Fire Island Inlet to Montauk Point

New York

FIRE ISLAND INLET
to
MONTAUK POINT
Reformulation Study

Final General Reevaluation Report

U.S. Army Corps of Engineers

New York District

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EXECUTIVE SUMMARY

Introduction

The Fire Island Inlet to Montauk Point, New York Combined Beach Erosion Control and Hurricane Protection Project (FIMP) was authorized by the Rivers and Harbors Act of 1960. The project is being reformulated to identify a long-term solution to manage the risk of coastal storm damages along the densely populated and economically valuable Atlantic Coast of Long Island, New York in a manner that balances the risks to human life and property, while maintaining, enhancing, and restoring ecosystem integrity and coastal biodiversity.

There is a long history of damaging storms along the Atlantic Coast of Long Island, as well as many efforts to mitigate the damages, including construction of several features of the authorized FIMP project that are described later in the report. This current study is called a Reformulation, because it seeks to reexamine the project that was originally formulated in the 1950s. This Reformulation came about in part due to a referral to the Council on Environmental Quality in response to the 1978 Environmental Impact Statement (EIS) that was prepared for the project subsequent to passage of the National Environmental Policy Act of 1969 (NEPA). As a result of the referral the U.S. Army Corps of Engineers (USACE) agreed to reformulate the project with particular emphasis on identifying and evaluating alternatives that consider cumulative impacts on the overall coastal system. The goal of the Reformulation is to identify an economically viable, environmentally acceptable plan that addresses the coastal storm risk management needs of the study area and is acceptable to the key Federal, State, and local stakeholders.

Included within the study area are critical coastal habitats and environmentally sensitive areas, including the Fire Island National Seashore (FIIS). Section 8 of Public Law (P.L.) 88-587, the FIIS authorizing law provides that the authority of the Chief of Engineers to undertake or contribute to shore erosion control or beach protection measures on lands within the FIIS shall be exercised in accordance with a plan that is mutually acceptable to the Secretary of the Army and Secretary of the Interior.

To assist in meeting the requirements of P.L. 88-587, a policy exception granting permission to deviate from USACE policy related to economic justification was issued by the Office of the Assistant Secretary of the Army (Civil Works) (ASA[CW]) on October 11, 2017 (Appendix L). It grants an exemption to the USACE requirement to demonstrate incremental justification of features and recommend a National Economic Development (NED) plan and allows USACE to recommend a plan mutually acceptable to the Secretary of the Army and Secretary of the Interior consistent with P.L. 88-587. The policy exception significantly impacted plan evaluation, formulation, and selection. It allowed the study team to consider and ultimately include in alternative plans measures that would have otherwise been screened from consideration.

Extensive interagency coordination was undertaken to ensure a proposed project is mutually acceptable to the Secretary of the Army and Secretary of the Interior. A Memorandum of Understanding (MOU) between the Department of the Army and the Department of Interior was signed on July 24, 2014. The MOU provides the foundation for "…developing a plan that is mutually acceptable for hurricane and storm damage reduction, including identifying and evaluating natural and nature-based measures that contribute to coastal storm damage risk reduction, in the Reformulation Study for the FIMP project" (Appendix L).

In a letter dated May 3, 2017 the regional directors of the U.S. Fish and Wildlife Service (USFWS), National Park Service (NPS), and U.S. Geological Survey (NPS) concurrent with the USACE Deputy Commanding General for Civil and Emergency Operations memorandum that the proposed project is mutually acceptable to the Department of the Army and Department of the Interior (Appendix L). The Department of the Interior's stance was reaffirmed in a June 6, 2019 letter in which the regional directors of the USFWS, NPS, and USGS jointly stated they, "confirm the Department of the Interior's commitment and interest in continuing to work with the [USACE] in finalizing a mutually acceptable plan" (Appendix L).

Given the complex coastal system and large number of stakeholders, an Executive Steering Committee made up of key Federal and State agencies was established to provide executive level leadership for the study. The Executive Steering Committee developed the vision statement that identified the broad objectives for the study.

In May 2009, a Formulation Report (USACE, 2009) was provided to the key government partners and stakeholders that identified the problems, opportunities, objectives, and constraints, analyzed alternatives, and proposed several alternative plans for consideration. Based on the comments received and subsequent discussions among the stakeholders and public, a Tentative Federally Supported Plan (TFSP) was jointly identified by USACE and the Department of Interior (DOI). The TFSP was submitted to the New York State Department of Environmental Conservation (NYSDEC), the non-Federal sponsor, in March 2011. The TFSP identified a plan that met the study objectives and the requirements of both USACE and DOI.

On October 29, 2012, Hurricane Sandy made landfall near Atlantic City, New Jersey, where it collided with a blast of arctic air from the north, creating conditions for an extraordinary historic 'super storm' along the East Coast with the worst coastal impacts centered on the northern New Jersey, New York City, and the Long Island coastlines. Storm damages within the FIMP study area, including flooding, erosion, and wave damages, as a result of Hurricane Sandy were severe and substantial. There were three breaches of the barrier island (Figure 1), multiple overwashes, extensive shorefront damages, and extensive back bay flooding. Post- Hurricane Sandy measurements of beach and dune volume loss on Fire Island indicated that the subaerial beach lost 55 percent of its pre-storm volume equating to a loss of 4.5 million cubic yards. A majority of the dunes either were flattened or experienced severe erosion and scarping (Hapke et al, 2013).

Figure 1. Post Hurricane Sandy Photo of the Breach in the Otis Pike High Dune Wilderness Area

Due to the significant changes brought about by Hurricane Sandy, a reanalysis of the TFSP was undertaken to take into account these changes to the landform, development patterns, and risk.

The post- Hurricane Sandy TFSP plan was provided to New York State in May 2013, who agreed in concept with the plan. With sponsor support, the TFSP was identified as the Tentatively Selected Plan, subject to refinement, based upon public and agency comment.

In July 2016, the draft GRR and EIS were released for public and agency review and comment. Based on the comments received, changes were made to the Tentatively Selected Plan as described in this report and in the EIS. Included in the Recommended Plan are project features that required an exception to the requirement that USACE recommend the National Economic Development (NED) plan and instead allow USACE to recommend the mutually acceptable plan consistent with requirement of the authorizing law, Section 8 of Public Law 88-587 that established Fire Island National Seashore. The policy exception was granted by the Office of the Assistant Secretary of the Army (Civil Works) on October 11, 2017.

This GRR serves as the decision document for implementation of the reformulated FIMP project. As an "authorized, but unconstructed" project, the FIMP Reformulation study is being completed with funds authorized by P.L. 113-2 at full Federal expense, subject to the availability of P.L. 113-2 funds. Additional costs would require cost sharing. As specified in P.L. 113-2, the initial project construction is eligible for 100 percent Federal funding, subject to approval of the Report, execution of a Project Partnership

Agreement, and availability of funds. Because of the devastation sustained in the region, Chapter 4 of P.L. 113-2 authorizes USACE as follows:

"For an additional amount for "Construction" for necessary expenses related to the consequences of Hurricane Sandy, $3,461,000,000, to remain available until expended to rehabilitate, repair and construct United States Army Corps of Engineers projects: Provided, That $2,902,000,000 of the funds provided under this heading shall be used to reduce future flood risk in ways that will support the long-term sustainability of the coastal ecosystem and communities and reduce the economic costs and risks associated with large-scale flood and storm events in areas along the Atlantic Coast within the boundaries of the North Atlantic Division of the Corps that were affected by Hurricane Sandy:..

Provided further, That efforts using these funds shall incorporate current science and engineering standards in constructing previously authorized Corps projects designed to reduce flood and storm damage risks and modifying existing Corps projects that do not meet these standards, with such modifications as the Secretary determines are necessary to incorporate these standards or to meet the goal of providing sustainable reduction to flooding and storm damage risks…

Provided further, That the completion of ongoing construction projects receiving funds provided by this division shall be at full Federal expense with respect to such funds…

Provided further, That for these projects, the provisions of section 902 of the Water Resources Development Act of 1986 shall not apply to these funds…"

Study Authorization and Construction History

The FIMP, New York, Combined Beach Erosion Control and Hurricane Protection Project was authorized by the Rivers and Harbors Act of July 14, 1960. The authorization provides for beach erosion control and hurricane protection (coastal storm risk management) along five reaches of the Atlantic Coast of New York from Fire Island Inlet to Montauk Point, a distance of about 83 miles, by widening the beaches along the developed areas to a minimum width of 100 feet, with berm elevation of 14 feet above mean sea level (MSL), and by raising dunes to an elevation of 20 feet above MSL, from Fire Island Inlet to Hither Hills State Park, at Montauk and opposite Lake Montauk Harbor.

The original authorization also provides for the construction of up to 50 groins, grass planting on the dunes, interior drainage structures at Mecox Bay, Sagaponack Lake and Georgica Pond, and beach renourishment for a period of ten years after initial construction.

This authorization was modified by Section 31 of the Water Resources Development Act (WRDA) of 1974, and Sections 103, 502, and 934 of the WRDA of 1986 (P.L. 99-662), which modified the cost-sharing percentages and the period of renourishment. As mentioned previously, the reformulated FIMP project is also eligible for funding under P.L. 113-2, which would be at "full federal expense" for initial construction.

Construction of two groins in East Hampton in the vicinity of Georgica Pond (Reach 4) were completed in September 1965. Eleven groins in Westhampton Beach (Reach 2) were completed in 1966, with an additional four groins completed in 1970.

Due to severe erosion in the community of Westhampton Dunes located west of the Westhampton groins, an interim project was approved in 1995 that provided for a beach berm and dune, tapering of the western two existing groins, construction of an intermediate groin between the two, and periodic renourishment for up to 30 years. Initial construction was completed in 1997 and renourishment took place in 2001, 2004, 2008, and also in 2014, following Hurricane Sandy.

An Interim Breach Contingency Plan was approved in 1996 that authorizes USACE to respond quickly to close breaches within three months. The Breach Contingency Plan was used following Hurricane Sandy to close two breaches of the barrier islands at Smith Point County Park, and at Cupsogue County Park.

An interim project was also approved in 2002 for beach nourishment along 4,000 feet of the vulnerable shoreline immediately west of Shinnecock Inlet, which was constructed in 2006. Following Hurricane Sandy, this area was renourished in 2013, utilizing funds appropriated through P.L. 113-2.

Utilizing funding from P.L. 113-2, USACE, in partnership with New York State has undertaken stabilization efforts on Fire Island and in Downtown Montauk, in order to reestablish a beach and dune in vulnerable areas. These projects were approved in 2014, and construction initiated in 2014. Construction of the Downtown Montauk Stabilization Project was completed in 2016 and construction of the Fire Island Inlet to Moriches Inlet (FIMI) Stabilization Project is scheduled to be completed in 2021.

Problems and Opportunities

Problems: Intensive development has occurred in the study area, which has resulted in structures, infrastructure, and people at risk due to coastal storms. In addition, the natural coastal processes that include longshore, cross-island, and bay shoreline sediment transport and estuarine circulation have been altered, which has impacted the natural dune and berm features, their resilience, and ecological functioning of the coastal ecosystem.

Consequences: With continued relative sea level change (RSLC), there is the potential for increased damages along the ocean shorefront and also the likelihood of increased coastal flooding along the bay shoreline.

Opportunities: Opportunities exist to manage coastal storm risk to residents, property, and infrastructure from inundation, wave attack, and erosion and also to reestablish the natural coastal processes and increase resilience within the coastal study area.

Constraints: Any plans to contribute to coastal storm risk management on lands within Fire Island National Seashore shall be done in accordance with a plan that is mutually acceptable to the Secretary of the Army and the Secretary of the Interior, and consistent with the Seashore's authorizing legislation.

Future Without Project Condition (FWOP): The FWOP is the projection of the likely future conditions in the study area in the absence of any action resulting from the current study. The FWOP condition is the baseline for the analysis and comparison of alternatives for this study. The FWOP condition for this study includes the following assumptions.

1. Maintenance of the navigation channels through the existing inlets (Fire Island, Moriches, and Shinnecock inlets) will continue as authorized
2. The breach within the Otis Pike High Dunes Wilderness Area of Fire Island National Seashore that opened during Hurricane Sandy will remain open indefinitely

3. Periodic renourishment of the Westhampton Interim Project will continue until 2027 consistent with the terms of the legal settlement.
4. The one-time, post-Hurricane Sandy FIMI Project is constructed, and in place (scheduled to be completed in 2021)
5. The one-time, post-Hurricane Sandy Downtown Montauk Stabilization Project is constructed and in place (completed in 2016)
6. The interim Breach Contingency Plan will not continue. Breaches of the barrier island will continue to be closed (with the exception of the Otis Pike High Dune Wilderness Area of Fire Island National Seashore) but will take a year to close in the absence of a streamlined process for Federal participation
7. Local interests will continue to maintain the beach and dune through the use of acceptable coastal management actions, subject to approval by permitting agencies

Quantification of Problem

Table 1 summarizes the expected average annual damages that are likely in the FWOP. This analysis is based upon the assumptions presented in prior section, and the continuation of the historic rate of RSLC (approximately +0.7 feet in 50 years). A range of RSLC projections were considered in project evaluation, and the effect of these different projections is addressed in the section that describes project performance. This Table illustrates that the majority of the damages that are experienced are due to flooding in the mainland communities that occurs during storm events. This flooding is due to the combined effects of storm surge through the inlets and wind and wave setup within the bays. During some large events additional storm surge enters the bay from barrier island overwash or the formation of breaches. The "total inundation" summary in Table 1 includes flooding from water that enters through the inlets, as well as flooding as a result of breaching and overwash. The summary of "breach open damages" are those damages that continue to occur in future storms, due to a breach remaining open. In this analysis, the Wilderness Breach is considered a permanent feature and impacts flood levels throughout the project lifecycle. Future breach damages are a comparatively infrequent occurrence and are limited to a 9-12-month duration. The short duration of future breaches relative to the permanent opening at the Wilderness Breach results in lower damages over the lifecycle. "Shorefront damages" are those that occur along the Atlantic Ocean shorefront.

Table 1. Expected Average Annual Damages in FWOP Condition (Oct 2019 P.L.)

Damage Category	FWOP Damages
Total Project	
Tidal Inundation occurring due to inlet conditions and wave setup in back bay	
Mainland	$118,511,000
Barrier	$20,494,000
Total	*$139,005,000*
Tidal Inundation occurring due to storm breaching and overwash	
Mainland	$23,589,000
Barrier	$4,079,000
Total	*$27,668,000*
Total Mainland Inundation	*$142,100,000*
Total Barrier Inundation	*$24,573,000*
Total Inundation	*$166,673,000*
Damages from Inundation due to a breach remaining open	
Inundation (Open Wilderness Breach)	$9,436,000
Inundation (Future Breaches)	$10,902,000
Total Breach Open Damages	*$20,338,000*
Shorefront Damages	$15,795,000
Emergency Costs/Breach Closure	$3,290,000
Total Damage	***$206,096,000***

Breach-related structure failures on the barrier islands are not included in the total breach failure due to the potential for double counting of these damages with other barrier island damage categories.
Price Level October 2019, Discount Rate 2.75 percent, Period of Analysis 50 years
Damages include the effects of the low rate of RSLC projected over the economic period of analysis

Plan Formulation

The goal of the Reformulation Study is to manage coastal storm risks and attendant loss of life from tidal flooding, waves, and erosion, in part by restoring the natural coastal processes while minimizing environmental impacts.

A "Vision Statement for the Reformulation Study" that integrates the policies of USACE, the State of New York, and the NPS was developed in 2004 and commits the partner agencies to recognize the following during the plan formulation process:

- Decisions must be based upon sound science, and a current understanding of the system
- Flooding will be addressed with site specific measures that address the various causes of flooding
- Priority will be given to measures that both provide storm risk management and reestablish and enhance the natural coastal processes and ecosystem integrity
- Preference will be given to nonstructural measures that minimize impacts to coastal landforms and natural habitats
- Project features should avoid or minimize adverse environmental impacts and address long-term demands for public resources

- Balances dune and beach replenishment considering storm damage reduction and environmental considerations
- Consideration will be given to alteration of existing shore stabilization structures, inlet stabilization measures, and dredging practices

In support of the goal of the Reformulation study, the planning objectives are:

1. Reduce tidal flooding on the mainland and barrier islands and attendant loss of life, property and economic activity
2. Reduce damages to structures due to beach and bluff erosion in critical areas
3. Reestablish the natural coastal processes and utilize coastal process measures to reduce storm damages and provide resilience to the system
4. Ensure that any plan on lands within the Fire Island National Seashore is compatible with the goals and objectives of the Fire Island National Seashore and is mutually acceptable to the Secretary of the Army and Secretary of the Interior

The formulation efforts to arrive at the TFSP included an initial Screening of Measures, preliminary design of alternatives, and design optimization. These formulation efforts were contained in a draft Formulation Report (USACE, 2009) which was provided to the partner agencies, DOI and the State of New York Department of Environmental Conservation, for review and comment. The information contained in the Formulation Report was also presented at public meetings in summer 2010 to obtain public input on the plans. The Formulation Report presented a series of plans that were developed in a system-wide framework that considered the interaction between the barrier island, shorefront system and the back bay environment. These plans include several alternative plans and were developed considering the effectiveness of project features in addressing the problems, with each successive plan building on the prior plan to increasingly satisfy the project objectives and Interagency Vision Statement.

Plan 1

Plan 1 includes measures to improve the sediment management of the existing system, which contains features to respond to breaches and also maintenance of the Federal navigation channels at Fire Island, Moriches and Shinnecock Inlets. The existence and current maintenance of the navigation channels results in insufficient sand bypassing to the downdrift beaches and instability of the downdrift shoreline due to the sediment deficit. Restoring the natural coastal processes by providing sufficient sand bypassing across the three inlets is an essential component of any mutually acceptable plan with DOI. It addresses the 3rd component of the "Vision Statement" by "provide(ing) storm risk management and restoring and enhancing the natural coastal processes and ecosystem integrity." While sand bypassing by itself does not increase the level of risk reduction that is afforded, it reduces the potential for future shoreline change, and provides a cost-effective source of sand for renourishment. The optimum inlet management alternative includes continuation of maintenance dredging (with beneficial reuse of the sediment to downdrift beaches) at the three inlets, plus additional bypassing of sand from the ebb shoals to offset the erosion deficit. Plan 1a is based on the economically optimum inlet management alternative with a Breach Response Plan triggered at +13 feet NGVD 29, while Plan 1b includes the economically optimum inlet management alternative with a Breach Response Plan triggered at +9.5 feet NGVD 29. Both plans performed similarly and were marginal in justification. These plans were not considered to be a complete solution, since the plans only addressed damages that could be attributed to breaching of the barrier island, which is approximately 10 percent of the damages.

Plan 2

The second series of plans (Plan 2a through Plan 2h) reflect the addition of nonstructural features, such as building retrofits and road raisings to Plans 1a and 1b. These features when combined provide a managed barrier island, with improved inlet management, and nonstructural features to directly address flood risk within the bays. The nonstructural storm risk management addresses flooding on the mainland from storm surge propagating through inlets into the bays and wind and wave setup within the bays. The nonstructural alternative that provided the greatest net benefits was nonstructural alternative 2R, which provides storm risk management for 4,450 structures. The plan provides for retrofits for 3,400 structures that are located within the 17 percent floodplain[1], and also raising the elevation of a total of about six miles of roads in the communities of Amityville, Lindenhurst, and Mastic that would provide storm risk management for an additional 1,050 homes. Also economically justified but providing slightly less net benefits than nonstructural alternative 2R, is nonstructural alternative 3R, which provides for 4,400 building retrofits within the 10-year floodplain, along with the 6 miles of road raising that provides coastal storm risk management for an additional 1,050 homes. When combined with Plan 1a and 1b, which provides inlet modifications and breach response, each of the Plan 2 combinations are cost-effective, with benefit-cost ratios (BCRs) greater than 1, both for each of the individual reaches and also for the combined reaches. Plan 2f, (+13.0 feet NGVD 29 Breach Closure, Inlet Management, and nonstructural plan 2R) provided slightly greater net benefits than Plan 2e (+9 feet NGVD 29 Breach Closure, Inlet Management, and nonstructural plan 2R).

Plan 2 was also not a complete solution since it does not address the coastal damages along the ocean shorefront and does not address restoring the natural coastal processes, beyond the sand bypassing, which reestablishes the alongshore transport coastal process.

Plan 3

The third series of plans (Plan 3a through Plan 3g) reflects the addition of the optimum beach nourishment alternative identified in Phase 2 to Plans 2e through Plan 2h. The optimum beach nourishment alternative included a +15 feet NGVD 29 dune and a 90 foot berm width design for the Great South Bay and Moriches Bay Reaches. Beach nourishment alternatives were not cost effective in reducing storm damage in the Shinnecock Bay, Ponds, and Montauk Reaches. For the Shinnecock Bay reach, a Breach Response Plan triggered at +13 feet NGVD 29 is provided.

