from the proposed non-structural measures of the overall NCBB study.

In accordance with Section 106 of the NHPA of 1966, as amended and its implementing regulations, 36 CFR 800, it is recommended that a Programmatic Agreement (PA) be prepared as part of the Final Feasibility Report and Environmental Impact Statement. The PA is a binding agreement between the NY SHPO and the USACE and that outlines the activities and tasks that must be carried out to conclude identification of significant resources, determine adverse effects, and mitigate for those adverse effects. These activities include carrying out additional archaeological and architectural investigations based on the locations of project elements; coordination and consultation with the NY SHPO, interested parties and federally recognized Tribes; and preparation of NRHP nomination forms.

The PA should also stipulate that, depending upon the results of surveys, treatment plans or a standard mitigation agreement will be prepared to outline the specific mitigation measures that will be taken to address adverse effects on structures and archaeological sites that cannot be avoided. Treatment plans or mitigation agreements would include but not be limited to specialized design guidelines for historic structures to ensure that flood protection measures are consistent with the historic fabric of the buildings, the design of the project elements fit the character of the historic districts, and the scope of data recovery for archaeological sites that cannot be avoided. Treatment plans and agreements for archaeological sites identified within the critical infrastructure floodwall measure, if selected, should also be included to address these specific alternatives.

6.7 Recreational Resources

Only the Freeport component of the critical infrastructure measures is anticipated to impact recreational resources. The construction of a 16 foot Type B floodwall around the commercial area that lies on the peninsula below Mill Road and west of Meadowbrook State Parkway would limit recreational access to The Narrows and Stadium Park Canal. This would be a permanent, direct, and major impact.

6.8 Aesthetics

The critical infrastructure measures would result in direct and permanent alterations to the viewshed at the five sites. No changes are expected to the aesthetics of natural areas. A description of anticipated impacts for each site is provided below:

Far Rockaway: The viewshed from the Nassau Expressway north and south of the intersection with Seagirt Blvd (north of the Atlantic Beach Bridge) would be permanently limited by the construction of a 16 foot Type C floodwall on either side of the road (7,059 ft). As this change would occur along a roadway (evacuation route), this is projected to be a minor impact.

Island Park: The viewshed in the vicinity of the E.F. Barrett Generation Plant would be permanently altered by construction of a 16 foot Type C floodwall (6,951 ft) around the plant and two sluice gates in the channel that bisects the plant. As this change would occur around an industrial site, this is projected to be a minor impact.

City of Long Beach: The viewshed around the following facilities would be permanently altered by the construction of a 16 foot Type C floodwall (10,283 ft): Long Beach Train Station, the water treatment plant, the wastewater treatment plant, the maintenance yard, the Long Beach Tennis Center, and the Mt. Sinai Mount Sinai South Nassau - Off-Campus Emergency Department at Long Beach. Additionally, the waterfront along this portion of the City of Long Beach would now be hardened with a 16 foot Type C floodwall. The impact to aesthetics from this component would be expected to be moderate because the area is industrial in nature but neighbored by residential communities and includes hardening the shoreline.

Village of Freeport: The Village of Freeport Industrial/Commercial Area situated on the peninsula that lies below Mill Road and west of Meadowbrook State Parkway would be confined by a 16 foot Type B floodwall (8,221 ft). Additionally, a Type C floodwall would extend from the eastern terminal of the Type B floodwall adjacent to the Meadowbrook State Parkway (4,024 ft). Although largely commercial, there are some undeveloped tree-lined portions of the shoreline in this area that are currently only rip-rip. There are also docks and water access throughout the peninsula. Given the current mix of commercial and recreation in this area, the construction of a 16 foot floodwall would have a major impact on the existing viewshed around the peninsula in Freeport of the Narrows and Stadium Park Canal. The implementation of the Type C floodwall to the north adjacent to the Meadowbrook State Parkway would be expected to be minor as the floodwall would hug the developed land and limit the view of the parkway.

Hamlet of Wantagh: The viewshed in the vicinity of the Cedar Creek Wastewater Treatment Plant would be permanently altered by construction of a 16 foot Type C floodwall (6,080 ft) around the plant. As this change would occur around an industrial site, this is projected to be a minor impact. Additionally, construction of a 16 foot Type C floodwall (792 ft) to protect an evacuation route along the on-ramp for Seaford-Oyster Bay Expressway would limit the southern viewshed. As this change would occur along a roadway (evacuation route), this is projected to be a minor impact.

6.9 Socioeconomic Conditions

By reducing coastal storm risk damage and adding resiliency to the critical infrastructure within the study area, the critical infrastructure measures are expected to have permanent, long-term and positive impacts on the socioeconomic resources of the Study Area. While there would be initial investments needed to implement the critical infrastructure, the localized floodwall measures will reduce damages to critical infrastructure that will allow communities to be more resilient and recover quicker from storms. In addition, reducing damages to critical infrastructure promotes a more socially equitable solution that benefits a wide range of citizens with varying socioeconomic conditions.

6.10 Navigation

Miter gates would be used in navigable waterways, while sluice gates would be used to prevent flooding in upper creek reaches where navigation is not a concern or in areas where the floodwall will cut off flow to a small stream, creek, tidal wetland or marsh. Miter gates are not proposed in any of the critical infrastructure measures. There is one sluice gate proposed for the localized floodwalls in Far Rockaway and two sluice gates proposed in Island Park. As only sluice gates are included, it would be expected that there would be no impact on navigation. Any small watercrafts that may use these waterways would be able to access the channels when the sluice gates are open. Under flood conditions when the gates would be closed, small watercraft would not be expected to be in these areas and therefore no impacts to navigation would be expected.

6.11 Cumulative Impacts

Based on the impacts analysis, resources with minor adverse impacts from the complimentary critical infrastructure measures were considered for inclusion in the cumulative impacts analysis. The complimentary critical infrastructure measures would have a minor adverse impact on the resources listed below and could contribute to cumulative regional impacts in addition to those discussed in Section 5.11 associated with the TSP:

- Land use
- Water Quality
- Physical Oceanography (hydrodynamics)
- Air Quality
- Noise
- Wetlands – estuarine subtidal benthic habitat, intertidal benthic habitat, low and high marsh, and palustrine forested wetlands
- Wildlife
- Upland Vegetation
- Recreational Resources
- Visual Resources
- Socioeconomic Conditions

The complimentary critical infrastructure measures would add resiliency and storm risk reduction measures for critical infrastructure in Nassau County to the regional CSRM network that includes efforts underway through a series of USACE projects: The Atlantic Coast of New York, Jones Inlet to East Rockaway Inlet, Long Beach Island, New York Storm Damage Reduction Project; East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Project; Long Beach Erosion Control; The Fire Island Inlet to Montauk Point, New York Combined Beach Erosion Control and Hurricane Protection Project; and Jamaica Bay Ecosystem Restoration; Shinnecock Inlet Navigation Project, the Westhampton Interim Project, the Moriches Inlet Navigation Project, and the West of Shinnecock Project (see Section 1.8 for further discussion); as well as local and regional efforts. The cricital infrastructure measures would protect evacuation routes, areas of high economic development, an energy generation plant, and a wastewater treatment plant. The viability of the socioeconomic resources of the region are enhanced by preventing or minimizing damages to these resources.