Within the Great South Bay and Moriches Bay Reaches there are several environmentally sensitive areas along Fire Island that are vulnerable to future breaches. These locations include the Otis Pike High Dune Wilderness Area (OPWA), areas designated as Major Federal Tracts (MFT) by Fire Island National

[1] A floodplain is an area of land adjacent to a stream, river, or coast that experiences flooding when water levels are relatively high, such as during coastal storms. Unless otherwise noted, all references to the floodplain in this report refer to the current-year floodplain determined. The term "percent flood" expresses the annual chance that a certain water elevation will occur in any given year, for a discrete flood event. This is based on an estimate of the annual exceedance probability, also known as the annual chance of exceedance. The term "percent floodplain" relates to the geographic extent of a flood with the corresponding annual exceedance probability.

Seashore, and the Smith Point County Park (SPCP). Alternative Plans were developed to evaluate the impact of not providing the optimized beach design at these locations, and instead providing a Breach Response Plan with a +9.5 feet closure design. Each of the plans provide for Inlet Management, Breach Response in the Shinnecock Bay Reach, and road raising on the mainland, but differ with regard to the nonstructural plan (NS2R or NS3R), the Breach Response Plan (Plan 13 or Plan 9.5), and the specific locations where beach nourishment would be excluded.

Each of the plans provide positive net benefits, with the continuous beachfill plan (Plan 3a) providing the greatest storm damage reduction benefits. However, since NPS policies do not permit placing fill within undeveloped tracts of land within Fire Island National Seashore, only Plans 3d and 3g were acceptable to the NPS. Both Plans 3d and 3g include beachfill in the developed areas, along with periodic renourishment for up to 50 years after the date of initiation of construction. The period of renourishment for the project is 30 years, spanning from initial construction in 2020 until 2050 (see Table 50 for implementation schedule). As discussed in Section 6.5.2, renourishment is expected to take place about every 4 years until year 30.

Plan 3g provides nonstructural storm risk management to structures within the 10-year floodplain (NS 3R), while Plan 3d provides nonstructural storm risk management to structures within the 6-year floodplain (NS 3R).

Plan 3g was the identified as the plan that best balances the objectives of coastal storm damage reduction, consistent with the Vision Criteria objectives. To further address the storm damage reduction needs and achieve the Vision Criteria objectives, this plan also integrated the following:

- Groin modifications
  - Shortening the groins in the Westhampton groin field to reduce renourishment needs to the west
  - Modifying groins at Ocean Beach upon relocation of the water supply
  - Monitoring groins in the area of Georgica Pond to determine if any structure modification is warranted
- Restoration of the Natural Coastal Processes
  - Sand bypassing
  - Integration of Sediment Management Features
  - Integration of natural features to reestablish the natural coastal processes
- Integration of Appropriate Land Use and Development Management Measures
- Integration of Considerations of Climate Change and Adaptive Management

Tentative Selected Plan (TSP)

Based upon the May 2009 Report, and subsequent public and stakeholder meetings, and coordination between the Army and DOI, in March 2011, USACE and DOI reached agreement on a TFSP. The TFSP was based on the Plan 3g including refinements made to ensure the plan was mutually acceptable to USACE and DOI. The TFSP was identified as the National Economic Development (NED) Plan, since this is the plan that maximized net benefits, and satisfied the requirement (constraint) to be mutually acceptable with the Secretary of the Army and Secretary of Interior.

In March 2011, USACE and DOI transmitted a summary of the TFSP to the State of New York to request their concurrence. By letter dated December 29, 2011, the State provided comments on the TFSP and requested clarification and further detail of the proposed project features and implementation steps.

Coordination was ongoing when Hurricane Sandy struck on October 29, 2012, and caused extensive damage to the project area, and created three breaches of the barrier island. Two of the breaches were closed. The breach within the Otis Pike High Dune Wilderness Area remains open. DOI has signed a Record of Decision for the Wilderness Breach Management Plan EIS on July 23, 2018. Under the selected action identified in the ROD, the evolution, growth, and/or closure of the breach will be determined by natural barrier island processes, and human intervention to close the breach will occur only "to prevent loss of life, flooding, and other severe economic and physical damage to the Great South Bay and surrounding areas." The National Park Service will continue to monitor the wilderness breach using established methods that staff and scientists have used since 2012. Monitoring is being conducted to determine if changes in the breach could elevate the risk, which could lead to a decision to close the breach..

Following Hurricane Sandy, USACE took several actions to update the TFSP. The effort included the following updates:

- Updated the structure inventory and shoreline conditions, based upon post-Hurricane Sandy changes.
- Updated the hydrodynamic modeling that was done previously, to account for the breach that occurred in the Otis Pike High Dune Wilderness Area.
- Updated the economics life-cycle model to account for the existing Wilderness Breach in the Otis Pike High Dune Wilderness Area, and also to reflect the new information available about observed / expected breach growth rates.
- Accounted for post-Hurricane Sandy efforts undertaken by USACE and others. This includes repair of the existing projects, the FIMI and Downtown Montauk Stabilization Projects, and nonstructural plans that have been implemented in the project area.

USACE updated the TFSP in response to these changed conditions, and the risk and vulnerability within the study area impacted by the hurricane. The changes made to the TFSP during plan refinement include:

- A dune alignment on Fire Island located further landward that reflects the post-Hurricane Sandy beach and dune condition and is consistent with the post-Hurricane Sandy FIMI Stabilization Project.
- A Proactive Breach Response Plan within Smith Point County Park and the Fire Island National Seashore Lighthouse Tract to provide a greater level of risk-reduction to these two heavily impacted areas.
- A 30-year commitment for periodic renourishment, and implementation of Breach Response Plans for years 31-50.
- A Conditional Breach Response Plan on Federally-owned property within the FIIS that provides for a decision-making process for potential breach closure. Mechanical closure of the breach will be taken if the breach does not close naturally within 60 days of opening.
- Refinement of the coastal process features, with an emphasis on features that contribute to coastal storm risk management.

- Recognition that future changes in land management regulations are the responsibility of non-USACE entities (NPS, State, and Local Govt.) that complement the features recommended for FIMP.

This updated plan was provided to New York State in May 2013. New York State agreed in concept with this plan in June 2013, recognizing that further refinements to the plan would be taking place. In August 2015, USACE advised New York State and DOI of their intent to proceed with this updated plan as the Tentatively Selected Plan.

Plan Refinements

The draft GRR and EIS were released in July 2016 for concurrent public and agency comment. The following is a summary of plan refinements to the Tentatively Selected Plan made in response to the comments received to the draft report (see Section 10 – Public Involvement) and subsequent coordination with NYS, partner agencies, HQUSACE, and the ASA(CW):

- The plan has been updated to reflect current conditions, with updated costs and benefits.
- Road raising features along the mainland have been eliminated and replaced with nonstructural measures for structures within the 10 percent floodplain.
- In several mainland locations, acquisition of structures and reestablishment of floodplain function is recommended instead of building retrofits.
- The specific criteria for breach response have been updated and clarified for each location. Breach Response Plans have been identified, including a response plan specific to the Otis Pike High Dune Wilderness Area.
- The Potato Road sediment management feature in the Village of Sagaponack has been removed from the plan, based upon changes in the FWOP condition, as well as public access concerns.
- The Downtown Montauk sediment management feature has been refined to increase the volume for initial construction and renourishment, and to incorporate the existing geotextile-reinforced dune as part of the project.
- The plans for further modification of the Westhampton Groins have been removed from the plan.
- The Ocean Beach groins are recommended to be removed, rather than modified.
- The number and nature of Coastal Process Features have been updated and refined based upon public and agency input.

Recommended Plan

A Recommended Plan was identified in coordination with NYS, partner agencies, HQUSACE, and the ASA(CW). Consistent with the policy exception granted by the ASA(CW) on October 11, 2017, the Recommended Plan includes features that are not incrementally justified as typically required by USACE guidance, but are necessary in order to achieve mutual acceptability between the Secretary of the Army and the Secretary of the Interior as required by P.L. 88-587. The Recommended Plan, which is the mutually acceptable plan identified to the Secretary of the Army and Secretary of the Interior, and supported by the non-Federal sponsor, is shown in Figure 2 and Figure 3. A chronology of discussions and agreements related to mutual acceptability of the Plan is included in Appendix L – Pertinent Correspondence. The Recommended Plan includes the following features:

Inlet Sand Bypassing

- Provides for sufficient sand bypassing across Fire Island, Moriches, and Shinnecock Inlets to reestablish the natural longshore transport of sand along the barrier island for 50 years. Scheduled OMRR&R dredging of the authorized navigation channel and deposition basin with sand placement on the barrier island will be supplemented, as needed, by dredging from the adjacent ebb shoals of each inlet to obtain the required volume of sand needed for bypassing
- The bypassed sand will be placed in a berm template at elevation +9.5 feet NGVD 29 in identified placement areas
- Monitoring is included to facilitate adaptive management changes

Mainland Nonstructural Measures

- Includes up to 4,432 structures within the ten percent floodplain using nonstructural measures, primarily, structural elevations and floodproofing, based upon structure type and condition.
- Ringwalls are provided for 93 structures that are not suitable for nonstructural measures. The ringwalls will meet all requirements of structural measures
- Includes acquisition of 14 structures in areas subject to high frequency flooding, and reestablishment of natural floodplain function

Breach Response Plans

- Proactive Breach Response – is an action that is triggered when the level of project performance at the shoreline falls below the condition under which the four percent flood would be capable of breaching the barrier island
- Reactive Breach Response – is an action that is triggered when a breach has occurred, and there is an exchange of ocean and bay water during normal tidal conditions. It is applicable to locations where there is agreement that a breach should be mechanically closed quickly, such as the Talisman Federal tract, where there is an acknowledgement of the high vulnerability of breaching, deep water in the back bay, and new infrastructure that connects communities east and west of this location
- Conditional Breach Response – is an action that is triggered when a breach has occurred, and there is an exchange of ocean and bay water during normal tidal conditions. It is applicable to most Federally-owned tracts within FIIS. A decision about potential breach closure will be made by the Breach Closure Team. Mechanical closure of the breach will take place if the breach does not close naturally within 60 days of opening
- Wilderness Breach Response – is an action that is triggered when a breach has occurred, and there is an exchange of ocean and bay water during normal tidal conditions. It is applicable to the Federally-owned Wilderness tracts within FIIS, and is consistent with the Wilderness Breach Management Plan/EIS prepared by NPS. A decision about potential breach closure will be made by the Breach Closure Team. Mechanical closure of the breach may take place if decided by the Breach Closure Team

Beach and Dune Fill on Shorefront

- Provides for a 90 foot width berm and +15 feet dune along the developed shorefront areas on Fire Island and Westhampton barrier islands

- All dunes will be planted with dune grass except where noted
- On Fire Island the post-Hurricane Sandy optimized alignment is followed and includes overfill in the developed locations to minimize tapers into Federal tracts
- Renourishment takes place approximately every four years for up to 30 years after project initiation; while proactive breach response takes place from years 31 to 50 after project initiation
- Provides for adaptive management to ensure the volume and placement configuration accomplishes the design objectives of offsetting long-term erosion
- Provides for construction of a feeder beach every four years for up to 30 years at Montauk Beach

Groin Modifications

- Provides for removal of the existing Ocean Beach groins

Coastal Process Features (CPFs)

- Provides for 12 barrier island locations and two mainland locations (Figure 1) as coastal process features and provide habitat for protected species
- Includes placement of approximately 4.2 million cubic yards of sediment, in accordance with a ASA(CW) policy exception (October 11, 2017). Sediment will be placed along the barrier island bayside shoreline over the 50-year period of analysis that reestablishes the natural coastal processes consistent with the reformulation objective of no net loss of habitat or sediment. The placement of sediment along the bay shoreline will be conducted in conjunction with other nearby beach fill operations undertaken on the barrier island shorefront
- The CPFs will compensate for reductions in cross-island transport and sediment input to the Bay, offset Endangered Species Act impacts from the placement of sediment along the barrier island shorefront, augment the resilience and enhance the overall barrier island and natural system coastal processes

Adaptive Management

- Provides for monitoring and the ability to adjust specific project features to improve effectiveness and achieve project objectives
- Climate change will be accounted for with the monitoring of climate change parameters, identification of the effect of climate change on the project design, and identification of adaptation measures that are necessary to accommodate climate changes as it relates to all the project elements

Integration of Local Land Use Regulations and Management

- Upon project completion, USACE's Annual Inspection of Completed Works (ICW) program provides for monitoring and reporting of any new development within the project area to the appropriate Federal, state, and local entities responsible for enforcing applicable land use regulations

Figure 2 and Figure 3 summarize the Recommended Plan features for Years 1-30 and Years 31-50, respectively.

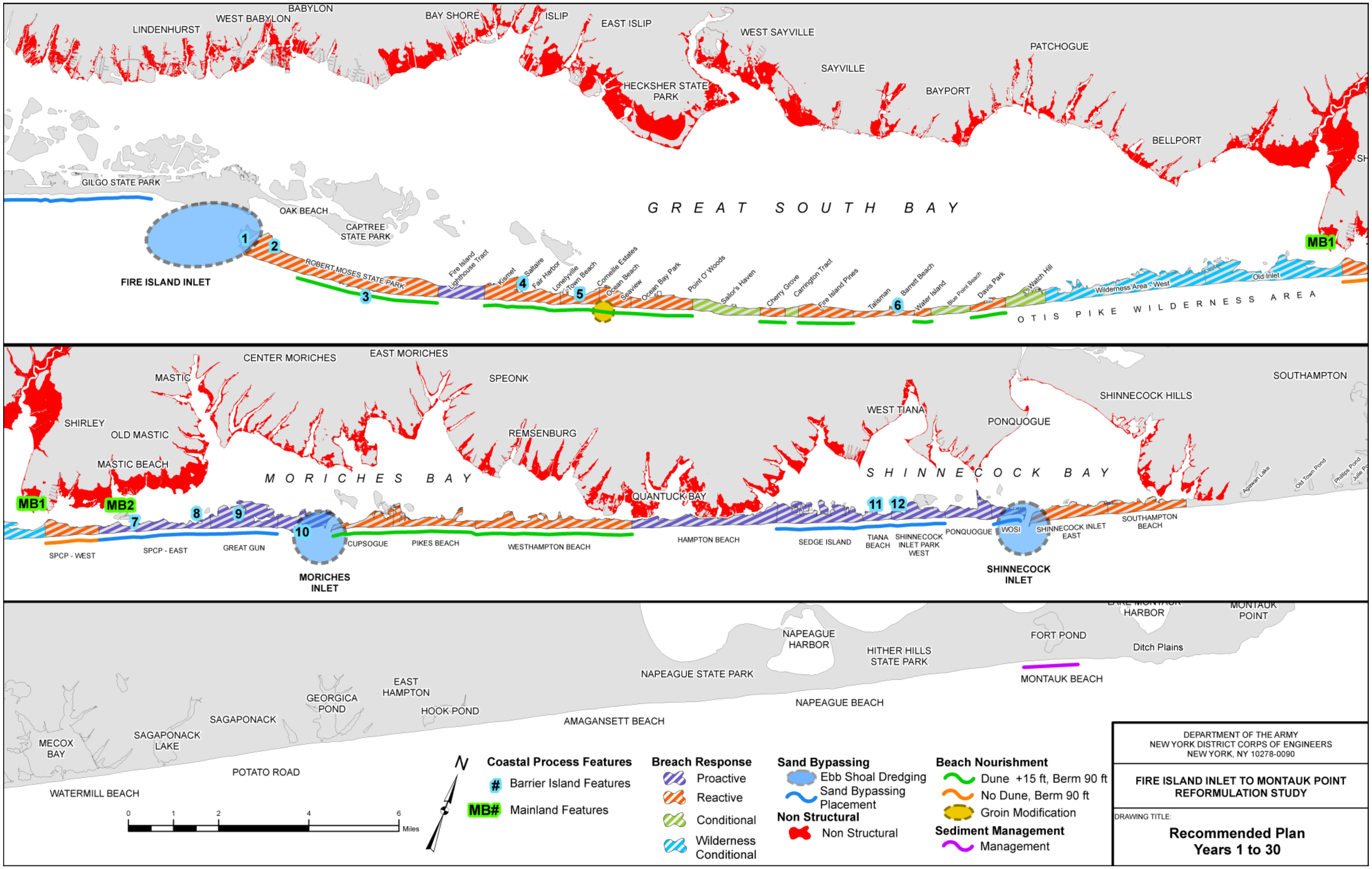

Figure 2. Recommended Plan (Years 1 to 30)

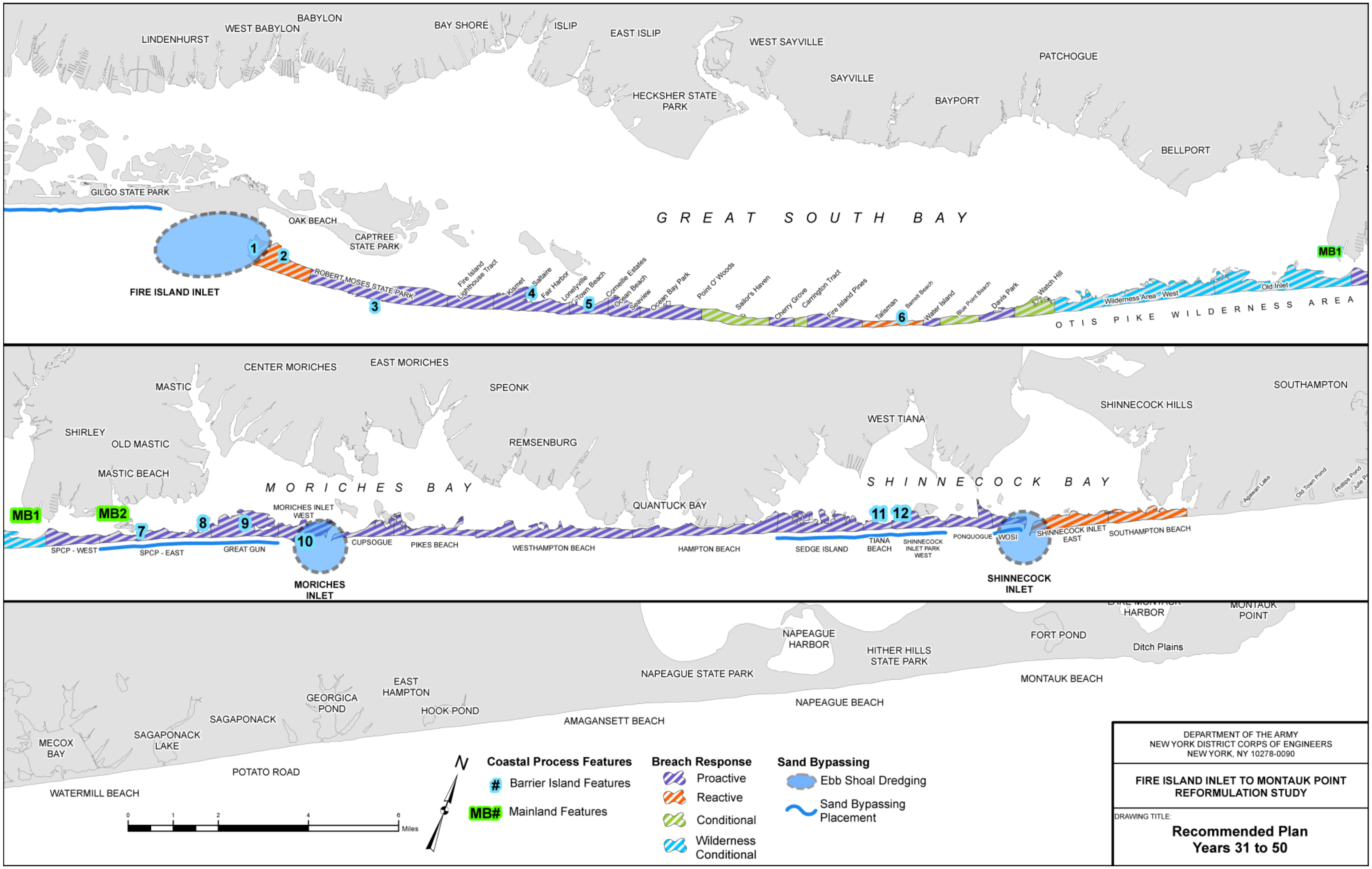

Figure 3. Recommended Plan (Years 31 to 50)

Recommended Plan Costs and Benefits

The Recommended Plan has been evaluated to compare the annualized With-Project damages to the Without-Project Damages in order to demonstrate the cost-effectiveness of the Tentatively Selected Plan. This comparison uses the FY 20 discount rate of 2.75 percent, a project base year of 2028, and a period of economic analysis of 50 years.