The complimentary critical infrastructure measures would have a minor impact on aquatic resources in the region. Most of the floodwalls associated with the critical infrastructure measures are being constructed on existing bulkheads and hardened shorelines. Therefore, impacts to the Mainland Upland and Barrier Island Ecosystems are expected to be minor. Situating these proposed projects on already hardened shorelines minimizes potential impacts to the regional ecosystem that would be expected from further shoreline hardening. As documented in Section 6.5.2, approximately 3.6 acres of aquatic habitat would be permanently converted to structures. The majority of this impact is to shallow estuarine benthic habitat (2.9 ac). The remainder of the impact is to unvegetated estuarine intertidal benthic habitat (0.46 ac) and vegetated estuarine intertidal benthic habitat (0.17 ac). Additionally, 3.95 acres of aquatic habitat would be temporarily impacted during construction. As with permanent affects, the majority of the impact is to shallow estuarine benthic habitat (2.94 ac). Both the permanent and temporary impacts would be concentrated in Freeport (2.64 ac). The remainder of the acreage is spread across the region at the other 4 critical infrastructure measure locations. The aquatic habitat to be impacted are along shorelines with substantial development, and currently do not provide optimal habitat to wildlife. The most substantial impact to resources would occur at Freeport along a heavily developed shoreline. These impacts would contribute to the substantial historic wetland loss that has occurred over the past century with human development in the region (0.17 ac of permenant and 0.26 ac of temporary impacts to vegetated wetlands).

Upland habitat and vegetation would also be negatively impacted by the project, and serve as a moderate contribution to further development of a highly developed landscape. The maroity of the upland impacts are associated with the Far Rockaway and Island Park components. A small portion of the impacts are tied to the Wantagh component. Permanent impacts would affect 3.54 ac of upland trees and 3.87 ac of grassland and shrubs. Another 0.43 ac of upland trees and 8.2 ac of grassland and shrubs would be temporarily impacted by construction. The Far Rockaway component would impact trees adjacent to the Nassau Expressway, and the impacts at Island Park would occur to the landscape adjacent to the E.F. Barrett Generation Plant. The impacts at Wantagh are on the edge of development or roadways. Project implementation at Island Park would reduce connectivity of the remaining forested landscape east of the plant.

The three sluice gates proposed as part of the critical infrastructure meaures (Far Rockaway and Island Park) would limit water flow as well as usage of the channels by wildlife when the gates are closed under storm conditions. However, given the size of these channels and that the closures would only occur temporarily during storms, this impact is not expected to result in cumulative regional impacts. These channels are not used for navigation, and it is not anticipated that potential local water way users would be using the channels under storm conditions. Broad-scale impacts to regional recreation is not anticipated from implementation of the critical infrastructure measures; however, there would be local impacts with regards to waterway access from implementation of the Freeport component.

Minor, direct impacts could be experienced in the study area due to increased noise and air emissions during construction. The critical infrastructure measures would contribute to these impairments in the study area, but impacts are expected to be noticeable only on a local basis, and not provide any cumulative impacts.

Water quality (increased turbidity, reduced clarity, reduced dissolved oxygen, increase nutrients) impacts during construction would occur at the discrete project locations, but are not anticipated to affect regional water quality.

7.0 Impacts of NNBF Measures Being Considered (*NEPA Required)

As referenced previously within Section 4.0, NNBF being considered within the study would be complementary to other measures and further evaluated during the optimization phase of the study. The application of marsh conservation and restoration in particular would be expected to produce benefits to environmental resources in addition to their contribution to CSRM. Overall, NNBF efforts would be expected to have limited negative effects on flora and fauna within the area. Impacts to aquatic resources and water quality would likely be temporary in nature. Besides temporary disturbances during any restoration implementation, many NNBF approaches to reducing CSRM have less impacts the local ecology than hard structural alternatives.

NNBF measures such as conserving and restoring marsh will likely maintain and amplify habitat of many marsh-associated species while ultimately maintaining habitat for aquatic species that make use of marsh and marsh-linked aquatic habitat. The positive environmental benefits associated with leveraging existing marsh features to restrict the flow of water through the back bay system align with those benefits discussed in parts of Section 3.0**.** Marsh and marsh-adjacent habitat provide critical benefits to a number of terrestrial and aquatic species. Conservation and restoration therefore provide the benefits to species that would be lost if no action is taken in the area. As indicated by the Unvegetated to Vegatated Ratio (UVVR) values, the further degradation of marsh in those areas with a higher ratio of open water, channelization, and bare sediment. Utilization of these areas as NNBF by restoring them would therefore have particular benefits.

Extreme deterioration of existing marsh resources due to rapid RSLC as well as other anthropogenic factors could lead to changing conditions of subaqueous habitat that benefit from their shelter and overall sediment stabilization. Restoration and conservation of marsh resources will potentially reduce fetch and flow related flood impacts by reduding energetic flow amongst tidal flat and shallow water habitats.

Marsh restoration and conservation often demands additional sediment for placement and elevation building. USACE has developed significant experience placing sediment along and within marshes via methods that enhance overall long-term marsh resilience at the cost of minimal short-term impacts (e.g. thin-layer placement). Given the cost associated with moving sediment large distances, marsh restoration could demand temporarily affecting potential sediment source areas within the study area. Given the potential to practice regional sediment management through the use of material from navigation channels within the study area, sediments could be sourced from areas that are already exposed to disturbances in order to maintain navigation, thereby avoiding the need for additional disturbance in there region.

The above discussion of limited impacts assume that primary potential NNBFs implementedwill be the conservation and restoration of marsh within the extant marsh system. If significant additional marsh platforms were constructed at the expense of shallow water bottom surface, the plan implementation will require additional investigation. While species dependent on wetlands may prosper as a result, aquatic species could see reduced habitat if significant amounts of marsh are restored beyond their original footprint.

It is possible that any wetland restoration work that may occur as a part of the complementary NNBF measures may generate temporary turbidity in open estuarine waters and adjacent tidal streams that would affect EFH. These impacts would be minimized through use of sediment control BMPs. Overall, NNBF measures are expected to result in beneficial effects on EFH. However, future refinement of the TSP and subsequent surveys (such as wetlands and SAV) is needed before a final EFH assessment can be completed.

The NNBF measures are not anticipated to impact floodplains, land use, HTRW, socioeconomic conditions, or navigation. Wetland conservation and restoration measures would have a long-term, direct, and positive impact on recreation and aesthetics in the study area by maintaining the natural, existing marsh island landscape. There would be short-term, minor increases in noise and emissions associated with construction to implement conservation and restoration measures.

8.0 Agency and Public Involvement, Review and Consultation

The purpose of public participation and agency coordination in the NEPA process is to ensure the productive use of input from private citizens, public interest groups, and government agencies to improve the quality of the environmental decision-making as part of the project (Canter, 1996). CEQ regulations (Title 40 CFR, Chapter V and Part 1506.6) require the incorporation of public participation into multiple phases of the NEPA process, including project scoping and the review process of the tentatively selected plan in the EIS.

Although since revoked in January 2021, the study was conducted to comply with Executive Order 13807 "Establishing Discipline and Accountability in the Environmental Review and Permitting Process for Infrastructure Projects", referred to as the One Federal Decision process.