Project Performance & Relative Sea Level Change

RSLC has the potential to affect project performance over time. RSLC is how the height of the ocean rises or falls relative to the land at a particular location. The study area is projected to experience relative sea level rise, as described in Chapter 3. In accordance with Engineer Regulation (ER) 1100-2-8162 "Incorporating Sea Level Change in Civil Works Programs" (December 31, 2013) and Engineering Pamphlet (EP) 1100-2-1 "Procedures to Evaluate Sea Level Change: Impacts, Responses, and Adaptation" (June 30, 2019), the alternative plans described in Chapter 5 were formulated, evaluated, and compared based upon one RSLC projection, since plan selection is not sensitive to RSLC. The USACE "low" RSLC projection was used for the analysis in order to arrive at a selected plan. Please note, the performance of the selected plan was evaluated under the low, intermediate, and high rate of RSLC in Chapter 7 to consider the costs and economic performance of the plan. In order to provide a plan that addresses RSLC, the Recommended Plan identifies the costs and benefits associated with the intermediate rate of RSLC.

Table 2 summarizes the project costs and economic benefits under both the "low" RSLC projection, which reflects the analysis used in plan selection, and the intermediate RSLC projection, which are reflected in the Recommendations. Costs and economic benefits of the Recommended Plan were subsequently developed using all three USACE RSLC projections: the "low," "intermediate," and "high." The analysis was performed in accordance with ER 1100-2-8162 and EP 1100-2-1, in order to understand the sensitivity of costs, economic benefits, and residual damages under the three RSLC projections. The results of the analysis are presented in Table 4 of this Executive Summary, as well as Chapter 7. In order to provide a plan that accounts for RSLC, this report presents the costs and benefits of the Recommended Plan for intermediate rate of RSLC, which will serve as the basis for project authorization. The cost estimates have been itemized to account for the increased cost for renourishment as a line-item for RSLC adaptation costs. The entire FIMP project includes a Monitoring and Adaptive Management Plan (MAMP) to allow for project adaption. Adaptation to RSLC is a component of the MAMP. It is acknowledged that given the potential for RSLC greater than for the low RSLC projection that authorizing an adaptation cost would be warranted. Specific modifications to the project would be addressed through the MAMP, and may require further analysis if determined to be outside the scope described in this report.

Table 2. Summary of Recommended Plan Costs, Benefits and BCR (Oct 2019 P.L.)

	Project Feature	RSLC Low	RSLC Intermediate
Initial Cost	06 Fish & Wildlife Facilities	$1,033,300	$1,033,300
	10 Breakwater & Seawalls	$5,151,000	$5,151,000
	17 Beach Replenishment	$130,282,400	$130,282,400
	18 Cultural Resources	$15,038,200	$15,038,200
	19 Buildings, Grounds & Utilities	$854,000,900	$854,000,900
	Construction Estimate Totals	*$1,005,505,800*	*$1,005,505,800*
	01 Land and Damages	$153,276,600	$153,276,600
	30 Planning, Engineering & Design	$292,422,700	$292,422,700
	31 Construction Management	$90,775,600	$90,775,600
	Project Cost Totals	*$1,541,980,700*	*$1,541,980,700*
	IDC	$28,372,100	$28,372,100
	Investment Cost	**$1,570,352,800**	**$1,570,352,800**
Annualized Cost	Investment Cost	$58,167,000	$58,167,000
	Periodic Renourishment for 30 years	$20,738,000	$20,738,000
	Inlet Bypassing for 50 years	$9,336,000	$9,336,000
	Proactive Breach Closure	$685,000	$636,000
	Breach Closure Costs	$839,000	$1,162,000
	Coastal/Engineering Monitoring	$1,805,000	$1,805,000
	Environmental Monitoring	$2,326,000	$2,326,000
	OMRR&R	$677,000	$677,000
	Emergency Beach Fill	$1,893,000	$1,893,000
	RSLC Adaptation	$0	$643,000
	Total Annual Cost	**$96,466,000**	**$97,383,000**
Residual	Damages – Breach Open	$9,734,000	$28,214,000
	Damages – Back Bay Inundation	$81,466,000	$85,012,000
	Damages – Shorefront	$7,216,700	$8,364,000
	Total Residual Damages	**$98,416,700**	**$121,590,000**
Annualized Benefits			
	Cost Avoided – Breach Closure	$3,290,000	$4,489,000
	Benefits – Breach Open	$10,605,000	$34,765,000
	Total Breach Closure Benefits	$13,895,000	$39,254,000
	Benefits – Back Bay Inundation	$85,208,000	$139,316,000
	Benefits – Shorefront	$8,578,100	$8,662,000
	Total Storm Damage Reduction Benefits	*$104,391,100*	*$182,743,000*
	Non-Federal Renourishment Cost Avoided	$3,143,000	$3,143,000
	Recreation Benefits	$25,731,000	$25,731,000
	Total Benefits	**$136,555,100**	**$216,106,000**
	Net Benefits	**$40,089,100**	**$118,723,000**
BCR		**1.4**	**2.2**

1 Based on EP 1100-2-1 "Procedures to Evaluate Sea Level Change: Impacts, Responses, and Adaptation" (June 30, 2019)

Oct 2019 PL, using a 50-year period of economic analysis at the federal discount rate of 2.75 percent

Table 3. Summary of Without and With Project Damages (Oct 2019 P.L.)

Damage Category	**FWOP Equivalent Annual Damage**	**With Project Equivalent Annual Damage Recommended Plan**
Total Project		
Storm surge inundation occurring due to inlet conditions and wave setup in back bay		
Mainland	$118,511,000	$48,115,000
Barrier Island	$20,494,000	$19,827,000
Total	*$139,005,000*	*$67,942,000*
Storm surge Inundation occurring due to storm breaching and overwash		
Mainland	$23,589,000	$9,577,000
Barrier Island	$4,079,000	$3,946,000
Total	*$27,668,000*	*$13,523,000*
Total Mainland Inundation	*$142,100,000*	*$57,692,000*
Total Barrier Island Inundation	*$24,573,000*	*$23,773,000*
Total Inundation	*$166,673,000*	*$81,465,000*
Damages from Inundation due to a breach remaining open		
Inundation (Open Breach at Wilderness Area)	$9,436,000	$9,436,000
Inundation (Future Breaches)	$10,902,000	$297,000
Total Breach Open Damages	*$20,338,000*	*$9,733,000*
Shorefront Damages	$3,290,000	$1,593,000
Emergency Costs/Breach Closure	$3,703,000	$1,793,000
Total Damage	***$206,096,000***	***$100,008,000***

* Oct 2019 PL, using a 50-year period of economic analysis at the federal discount rate of 2.75 percent and reflecting the "low" RSLC projection

Table 4. Summary of Without and With Project Damages for the Three RSLC Projections (Oct 2019 P.L.)

	Low RSLC	Intermediate RSLC	High RSLC
Damages			
Breach Open Inundation	$20,338,000	$62,979,000	$649,236,000
Back Bay Inundation	$166,673,000	$224,328,000	$569,776,000
Shorefront	$15,795,000	$17,026,000	$22,338,000
Total FWOP Storm Damages	**$202,806,000**	**$304,333,000**	**$1,241,350,000**
Benefits			
Cost Avoided – Breach Closure	$3,290,000	$4,489,000	$12,078,000
Benefits – Breach Open	$10,605,000	$34,765,000	$503,896,000
Total Breach Closure Benefits	$13,895,000	$39,254,000	$515,974,000
Benefits – Back Bay Inundation	$85,208,000	$139,316,000	$301,693,000
Benefits – Shorefront	$8,578,100	$8,662,000	$8,283,000
Total Storm Damage Reduction Benefits	*$104,391,100*	*$182,743,000*	*$813,872,000*
Non-Federal Renourishment Cost Avoided	$3,143,000	$3,143,000	$3,143,000
Recreation Benefits	$25,731,000	$25,731,000	$25,731,000
Total Benefits	**$136,555,100**	**$216,106,000**	**$854,824,000**
Net Benefits	**$40,089,100**	**$118,723,000**	**$753,242,000**
BCR	**1.4**	**2.2**	**8.4**

Oct 2019 PL, using a 50-year period of economic analysis at the federal discount rate of 2.75 percent

PERTINENT DATA

Description

The Recommended Plan provides for coastal storm risk management along the Atlantic Coast of Long Island from Fire Island Inlet to Montauk Point, New York. The plan enhances coastal resilience and sustainability in the project area.

General Data

Study area: 126 sq. miles within Suffolk County, New York. Includes portions of Towns of Babylon, Islip, Brookhaven, Southampton, and East Hampton, as well as 12 incorporated villages, the entirety of Fire Island National Seashore (FIIS), the Poospatuck Indian Reservation, and the Shinnecock Indian Reservation.

Shoreline: 83 miles along Atlantic Coast shoreline and over 200 miles of back bay shoreline along Great South, Moriches, and Shinnecock Bays.

Structures impacted by a one percent flood: approximately 9,000

Population residing within the one percent floodplain: approximately 150,000

Datums

This study was prepared with references to the National Geodetic Vertical Datum of 1929 (NGVD 29). The project datum will be updated to the North American Vertical Datum of 1988 (NAVD 88) in the design phase. The conversion from NGVD 29 to NAVD 88 in the study area is accomplished by subtracting 1.1 feet from the NGVD 29 elevation value, or in other words NGVD 29 - 1.1 feet = NAVD 88.

Recommended Plan

The plan includes the following components, as shown in Figure 2 and Figure 3.

Sand Bypassing

Provides for sand bypassing at all three inlets and includes dredging of the ebb shoals and placing the material on the downdrift beach in the quantities needed to supplement the OMRR&R dredging and bypassing to reestablish littoral transport of sediment across the inlets for 50 years. The ebb shoal dredging would be undertaken in conjunction with scheduled/authorized navigational Operations and Maintenance (OMRR&R) dredging of the inlets and would increase sediment bypassing and reduce future renourishment fill requirements.

Fire Island Inlet

- OMRR&R maintenance dredging of authorized channel and deposition basin to take place on a 2-year interval, as authorized
- 379,000 cubic yards (per OMRR&R event) dredged from the ebb shoal (as needed to offset sediment deficit) and placed downdrift at Gilgo Beach

Moriches Inlet

- OMRR&R maintenance dredging of authorized channel to take place on a 1-year interval (as authorized)
- Approximately 73,000 cubic yards (per OMRR&R event) dredged from the ebb shoal (as needed to offset sediment deficit) and placed downdrift at Smith Point County Park

Shinnecock Inlet

- OMRR&R maintenance dredging of authorized channel to take place on a 2- year interval as authorized)
- 105,000 cubic yards (per OMRR&R event) dredged from channel/deposition basin, and from ebb shoal (as needed to offset sediment deficit) and placed downdrift at Sedge Island, Tiana Beach, and West of Shinnecock (WOSI)

Mainland Nonstructural Measures

Includes up to 4,432 structures:

- 3,675 structure elevations
- 650 floodproofed structures
- 14 structure acquisitions

  93 structures within ringwalls*

The specific nonstructural measures will be reviewed and refined in the Preconstruction Engineering and Design (PED) phase to ensure that the proposed measures, and the applicable population is appropriately identified.

* Ringwalls are classified as structural measures, per USACE Planning Bulletin 2016-01 "Clarification of Existing Policy for USACE Participation in Nonstructural Flood Risk Management and Coastal Storm Damage Reduction Measures" (December 22, 2015). Ringwalls were considered as part of the nonstructural analysis, and are thus presented here.

Breach Response on Barrier Islands

Proactive Breach Response – is an action that is triggered when the level of project performance at the shoreline falls below the condition under which the four percent flood would be capable of breaching the barrier island.

- Reactive Breach Response – is an action that is triggered when a breach has occurred, and there is an exchange of ocean and bay water during normal tidal conditions. It is applicable to locations where there is agreement that a breach should be mechanically closed quickly, such as the Talisman Federal tract, where there is an acknowledgement of the high vulnerability of breaching, deep water in the back bay, and new infrastructure that connects communities east and west of this location
- Conditional Breach Response – is an action that is triggered when a breach has occurred, and there is an exchange of ocean and bay water during normal tidal conditions. It is applicable to most Federally-owned tracts within FIIS. A decision about potential breach closure will be made by the

Breach Closure Team. Mechanical closure of the breach will take place if the breach does not close naturally within 60 days of opening

- Wilderness Breach Response – is an action that is triggered when a breach has occurred, and there is an exchange of ocean and bay water during normal tidal conditions. It is applicable to the Federally-owned Wilderness tracts within FIIS, and is consistent with the Wilderness Breach Management Plan/EIS prepared by NPS. A decision about potential breach closure will be made by the Breach Closure Team. Mechanical closure of the breach may take place if decided by the Breach Closure Team

Barrier Islands – Include the following components:

- Provides for +15 feet NGVD 29 dune with 90 foot berm (+9.5 feet NGVD 29), with post-Hurricane Sandy optimized alignment for 11 project reaches, totaling approximately 81,000 feet of shoreline.
- Periodic renourishment would take place about every 4 years for a 30-year period after initial construction
- For years 31 through 50, there would be proactive breach response in those reaches, which continues to provide some storm risk management, albeit less than what was provided by the periodic renourishment
- Montauk Beach - Feeder beach – initial placement of about 450,000 cubic yards of sand along 6,000 feet of shoreline with subsequent placement of about 400,000 to 450,000 cubic yards about every 4 years for a 30-year period after initial construction

Ocean Beach Groin Modifications

Remove the existing groins

Coastal Process Features

- Provides for 12 barrier island locations and two (2) mainland locations
- Includes placement of approximately 4.2 million cubic yards of sediment along the barrier island bayside shoreline over the period for renourishment to ensure no net loss of habitat or sediment. The placement of sediment along the bay shoreline will be conducted in conjunction with other nearby beach fill operations undertaken on the barrier island shorefront
- The CPFs will compensate for reductions in cross-island transport and sediment input to the Bay, offset Endangered Species Act impacts from the placement of sediment along the barrier island shorefront, augment the resilience and enhance the overall barrier island and the natural coastal processes

ECONOMICS

Project First Cost (Oct 2019 PL)... **$1,541,981,000**

Total Project Cost (cost including inflation to mid-point of construction) **$1,759,459,000**

Periodic renourishment (7 cycles over 30 year period)…… **$1,485,853,000**

Periodic renourishment (fully funded to mid-point of construction)……… **$3,416,774,000**

Total Annual Benefits $216,106,000

Total Annual Cost $97,383,000

Net Benefits $118,723,000

Benefit to Cost Ratio 2.2

Base Year 2028

Damage Model Used .... HEC-FDA 1.2.5a**

* Oct 2019 PL, using a 50-year period of economic analysis at the federal discount rate of 2.75 percent and reflecting the intermediate RSLC projection

**A suite of models using SAS v9 and @RISK v6 were developed specifically for this study and were subject to certification procedures in accordance with EC 1105-2-412. Data generated using HEC-FDA v1.4.1 was also used to develop key inputs for the SAS and @RISK models.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDICES

ACRONYMS AND ABBREVIATIONS

APE Area of Potential Effect
BFE Base Flood Elevation
BRP Breach Response Plan
C Celsius
CBRA Coastal Barrier Resources Act of 199
CDP Census Designated Place
CEHA Coastal Erosion Hazard Area
CENAN U.S. Army Corps of Engineers, New York District
CMP Coastal Management Program
cy cubic yards
CWA Clean Water Act
CZM Coastal Zone Management
DOI United States Department of the Interior
EFH Essential Fish Habitat
EIS Environmental Impact Statement
ESA Endangered Species Act
F Fahrenheit
FEMA Federal Emergency Management Agency
FIIP Fire Island Interim Project
FIIS Fire Island National Seashore
FIMP Fire Island Montauk Point
FIRM Flood Insurance Rate Map
FVC future vulnerable condition
FWOP Future Without Project Condition
GIS geographic information system
GMP General Management Plan
HMP hazard mitigation plan
IRG Interagency Reformulation Group
JMA John Milner Associates
LIPA Long Island Power Authority
LIRR Long Island Railroad
LWRP Local Waterfront Revitalization Plan
LWRPs Local Waterfront Revitalization Programs
MFCMA Magnuson-Stevens Fishery Conservation and Management Act
mg/l milligrams per liter
MHW mean high water
MLW mean low water
MOU Memorandum of Understanding
MREI minimum real estate impact
MSL mean sea level
MTA Metropolitan Transportation Authority
NEPA National Environmental Policy Act of 1969
NFIP National Flood Insurance Program
NGVD National Geodetic Vertical Datum
NMFS National Marine Fisheries Service
NPS National Park Service

NRC National Research Council
NRHP National Register of Historic Places
NYCRR New York Code of Rules and Regulations
NYSDEC New York State Department of Environmental Conservation
NYSDOS New York State Department of State
NYSECL New York State Environmental Conservation Law
NYSEMO New York State Emergency Management Office
NYSOPRHP New York State Office of Parks, Recreation and Historic Preservation
OFD Oceanfront Dune District
OMRR&R Operation, Maintenance, Repair, Replacement and Rehabilitation
SAV submerged aquatic vegetation
SCDPW Suffolk County Department of Public Works
SEQR State Environmental Quality Review
SHPO State Historic Preservation Office
TFSP Tentative Federally Supported Plan
TSP Tentative Selected Plan
USACE U.S. Army Corps of Engineers

1 INTRODUCTION

The FIMP, New York Combined Beach Erosion Control and Hurricane Protection Project was authorized by the Rivers and Harbors Act of 1960. As described in Section 1.3, the project has been partially constructed, but is being reformulated to identify a long-term solution to manage the risk of coastal storm damages along the densely populated and economically valuable Atlantic Coast of Long Island, New York in a manner which balances the risks to human life and property, while maintaining, enhancing, and restoring the natural coastal processes and ecosystem integrity.

There is a long history of damaging storms along the Atlantic Coast of Long Island, as described in detail in Appendix E Plan Formulation. There have also been efforts to mitigate the damages, including construction of several features of the authorized FIMP project, which are described later in this Chapter. The study area also includes critical coastal habitat and environmentally sensitive areas, such as the Fire Island National Seashore.

This current study is called a Reformulation, because it seeks to reexamine the project that was originally formulated in the 1950s. This Reformulation came about in part due to a referral to the Council on Environmental Quality in response to the 1978 EIS that was prepared for the project subsequent to passage of the National Environmental Policy Act of 1969. As a result of the referral the U.S. Army Corps of Engineers (USACE) agreed to reformulate the project with particular emphasis on identifying and evaluating a broad array of alternatives in the context of cumulative impacts on the overall coastal system. The goal of the Reformulation study is to identify an economically viable, environmentally acceptable plan that addresses the storm risk management needs of the project area and is acceptable to the key Federal, State, and local stakeholders. Included within the study area is the Fire Island National Seashore (FIIS). The authorizing law for FIIS specifies that any plan for coastal storm risk management with the boundary of FIIS be mutually acceptable with the Secretary of the Interior and Secretary of the Army.

Given the complex system and the large number of stakeholders, a collaborative planning approach has been utilized to involve the key stakeholders and the public. An Interagency Reformulation Group (IRG) was established that provided executive level leadership for the reformulation from the key Federal and State agencies. The IRG developed a vision statement that identified the broad objectives for the study. The IRG also established various Technical Management Groups that included agency members, as well as non-governmental organizations and academia.

In May 2009, a draft report (USACE, 2009) was provided to the key government partners and stakeholders, which identified problems, opportunities, objectives and constraints, provided a detailed analysis of the alternatives, and identified several alternative plans for consideration. Based on the comments received and subsequent discussions among the stakeholders and public, a TFSP was developed and provided to the sponsor in March 2011. Appendix E- Plan Formulation describes the detailed formulation process that led to the 2009 draft report and the subsequent coordination and modifications that led to the TFSP.

On October 29, 2012, Hurricane Sandy made landfall near Atlantic City, New Jersey, where it collided with a blast of arctic air from the north, creating conditions for an extraordinary historic 'super storm' along the East Coast, with the worst coastal impacts centered on northern New Jersey, New York City, and the Long Island coastlines. Hurricane Sandy's unusual track and extraordinary size generated record storms surges and offshore wave heights in the New York Bight. The maximum water level at The Battery, New York peaked at +12.4 feet NGVD 29, exceeding the previous record by over 4 feet. Coastal erosion and damages within the FIMP study area as a result of Hurricane Sandy were severe and substantial. For example, post-Hurricane Sandy measurements of volume loss of the beach and dunes on Fire Island indicated that the subaerial beach lost 55 percent of its pre-storm volume equating to a loss of 4.5 million cubic yards (cubic yards). A majority of the dunes either were flattened or experienced severe erosion and scarping (Hapke et al, 2013).

Following Hurricane Sandy, further refinements were made to the TFSP, in order to arrive at the Tentatively Selected Plan (TSP) that was recommended in the Draft GRR and EIS that was released for public and agency comment in July 2016.

This report incorporates all comments received during the public review period and subsequent agency incorporation. It identifies the recommended plan, and identifies changes in the TSP, based upon these reviews, and agency coordination. It will serve as the decision document for implementation of the reformulated FIMP project, in accordance with the Disaster Relief Appropriations Act of 2013 (P.L. 113-2). As an "authorized, but unconstructed" project, the reformulated FIMP project is eligible for funding under P.L. 113-2 for initial construction at full Federal expense.