The initial Notice of Intent to prepare an EIS was published on April 21, 2017. The USACE conducted an EIS Kick-Off/Scoping Meetings on May 2 and 3, 2017. The purpose of the meetings was to identify CSRM problems, purpose and need, alternatives, data gaps, ecological resources, preliminary impacts, critical paths, deliverables, etc.

8.1 Agency Coordination

Initially invited to be cooperating agencies at the time of the study kick-off in 2017, USACE re-initiated coordination for the study with cooperating agencies (USFWS, NMFS, EPA, and FEMA) in July 2019. A series of three agency coordination meetings were held in alignment with One Federal Decision Concurrence Points 1 and 2, and following the selection of the Tentatively Selected Plan. Agencies invited to these meetings were: U.S. Fish and Wildlife Service, National Oceanic and Atmospheric Association/National Marine Fisheries Service, the U.S. Environmental Protection Agency, the U.S. Coast Guard, the Federal Emergency Management Association, U.S. Geological Survey, the National Park Service and Fire Island National Seashore, Stockbridge-Munsee Mohican Tribal Historic Preservation, Delaware Tribe Historic Preservation, Eastern Shawnee Trie of Oklahoma, Oneide Indian Nation, St. Regis Mohawk Tribe, Seneca Nation of Indians, Delaware Nation of Oklahoma, Shinnecock Environmental Department Shinnecock Nation, the South Shore Estuary Reserve, Nassau County, New York State Department of Environmental Conservation, New York Department of State, and New York State Historic Preservation Office. Table 35 summarizes relevant agency correspondence throughout the study process.

Table 35 - Summary of Relevant Agency Correspondence

Date	Summary of Agency Correspondence
April 21, 2017	Publication of Notice of Intent to prepare an EIS in Federal Register
October 6, 2017	USACE sent letters inviting USFWS, /NOAANMFS, FEMA, EPA, and USCG to be cooperating agencies.
October 25, 2017	Letter received from EPA accepting invitation to serve as a cooperating agency.
April 1, 2019	NCBB Status Report published.

Date	Summary of Agency Correspondence
July 2, 2019	USACE sent emails to USFWS, NOAA/NMFS, FEMA, and EPA indicating that USACE - Philadelphia District was leading the NCBB study; requesting a meeting to discuss the study and confirmation of the agency's intent to continue to serve as cooperating agencies; initiate ESA and EFH consultation; and to request coordination under Executive Order (E.O.) 13807 (One Federal Decision (OFD))
July 26, 2019	Letter received from NOAA/NMFS accepting invitation to serve as a cooperating agency.
September 10, 2019	Email received from EPA confirming that EPA will serve as a cooperating agency.
June 8, 2020	Publication of Withdrawal of April 21, 2017 NOI in Federal Register
July 21, 2020	Agency Coordination/One Federal Decision Concurrence Point #1 Meeting
August 4, 2020	Email from USACE to resource agency partners requesting concurrence with OFD Concurrence Point #1: Purpose and Need
August 5, 2020	Letter received from Delaware Tribe Historic Preservation stating concurrence with the Purpose and Need.
August 10, 2020	Letter received from New York State Parks, Recreation, and Historic Preservation stating concurrence with the Purpose and Need.
August 10, 2020	Letter received from USFWS providing comments on the purpose and need statement.
August 11, 2020	Email received from NMFS stating concurrence with the Purpose and Need.
September 10, 2020	Publication of (second) Notice of Intent to prepare an EIS in Federal Register
September 14, 2020	Communication (email) of no comments at this time on NOI from USGS.
October 1, 2020	Letter received from USFWS providing comments in response to NOI.
October 5, 2020	Email from USACE to resource agency partners providing revised Purpose and Need and requesting concurrence.
October 6, 2020	Email from EPA stating concurrence with the Purpose and Need.
October 13, 2020	Email from NMFS confirming concurrence with revised Purpose and Need
October 23, 2020	Email to resource agency partners requesting review of draft Permitting Timetable.
October 23, 2020	Email from NFMS providing comments on the draft Permitting Timetable.
October 29, 2020	Email from Delaware Tribe Historic Preservation confirming concurrence with revised Purpose and Need.
November 12, 2020	Emails to FWS and NMFS from USACE requesting confirmation that USACE is working with the correct threatened and endangered species list for Endangered Species Act coordination.
November 12, 2020	Email to NMFS from USACE requesting confirmation that USACE is working with the correct Essential Fish Habitat (EFH) species list for the Magnuson-Stevens Act coordination.
November 17, 2020	Agency Coordination/One Federal Decision Concurrence Point #2/Permitting Dashboard Meeting
November 17, 2020	Email from NFMS providing feedback on the endangered and threatened species list.

Date	Summary of Agency Correspondence
November 18, 2020	Email from FWS providing feedback on the endangered and threatened species list.
November 30, 2020	Permitting Timetable published on One Federal Decision
December 1, 2020	Email to resource agency partners requesting concurrence with OFD Concurrence Point #2: Alternatives Analysis, and review of the Permitting Timetable.
December 1, 2020	Email from NFMS providing feedback on the EFH species list.
December 4, 2020	Email from FEMA stating concurrence with the Alternatives Analysis.
December 7, 2020	Email from FEMA providing comments on the projected TSP.
December 10, 2020	Email from NMFS stating concurrence with the Alternatives Analysis.
December 15, 2020	Letter from USFWS providing comments on the alternatives array.
February 1, 2021	Email from USACE to resource agency partners providing a study update and communicating revocation of EO 13807,and delay of the DEIS until later in 2021.
May 18, 2021	Meeting with USFWS and South Shore Estuary Reserve to discuss NNBF measures.
May 3, 2021	Email to resource agency partners stating that a TSP milestone meeting has been set and initiating planning for an agency coordination meeting.
May 11, 2021	Email from Oneida Indian Nation stating that the project falls outside the Oneida aboriginal territory and is. therefore, beyond their purview.
June 10, 2021	Revised Permitting Timetable provided for review.
June 14, 2021	Agency Coordination Meeting to present the Tentatively Selected Plan.
June 14, 2021	Email from NMFS providing comments on the revised Permitting Timetable.
June 16, 2021	Email from NMFS providing confirmation that the updated Permitting Timetable including their June 14 comments has been approved by NMFS HQ.

8.2 Compliance with Applicable Laws and Environmental Regulations

Pertinent public laws applicable to the NCBB study are presented below. In some situations, the laws have been previously discussed and prior section references are provided. The status of compliance with applicable environmental laws and executive orders is provided in Table 36.

8.2.1 National Environmental Policy Act of 1970, As Amended, 42 U.S.C. 4321, et seq.

NEPA requires that all federal agencies use a systematic, interdisciplinary approach to protect the human environment. NEPA requires the preparation of an EIS for any major federal action that could have a significant impact on quality of the human environment and the preparation of an EA for those federal actions that do not cause a significant impact but do not qualify for a categorical exclusion. Section 102 authorized and directed that, to the fullest extent possible, the policies, regulations and public law of the United States shall be interpreted and administered in accordance with the policies of the Act. The NEPA regulations issued by CEQ (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 provide for a scoping process to identify the scope and significance of environmental issues associated with a project. The process identifies and eliminates from further detailed study issues that are not significant. USACE has used this process to comply with NEPA and focus this EIS on the issues most relevant to the environment and the decision making process.

8.2.2 Clean Air Act, as amended, 42 U.S.C. 7401, *et seq.*

The diesel-fueled construction emissions associated with the proposed TSP will be subject to General Conformity requirements (40 CFR§93.150-165) and the project will fully comply with the applicable regulations. The project's air quality mitigation will be coordinated with the Regional Air Team (RAT). Since the project will comply with General Conformity, it is projected that air quality would not be adversely affected by the TSP. Upon completion of the draft EIS, EPA and NYSDEC will be forwarded a copy for their review to confirm compliance with Section 309 of the Clean Air Act.

8.2.3 Clean Water Act, 33 U.S.C. 1251, et seq.

The TSP is in compliance with the Clean Water Act of 1977 and subsequent amendments. Implementation of the TSP would not result in changes in water quality. All state water quality standards would be met. An application for a Section 401 water quality certification will be submitted to the New York State Department of Environmental Conservation (NYSDEC) during the Planning, Engineering, and Design Phase of the project (next phase). The DIFR-EIS discusses impacts to water quality in the event that the critical Infrastructure measures are included in the final recommended plan (see Section 5.4.3).

8.2.4 Coastal Resources Barrier Act and Coastal Barrier Improvement Act of 1990

The Coastal Barrier Act Resources (CBRA) and its amendments prohibit the spending of new federal expenditures that tend to encourage development or modification of coastal barriers that are within the defined Coastal Barrier Resource System (CBRS). Based on USACE review, there are a number of CBRA units located within the proposed Project area (see Section 1.3.2.2) . Through the study formulation process, storm surge barriers were eliminated due largely to their footprint within CBRA units. The proposed Project would meet the provisions of Section 6 of the CBRA, which provides exceptions for expenditures of federal funds within CBRA units. The TSP proposes nonstructural measures to structures located outside of the CBRA units. In addition, the critical infrastructure measures are not located within CBRA units.

8.2.5 Coastal Zone Management Act of 1972

A Federal consistency determination in accordance with 15 CFR 930 Subpart C has been made stating that the TSP is consistent with the enforceable policies of New York State's federally approved coastal management program. The New York State Department of State must review the USACE determination of the TSP's consistency with the policies of the State's Coastal Management Program (Coastal Zone Management Act of 1972, P.L. 92-583 and New York State Waterfront Revitalization and Coastal Resources Act of 1982). State consistency review will be conducted during the coordination of the DEIS.

8.2.6 Endangered Species Act of 1973

The TSP will be in compliance with the Endangered Species Act of 1973 (ESA). Pursuant to Section 7 of the ESA, a draft Biological Assessment (BA) has been prepared (see Appendix G2) and a consultation with the U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) by the USACE will be initiated after release of the DIFR/EIS. Relevant sections of the BA have been integrated into the DEIS impact analysis. The TSP is not anticipated to affect threatened or endangered species. If the critical infrastructure measures are included at a future point, measures would be taken to avoid and minimize impacts to species.

8.2.7 Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act (FWCA) requires Federal agencies to consult with the USFWS, NMFS, and the fish and wildlife agencies of States where the "waters of any stream or other body of water are proposed or authorized, permitted or licensed to be impounded, diverted or otherwise controlled or modified" by any agency under a Federal permit or license. Consultation is to be undertaken for the purpose of "preventing loss of and damage to wildlife resources." The intent is to give fish and wildlife conservation equal consideration with other purposes of water resources development projects.

A draft Fish and Wildlife Coordination Act report will be provided by USFWS for inclusion in the draft EIS at the request of USACE towards fulfillment of Section 2(b) of the FWCA (48 Stat.401, as amended, 16 U.S.C. 661 *et seq.*). Coordination with USFWS and NFMS for the FWCA will be ongoing through the remainder of the study.

8.2.8 Magnuson-Stevens Fishery Conservation and Management Act

The Magnuson-Stevens Act is the primary law governing marine fisheries management in U.S. federal waters. Pursuant to Section 305 (b)(2) of the Magnuson-Stevens Fishery Conservation & Management Act, the USACE is required to prepare an Essential Fish Habitat [EFH] Assessment for the NCBB study. The draft assessment is provided in Appendix G3. See Section 1.5.5.4 for a discussion of EFH in the study area and Section 4.5.5.4 for a summary of the full assessment. The TSP is in compliance with the Magnuson-Stevens Act. If the critical infrastructure measures are included in the TSP at a future time, the study is expected to remain in compliance.

8.2.9 Marine Mammal Protection Act

The Marine Mammal Protection Act (MMPA), enacted in 1972, prohibits, with certain exceptions, the taking of marine mammals in U.S. waters and by U.S. citizens on the high seas, and the importation of marine mammals and marine mammal products into the U.S. The TSP is in compliance with the MMPA. If the critical infrastructure measures are included in the TSP at a future time, the study is expected to remain in compliance.

8.2.10 Migratory Bird Treaty Act, 16 U.S.C. 715 – 715s, and Executive Order 13186 Responsibilities of Federal Agencies to Protect Migratory Birds

The Migratory Bird Treaty Act (MBTA) prohibits the taking or harming of any migratory bird, its eggs, nests, or young without an appropriate Federal permit. Almost all native birds are covered by this Act and any bird listed in wildlife treaties between the United States and several other countries. A “migratory bird” includes the living bird, any parts of the bird, its nest, or eggs. The take of all migratory birds is governed by the MBTA’s regulation of taking migratory birds for educational, scientific, and recreation purposes and requiring harvest to be limited to levels that prevent over-utilization. Section 704 of the MBTA states that the Secretary of the Interior is authorized and directed to determine if, and by what means, the take of migratory birds should be allowed and to adopt suitable regulations permitting and governing take. Disturbance of the nest of a migratory bird requires a permit issued by the USFWS pursuant to Title 50 of the CFR. The TSP is in compliance with the MBTA and EO 13186. If the critical infrastructure measures are included in the TSP at a future time, the study is expected to remain in compliance.

8.2.11 Section 106 of the National Historic Preservation Act of 1966, as amended

The National Historic Preservation Act (NHPA) of 1966, as amended (54 U.S.C. § 306108), and its implementing regulations require USACE, in consultation with the NY SHPO, to take into account the effects of the undertaking on historic properties in the project area. If any historic properties listed on or eligible for inclusion in the National Register of Historic Places will be adversely affected, USACE must develop mitigation measures in coordination with the NY SHPO and the Advisory Council on Historic Preservation. Coordination with the NYSHPO and tribal nations has been ongoing throughout the plan formulation process. In accordance with Section 106 of the NHPA of 1966, as amended and its implementing regulations, 36 CFR 800, it is recommended that a Programmatic Agreement (PA) be prepared as part of the Final Feasibility Report and Environmental Impact Statement. A PA is a binding agreement between the NY SHPO and the USACE and that outlines the activities and tasks that must be carried out to conclude identification of significant resources, determine adverse effects, and mitigate for those adverse effects. These activities include carrying out additional archaeological and architectural investigations based on the locations of project elements; coordination and consultation with the NY SHPO, interested parties and federally recognized Tribes; and preparation of NRHP nomination forms.