1.1 Study Area

The study area (Figure 4) extends from Fire Island Inlet east to Montauk Point along the Atlantic Coast of Suffolk County, Long Island, New York, a distance of about 83 miles. It includes the barrier island chains from Fire Island Inlet to Shinnecock Inlet, and a shorefront area east of Shinnecock Bay to Montauk Point. Behind the barrier islands, the back-bay and lands adjacent to Great South, Moriches, and Shinnecock Bays cover over 200 miles of shoreline that comprises the back bay and estuary system. The study area includes about 126 square miles on the mainland that are vulnerable to flooding.

Within the study area, sediment on the ocean shoreline has a net east to west alongshore movement, in response to waves and currents during normal conditions and during storms. This alongshore movement of sand primarily shapes the prevailing shoreline conditions. In addition to alongshore movement, sediment is also exchanged in the cross-shore direction, through erosion and accretion of the beach and dune, exchange of sand through tidal inlets, cross shelf sediment flux, and during large storm events (storms generally greater than a 2 percent annual chance of occurrence) through the episodic transport of sand over the island through overwash or breaching.

There has been extensive development on both the barrier islands and the mainland floodplains and significant modifications to the natural coastal process system. These include constructing jetties and providing navigation channels through Fire Island, Moriches, and Shinnecock Inlets and within the bays; constructing of groins, seawalls, revetment, bulkheads and other structures along the ocean and bays; placing fill and sand along the beaches; ditching of wetlands for mosquito control; and periodic openings of temporary inlets at coastal ponds.

The study area includes portions of the towns of Babylon, Islip, Brookhaven, Southampton, and Easthampton and 12 incorporated villages. FIIS, the Poospatuck Indian Reservation, and the Shinnecock Indian Reservation are all within the study area. The study area contains over 46,000 buildings, including

42,600 homes, and more than 3,000 businesses. There are 60 schools, 2 hospitals, and 21 firehouses and police stations in the study area. Of the buildings within the study area, more than 9,000 fall within the modeled one percent floodplain[2].

Approximately 150,000 people reside within the coastal one percent floodplain of the South Shore of Suffolk County (2010 U.S. Census). The study area is also a popular summer recreation area with a large seasonal influx of beachgoers and visitors, as well as businesses which support the year round and seasonal population of the area.

1.2 Project Authority

The FIMP, New York, Combined Beach Erosion Control and Hurricane Protection Project was authorized by the River and Harbor Act of July 14, 1960. The authorization provides for beach erosion control and hurricane protection (coastal storm risk management) along five reaches of the Atlantic Coast of New York from Fire Island Inlet to Montauk Point, a distance of about 83 miles, by widening the beaches along the developed areas to a minimum width of 100 feet, with an elevation of 14 feet above MSL, and by raising dunes to an elevation of 20 feet above MSL, from Fire Island Inlet to Hither Hills State Park, at Montauk and opposite Lake Montauk Harbor.

The original authorization also provides for the construction of up to 50 groins, grass planting on the dunes, interior drainage structures at Mecox Bay, Sagaponack Lake and Georgica Pond, and beach renourishment for a period of ten years after initial construction. The authorized plan is shown Figure 5, which shows the five reaches that were to be developed and implemented.

This authorization has been modified by Section 31 of the Water Resources Development Act (WRDA) of 1974, and Sections 103, 502, and 934 of the WRDA of 1986 (P.L. 99-662), which modified the cost-sharing percentages and the period of renourishment. As mentioned previously the reformulated FIMP project is also eligible for funding under P.L. 113-2, which would be at "full Federal expense."

[2] A floodplain is an area of land adjacent to a stream, river, or coast that experiences flooding when water levels are relatively high, such as during coastal storms. Unless otherwise noted, all references to the floodplain in this report refer to the current-year floodplain. The term "percent flood" expresses the annual chance that a certain water elevation will occur in any given year, for a discrete flood event. This is based on an estimate of the annual exceedance probability, also known as the annual chance of exceedance. The term "percent floodplain" relates to the geographic extent of a flood with the corresponding annual exceedance probability.

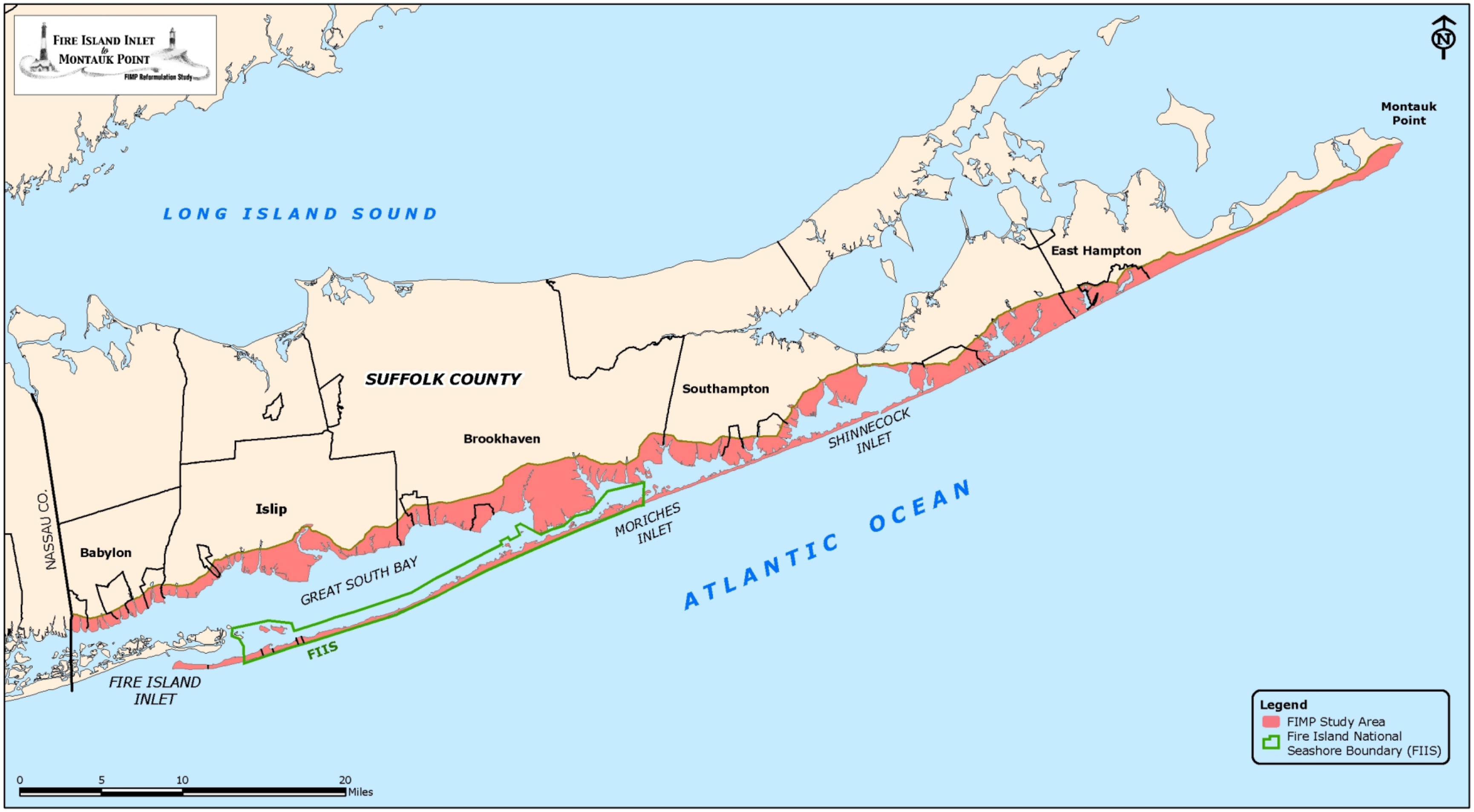

Figure 4. Study Area

1.3 Project History

The study area has a long history of storm damage. Prior to the 1930s the recorded history is largely anecdotal, but records describe the great storm of 1690 which opened Fire Island Inlet; the major hurricane of 1821, which resulted in flooding 9.3 feet above average in NYC, and the hurricane of 1890 which was labeled as "Long Island's Most Destructive Storm." The 1930s had a number of significant storms, including the March 1931 nor'easter, which created Moriches Inlet and caused widespread erosion. The 1938 hurricane, named the Long Island Express had wind gusts of up to 135 MPH and caused widespread destruction with 50 people killed and over 1,000 homes destroyed. The storm resulted in 11 new openings in the barrier islands, 10 of which were closed using trucks and bulldozers. The 11th breach was at Shinnecock Inlet, which Suffolk County stabilized with a timber crib structure on the western side to create a permanent inlet.

There was a series of storms beginning with the November 1950 and November 1953 Nor'easters, Hurricane Carol in 1954, Hurricane Donna in 1960, and the Ash Wednesday Nor'easter of 1962, also known as the "5 High-Tide Storm", since the storm resulted in flooding over a period of five high tides. These storms had significant impacts on the project area and resulted in the original FIMP study. The study concluded with a 1958 Survey report that was the basis of the 1960 project authorization.

1.3.1 Project Implementation in the 1960s

Following the original project authorization in 1960, several design memoranda (reports) covering portions of the project were prepared. General Design Memorandum (GDM) No. 1 that was approved in January 1964 recommended the construction of 13 groins in the portion of the project between Moriches and Shinnecock Inlet (Reach 2) along with beachfill and dune construction concurrent with the groin construction. Due to objections from local interests, the plan was modified to include construction of 11 groins in Reach 2 with beach fill to be added as necessary but not sooner than three years after groin completion. In a special report of design memorandum scope dated July 1964, the construction of two groins in East Hampton, in the vicinity of Georgica Pond (Reach 4), was recommended and approved. Construction of the 11 groins within Reach 2 was completed in September 1966, while construction of the two groins in Reach 4 was completed in September 1965.

In the years following construction of the eleven groins in Reach 2, erosion was evident in the area west of the eleven groins. In February 1969, Supplement No.1 to GDM No. 1 (Moriches to Shinnecock Reach) recommended the construction of four more groins and placement of beach fill backed by a dune at an elevation of 16 feet above MSL in the 6,000 feet section of beach west of the 11-groin field. The four new groins were filled with 1.95 million cubic yards of sand to construct a beach and dune. This groin construction was completed in July 1970, bringing the total number of groins in Reach 2 to fifteen. Dune and beach fill was placed between October 1969 and October 1970.

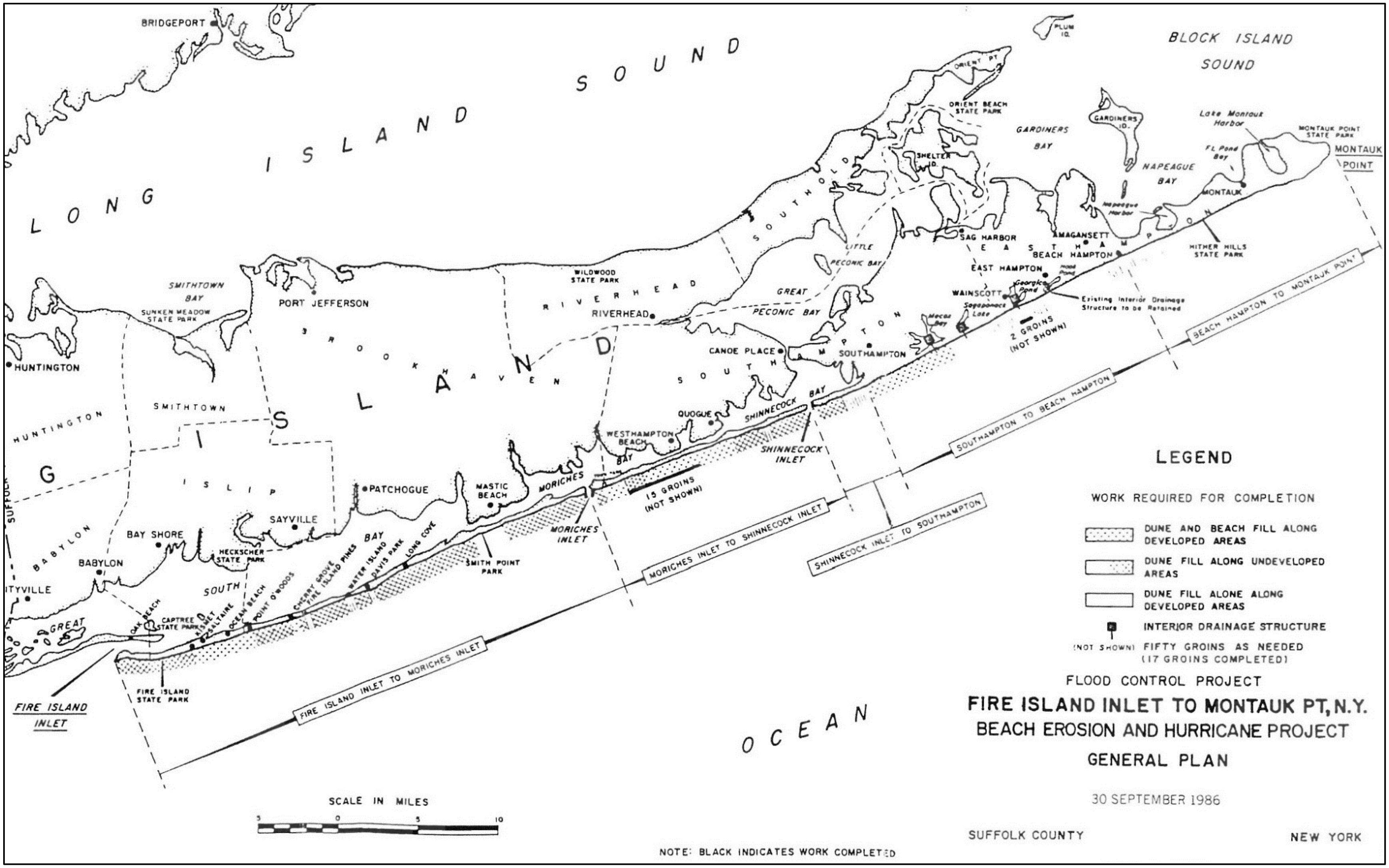

Figure 5. Original Authorized Project

1.3.2 1970s Design and NEPA Analysis

Recognizing the need to complete construction within the Moriches to Shinnecock Reach, the New York District prepared plans for six additional groins to the west of the constructed groin field at Westhampton (Section 1B). However, in November 1971, New York State withdrew its support due to a moratorium it imposed on capital projects funding. In April 1973, the State requested that the New York District resume planning for the construction of Section 1B. In November 1974, the Suffolk County Executive opposed the use of Moriches Bay and Moriches Inlet as the sand borrow source for Section 1B. Subsequently, offshore borrow sources were investigated and identified. In 1978 the Suffolk County Legislature and the NYSDEC approved participation in the Westhampton project, including beach fill and dune construction obtained from an offshore borrow area.

In conjunction with the design of Section 1B, USACE was required to comply with the National Environmental Policy Act (NEPA), because the originally authorized project was developed prior to the enactment of the NEPA in 1969. An EIS for the entire project area was prepared and filed with USEPA on January 28, 1978. On March 7, 1978, the DOI, supported by other agencies, referred the EIS to the Council on Environmental Quality (CEQ) as unacceptable. The CEQ concluded that the EIS did not sufficiently consider alternatives, did not adequately address project impacts, and did not consider cumulative impacts to the entire system. Following public meetings and public and government agency input, a Plan of Study was approved in July 1980 for a Reformulation Study and an updated EIS.

1.3.3 1980s Project Reformulation, Litigation and Westhampton Interim Project

At the time the Reformulation Study was being scoped, the involved Federal agencies agreed on an approach to address the critical erosion in the area west of the existing groin field at Westhampton Beach independent of the overall Fire Island Inlet to Montauk Point reformulation effort. In 1980 HQUSACE approved a plan for beachfill and dunes in this area. However, in 1981, the State objected to the cost-sharing of 6 percent Federal and 94 percent non-Federal for the required periodic renourishment at Westhampton. With the State withdrawing their support, all work on both Westhampton and the Reformulation was suspended due to lack of local support.

The State of New York's concern about the cost sharing were resolved with enactment Section 502 of the Water Resources Development Act of 1986 which provides for 70 percent Federal funding to be applied to periodic renourishment of continuing construction at Westhampton Beach, for a period of 20 years following the Act. With this resolution, coordination between the State and the New York District resumed on both Westhampton Beach and the Reformulation Study.

In 1984 several lawsuits were brought by various homeowners against the Federal government, New York State, and Suffolk County claiming that the failure to complete the project had resulted in the loss of their property. In 1989 the litigation was wrapped into a single suit borne by the Barrier Beach Association (BBA). In November 1993, homeowners, and representatives of the BBA established the area west of the existing groin field into the Village of Westhampton Dunes. Court proceedings took place in 1993 and 1994. The outcome of the litigation was a settlement agreement in November 1994 that provided for a mutually agreeable Westhampton Interim Project in the Westhampton Dunes area.

1.3.4 1990s Reformulation and Interim Projects

In 1992 concurrent efforts resumed on the overall reformulation and also on the study for an interim project for the Westhampton Beach potion of the Moriches Inlet to Shinnecock Inlet reach. The Initial Project Management Plan (IPMP) dated June 1993 provided for a comprehensive study of the entire project area as an interrelated system and for consideration of a wide range of possible plan alternatives. During this time there were a series of damaging storms that resulted in breaches to the barrier islands. During the December 1992 Nor'easter, two breaches occurred in the vicinity of Pikes Beach, spanning approximately 4,000 feet, westward of the westernmost groin. The western most breach (dubbed Pikes Inlet) was closed by placing 60,000 Cubic yards of sand taken from the Intracoastal Waterway. The eastern breach was originally the smaller of the two and was dubbed Little Pikes Inlet. Additional winter storms plus tidal and littoral forces resulted in a growth of this breach to 3,000 feet wide and 12 to 20 feet deep. During the time the breach was open, the consequences of the hydrodynamic changes in the bay were observed. During a relatively small nor'easter in March 1993, there were record levels of flooding along the back-bay communities of East Moriches, Remsenburg, and Mastic Beach. Because of the lengthy process to obtain approvals and funding, closure of the breach required the placement of 1.5 million cubic yards of sand, and also 1,800 feet of double row steel sheet pile, to aid in the closure, at a cost of $7,000,000.

Following these storms, USACE was requested by New York State, Congress and the Acting Assistant Secretary of the Army (Civil Works) to evaluate the feasibility of developing other interim projects under the reformulation effort, recognizing that the Reformulation Study was a long-term effort that would leave areas vulnerable to storm damages in the intervening years. The interim projects were intended to be "soft" solutions that would not limit or constrain alternatives for consideration under the Reformulation study. Below is a summary of the interim projects undertaken:

Breach Contingency Plan. As a result of the experience in the closure of the Little Pikes Inlet, a Breach Contingency Plan was prepared and approved in 1996 by USACE Headquarters (HQUSACE) that provides for a rapid response to close breaches along the barrier islands within the authorized project area. This plan provides for a limited response action to reestablish the barrier island to an elevation of +9 feet NGVD 29 and provides limited risk management (the 20 percent flood) for low-lying areas likely to be overwashed and subsequently breached again during relatively minor events.

Westhampton Interim Project. A plan to provide interim storm risk management to the Westhampton Beach area west of Groin 15 and the affected mainland communities north of Moriches Bay was completed in July 1995. The plan provides for a beach berm 90 feet wide and a dune of +15 feet NGVD 29,[3] tapering of the western two existing groins (groins 14 and 15) and construction of an intermediate groin (groin 14A) between these two. The project also includes periodic renourishment, as necessary to ensure the integrity of the project design, for up to 30 years (2027). Beachfill for this interim project also includes placement within the existing groin field to fill the groin compartments and encourage sand transport to the areas west of groin 15. The interim plan was determined to be in the Federal interest to provide storm risk management until the findings of the reformulation effort are available. Initial construction of the project was completed in December 1997. The interim project was subsequently renourished in 2001, 2004 and 2008, requiring

[3]National Geodetic Vertical Datum of 1929 (NGVD 29) is approximately 1.06 feet lower than North American Vertical Datum of 1988 (NAVD 88) within the FIMP study area. Therefore, the crest elevation the dune is +13.94 feet NAVD 88.

less sand at longer intervals than was estimated when designed. Due to severe erosion experienced due to Hurricane Sandy in 2012, approval was received from HQUSACE to repair the project to the pre-storm conditions and repair the project to its design condition. A contract was awarded in Sept 2014 with about 750,000 cubic yards of sand placed.

Fire Island Interim Project (FIIP). The Fire Island Interim Study was initiated in 1995 with a Technical Support Document and Environmental Assessment completed in 1997. Based upon the findings of the Environmental Assessment, it was determined that an EIS was required, which was released for public review in December 1999. Due to lack of commitment for the project by the non-Federal sponsor, the State of New York Department of Environmental Conservation, the report for the FIIP was never finalized. However, the extensive agency and public input received on the FIIP has been utilized in the development of the Reformulation Study.