8.2.12 River and Harbors Act, 33 U.S.C. 401, et seq.

Section 9 of this law and its implementing regulations prohibit the construction of any bridge, dam, dike, or causeway over or in navigable waters of the U.S. without Congressional approval. The U.S. Coast Guard administers Section 9 and issues bridge crossing permits over navigable waters. Section 10 of the Rivers and Harbors Act of 1899 requires authorization from the Secretary of the Army**,** acting through the Corps of Engineers, for the construction of any structure in or over any navigable water of the United States. The TSP is in compliance with the Rivers and Harbors Act. If the critical infrastructure measures are included in the TSP at a future time, the study is expected to remain in compliance.

8.2.13 Resource Conservation and Recovery Act, as amended, 43 U.S. C. 6901, *et seq.*

The Resource Conservation and Recovery Act (RCRA) controls the management and disposal of hazardous waste. "Hazardous and/or toxic wastes", classified by the RCRA, are materials that may pose a potential hazard to human health or the environment due to quantity, concentration, chemical characteristics, or physical characteristics. This applies to discarded or spent materials that are listed in 40 CFR 261.31-.34 and/or that exhibit one of the following characteristics: ignitable, corrosive, reactive, or toxic. Radioactive wastes are materials contaminated with radioactive isotopes from anthropogenic sources (e.g., generated by fission reactions) or naturally occurring radioactive materials (e.g., radon gas, uranium ore). HTRW is discussed in Sections 2.4.5, 3.4.5, and 5.4.5. The TSP is in compliance with the RCRA. If the critical infrastructure measures are included in the TSP at a future time, the study is expected to remain in compliance.

8.2.14 Comprehensive Environmental Response, Compensation, and Liability Act, 42 U.S. C. 9601, *et.seq.*

The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) governs the liability, compensation, cleanup, and emergency response for hazardous substances released into the environment and the cleanup of inactive hazardous substance disposal sites. See Section 5.4.5. The TSP is in compliance with the CERCLA. If the critical infrastructure measures are included in the TSP at a future time, the study is expected to remain in compliance.

8.2.15 Executive Order 11990, Protection of Wetlands

This EO directs Federal agencies to avoid undertaking or assisting in new construction located in wetlands, unless no practicable alternative is available. The TSP is in compliance with EO 11990. If the critical infrastructure measures are included in the TSP at a future time, the study is expected to remain in compliance. See Section 5.5.2 for a discussion of wetland impacts.

8.2.16 Executive Order 11988, Floodplain Management

Executive Order 11988 requires federal agencies to avoid, to the extent possible, the long and short term adverse impacts associated with the occupancy and modification of floodplains 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 floodplains in carrying out its responsibilities."

The Water Resources Council Floodplain Management Guidelines for implementation of EO 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 is in the base floodplain (that area which has a one percent or 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 property and infrastructure.
2. **If the action is in the base floodplain, identify and evaluate practicable alternatives to the action or location of the action in the base floodplain.** Chapter 4 of this document presents an analysis of potential alternatives. Practicable measures and alternatives were formulated and evaluated against Corps of Engineers guidance, including non-structural measures.
3. **If the action must be in the floodplain, 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.
4. **Identify beneficial and adverse impacts due to the action and any expected losses of natural and beneficial floodplain values. Where actions proposed to be located outside the base floodplain will affect the base floodplain, impacts resulting from these actions should also be identified.** The anticipated impacts associated with the TSP are summarized in Chapter 5 of this report. The TSP is not expected to affect floodplains. Recognizing the Federal government's commitment to ensure no inducement of development in the floodplain pursuant to Executive Order 11988, this project will identify in the PPA the need for the non-Federal sponsor to develop a floodplain management plan and a requirement for the sponsor to certify that measures are in place to ensure that the project does not induce development within the floodplains.
5. **If the action is likely to induce development in the base floodplain, determine if a practicable non-floodplain alternative for the development exists.** The project provides benefits solely for existing and previously approved development, and is not likely to induce development.

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 floodplain values. This should include reevaluation of the No Action Alternative.** There is no mitigation to be expected for the TSP. The project will not induce development in the floodplain and the project will not negatively impact the natural or beneficial floodplain values. Chapter 4 of this report summarizes the alternative identification, screening and selection process. The No Action Plan was included in the plan formulation phase.
7. **If the final determination is made that no practicable alternative exists to locating the action in the floodplain, advise the general public in the affected area of the findings.** The DIFR/EIS will be provided for public review In August 2021. 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 (Appendix G1).
8. **Recommend the plan most responsive to the planning objectives established by the study and consistent with the requirements of the Executive Order.** The TSP is the most responsive to all of the study objectives and the most consistent with the executive order.

8.2.17 Executive Order 12898, Environmental Justice

This EO directs Federal agencies to determine whether the recommended plan would have a disproportionate adverse impact on minority or low-income population groups within the project area. See Section 2.9.1 for a discussion of Environmental Justice considerations for the study and the critical infrastructure measures. As discussed previously, the feasibility study formulation focused on critical infrastructure and highly vulnerable areas. The highly vulnerable areas identified in the array of alternatives are very consistent with the Socially Vulnerable Areas that the CDC identified in Nassau County. Given that the CDC emphasizes the impacts of socioeconomic status, household composition/disability, race/ethnicity/language/minority status and housing/transportation on social vulnerability, the USACE believes the focused array of alternatives align with the intent of Executive Order 12989 (dated February 11, 1994).

8.2.18 Executive Order 13045, Protection of Children from Environmental and Safety Risks

This EO requires Federal agencies to make it a high priority to identify and assess environmental health and safety risks that may disproportionately affect children and to ensure that policies, programs, activities, and standards address these risks. No risks to children are expected from the TSP once construction is complete. Construction of non-structural measures in homes with children would need to take all standard precautions to ensure the safety of children. No risks to children would be expected in association with inclusion of the Critical Infrastrure Plan in the TSP.

Table 36 - Compliance with Federal Environmental Protection Statutes and Executive Orders

Federal Statutes and Executive Orders	Level of Compliance for draft EIS*
Archaeological and Historic Preservation Act	Full
Bald and Golden Eagle Protection Act	Full

Federal Statutes and Executive Orders	Level of Compliance for draft EIS*
Clean Air Act	Full
Clean Water Act	Full
Coastal Barrier Resources Act	Full
Coastal Zone Management Act	Full
Comprehensive Environmental Response, Compensation and Liability Act	Full
Endangered Species Act	Full
Estuary Protection Act	Full
Farmland Protection Policy Act	Full
Fish and Wildlife Coordination Act	Full
Magnuson-Stevens Fishery Conservation and Management Act	Full
Marine Mammal Protection Act	Full
National Environmental Policy Act	Full
National Historic Preservation Act	Full
Resource Conservation and Recovery Act	Full
Rivers and Harbors Act	Full
Wild and Scenic Rivers Act	N/A
Executive Orders (EO), Memoranda, etc.	
Migratory Bird (EO 13186)	Full
Protection and Enhancement of Environmental Quality (EO 11514)	Full
Protection and Enhancement of Cultural Environment (EO 11593)	Full
Floodplain Management (EO 11988)	Full
Protection of Wetlands (EO 11990)	Full
Environmental Justice in Minority and Low-Income Populations (EO 12898)	Full
Invasive Species (EO 13112)	Full
Protection of Children from Health Risks and Safety Risks (EO 13045)	Full
Prime and Unique Farmlands (CEQ Memorandum, 11 August 1980)	N/A

*Level of Compliance Relevant to the current study phase:
Full Compliance (Full): Having met all requirements of the statute, E.O., or other environmental requirements.
Partial Compliance (Partial): Not having met some of the requirements at current stage of planning. Compliance with these requirements is ongoing.
Non-Compliance (NC): Violation of a requirement of the statute, E.O., or other environmental requirement.
Not Applicable (NA): No requirements for the statute, E.O, or other environmental requirement for the current stage of planning.