West of Shinnecock Inlet Interim Project (WOSI). The West of Shinnecock Interim Project study was initiated in 1995 and was approved in May 2002. The recommendations include beach nourishment along the 4,000 feet long shoreline immediately west of the inlet, and renourishment every 2 years for a period of 6 years, to provide storm risk management for the area until the completion of the Reformulation Study. The project was constructed in March 2005 and received limited placement of sand as part of the maintenance dredging of Shinnecock Inlet, but no renourishment during the authorized period of renourishment between 2005 and 2011. Due to severe erosion experienced due to Hurricane Irene in 2011 and Hurricane Sandy in 2012, approval was received from HQUSACE to repair and reestablish the beach and dune to the design conditions. Two contracts were awarded with a total of about 500,000 Cubic yards of sand placed.

1.3.5 Hurricane Sandy

According to the National Hurricane Center, Hurricane Sandy, at nearly 1,200 miles in diameter, is the largest storm on historical record in the Atlantic basin. The storm, which made landfall coincident with astronomical high tides in the New York Bight, affected an extensive area of the east coast of the United States. The highest waves and storm surge were focused along the heavily populated New York and New Jersey coasts. The storm made landfall near Atlantic City, New Jersey, the evening of October 29, 2012. At the height of the storm, a record significant wave height of 31.5 feet was recorded at the wave buoy offshore of Fire Island, New York. During the storm, beaches were severely eroded and dunes extensively overwashed. The study area's barrier islands were breached in three locations, and the coastal infrastructure, including many private residences, were heavily damaged. Two of the three breaches were closed by USACE in partnership with NYS using the provisions contained in the Breach Response Plan, the breach within the Otis Pike High Dune Wilderness Area of FIIS (referred to as the Wilderness Breach) has remained open. DOI signed a Record of Decision for the Wilderness Breach Management Plan EIS on July 23, 2018. Under the selected action identified in the ROD, the evolution, growth, and/or closure of the breach will be determined by natural barrier island processes, and human intervention to close the breach will occur only "to prevent loss of life, flooding, and other severe economic and physical damage to the Great South Bay and surrounding areas." NPS will continue to monitor the Wilderness Breach using established methods that staff and scientists have used since 2012. Monitoring is being conducted to determine if changes in the breach could elevate the risk, which could lead to a decision to close the breach.

1.3.6 Post-Hurricane Sandy Emergency Stabilization.

Fire Island to Moriches Inlet Stabilization Project. Following Hurricane Sandy, the beach and dune condition along Fire Island were heavily impacted, and there was the need to take action quickly since homes and businesses were vulnerable to subsequent storms. In response to this need, USACE, in partnership with New York State initiated a stabilization project, under P.L. 113-2 to reestablish the beach and dune condition, as a one-time action. USACE developed a plan that was supported by NYS and DOI that included a 90 feet berm and dune at elevation +15 feet NGVD 29. The dune is located to consider the post-Hurricane Sandy dune alignment, and as such, included the acquisition or relocation of approximately 40 homes. The report and NEPA documents (USACE, 2014a) for this project were approved in July 2014, and a Project Partnership Agreement was executed in August 2014. Construction was initiated in September 2014 and is currently underway. The plan features contained in the TSP are similar to those included in the Fire Island stabilization effort.

Downtown Montauk Stabilization Project. The area of downtown Montauk was heavily impacted by Hurricane Sandy. Based upon this need, USACE, in partnership with New York State initiated a stabilization project under the authority of Public Law 113-2. A study was completed and approved in November 2014 (USACE, 2014b) that recommended a geotextile reinforced dune as a one-time project to stabilize the area until a long-term solution could be implemented. A Project Partnership Agreement was entered into in February 2015. Construction was initiated in October 2015 and was completed in April 2016.

1.4 Other Federal, State and Local Constructed Projects within Project area

In addition to the constructed portions of the Fire Island Inlet to Montauk Point Project described in the previous Section, there have been several other major coastal engineering actions within the project area that have affected the functioning of the coastal system that include:

- Inlet Stabilization and Navigation Channels. These include the construction of jetties and construction and maintenance of navigation channels in the three inlets within the study area: Fire Island Inlet, Moriches Inlet, and Shinnecock Inlet.
- Major Structural Measures. This includes groins at Ocean Beach, a bulkhead at Smith Point County Park, state groins at Georgica Pond and Hook Pond, a groin at Ditch Plains, and the Montauk Point Revetment.

There are also structures built by individual property owners or community groups to protect their residences. These include small groins, bulkheads, revetments, geotextile-type structures, tetrapod structures, and other measures (cars buried in dunes). There also have been localized beach fill projects that have taken place within the study area following major storms

1.5 Non-Federal Partners and Stakeholders

The non-Federal sponsor for the overall FIMP project is the New York State Department of Environmental Conservation (NYSDEC). In addition to the non-Federal sponsor, there has been extensive coordination with study stakeholders including:

- U.S. Department of the Interior: National Park Service, Fish and Wildlife Service, U.S. Geological Survey
- U.S. Environmental Protection Agency
- U.S. Department of Commerce: NOAA/National Marine Fisheries Service
- US Department of Homeland Security - Federal Emergency Management Agency
- New York State: Department of State and the Office of Emergency Management
- Suffolk County: County Executive, County Parks and Department of Public Works
- Towns of Babylon, Islip, Brookhaven, Southampton, and East Hampton, and also the incorporated villages and unincorporated hamlets within the study area portion of those Towns.

1.6 Problems and Opportunities

Problem Statement: Nor'easters and hurricanes periodically impact both the barrier islands and mainland of the Atlantic Coast of Long Island. These storms produce waves and storm surges that cause extensive flooding and erosion, as was recently seen during Hurricane Sandy.

Opportunities to provide resilient storm damage reduction while also restoring the natural coastal processes will be identified and evaluated for the three primary problem areas within the study area:

- Barrier Island Segments. These include Fire Island and the barrier island between Moriches Inlet and Shinnecock Inlet where many of the structures and buildings are vulnerable to storm damages due to wave attack, erosion of the natural beach and dunes, and tidal flooding. The barrier islands can overwash and breach during significant storm events, which is an important coastal process that contributes to the long-term sustainability of the system, but also impacts existing development on both the barrier island and the back bay,

- Mainland Areas. The back bay segments of the project area include the portions of the mainland along Great South Bay, Moriches Bay and Shinnecock Bay that are vulnerable to flooding primarily from storm surge through the inlets, and to a lesser extent as a result of breaches of the barrier islands.

- Atlantic Ocean Shoreline Segments. These include the eastern portion of the study area between the Village of Southampton and Montauk Point, which are vulnerable to damages from erosion, wave attack, and tidal flooding; similar to the problems along the barrier islands.

Within each of these problem areas, there are opportunities to restore the natural coastal processes that have been impacted by past human activities including:

- Longshore Transport (reestablish interrupted natural longshore movement of materials)
- Cross-Island Transport (reestablish disrupted natural pathways)
- Dune Growth and Evolution (reestablish the processes that allow for natural dune formation and evolution)
- Bay Shoreline Processes (reestablish disrupted sediment transport processes and
- Estuarine Circulation (reestablish altered circulation patterns within the bay).

2 EXISTING CONDITIONS

This Section provides a summary of the natural and human environment within the FIMP project area and serves as a reference point to understand FWOP and impacts associated with project alternatives.

2.1 Physical Conditions

The 83-mile study area spans the Atlantic Coast of Suffolk County, New York. Though it is diverse in terms of its physical characteristics, land use, and development, it functions as a system. Like many Atlantic coastal shorelines, sediment moves to and from beaches and barrier islands. Although the coast contains a variety of shore types (barrier islands and spits, mainland beaches and glacial bluffs), they are all primarily composed of small, loose materials such as gravels, sands and clays. Most of these sediments can be easily moved by wind and water, so the shorelines are inherently unstable and constantly changing in response to natural and human forces. The study area is extremely dynamic, constantly changing in response to natural processes associated with wind, waves, and tides as well as human activities.

The dynamic nature of the shoreline coupled with people's desire to use and enjoy the shoreline presents unique challenges in managing the study area, especially as it relates to managing coastal storm risk. Making recommendations such as for this study that balance conservation of the natural environment with significant demand for use of the shore requires a sound understanding of the processes shaping and impacting the coast.

2.1.1 Project Reaches

Due to its large size and the physical diversity within its borders, the study area has been divided into smaller reaches to facilitate study efforts, and for improvement design. Five project reaches subdividing the FIMP study area have been established based on major morphological features. Project reaches are large in scale and are defined by common physical characteristics that reflect environmental site conditions such as waves and underlying geology, and which may influence the design of risk management works. The study shoreline has been divided into five project reaches (Figure 6), as follows:

Project Reach 1 – Great South Bay (GSB)
Project Reach 2 – Moriches Bay (MB)
Project Reach 3 – Shinnecock Bay (SB)
Project Reach 4 – Ponds (P)
Project Reach 5 – Montauk (M)

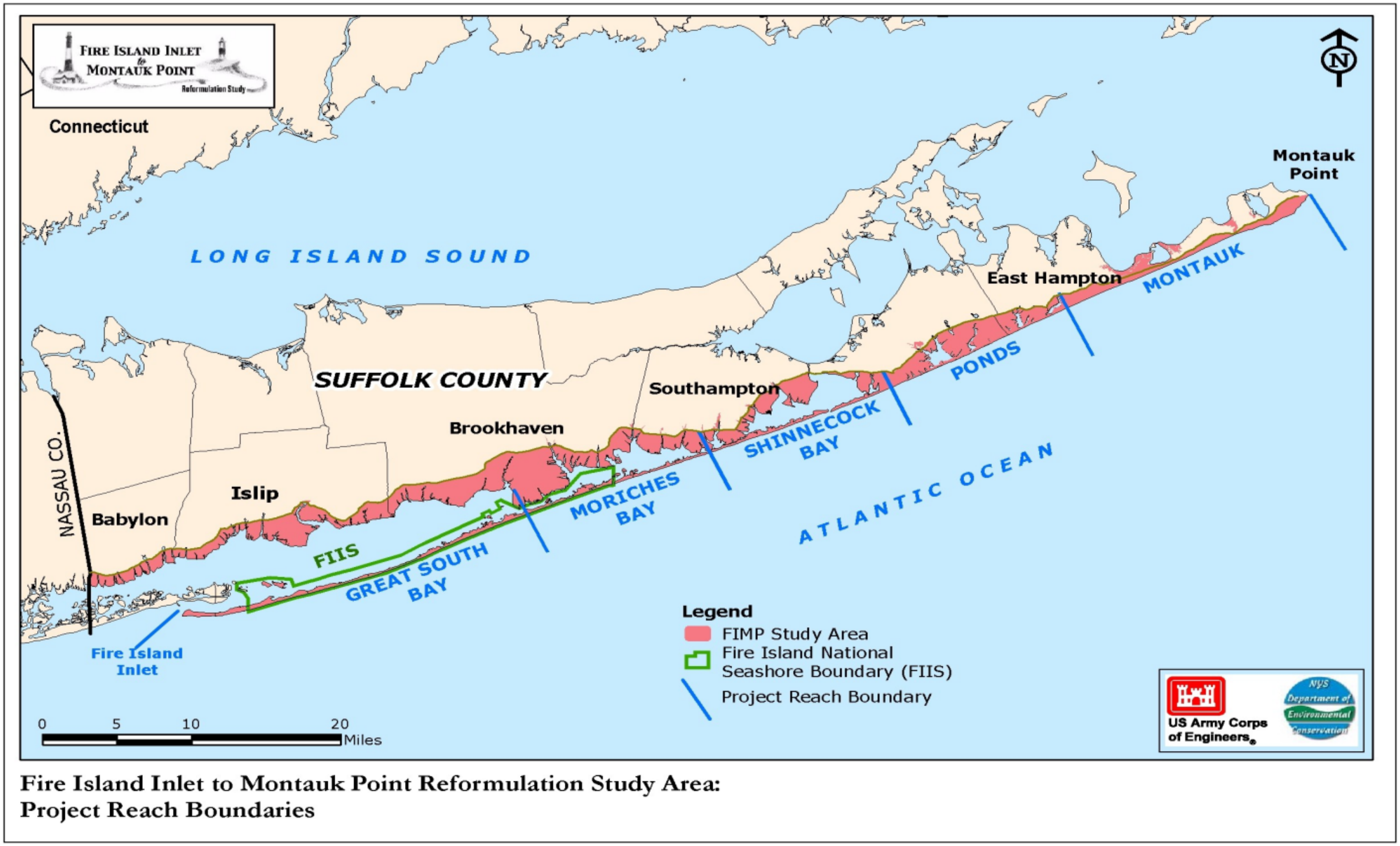

Figure 6. FIMP Study Reaches

2.1.2 Geology

Long Island is part of the Atlantic and Gulf Coastal physiographic province which lies along the eastern border of the United States and lays at the southern boundary of the late Pleistocene glacial advance in the eastern part of North America (Taney, 1961). The Ronkonkoma and Roanoke Point moraine deposits (i.e., mounds of unstratified glacial drift chiefly consisting of boulders, gravel, sand and clay) characterize the topography along the northern side of Long Island, while a gentler southward dipping gradient on the outwash plains makes up much of the southern side of the island (Schwab et al., 1999).

From Montauk Point west to Southampton (approximately 33 miles) headlands formed by Ronkonkoma moraine and outwash deposits are eroded forming a narrow beach and a series of small bays (i.e., ponds). Eroded sediments along this reach are transported westward by wave action. West of Southampton reworked glaciological outwash has formed low-relief, sandy (fine- to medium-grained sand) barrier islands enclosing shallow back-barrier bays. The barrier islands were formed by a combination of spit extension (westward from Southampton) and offshore bar development. The larger bays have historically been intermittently connected to the ocean by tidal inlets. In the normal course of events, inlets would be cut through the barrier island during storms, migrate over time to the west, and eventually close by natural coastal processes (Taney, 1961).

The principal geologic features of the inner continental shelf offshore of Fire Island are summarized by Schwab et al. (2013):

> *(1) a regional unconformity separating Cretaceous-age coastal plain strata from overlying Quaternary sediment; (2) a Pleistocene glaciofluvial sedimentary deposit exposed at the seafloor over much of the inner continental shelf at water depths between ~15 and ~32 m, the seaward limit of the study area; and (3) a series of Holocene sand ridges on the inner continental shelf W of Watch Hill extending across the study area.*

West of Watch Hill, the Holocene (modern) sedimentary deposit is organized into a series of shoreface-connected sand ridges oriented at angles of 30° to 40° to the coast (Schwab et al., 2013). Seismic reflection data collected in 1996 and 2011 by the USGS (Schwab et al. 2013) indicate that the thickness of the Holocene sediment thickness is between 1 and 6 meters. The thickness of the sand ridges is greatest (approximately 6 meters) offshore of central Fire Island and gradually thins to the west (approximately 1 meter thick offshore of Fire Island Inlet).

2.1.3 Barrier Islands & Shorefront Geological Processes

Barrier islands (i.e., barriers) are sandy, ridge-like, features located offshore and parallel to the mainland. As the name implies, barrier islands serve to protect both the mainland and the water body (bay or lagoon) that lies between the mainland and the leeward side of the barrier from ocean waves and filters the offshore signal of high water levels from storm tides. Figure 7 summarizes the principal features of common barrier island systems. The seaward features of the barrier are, from sea to land, comprised of a submerged beach profile, a shoreface, a berm and finally, a coastal dune. This natural shorefront encompasses a range of geometries depending on wave climate, sand supply and condition of the near shore bar. Specifically, the beach may erode under large waves and elevated water levels to assume a storm or “winter” profile. The beach may recover post-storm to assume a “summer” profile.

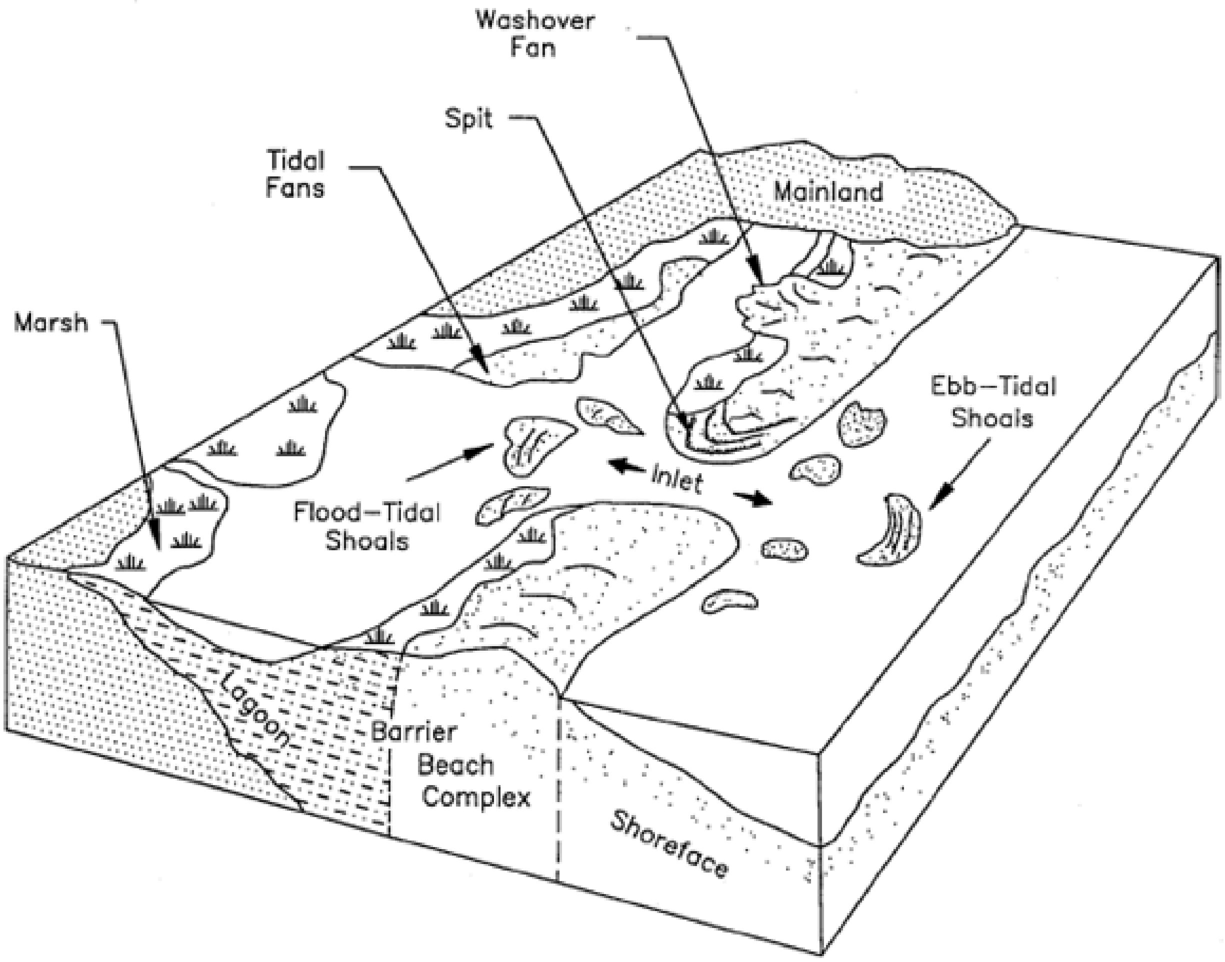

Figure 7. Cross Section of Barrier Island

Dunes are an important feature of barrier geometry. Dunes provide the last line of natural defense on a natural beach and normally have elevations 10 to 15 feet higher than normal high tides. During severe storms dunes may be overtopped (i.e., overwashed) or breached; the latter can lead to the formation of a new tidal inlet. The landward portion of the barrier island extends from the center of the dune area and consists of the back dune face, a leeward beach, a tidal marsh (in some cases) and an underwater profile extending into a lagoon or bay.

The dynamics of island overwashing, breaching and new inlet formation are dictated by the complicated interaction of numerous geomorphologic and hydrodynamic factors. A distinction between island overwash, island breaching and permanent inlet formation is illustrated in Figure 8. Overwash is the flow of water in restricted areas over low parts of barriers that typically occur during high tides or storms. Depending on the storm magnitude and island width, overwash areas of newly transported sand may penetrate no farther than the dunes, or may be spread onto the marshes or into the bay. In general, major overwashes extending into the bay occur only during severe storms (storms with greater than 2 percent annual chance of occurrence). Therefore, overwash has a more significant impact on subaerial and intertidal barrier island resources (e.g., back-bay marshes) than on back-bay areas located away from the barrier.