8.3 Public Involvement

8.3.1 Public Scoping Meetings

Following the publication of the 2017 NOI, public scoping meetings were conducted on May 2 and 3, 2017 in Seaford and Freeport, respectively. Two additional public meetings were held in September 2017 in the City of Long Beach and Hewlett.

8.3.2 Public Update Meetings

A Status Report was made publicly available on April 30, 2019. Also, at that time, public outreach meetings were conducted. Two meetings were held, one in Freeport and one in the City of Long Beach. These meetings were held in-person and recorded.

As part of the process to identify the TSP, a number of meetings were held with stakeholders in the study area. USACE held a public webinar on January 14, 2021, met virtually with elected officials on January 27, 2021, and virtually with elected officials of the City of Long Beach March 5 and April 23, 2021.

8.3.3 Public Review of DEIS and Public Meetings

The DEIS will be available for review by the public and agencies for 45 days beginning September 1, 2021. The availability of the DEIS for review will be published in the Federal Register. Comments can be provided through the project website at: [Nassau County Back Bays Study (army.mil)] or mailed to: USACE Philadelphia District, Planning Division, 100 Penn Square E., Philadelphia, PA 19107. All comments are due by October 18, 2021 when the public review period ends. Public meetings will be held in September 2021 prior to the comment period concluding.

9.0 Implementation Requirements

9.1 Institutional Requirements

The release of the DIFR-EIS is a significant step toward completion of the feasibility study. Feasibility study and an associated recommendation by the District Engineer are the first steps toward implementing the design and construction of the CSRM project along the back bay of Nassau County. Upon approval of the feasibility findings by the ASA (CW), Congress will consider authorizing the project for construction in a Water Resources Development Act (WRDA) and subsequently appropriating funds for construction.

Upon receipt of Federal construction funds, USACE and the non-Federal sponsor would enter into a Project Partnership Agreement (PPA). This PPA would define the Federal and non-Federal responsibilities for implementing, operating and maintaining the project. The construction of the CSRM project will be cost-shared 65% by the Federal government and 35% by the non-Federal sponsor. Based on the current costs for the TSP, the potential cost apportionment is summarized on Table 37:

Table 37 - Cost Apportionment for the TSP (October 2020 Price Level)

	Federal Cost (65%)	Non-Federal Cost (35%)	Total Cost
Coastal Storm Risk Management Cost	$2,502,300,450	$1,347,392,550	$3,849,693,000
LERRD Cost	$0	$0*	$3,849,693,000
Total Cost	$2,502,300,450	$1,347,392,550	$3,849,693,000

Note: *Please refer to Section 4.9.2 for details on the LERRD cost sensitivity analysis

The non-Federal sponsor must comply with all applicable Federal laws and policies and other requirements, including but not limited to:

- Provide a minimum of 35% of initial project costs assigned to coastal and storm damage reduction, plus 100% of initial project costs assigned to protecting undeveloped private lands and other private shores which do not provide public benefits, and as further described below:
    - Provide, during design, 35% of design costs allocated to coastal and storm damage reduction in accordance with the terms of the PPA 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 renourishment or operation and maintenance of the project;
    - Provide, during construction, any additional amounts necessary to make its total contribution equal to 35% of initial project costs assigned to coastal and storm damage reduction plus 100% of initial project costs assigned to protecting undeveloped private lands and other private shores which do not provide public benefits;
- Perform, or cause to be performed, any investigations for hazardous substances as are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Public Law (PL) 96-510, as amended, 42 U.S.C. 9601-9675, that may exist in, on, or under lands, easements, or rights-of-way that the Federal government determines to be required for the construction, operation, and maintenance of the project.
- Coordinate all necessary cleanup and response costs of any CERCLA-regulated materials located in, on, or under lands, easements, or rights-of-way that the Federal government determines to be necessary for the construction, operation, or maintenance of the project.
- Coordinate mitigation and data recovery activities associated with historic preservation, that are in excess of one percent of the total amount authorized to be appropriated for the project.
- Operate, maintain, repair, replace, and rehabilitate the completed project, or functional portion of the project, including mitigation features, at no cost to the government, in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and state laws and any specific directions prescribed by the government in the Operations, Maintenance, Replacement, Repair and Rehabilitation (OMRR&R) manual and any subsequent amendments thereto.
- Provide the Federal government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal project partner, now or hereafter, owns or controls for access to the project for the purpose of inspection, and, if necessary after failure to perform by the non-Federal project partner, for the purpose of completing, operating, maintaining, repairing, replacing, or rehabilitating the project. No completion, operation, maintenance, repair, replacement, or rehabilitation by the Federal government shall operate to relieve the non-Federal project partner of the responsibility to meet the non-Federal project partner's obligations, or to

preclude the Federal government from pursuing any other remedy at law or equity to ensure faithful performance.

- Hold and save the United States free from all damages arising from the construction, operation, maintenance, repair, replacement, and rehabilitation of the project and any project-related betterments, 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 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.
- As between the Federal government and the non-Federal project partners, the non-Federal project partner shall be considered the operator of the project for the purpose of CERCLA liability. 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 applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1790, Public Law 91-646, as amended by Title IV of the Surface Transportation and Uniform Relocation Assistance Act of 1987 (Public Law 100-17), and the uniform regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way, required for construction, operation, and maintenance of the project, including those necessary for relocations, borrow materials, and dredged or excavated material disposal, 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 issue pursuant thereto, as well as Army regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted of Conducted by the Department of the Army.
- Participate in and comply with applicable Federal floodplain management and flood insurance programs and comply with requirements in Section 402 of the Water Resources Development Act of 1986, as amended.
- Not less than once each year inform affected interests of the extent of protection afforded by the project.
- Publicize floodplain information in the area concerned and provide this information to zoning and other regulatory agencies for their use in preventing unwise future development in the floodplain and in adopting such regulations as may be necessary to prevent unwise future development and to ensure compatibility with the protection provided by the project.
- Prevent obstructions of or encroachments on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) which might hinder its operation and maintenance, or interfere with its proper function, such as any new development on the project lands or the addition of facilities which would degrade the benefits of the project.
- Provide and maintain necessary access roads, parking areas, and other public use facilities, open and available to all on equal terms.

- Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended, and Section 103 of the Water Resources Development Act of 1986, Public Law 99-662, as amended, which provides the Secretary of the Army shall not commence the construction any water resources project or separable element thereof, until the non-Federal project partner has entered into a written agreement to furnish its required cooperation for the project or separable element.
- At least twice annually and after storm events, perform surveillance of the Line of Protection and determine any physical variances from the project design section and provide the results of such surveillance to the Federal government.
- Inform affected interests, at least annually, of the extent of protection afforded by the structural flood damage reduction features.
- 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 construction, operation, maintenance, repair, rehabilitation, or replacement of the project.
- 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.

9.2 Implementation Schedule

Before design and construction may be initiated, the report must be approved and submitted to the Office of Management & Budget. Further, the PPA must be executed by USACE and the non-Federal sponsor. The following provides the current schedule for study approval and PPA execution:

Agency Decision Milestone	December 2021
Integrated Final Feasibility Report/EIS to Corps Higher Authority for Approval	December 2022
Chief's Report submitted to ASA (CW)	July 2023
ASA (CW) Integrated Final Feasibility Report/EIS Approval	September 2023
ASA (CW) submits report to OMB	September 2023
Final Report to Congress	September 2023
Start Plans and Specifications (Design Phase)	April 2024
Execute PPA with non-Federal Sponsor	April 2024
Finalize Plans and Specifications for Contract	November 2024
Real Estate Certification for Contract	December 2024
Ready to Advertise Contract	February 2025
Award Construction Contract with Notice to Proceed	June 2025

9.3 Cost Summary

The estimated cost for the recommended plan is $3,849,693,000 (October 2020 price level) which includes real estate acquisition costs (including administration costs); planning, engineering and design (PE&D); construction management (S&A); Operation, Maintenance, Repair, Replacement and Rehabilitation (OMRR&R); and associated contingencies. A summary of estimated project costs is provided on Table 38.

Table 38 - Estimated Cost Data for TSP

ESTIMATED COSTS FOR THE TSP	
Period of Analysis	2030 to 2080 (50 Years)
Price Level	October 2020 (FY21)
Discount Rate	2.5%
Base Year	2030
Initial Construction Costs	$3,849,693,000
Interest During Construction	$11,864,000
Annual OMRR&R	$0
Average Annual Cost	$135,733,000
Average Annual Benefits	$610,751,000
Average Annual Net Benefits	$474,839,000
BCR	4.5
Residual Risk	40%

In accordance with the Water Resources Development Act of 1986, as amended, the cost sharing for initial construction is 65% Federal and 35% non-Federal, which includes cash and credits associated with obtaining the required lands, easements, rights-of-way, and relocations (LERR). OMRR&R is a 100% non-Federal responsibility and is included in the calculation of annualized project costs for economic purposes.

The Federal government will design the project, prepare detailed plans/specifications and construct the project, exclusive of those items specifically required of the non-Federal partner.

9.4 View of Non-Federal Sponsor(s)

The non-Federal sponsor (New York State Department of Environmental Conservation in partnership with Nassau County, NY) fully supports the TSP and the continuation of the feasibility analysis.

10.0 Recommendations

The TSP is the NS Countywide Plan which includes the following:

- Elevation of 14,183 residential structures to the modeled 1% AEP non-structural design water surface elevation (which includes intermediate sea level change projected to 2080).
- Dry flood proofing of 2,667 industrial/commercial (non-residential) structures from the ground surface up to 3 feet above ground.

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 within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to the Congress as proposals for authorization and implementation funding." However, prior to transmittal to the Congress, the sponsor, the States, interested Federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

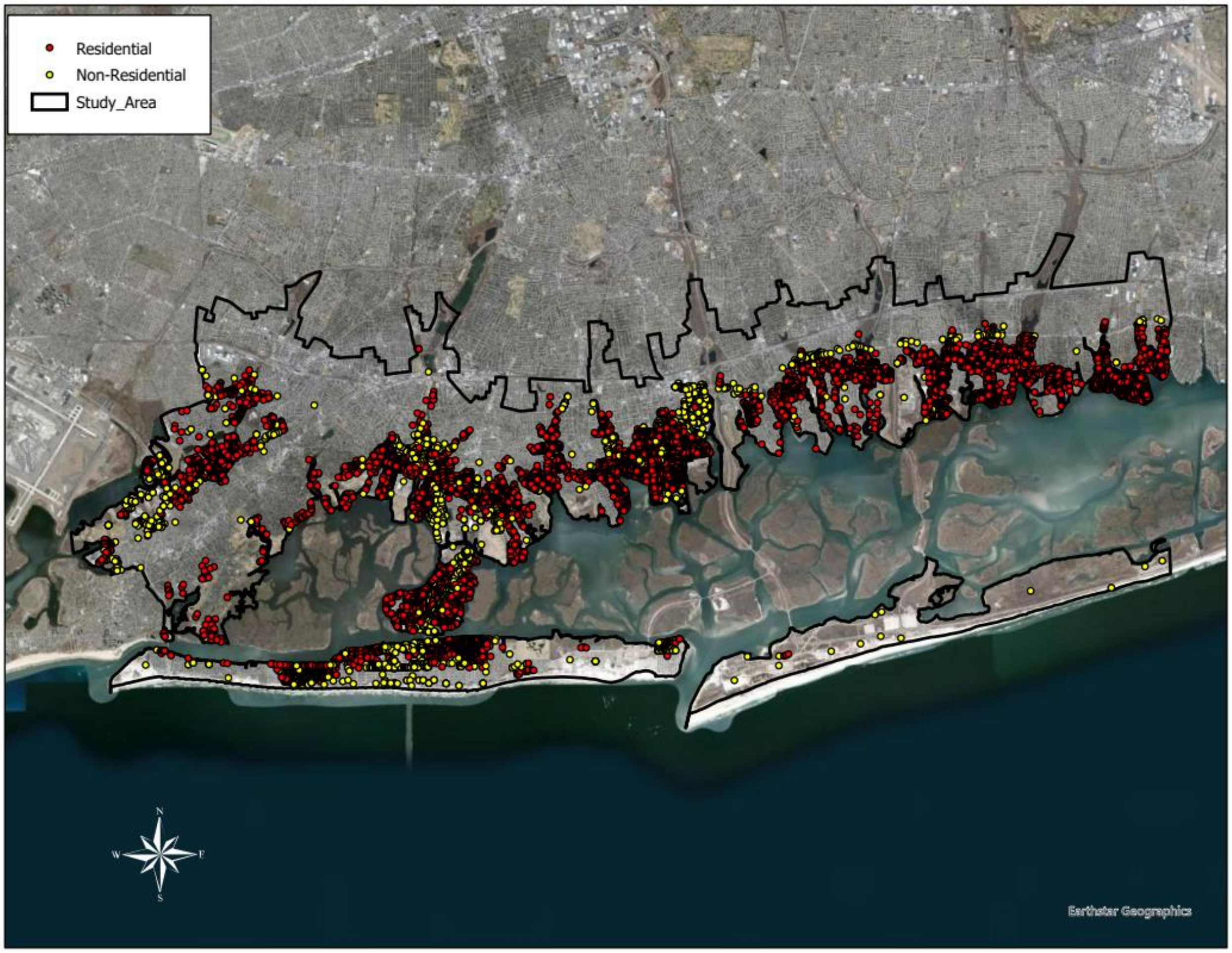

Figure 59 - TSP Location

In making the above-reference recommendation, USACE has given consideration to all significant aspects in the overall public interest, including environmental quality, social effects, economic effects, engineering feasibility, and compatibility of the TSP with policies, desires, and capabilities of the State of New York and other non-Federal interests. USACE has evaluated several alternative plans for the purpose of coastal storm risk management. A TSP has been identified that is technically sound, economically cost-effective over the 50-year period of analysis, socially and environmentally acceptable, and has support from the non-Federal sponsor.