Breaching refers to the condition where a channel across the island is formed that permits the exchange of ocean and bay waters under normal tidal conditions. The breach may be temporary or permanent (i.e., a new inlet) depending on its size, adjacent bay water depths, potential tidal prism, littoral drift, and water level and wave conditions following the storm. The recent stability of the existing inlets in the study area is largely due to maintenance and stabilization efforts that have included dredging of navigation channels and jetty construction. Breaches that remain open and become new inlets have the greatest influence on decadal or century-long sediment transport dynamics by redirecting/trapping longshore sediment transport into ebb and flood shoals during the period that the breach remains open (USACE-NAN, 1999a). The process of opening-migration-closing of inlets is fundamental to the long-term geologic resilience of barrier islands. Flood shoals serve as platforms for new marsh development. Most of the marshes in Great South, Moriches, and Shinnecock Bays are associated with former flood shoals (Leatherman and Allen, 1985).

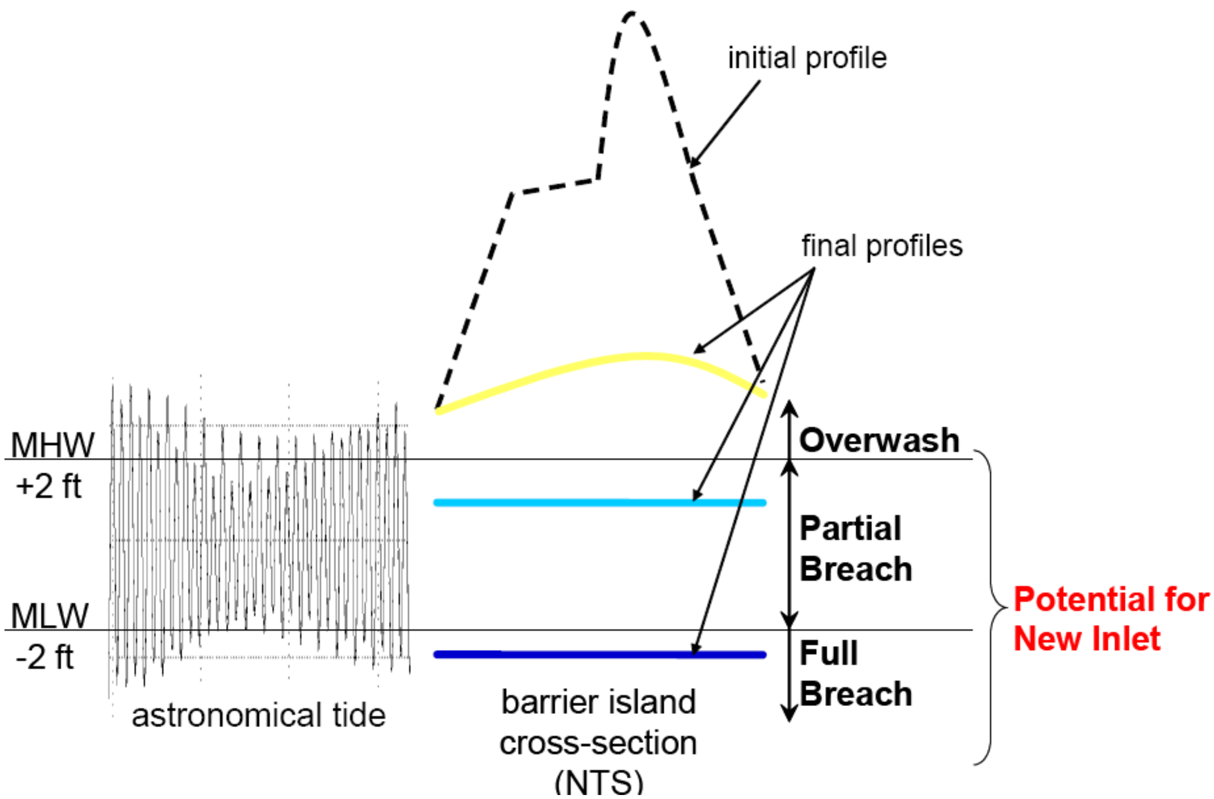

Figure 8. Morphological Responses to Overwash and Breaching

2.1.4 Astronomical Tides

Astronomical tides on the Atlantic Coast of Long Island are semi-diurnal, rising and falling twice daily. For storm damage assessment, understanding the expected range of astronomical tide along the project length and within the three bays is required. For this study, the ADCIRC long-wave hydrodynamic numerical model was employed to determine astronomical tide amplitudes throughout the project and to determine the maximum expected annual water level associated with astronomical tides. Additional details on the ADCIRC model are provided in Appendix A -Engineering.

2.1.5 Relative Sea Level Change

RSLC is a change (increase or decrease) in the mean level of the ocean. Eustatic sea level rise is an increase in global average sea level brought about by an increase to the volume of the world's oceans (thermal expansion) including the addition of water to the oceans by land-based ice (i.e. ice sheets and glaciers). Recent climate research has documented observed global warming for the 20th century and has predicted either continued or accelerated global warming for the 21st century and possibly beyond (IPCC 2013). One impact of continued or accelerated climate warming is continued or accelerated rise of eustatic sea level due to continued thermal expansion of ocean waters and increased volume due to the melting of the Greenland and Antarctic ice masses (IPCC, 2013). A significant increase in relative sea level could result in extensive shoreline erosion and dune erosion. Higher relative sea level elevates flood levels which may result in smaller, more frequent storms that could result in dune erosion and flooding equivalent to larger, less frequent storms.

RSLC takes into consideration the eustatic increases in sea level, as well as local land movements of subsidence or lifting. Long Island is one of many areas in which the land is subsiding. A range of RSLC projections were considered, including the USACE "low," "intermediate," and "high" projections described in Engineer Regulation (ER) 1100-2-8162 "Incorporating Sea Level Change in Civil Works Programs."

ER 1100-2-8162 and Engineering Pamphlet (EP) 1100-2-1 "Procedures to Evaluate Sea Level Change: Impacts, Responses, and Adaptation" (June 30, 2019), require that proposed alternatives should be formulated and evaluated for a range of possible future RSLC projections. In accordance this guidance, the alternative plans described in Chapter 5 were formulated, evaluated, and compared based upon one RSLC projection. The USACE "low" RSLC projection was used for the analysis. These rates of rise correspond over the period of analysis (2028 – 2078) to 0.64 feet, 1.18 feet, and 2.90 feet from 2028 – 2078 under the low, intermediate, and high rates of USACE RSLC projections, respectively. Considering the 100-year adaptation horizon (2028 – 2128), RSL is expected to increase by 1.28 feet, 2.81 feet, and 7.66 feet under the low, intermediate, and high rates of USACE RSLC projections, respectively.

Costs and economic benefits of the Recommended Plan were subsequently developed using all three USACE RSLC projections: the "low," "intermediate," and "high." The analysis was performed in accordance with ER 1100-2-8162 and EP 1100-2-1, in order to understand the sensitivity of costs, economic benefits, and residual damages under the three RSLC projections. The results of the analysis are presented in Table 4 of this Executive Summary, as well as Chapter 7.

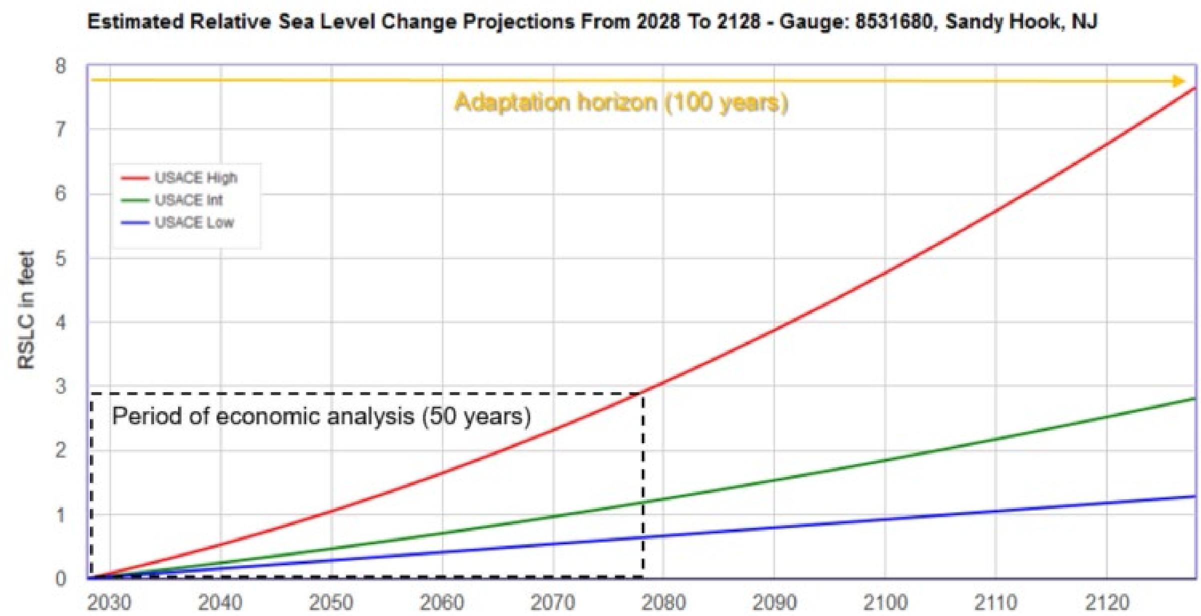

Figure 9. Relative Sea Level Change, 2028 – 2128 (Sandy Hook, NJ Gauge)

New York State has also recently adopted RSLC projections as part of the Community Risk and Resiliency Act. As part of this statute, NYSDEC has identified five different projections of sea level rise for three different regions within tidally influenced portions of the state. The projections for the Long Island Region are as follows. The 2050s projections are: eight in (low), 11 in (low-medium), 16 in (medium), 21 in (high-medium), and 30 in (high). The 2080s projections are: 13 in (low), 18 in (low-medium), 29 in (medium), 39 in (high-medium), and 58 in (high).

Most of the analysis presented in this report communicates project performance under the "low" RSLC projection; however, based upon the analysis contained in Chapter 7, the Recommended Plan is presented for the intermediate RSLC projection.

2.1.6 Storms

Two types of storms are of primary significance along the Atlantic Coast of Long Island: (1) tropical storms which typically impact the New York area from July through October, and (2) extratropical storms which are primarily winter storms occurring from October to April. Extratropical storms (nor'easters) are usually less intense than hurricanes but tend to have a longer duration. These storms often cause high water levels and intense wave conditions and are responsible for significant damages and flooding throughout the Long Island coastal region. A detailed discussion of the major storms that have impacted the study area is found in Appendix A – Engineering.

Hurricanes are the most powerful tropical storms to reach the New York area with wind speeds in excess of 74 mph (by definition). Records are available for 24 hurricanes having impacted the New York area in the past century. Heavy storm damage usually occurs when high astronomical tides and storm surge coincide for storms approaching the project area from the south-southwest. The combined water levels allow large waves to penetrate inland resulting in extreme erosion and flooding.

Extratropical storms originate outside of the tropics, usually in the mid- to upper-latitudes during winter months. In the New York region, these storms are referred to as nor'easters due to the predominant direction from which the winds originate. Nor'easters are less intense than hurricanes with sustained wind speeds generally below 57 mph. Localized winds may, however, reach hurricane strength. Extratropical storms cover large areas and are slow moving with typical storm duration lasting for a period of days thus persisting through several periods of high astronomical tide. The long duration greatly enhances the ability of nor'easters to cause damages.

2.1.7 Shoreline Changes and Erosion

Beach and dune erosion is the result of processes that occur over a variety of space and time scales and include long-term erosion resulting from day to day wave and longshore and cross-shore sediment transport, short-term storm-induced erosion, and transgression resulting from RSLC. Interruptions in cross-shore sediment flux from off-shore borrow sites could also be a factor. See Appendix J - Monitoring and Adaptive Management for planned monitoring of borrow sites. Long-term erosion is associated with gradients and/or interruptions in littoral drift (i.e. longshore sediment transport), due to the presence of structures such as groins and jetties. Storms and RSLC, on the other hand produce cross-shore sediment transport that erodes the shoreface, beach berm and dunes. Storms can dramatically alter the shoreline geometry in a matter of hours or days. The beach profile, however, tends to recover after storm passage and, with sufficient supplies of sediment, can eventually build back to pre-storm geometry. Net shoreline retreat may occur if there is not enough sand available for a full recovery, particularly when longshore sediment transport is interrupted.

Historic Shoreline Rate-of-Change (SRC) values for the FIMP study are were first documented in Gravens et al. (1999), which examined three non-overlapping time intervals using available shoreline data sets. The first period, representative of the epoch prior to significant human influence on the barriers, is 63 years long (1870 to 1933). The second period, representative of initial development on the barriers and the initiation of human intervention with natural coastal processes, including inlet stabilization and significant beach fill placements, is approximately 46 years long (1933 to 1979). The third period, representative of modern times and reflecting more recent beach nourishment practices, is approximately 15 years long (1979 to 1995). Computed average SRC and associated standard deviation values are summarized in Table 5 for each of three barrier island-scale analysis domains in the study.

It is important to note that these SRC values from Table 5 are average values for relatively long reaches and that the standard deviations in the SRC is between 3 and 4 times larger than the mean. The comparatively large SRC standard deviation indicates significant variation in shoreline change along Fire Island.

Table 5. Average Shoreline Rate of Change and Associated Standard Deviation

Time Period	ANALYSIS REACH		
	Fire Island (i.e., Fire Island to Moriches Inlet)	**Westhampton (i.e., Moriches to Shinnecock Inlet)**	**Montauk (i.e., Shinnecock Inlet to Montauk Point)**
1870-1933	-1.3 (3.6)	+3.3 (2.0)	+0.7 (1.0)
1933-1979	-1.3 (5.9)	-3.6 (3.6)	-1.3 (2.0)
1979-1995	-2.3 (6.2)	-2.6 (9.2)	+0.0 (4.3)

NOTES Table adapted from Gravens et al., (1999) All values in feet/year
Standard Deviation in parenthesis All values adjusted to account for beach fill placement

Table 6 shows updated shoreline change rates based additional shoreline and beach profile data through 2001 at the design sub-reach level of detail (Figure 10). These updated estimates, which were also adjusted to remove the effects of beach fill, and refined level of detail were used to evaluate life cycle vulnerability.

Lentz, et al, 2013 analyzed three historical data sets (topography derived from 1969 aerial photography and LIDAR data from October 1999 and December 2009) to extract shoreline change data along Fire Island for three time periods: 1969-1999, 1999-2009 and 1969-2009. Shoreline change results, which include the positive (i.e., accretional) effect of beach fill activity (unlike the values presented in Table 5 and Table 6), show a mean accretional trend between 1969 and 1999 of +2.15 feet/year along Fire Island. The period from 1999 to 2009 is dominated by erosion (-0.62 feet/year) particularly in the eastern reach of the island. Total change results from 1969 to 2009 are more similar to the 1969 to 1999 period (+1 foot/year).

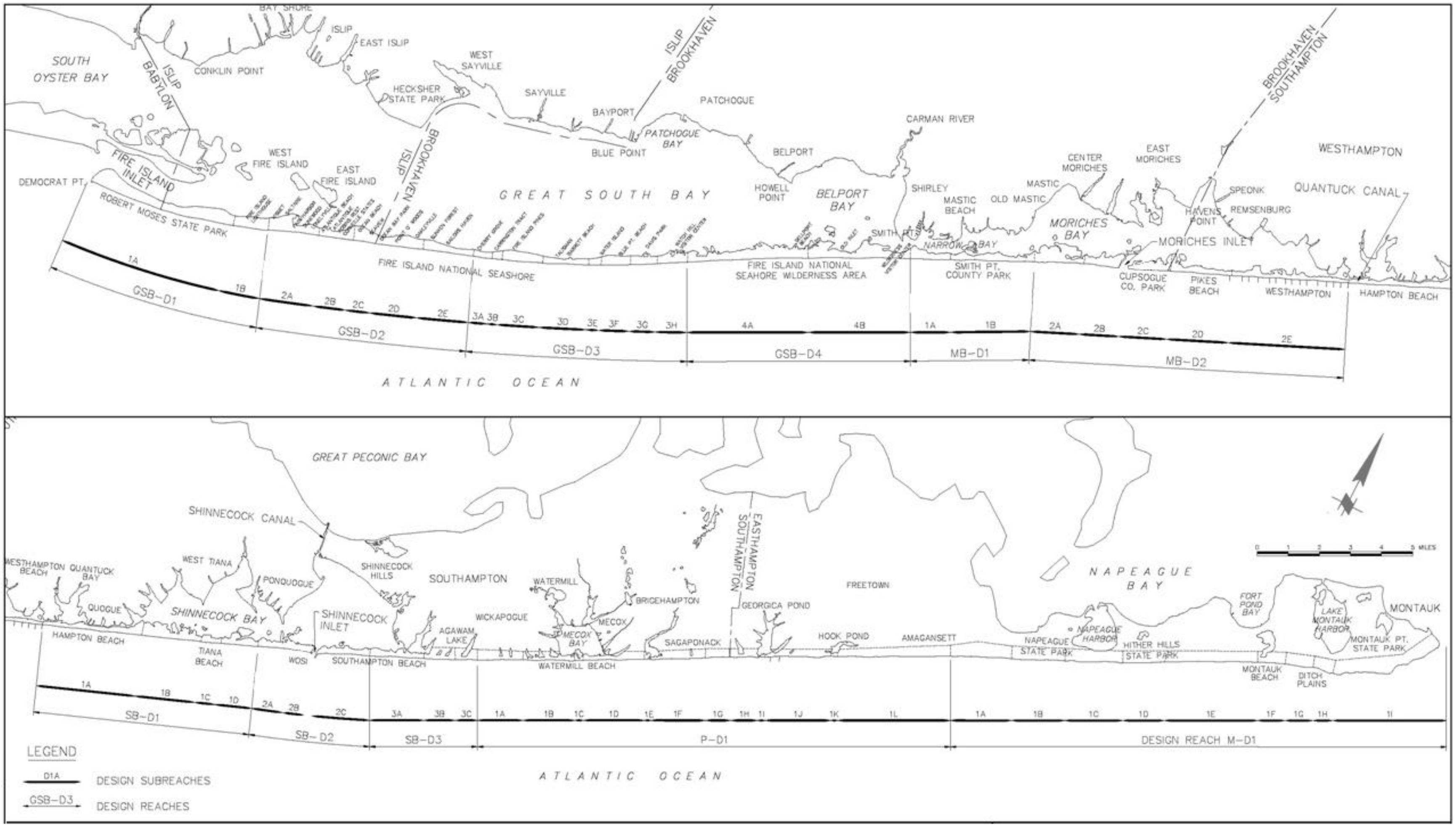

Figure 10. Study Reaches and Design Sub-Reaches

Table 6. Shoreline Rate of Change (1979-2001) by Design Subreach

Design Subreach	Shoreline Change Rate (ft./year)
Great South Bay	
GSB-D1A	1
GSB-D1B	4
GSB-D2A	4
GSB-D2B	4
GSB-D2C	1
GSB-D2D	1
GSB-D2E	1
GSB-D3A	1
GSB-D3B	1
GSB-D3C	1
GSB-D3D	1
GSB-D3E	1
GSB-D3F	1
GSB-D3G	1
GSB-D3H	1
GSB-D4A	1
GSB-D4B	2
Moriches Bay	
MB-D1A	2
MB-D1B	2
Moriches Bay (continued)	
MB-D2A	2
MB-D2B	0
MB-D2C	1
MB-D2D	0
MB-D2E	0
Shinnecock Bay	
SB-D1A	1
SB-D1B	3
SB-D1C	3
SB-D1D	3
SB-D2A	0
SB-D2B	0
SB-D2C	0
SB-D3A	1
SB-D3B	1
SB-D3C	1
Ponds	
P-D1A	1
P-D1B	1
P-D1C	2
Ponds (continued)	
P-D1D	2
P-D1E	2
P-D1F	2
P-D1G	4
P-D1H	1
P-D1I	1
P-D1J	1
P-D1K	1
P-D1L	1
Montauk	
M-D1A	1
M-D1B	1
M-D1C	1
M-D1D	1
M-D1E	2
M-D1F	3
M-D1G	3
M-D1H	3
M-D1I	3

2.1.8 Shoreline Undulations

At least part of the alongshore variability in the observed shoreline rate-of-change owes to undulating shoreline features that are locally referred to as longshore sand waves or erosion waves (Gravens et al., 1999). The presence of these features should be considered in the formulation of a project within Fire Island. Gravens et al. (1999) showed that the wavelength of the shoreline undulations generally ranges between 0.6 and 1.2 miles. The total root mean square (rms) shoreline undulation height was determined to be about 104 feet. The landward and seaward rms amplitudes were both quantified at about 52 feet. Gravens et al. (1999) also showed that the shoreline undulations do not appear to propagate from one end of the barrier to the other, although limited alongshore propagation 0.6 to 1.2 miles of the shoreline undulations is possible. An important finding of the study was that the seaward and landward bulges of the shoreline undulations were preferentially positioned along the shoreline. That is, based on the data sets examined, certain locations along the shoreline can be expected to periodically develop large erosion or accretion cusps but not likely both. This finding indicates that the shoreline undulations may be excited by specific environmental forcing conditions (waves from a particular direction) and their location controlled by irregularities in the offshore bathymetry. In support of the assertion that specific environmental forcing excites the shoreline undulations is the finding from the spatial analysis that the shoreline undulations are intermittent features that are more prominent in some data sets than in others. Nonetheless, the data also suggests that undulations may occur at any location along the project shoreline.

The impact of shoreline undulations on a typical beach fill design configuration was shown to be significant and could lead to greater than anticipated maintenance costs or a reduced level of storm risk management at areas of erosional cusps. Explicit consideration of the presence of shoreline undulations in the development of alternative design configurations and the assessment of baseline and FWOP conditions is essential for a full understanding of storm risks.

Offshore sediment sources may contribute to Fire Island's sediment budget. Rosati et al. 1999 concluded that suche offshore sediment sources may exist off of central Fire Island, although the forcing mechanism is currently unknown.

2.1.9 Inlets

There are three stabilized inlets in the study area: Fire Island Inlet, Moriches Inlet, and Shinnecock Inlet, all of which are Federal navigation projects. A fourth inlet has formed within the Otis Pike High Dune Wilderness Area of the Fire Island National Seashore (FIIS) as a result of a breach in the barrier island during Hurricane Sandy. Coastal inlets play an important role in nearshore processes. Inlets are the openings in coastal barriers through which water, sediments, nutrients, 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. 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.

Tidal inlets experience diurnal or semidiurnal (along Long Island) 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). 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.

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. However, jetties can profoundly affect sand bypassing and other processes at inlets and adjacent shorelines (USACE, 2002). The stabilized inlets do not function as natural inlets in several respects. First, the stabilized inlets are maintained by jetties (only one jetty in the case of Fire Island), are periodically dredged, and do not migrate as natural inlets do. Second, the stabilized FIMP inlets are judged to be 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 following paragraphs provide an overview of the most relevant coastal processes at each FIMP area inlet.

2.1.9.1 Shinnecock Inlet

Shinnecock Inlet was formed as a result of a barrier island breach during the "Long Island Express" hurricane of 1938 and has since been stabilized with jetties at its present location and geometry since 1953. The presence and continued evolution of Shinnecock Inlet has strongly influenced adjacent shoreline conditions, particularly west of the inlet. Historic interruption of westerly-directed sediment transport has created a large offset in the shoreline position across the inlet from east to west. Beach material is distributed throughout the inlet and is generally confined to three primary locations: (1) east of the east jetty in a large accretional fillet, (2) ebb-tidal shoal, including updrift and downdrift lobes or bars, (3) flood-tidal shoal. Nevertheless, Shinnecock Inlet has, albeit intermittently, permitted natural bypassing that serves to re-establish littoral transport to the downdrift shoreline. This effect is apparent in the shoreline near Ponquogue where a bulge in the shoreline points to the location where ebb shoal materials are bypassed to shore.

2.1.9.2 Moriches Inlet

The present Moriches Inlet was opened during a storm on March 4, 1931, and the existing jetties were constructed in 1954. A notable offset in the shoreline progressing east to west across the Moriches Inlet reflects shoreline impacts associated with the westerly-directed littoral drift. Nonetheless, shoreline conditions immediately west of Moriches Inlet are generally characterized by a relatively robust barrier system with wide beaches and high dunes. Beach widths increase notably approximately 4,000 feet west of the inlet and reflect dredged material placement and natural bypassing of Moriches Inlet. It should also be noted that the historic updrift sediment accumulation (fillet) east of Moriches Inlet appears to be less than at Shinnecock Inlet. This condition is likely to have arisen due to four primary factors, namely: (1) the Westhampton groin field reduces transport reaching Moriches Inlet, (2) historical migration of Moriches Inlet left a narrow barrier segment, (3) tidal currents have scoured the bayside shoreline, and (4) a shorter updrift (east) jetty.

2.1.9.3 Fire Island Inlet

Available records indicate that only Fire Island Inlet has existed continuously since the early 1700s and has been stabilized in its present conditions since 1940. Continued dredging of the inlet has been performed to maintain a navigable channel. Sand dredged from Fire Island Inlet has been placed to the west and north of the inlet to offset the marked downdrift erosion in those areas arising from the interruption of the predominate mode of westerly-directed littoral transport. Sand fill from the dredging of Fire Island Inlet has also been placed to the east of the inlet approximately every 2-6 years to address the chronic erosion problem within Robert Moses State Park.

2.1.9.4 Wilderness Breach

Hurricane Sandy resulted in three barrier island breaches within the study area. One of the breaches within the Otis Pike High Dune Wilderness Area of FIIS was not closed immediately following the storm. After the initial formation of the breach during Hurricane Sandy the breach grew rapidly for several months before breach growth slowed. DOI signed a Record of Decision for the Wilderness Breach Management

Plan EIS on July 23, 2018. Under the selected action identified in the ROD, the evolution, growth, and/or closure of the breach will be determined by natural barrier island processes, and human intervention to close the breach will occur only "to prevent loss of life, flooding, and other severe economic and physical damage to the Great South Bay and surrounding areas." NPS will continue to monitor the Wilderness Breach using established methods that staff and scientists have used since 2012. Monitoring is being conducted to determine if changes in the breach could elevate the risk, which could lead to a decision to close the breach.

Observations and modeling developed in conjunction with the North Atlantic Coast Comprehensive Study (USACE, 2014) and Federal Emergency Management Agency (FEMA) December 2012 stage frequency curves which includes wave set up have shown that, at its current size, the Wilderness has not significantly altered tidal elevations in Great South Bay or Moriches Bay by more than one inch, which is consistent with the findings of Aretxabaleta et al., 2014. However, the model simulations show that the Wilderness Breach increases storm water levels within Great South Bay and Moriches Bay during storm events (See Sub-Appendix A-4 – Numeral Modeling of Breach Open at Old Inlet.

2.1.10 Bayside Tidal Hydrodynamics

The study area estuarial system, comprised of Great South, Moriches and Shinnecock Bays, are respectively connected to the Atlantic Ocean through Fire Island, Moriches and Shinnecock Inlets, as well as the Wilderness Breach. Great South and Moriches bays are also connected to each other through narrow tidal waterways of the Long Island Intracoastal Waterway (ICW). A summary of hydrodynamic conditions is presented in the following paragraphs.

Bay water levels are controlled by tidal elevations at Fire Island, Moriches, and Shinnecock Inlets. The uniformity of tide ranges throughout Great South, Moriches, and Shinnecock Bays is a characteristic of the so-called "pumping mode" of inlet-bay hydraulics where water levels within an embayment remain nearly horizontal during ebb and flood tide phases. Bay tides are generally less than and lag the ocean tides. The difference between ocean and bay tides is particularly significant within central and eastern Great South Bay. The tidal range at the ocean end of Fire Island Inlet is approximately 4.3 feet. However, the ocean tidal signal is significantly muted along the long inlet throat. Monitoring at the Fire Island Coast Guard Station suggests a tidal range of 1.6 feet at this location (i.e., a 50 percent reduction in approximately 3 miles) compared to bay waters in most of Great South Bay away from the inlet that have an average tidal range on the order of 1 foot, i.e., a 70 percent reduction. Tidal prism discharge through Fire Island Inlet is the order of 2,300 million cubic feet. The average tidal range in the bay is approximately 1 foot.

The tidal range at the ocean side of Moriches Inlet is approximately 3.6 feet; the range is decreased to 2.5 feet across the inlet in the vicinity of the Moriches Coast Guard Station. In areas removed from the inlet, such as Potunk Point and Mastic Beach at the eastern and western limits of Moriches Bay, respectively, the range is decreased to 1.6 to 2 feet. The estimated average tidal range in Moriches Bay obtained using recent available tidal records is on the order of 2 feet. Tidal prism is estimated as on the order of 1,300 million cubic feet.

The reduction in tidal range within Shinnecock Bay is less pronounced due to the configuration of the inlet and flood shoals. The range goes from approximately 3.3 feet at the ocean side of the inlet to 2.5 feet in the vicinity of Ponquogue Point. The tide range in the bay averages approximately 2.9 feet. The estimated tidal prism is on the order of 1,300 million cubic feet.

Freshwater enters the estuaries primarily through adjoining tributaries and groundwater seepage. Drainage areas for each bay were estimated as: (1) Great South Bay – 378 square miles, (2) Moriches Bay – 75 square miles, and (3) Shinnecock Bay – 25 square miles. Information concerning freshwater sources is relatively sparse. However, the U.S. Geological Survey (USGS) monitors several tributaries at locations far removed from the bays (the available average daily flow rates for major tributaries). Estimates indicate that nearly 25 percent of all freshwater entering the estuaries can be attributed to groundwater seepage.

2.1.11 Breach and Overwash Impacts

Breaches and overtopping of the barrier island occur periodically in conjunction with larger storms (generally storms greater than the two percent flood). During Hurricane Sandy two breaches occurred along Fire Island and one along the reach between Moriches Inlet and Shinnecock Inlet. Two of the breaches were closed mechanically, while the Wilderness Breach remains open and is being monitored by DOI.

Overwash occurred along approximately 45 percent of the island. Based on numerous studies, including Conley (1999; Leatherman and Allen, 1985), New York Sea Grant (2001), and USACE modelling efforts (USACE, 1995; 2007) the e physical impacts of a breach include:

- Increase in bay tide levels;
- Increase in bay storm water levels due to presence of large persistent breach or ocean storm water levels overwashing the barrier island;
- Changes in bay circulation patterns, residence times, and salinity due to breaches;
- Increase in sediment shoaling in navigation channels and shellfish areas due to a major breach;
- Increased transport and deposition of sediment to bay including creations of overwash corridors.

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 submerged aquatic vegetation (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, sea beach amaranth and sea beach knotweed. Overwash and breach deposits are beneficial to natural accumulation of sand on the barrier and landward of the barrier. These processes contribute to the deposition of material that facilitates northward migration of the barrier from its present location and contributes to the long-term stability of the island.

2.1.12 Flooding Impacts

The presence of the existing barrier island system and topography reduces widespread inundation of low-lying areas on the mainland. The existing inlets act both as hydraulic conveyances and hydraulic constrictions which limit the storm surge volume entering Great South, Moriches, and Shinnecock Bays. As the surge spreads out away from the inlets, the corresponding flood stage decreases. However with larger storm events that cause overwash and breaches of the barrier island (generally, storms greater than the two percent flood), areas of the mainland that are distant from the inlets, become vulnerable to higher flood stages from the storm surges through the breach . Therefore, the flood problem along the mainland is linked to the topographic condition of the barrier system where there is a high potential for overwash or breaching. The most severe flooding occurs due to the combination of storm surge propagating through the inlets and the overtopping and/or breaching of a barrier island, which brings more storm ocean water into the bay system during the times of moderate to severe storms.

The numerical model framework developed for FIMP is a comprehensive modeling study involving storm surge and barrier island system breaching and morphology. The numerical model includes all the necessary processes to accurately simulate the inlet and barrier island overwash processes and breaching processes in a system-wide and comprehensive manner for the complete FIMP project area, considering the three bay and inlet system. (Irish and Cañizares, 2009; Cañizares and Irish, 2008; Irish and Cañizares R, 2006; Cañizares and Alfageme, 2005; Irish, et al.,(2004; Canizares, et al., 2004; Irish, et al., 2004; Roelvink, et al., 2003; Cañizares' et al.,2003.

2.2 Socio-Economic Conditions

The study area includes portions of five towns: (1) Town of Babylon, (2) Town of Islip, (3) Town of Brookhaven, (4) Town of Southampton, and (5) Town of East Hampton. Each of these towns is comprised of incorporated villages and unincorporated hamlets. Hamlets are governed by the town in which it is located, whereas villages have their own local governments. Land use differs throughout the study area. The study area is generally more developed to the west with decreasing development to the east. The eastern towns, including Southampton and East Hampton, have a significant portion of land use devoted to agriculture and a relatively smaller portion devoted to commercial/industrial use.

Town of Babylon: The Town of Babylon includes communities on the mainland including the Villages of Amityville, Lindenhurst, and Babylon and the hamlets of Copiague and West Babylon. Land use in this area generally consists of medium-density detached homes, with high-density residential uses found close to the water's edge. There is very little agricultural use and more commercial/industrial use.

Commercial uses run along most of the length of Montauk Highway. The Babylon portion of the study area also includes several recreational and park uses which front the Great South Bay. In addition, the Town of Babylon includes part of Captree State Park on Captree Island and the easternmost tip of the Jones, Gilgo, and Oak beaches on the barrier island to the west of Fire Island Inlet.

Town of Islip: The study area within Islip is primarily residential, with some large open spaces (e.g., Great River and Connetquot River State Park) and commercial development concentrated along Montauk Highway. Communities in this area include West Bay Shore, Bay Shore, the Village of Brightwaters, Islip and East Islip, Great River, Oakdale, West Sayville, Sayville, and Bayport.

Commercial development includes primarily small- to medium-sized shops and services, some of which are part of strip mall developments. Marine and marine-related commercial development is located near Great South Bay and its tributaries. There is no significant amount of industrial activity south of the Montauk Highway; industrial uses are located just outside of the study area, primarily along Union Boulevard.

Town of Brookhaven: With 260 square miles of land area, Brookhaven is the largest municipality on Long Island. Development in the municipality is generally less dense than Islip (with a notable exception being the area that includes Shirley and Mastic), with a number of undeveloped parcels. Communities in this area include Blue Point, the Village of Patchogue, Bellport, Brookhaven, Shirley, Mastic, Mastic Beach, Center Moriches, and East Moriches.

Within Brookhaven, retail commercial development is found along the Montauk Highway, especially in downtown Patchogue and in Shirley. Industrial uses, including maritime industry and boating, are found along the Patchogue River. There are also major open spaces and recreational amenities, including the Bellport Park Golf Course at South Country Road and South Howell's Point Road, Smith Point County Marina near the Smith Point Bridge, Cupsogue Beach County Park on the east side of Moriches Inlet, and Wertheim National Wildlife Refuge, between Shirley and Brookhaven. There are also a number of smaller neighborhood parks and playgrounds.

Town of Southampton: The western portion of the Town of Southampton is predominantly residential with open space and recreational uses, particularly along the barrier islands. Some of the larger open spaces are found at the inlets, including Shinnecock County Park which is both east and west of Shinnecock Inlet, but is primarily west of the inlet. Residential development density generally decreases from west to east, with residential lots averaging about 1-2 acres in size in the area between the Villages of Westhampton Dunes and Westhampton Beach. There are also town open spaces (e.g., the Town Beach east of Cupsogue Beach County Park) that are smaller in size than the county parkland. Retail and commercial uses are concentrated along County Road 27 (Montauk Highway) as well as the main streets and commercial roads within the incorporated villages. Hamlets in the Town of South Hampton include Bridgehampton, Eastport, East Quogue, Flanders, Hampton Bays, Northampton, North Sea, Noyack, Quioque, Remsenburg, Riverside, Shinnecock Hills, Speonk, Tuckahoe, Water Mill, and Westhampton. Villages in the Town of South Hampton include North Haven, Quogue, Sag Harbor, Sagaponack, Southampton, Westhampton Beach, Westhampton Dunes

Town of East Hampton: The Town of East Hampton encompasses the east half of the South Fork of Long Island and covers 68.7 square miles of land. It is bordered to the west by the Town of Southampton, to the north by the Peconic Bay, and to the east and south by the Atlantic Ocean. The study area extends north to County Road 27 (Montauk Highway) and also includes the Village of East Hampton and hamlets (e.g., Amagansett, Montauk), but does not include the shoreline along Peconic Bay and the villages and hamlets along that shoreline. The western portion of the East Hampton study area is predominantly residential with a moderate distribution of agricultural, open space, and recreational uses. The eastern portion is largely recreational lands and open space with a concentration of low, medium and high-density residential development south of Montauk Highway.

2.2.1 Population

The estimated population (2012) of Suffolk County is slightly below 1,500,000. The eastern end of Suffolk County, including the Towns of East Hampton and Southampton, is less populated but is expected to undergo continued growth. The western portion of the study area contains the majority of the study area's populace and is markedly denser. Of the County population, about 10 percent or 150,000 live within the study area. Additionally, the Towns of East Hampton and Southampton experience an exponential increase in their populations during the summer months as a consequence of the second home industry, tourism, and the recreational activities provided by the coast.

2.2.2 Income

There is considerable variation in the per capita and family income among study area towns as shown in Table 7. Per capita income in most of the study area is slightly above the state average. Median family incomes in the study area towns are all higher than the median family income for New York State.

Table 7. Per Capita and Family Income (October 2018 P.L.)

Location	Per Capita Income	Median Family Income	Family Size
New York State	$31,796	$69,202	3.20
Suffolk County	$36,588	$99,474	3.36
Town of Babylon	$31,255	$90,853	3.45
Town of Islip	$31,493	$92,482	3.56
Town of Brookhaven	$34,201	$97,520	3.33
Town of Southampton	$47,679	$68,876	3.10
Town of East Hampton	$51,316	$56,607	3.05

Sources: American Community Survey 2007-2011 five-year Estimate
Community Facts, 2010 Census, General Population and Housing Characteristics

2.2.3 Economy

The largest segment of the study area population is employed in the education, health and social services sector. Retail trade, professional/management services and manufacturing also employ a large portion of the population. In the eastern end of the study area more people are employed in agriculture, while fewer are employed in the retail and manufacturing sectors.

2.2.4 Transportation

The study area has a large network of roadways. A number of highways provide east-west access including the Southern State Parkway, Sunrise Highway (Route 27) and Montauk Highway (Route 27A).

There are no major roadways on Fire Island, except at the western end of the island, where the Robert Moses Causeway connects with Ocean Parkway and on the eastern end, where the William Floyd Parkway connects Fire Island with the mainland. Access to Fire Island is mainly by ferry service from Bay Shore, Sayville and Patchogue, as well as private boat access. The beach on Fire Island serves as a primary transportation corridor, including emergency vehicle access.

Dune Road is the major east-west thoroughfare between Moriches Inlet and the western side of Shinnecock Inlet. Dune Road connects to the mainland via Jessup Lane and Beach Lane in Westhampton Beach, by Post Lane in Quogue, and by the Ponquogue Bridge in Ponquogue.

East of Shinnecock Inlet, Dune Road also provides east-west access from the barrier island to the Village of Southampton via Halsey Neck Road, Cooper Neck Lane, First Neck Lane and South Main Street.

East of the Village of Southampton, Montauk Highway (Route 27) is the only major east-west thoroughfare, and therefore, is a critical roadway in egress and ingress to this part of Long Island. There are a number of north-south thoroughfares in the eastern part of Suffolk County as follows:

- Moriches-Riverhead Road (Route 51) connects Sunrise Highway with Montauk Highway.
- Route 111 (NY-111)connects Sunrise Highway with the Long Island Expressway.
- Nicholls Road (Route 97) connects the Long Island Expressway, Sunrise Highway and Montauk Highway.

In addition to these vehicular routes, the Montauk Branch of the Long Island Railroad (LIRR) provides passenger railroad service from Montauk Point to New York City via Jamaica Station, New York.

The Hurricane Evacuation Study for Suffolk County, completed in 1993, and updated in 2008 included a traffic flow analysis which was used to identify critical roadway links and intersections where congestion impacts the estimated clearance times. This report identifies locations within the region which are known traffic congestion points, which impact evacuation times. The intersections that directly impact evacuation within the study area include the following locations:

- Montauk Highway east of Southampton
- Route 27 (Sunrise Highway) and North Sea Road intersection at Southampton
- Route 111 (NY-111) and Southern State Parkway interchange
- Wellwood Road and Sunrise Highway north of Lindenhurst
- I-495 (Long Island Expressway) westbound
- Ferry service between Fire Island and mainland

2.2.5 Land-Use Controls

While the Federal, state and county governments each have regulatory authority, the local governments have regulatory jurisdiction with respect to land management, principally through zoning and also management of environmental features (e.g., freshwater and tidal wetlands). In addition, FIIS is administered by the NPS under the DOI, a Federal agency with land use and environmental management authority.

Established in September, 1991 (36 CFR Part 28), the Federal zoning regulations within FIIS provide a set of standards for the use, maintenance, renovation, repair, and development of property within FIIS boundaries. NPS has established three districts within its boundary:

- The Community Development District comprises the 17 existing communities and villages on Fire Island and permits existing uses and development of single-family houses.
- The Seashore District includes all land in FIIS that is not in the Community District. No new development is allowed in the Seashore District, but existing structures may remain.
- The Dune District extends from Mean High Water (MHW) to 40 feet landward of the primary natural high dune crest as mapped by NPS. This district overlaps the other two districts. Only necessary vehicles, such as ambulances, and pedestrians are allowed. Like the Seashore District, existing legal structures may remain and be repaired and maintained.