The TSP has primary benefits based on coastal storm risk management and provides average annual total net benefits in accordance with Table 39:

Table 39 – TSP Economic Summary

Future Without-Project AAD	$1,011,964,000
Future With-Project AAD	$401,393,000
Total Reduced AAD	$610,571,000

Total Initial Construction	$3,849,693,000
Average Annual OMRR&R	$0
Average Annual Cost (AAC)	$135,733,000
Average Annual Net Benefits	$474,839,000
Benefit-Cost Ratio	4.5
Residual Damages	40%

11.0 List of Preparers

The project delivery team (PDT) prepared the report and consisted of the following people:

Table 40 - List of Preparers

Name	Discipline
Scott Sanderson	USACE – Project Manager
Angie Sowers	USACE – Environmental Coordinator
Valerie Whalon	USACE – Planner/Environmental Coordinator
Rachel Ward	USACE – Environmental Coordinator
Nicole Minnichbach	USACE – Cultural Resources
Marc Paiva	USACE – Cultural Resources
Preston Oakley	USACE – Economics
Michael Kastner	USACE – Economics
Eric Majusiak	USACE – Non-Structural Planning
Steve Long	USACE – GIS & Floodplain Management
Bob Griggs	USACE – Engineering Design Management
Rob Hampson	USACE – Hydrology & Hydraulics
Jake Helminiak	USACE – Hydrology & Hydraulics
Mary Cialone	USACE – ERDC
Gregory Slusarczyk	USACE – ERDC
John Benigno	USACE – Civil Design
Chris Bomba	USACE – Civil Design
Melinda Eason	USACE – Geotechnical Engineering
William Harris	USACE – GeoEnvironmental
Bryan Adkins	USACE – Cost Engineering
Janay Dixon	USACE – Real Estate
Kathleen Ha	USACE – Real Estate
Ron Santos	USACE – Real Estate
Amanda Phily	USACE – Office of Counsel

Matthew Chlebus – Non-Federal Sponsor	NYSDEC
Ryan Hodgetts – Non-Federal Sponsor	NYSDEC
Brian Schneider – Non-Federal Sponsor	Nassau County, NY

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13.0 List of Acronyms

AAB – Average Annual Benefits

AAC – Average Annual Costs

AAD – Average Annual Damages

AANB – Average Annual Net Benefits

ADM – Agency Decision Milestone

AEP – Annual Exceedance Probability

AISAP – Automatic Identification System Analysis Package

APE – Area of Potential Effect

ASA (CW) – Assistant Secretary of the Army for Civil Works

ATR – Agency Technical Review

AWOIS – Automated Wreck and Obstruction Information System

BCR – Benefit Cost Ratio

BMP – Best Management Practice

CAA – Clean Air Act

CBIA – Coastal Barrier Improvement Act

CBRA – Coastal Barrier Resources Act

CDC – Center for Disease Control

CERCLA – Comprehensive Environmental Response, Compensation, and Liability Act

CFR – Code of Federal Regulations

CI – Critical Infrastructure

CMP – Coastal Management Program

CO – Carbon Monoxide

CSRM – Coastal Storm Risk Management

CWA – Clean Water Act

CZMA – Coastal Zone Management Act

DCR – New York Department of State Division of Coastal Resources

DEM – Digital Elevation Model

DQC – District Quality Control

DIFR-EIS – Draft Integrated Feasibility Report/Environmental Impact Statement

DO – Dissolved Oxygen

DOS – New York Department of State

DRV – Depreciated Replacement Value

EFH – Essential Fish Habitat

EIS – Environmental Impact Statement

EO – Executive Order

EQ – Environmental Quality

ER – Engineering Regulation

ESA – Endangered Species Act

FCSA – Feasibility Cost Share Agreement

FEMA – Federal Emergency Management Agency

FFE – First Floor Elevation

FIFR-EIS – Final Integrated Feasibility Report/Environmental Impact Statement

FWCA – Fish and Wildlife Coordination Act

FWOP – Future Without Project Condition

GHG – Greenhous Gas

HAPC – Habitat of Particular Concern

HEC-FDA – Hydrologic Engineering Center-Flood Damage Reduction Analysis

HTRW – Hazardous, Toxic, and Radioactive Waste

HUC – Hydrologic Unit Code

HUD – Department of Housing and Urban Development

HVA – Highly Vulnerable Area

IDC – Interest During Construction

IEPR – Independent External Peer Review

LERR – Lands, Easements, Rights-of-way, and Relocations

LiDAR – Light Detection and Ranging

LMSL – Local Mean Sevel

LWRP – Local Waterfront Revitalization Program

MBTA – Migratory Bird Treaty Act

MGP – Manufactured Gas Plant

MHW – Mean High Water

MLW – Mean Low Water

MMPA – Marine Mammal Protection Act

MSFCMA – Magnuson-Stevens Fishery Conservation and Management Act

MSL – Mean Sea Level

NAAQS – National Ambient Air Quality Standards

NACCS – North Atlantic Coast Comprehensive Study

NAVD88 – North Atlantic Vertical Datum of 1988

NCBB – Nassau County Back Bays

NED – National Economic Development

NEPA – National Environmental Policy Act

NGO – Non-Government Organization

NHPA – National Historic Preservation Act

NJBB – New Jersey Back Bays

NNBF – Natural & Nature-Based Features

NMFS – National Marine Fisheries Service

NOAA – National Oceanic & Atmospheric Administration

NOI – Notice of Intent

NOx – Nitrogen Oxides

NPDES – National Pollution Discharge Elimination System

NRC – National Research Council

NS – Non-Structural

NWR – National Wildlife Refuge

NWS – National Weather Service

NYSDEC - New York State Department of Environmental Conservation

OMB – Office of Management and Budget

OMRR&R – Operations, Maintenance, Replacement, Repair and Rehabilitation

OSE – Other Social Effects

PA – Programmatic Agreement

PDT – Project Delivery Team

PPA – Project Partnership Agreement

PPT – Parts per thousand

PRP – Potentially Responsible Party

RCRA – Resource, Conservation and Recovery Act

RED – Regional Economic Development

RSLC – Relative Sea Level Change

SAV – Submerged Aquatic Vegetation

SCFWH – Significant Coastal Fish and Wildlife Habitats

SHPO – State Historic Preservation Office

SLAMM - Sea Level Affecting Marshes Model

SLC – Sea Level Change

SSA – Sole Source Aquifer

SSER – South Shore Estuary Reserve

SWEAT-MSO – Sewage, Water, Electricity, Academics, Trash, Medical, Safety and Other Considerations

TMDL – Total Maximum Daily Loads

TRI – Toxic Release Inventory

TSCA – Toxic Substance Control Act

TSP – Tentatively Selected Plan

USACE – U.S. Army Corps of Engineers

USEPA – U.S. Environmental Protection Agency

USFWS – U.S. Fish and Wildlife Service

USGS – U.S. Geological Survey

UVVR – Unvegetated to Vegetated Marsh Ration

VOCs – Volatile Organic Compounds

WRDA – Water Resources Development Act

WWTP – Wastewater Treatment Plant