While NPS is responsible for enforcing the Federal standards in the communities and villages, local governments maintain regulatory jurisdiction. As long as local zoning ordinances conform to standards issued by the Secretary of the Interior, the Federal power of condemnation is suspended. Other relevant land use controls include:

- National Flood Insurance Program (NFIP): Administered by FEMA, participation in the NFIP requires that a municipality adopt a local floodplain management ordinance that regulates floodplain development and redevelopment following damage, such as requiring that the first finished floor of new construction be elevated above the base flood elevation. All municipalities within the study area participate in the NFIP.
- The Coastal Barrier Resources Act of 1982: established the Coastal Barrier Resources System (CBRA) to identify undeveloped coastal barriers on the United States coastline. The Coastal Barrier Improvement Act of 1990 reauthorized the CBRA and expanded the protected areas. The 1990 Act and future amendments added protections to portions of the study area. The U.S. Fish and Wildlife Service (USFWS) is the responsible agency for administering CBRA. Coastal barriers include barrier islands, bay barriers, and other geological features that protect landward aquatic habitats from direct wind and waves. Associated aquatic habitats, including wetlands, marshes, and estuaries adjacent to barrier islands and nearshore waters and inlets are also covered by CBRA. CBRA units are prohibited from receiving Federal monies or financial assistance or insurance for new development in CBRA areas. The CBRA, however, identifies exceptions to this restriction, including natural stabilization systems; the maintenance of channel improvements, jetties, and roads; necessary oil and gas exploration and development; essential military activities; and scientific studies. The eastern portion of Robert Moses State Park is located in Fire Island Unit NY-59 (the identifier or designation under CBRA). The majority of Fire Island, however, is located within the Fire Island Unit NY-59P, which is an "otherwise protected area" not within the CBRA. The incorporated villages of Saltaire and Ocean Beach are excluded from the "otherwise protected area" designation, as are the communities on Fire Island, including Lighthouse Tract, Kismet, Fair Harbor, Lonelyville, Atlantique, Robbins Rest, Seaview, Ocean Bay Park, Point O' Woods, Cherry Grove, Fire Island Pines, Water Island, and Davis Park. There are also four designated CBRA units in the Town of Southampton and several in the Town of East Hampton; additional information on these areas can be found in the FEIS for the project. U.S. Fish and Wildlife Service is actively reviewing and revising the national list of CBRA sites.
- The Coastal Erosion Hazard Areas Act (ECL Article 34; 6 NYCRR Part 505) directs the New York State DEC to identify and map coastal areas that are subject to erosion, and landforms such as beaches, bluffs, dunes and nearshore areas that protect coastal lands and development from the adverse impacts of erosion and high water. These areas are identified on Coastal Erosion Hazard Area (CEHA) Maps prepared by the New York State DEC. Lands within CEHA jurisdiction are subject to regulation under Article 34 and Part 505, which limits land use to protect these sensitive areas and limit high risk development. ECL Article 34 and 6 NYCRR Part 505 allow for local municipalities to administer their own local CEHA program, if the local municipality passes a CEHA law, the program is approved by DEC, and the program meets the minimum standards of 6 NYCRR Part 505. Local programs are required to use the DEC issued CEHA maps. Presently, all the towns within the study area have CEHA regulations in effect. Currently, the towns of Babylon,

Brookhaven, and Southampton are administrating CEHA, as well as the Villages of East Hampton, Quogue, Sagaponack. Saltaire, Southampton, West Hampton Dunes, and Westhampton Beach.

- The Waterfront Revitalization and Coastal Resources Act (Article 42 of the Executive Law) was enacted in 1981 to implement the State Coastal Management Program (CMP) at the state level. The CMP and Article 42 establish a balanced approach for managing development and providing for the protection of resources within the state's designated coastal area. The policies of New York State, reflected in the CMP, express clear preference for nonstructural solutions for erosion and flooding, such as elevating or flood-proofing buildings. Municipalities are encouraged to prepare Local Waterfront Revitalization Programs (LWRPs) in order to refine the state's CMP and take local factors into account. In communities with fully approved LWRPs, Federal actions must be consistent with the Local Waterfront Revitalization Plan (LWRP) policies in order for a consistency determination to be issued. Recreation and Public Access Public access to the beaches and natural areas within the South Shore of Long Island study area has been critical to it being a major destination for visitors from within Nassau and Suffolk County, New York City, and beyond. Significant public investments have been made over time to create local, county, state, and national parks, and the construction of necessary transportation linkages for access. Examples include FIIS, Robert Moses State Park, the Otis G. Pike Wilderness Area, and Smith Point County Park. Robert Moses State Park receives 3.5 million visitors per year.[4] The Public Access Plan can be found in Appendix G – Public Access Plan. While many of these facilities are open to the general public, there are some facilities outside of Fire Island that are effectively restricted to local resident use due to limitations on parking and transportation access or by municipal ordinance. Habitat protection rules can also limit public access to certain times of the years; e.g., to avoid prime nesting seasons for endangered birds. Another important aspect of public use and access is the public trust interest that local governments hold over underwater lands. There are several New York and Federal laws and agency regulations that serve to achieve various legislative goals related to environmental protection and the public trust (NYSDOS, 1999). As part of the study in areas where project measures are recommended that include sand placement; e.g., dune and beach berm, etc., a public access assessment will be made to determine the level of existing access, identify gaps and restrictions, and propose necessary measures to ensure that any recreation benefits provided are available to the public at large, and not limited to local residents only, while also ensuring that the use of the area is appropriate to its environmental setting and carrying capacity.

2.3 Environmental Resources

This section is a summary of more detailed descriptions of the natural and human environment that are presented in the EIS and its Appendices. The study area is a complex array of marine, coastal and estuarine ecosystems expected in a barrier island environment. Table 8 provides a summary of the five major ecosystems and specific habitats found within the study area:

- Marine Offshore Ecosystem, which includes the sub tidal marine pelagic and benthic habitats.
- Atlantic Shores and Inlets Ecosystem, which includes the Marine Nearshore, Marine Intertidal, Marine Beach, and Inlet habitats.

[4] https://www.governor.ny.gov/news/governor-cuomo-announces-robert-moses-and-jones-beach-state-parks-now-open

- Barrier Island Ecosystem, which includes Dunes and Swales, Terrestrial Upland, Maritime Forest and Bayside Beach habitats.
- Back Bay Ecosystems, which include the Bay Intertidal, Sand Shoals and Mud Flats, Salt Marsh, Bay Subtidal, and SAV habitats.
- Mainland Upland Ecosystem, which includes the areas above the Mean High Tide along the Bays and also at the landward toe of the primary dune on the eastern Atlantic shorefront between Southampton and Montauk.

Detailed descriptions of each of the habitats, including specific biota, are provided in the EIS. Several of these habitats are designated as Essential Fish Habitat (EFH) for one or more managed fish species, including Marine Offshore, Marine Nearshore, Marine Intertidal, Inlets, Bay Intertidal, Sand Shoals and Mudflats, Salt Marsh, Bay Subtidal, and SAV. The study area contains EFH for various life stages for 39 managed fish and invertebrate species. There are 25 Federally and/or State-listed species in the study area: five mammals, 10 reptiles, 12 birds, two fish, and three plant species. The habitats, EFH, species, and impacts are described in detail in the Environmental Impact Statement.

2.3.1 Threatened and Endangered Species

Two Federal agencies, the Fish and Wildlife Service (USFWS), in the DOI, and the National Oceanic and Atmospheric Administration (NOAA) Fisheries, in the Department of Commerce, share responsibility for administration of the Endangered Species Act (ESA). The USFWS is responsible for terrestrial and avian listed species, as well as freshwater aquatic species. NOAA, through the Protected Resources Division of the National Marine Fisheries Service (NMFS) is responsible for marine aquatic species. In addition to species protected under the Federal ESA, the State of New York maintains a list of species that are Threatened, Endangered, Rare, or of Special Concern in the State.

Based on habitat and life history assessments, recommendations from the USFWS and NOAA, and site assessments, the following Federally-listed species are likely to occur in the FIMP project area and warrant a Biological Assessment:

- Piping Plover (*Chardrius melodus*), Federally Threatened;
- Rosette Tern (*Sterna dougallii*), Federally Endangered;
- Rufa Red Knot (*Calidris canutus*) Federally Threatened;
- Seabeach Amaranth (*Amaranthus pumilus*), Federally Threatened; and
- Sandplain Gerardia (*Agalinis acuta*), Federally Endangered.

The three Federally listed avian species nest or carry out a major portion of their life cycle activities (i.e., breeding, resting, foraging) within essentially the same Marine Beach habitat that consists of sand/cobble beaches along the ocean shores, bays, inlets and occasionally in blowout areas located behind dunes. The two Federally listed plant species are found in these same habitats. The District has received concurrence from USFWS on the Not Likely to Adversely Affect (NLAA) determination for the rufa red knot and the no effect determination for the roseate tern; additional information is available in the FEIS.

Table 8. Major Ecosystems within Study Area

ECOSYSTEM/HABITAT	DEFINITION
Marine Offshore Ecosystem	
Marine Offshore	Subtidal marine habitat ranging in depth from 10 to 30 meters; includes pelagic and benthic zones
Atlantic Shores and Inlets Ecosystem	
Marine Nearshore	MLW to depth of 10 meters; includes pelagic and benthic zones
Marine Intertidal	Extends from MLW to MHW with a sandy and/or rocky substrate
Marine Beach	Extends from the MHW line on the ocean side to the boundary of the primary Dune and Swale habitat within the Barrier Island Ecosystem; sandy substrate
Inlets	Areas of water interchange between bay and ocean zones (e.g., Fire Island Inlet, Moriches Inlet, and Shinnecock Inlet)
Barrier Island Ecosystem	
Dunes and Swales	Primary dune through most landward primary swale system
Terrestrial Upland	Extends from the landward boundary of the primary dunes and swales on the ocean side, to the MHW boundary of the Bay Intertidal habitat on the bay side of the island contains all upland habitats excluding the maritime forest; scrub/shrub are also included in this habitat, along with bayside beach areas
Maritime Forest	Forested area on barrier island defined by salt tolerant vegetation, high salinity and salt spray adapted soils and vegetation assemblages such as trees, shrubs, and herbaceous species (e.g. Sunken Forest)
Bayside Beach	Area between MHW to seaward limit of vegetation or "upland" boundary
Back bay Ecosystem	
Bay Intertidal	Extends from MHW to MLW on the bay side of the barrier island. Habitats such as Salt Marsh, and Sand Shoals and Mud Flats may also be present between MHW and MLW.
Sand Shoals, Bare Sand, Mud Flats	Found within the Intertidal Habitat and exposed at low tide; specific habitat type is defined by the substrate type
Salt Marsh	Bayside vegetation communities dominated and defined by salt-tolerant species; 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
SAV	Bayside submerged aquatic vegetation (SAV) communities found within the 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 (i.e., +16 feet NGVD 29), which generally correlates with Montauk Highway (Route 27). On the Atlantic shorefront, Mainland Upland begins at the landward toe of the primary dune.

Atlantic (*Acipenser oxyearinchus oxyearinchus*) and shortnose sturgeon (*Acipenser brevirostrum*) may also occur in the project area. The District has received concurrence from NMFS on the NLAA determination conducted for the Federally-listed species of Atlantic and shortnose sturgeon, whales and marine turtles (See FEIS).

2.3.2 Essential Fish Habitat

The NMFS is responsible for enforcing the Magnuson-Stevens Fishery Conservation and Management Act (MFCMA), (1996 amendments) (MSA), which, is intended to promote sustainable fisheries. To implement the MSA, the NMFS and the eight regional Fishery Management Councils have identified and described EFH for each managed fish species. EFH can consist of both the water column (pelagic) and the underlying surface (seafloor) of a particular area. Areas designated as EFH contain habitat essential to the long-term survival and health of our nation's fisheries.

Several habitats within the study area, including Marine Offshore, Marine Nearshore, Marine Intertidal, Inlets, Bay Intertidal, Sand Shoals and Mudflats, Salt Marsh, Bay Subtidal, and SAV, have been designated as EFH for one or more managed fish species. In compliance with Section 305(b)(2) of the MSA, the EIS includes an assessment of the potential effects of the proposed alternatives on EFH. This EFH assessment includes all pelagic and benthic fish habitat off of Long Island, 1,000 feet seaward of mean low water (MLW) and coastal and open Atlantic Ocean. The study area contains EFH for various life stages for 39 species of managed fish and invertebrates.

Fish occupation of waters within the project impact areas is highly variable spatially and temporally. Some of the species are strictly offshore, while others may occupy both nearshore and offshore waters. In addition, some species may be suited for the open ocean or pelagic waters, while others may be more oriented to bottom or demersal waters. This can also vary between life stages of Federally managed species. Also, seasonal abundances are highly variable, as many species are highly migratory.

2.3.3 Significant Habitats

The USFWS has identified Shinnecock Bay, Moriches Bay, Great South Bay, Montauk Peninsula, and South Fork Long Island Beaches as Significant Habitats and Complexes of the New York Bight Watershed. These areas have been recognized as regionally significant habitats and species populations. In addition, all of the back bay waters, including Bay Intertidal and Bay Subtidal habitats within the study area have been designated as Significant Coastal Fish and Wildlife Habitats by the New York State Department of State (NYSDOS).

Within the Dunes and Swales habitat, the maritime freshwater interdunal swale community, which occupies the low-lying and wet areas between the dunes, generally supports a variety of plants designated as rare or unique by the NYSDEC Natural Heritage Program and hence, has been designated as a Significant Habitat by NYSDEC.

The rocky intertidal zone of Montauk Point has been designated as a rare community by NYSDEC Natural Heritage Program. The rocky intertidal zone is considered a generally rare habitat and has been assigned a rarity rank of S1, indicating that the habitat is very vulnerable in the state. The Montauk Point habitat is one of the two large, high quality sites in State. There are only approximately 40 rocky intertidal habitats sites in New York. The current trend of this community is probably stable in the short term but may decline slightly in the future due to moderate threats that include alteration of the natural shoreline, invasive species, and RSLC (NYSDEC, 2006).

The Sunken Forest is one of three locations where maritime forests persist on the eastern seaboard. The Sunken Forest is from 200 to 300 years old and is located within FIIS, near the Sailors Haven marina and visitor center. Because of its uniqueness as a maritime forest community, the Sunken Forest is of particular ecological importance and warrants special protection.

SAV is a unique vegetated intertidal habitat. The establishment of SAV is dependent on suitable water quality, substrate, depth and water currents. SAV is one of the most important features of the Back Bay Ecosystem since it provides nursery areas for finfish and a niche for colonization of epiphytic algae and invertebrates.

2.4 Cultural and Archeological Resources

This Section provides a summary of known and potential cultural, archaeological and architectural resources within the Area of Potential Effect (APE). Reconnaissance level cultural resource reviews of the entire study area were conducted in 1998. More intensive investigations consisting of literature review, examination of data inventories, and field investigations were undertaken to characterize resources in the Area of Potential Effect including the offshore, the onshore barrier islands, and the Mainland and Back Bay areas. The specific details of the studies are provided in the EIS and appendices.

There has also been coordination with the New York State Office of Parks, Recreation and Historic Preservation (NYSOPRHP) to assess potential effect and develop strategies to avoid or minimize adverse effects. A Programmatic Agreement has been executed and is included in EIS Appendix E.

2.4.1 Offshore Areas

The APE for the offshore area includes the borrow areas that will supply sand for the creation of the beach areas. Known and potential submerged archaeological and cultural resources in the offshore zone along the Atlantic Coast of Long Island from Fire Island Inlet to Montauk Point have been inventoried through a number of studies (USACE/John Milner Associates (JMA), 1998; Tidewater Atlantic Research, Inc. (TAR), 2002). According to the JMA, 1998 report, no underwater, former terrestrial archeological sites have been identified off-shore of Long Island, however artifacts, primarily stone projectile points, have been found on area beaches after sand placement activities (SHPO, 2019). There is the potential for the dredging of the offshore borrow areas to have an adverse effect on shipwrecks and buried landsurfaces. The Programmatic Agreement includes stipulations for additional remote sensing investigations for borrow areas that have not been surveyed and underwater investigations for targets and/or anomalies that cannot be avoided. In addition, to determine if there is the potential to affect ancient landsurfaces, geophysical studies and investigations may also be recommended.

2.4.2 Barrier Islands

This Section identifies existing significant cultural resources, including archaeological and architectural resources, on the barrier islands of Long Island's Atlantic Coast from Fire Island Inlet to Shinnecock Inlet. JMA, 1998 reports two previously recorded historic archaeological sites within the barrier island APE, according to NY SHPO's archaeological site files. Site A103-05-000605, within Robert Moses State Park, was a recreational facility built for handicapped children in the early part of the 20th century; the other site (Site A103-02-1579) is a complex of structures near Whalehouse Point used by the Coast Guard from the mid-19th century to the early 20th century. Both sites are located on sand dunes bordering Great South Beach. The Historic Preservation Field Services Bureau considers both sites to be potentially eligible for listing on the National Register of Historic Places (NRHP).

In addition to the sites identified in the JMA report, the Gray & Pape, 2005 study identify 11 other previously identified archaeological sites within FIIS: 1) William Floyd Estate Manor House Area, 2) Point O' Woods Refuse Midden, 3) Blue Point Life Saving Station, 4) Smith Point Coast Guard Station, 5) Forge River Life Saving Station, 6) Fire Island Lighthouse Tract, 7) Fire Island Lighthouse Tract (additional), 8) Razed Factory, 9) Greenburg House Site, 10) Saltaire Dump, and 11) Casino Site, in addition to one new site: an 1826 Fire Island Lighthouse Ruin. Most of these sites are related to maritime, military, or recreation/resort activities.

The JMA report identifies a high potential for buried archaeological deposits within undefined portions of the study area underlying the beaches and dunes that have not been previously surveyed. Moreover, the Gray & Pape report indicates that the potential is high for the presence of archaeological resources within the large areas of FIIS that have not been surveyed. In areas that may be disturbed, it is recommended that core borings be taken in areas of disturbance that would be examined by a geoarcheologist knowledgeable of coastal sedimentology. If any preserved surfaces are identified in the borings, monitoring of construction activities in those locations for potential archaeological deposits may be necessary.

Resources Listed or Determined Eligible for Listing on the NRHP. Fire Island Light Station (Town of Islip), located about five miles from the western end of FIIS was listed in the NRHP on September 11, 1981. Resources Potentially Eligible for Listing on the NRHP. JMA's architectural investigation identified several potentially eligible historic resources within the study area, which were related to the historical settlement and pre-resort development, vacation/resort industry, and maritime histories of the barriers. Reconnaissance field surveys identified 22 potentially eligible resources that meet the 50-year age consideration of the NRHP. Potentially affected architectural properties were considered to be only those visible from the beach itself. It is noted that a formal determination of eligibility requires an intensive survey of each property.

The TWA Flight 800 International Memorial and Gardens is located along the beach within Smith Point County Park just was of the William Floyd Parkway traffic circle. The memorial sits on a one-and-one half acre site overlooking the site of the crash of TWA Flight 800, which crashed into the ocean along the Atlantic Coast of Long Island on July 17, 1996, claiming all 230 lives on board (TWA Flight 800 International Memorial and Gardens, 2019).

Although the dredging of the inlets to their authorized depths and sand placement is not anticipated to have an adverse effect on historic properties, the construction of coastal process features and nonstructural measures have the potential to have an adverse effect on archaeological and/or architectural historic properties.

2.4.3 Mainland and Back Bay

This Section identifies significant architectural resources along Long Island's back bay shore, based on a historic resources study prepared in March 2006 (URS, 2006). The APE consists of the area between the bay shoreline and Montauk Highway to the north, the Nassau-Suffolk County border to the west and First Neck Land on the western side of the Village of Southampton to the east.

There are approximately 70 archaeological sites located on the mainland and back bay APE, representing either the historic or prehistoric period. Not all of the archaeological sites have been evaluated for their eligibility to the National Register. Despite the area's development, the range and number of the sites found within the APE indicate the area remains sensitive to the recovery of the archaeological sites related to both the historic and prehistoric periods. Individual Properties Potentially Eligible for Listing on the NRHP. The historic resources survey identified 49 properties as being potentially eligible for the NRHP. Most are residential properties associated with the time period of 1840-1960 and most are located in the easternmost parts of the APE. Only one resource (located in Babylon) was identified as being built before 1840. The primary context of the resources was early suburbanization between 1890 and 1920.

Districts Potentially Eligible for Listing on the NRHP. According to National Register Bulletin 15, a district "results from the interrelationship of its resources, which can convey a visual sense of the overall historic environment or be an arrangement of historically or functionally related properties." In addition, a district may be considered eligible if all of the components lack individual distinction, provided that the grouping achieves significance as a whole within its historic context. Within the APE, 10 potentially eligible historic districts were identified. The districts are primarily residential; however, one in Lindenhurst is associated with the maritime and fishing industry. The majority of the residential districts are associated with the primary contexts of early or postwar suburbanization, spanning almost 70 years in history. The district identified in Mastic has a considerable number of vacation or seasonal homes, and the Westhampton Beach district has 13 properties of the 31 associated with the secondary context of resort development. Although resort and vacation community construction historically occurred in the western portion of Suffolk County along the South Shore, today more of those properties are located further east.

The proposed nonstructural alternative, including retrofitting, flood-proofing, ringwalls, acquisitions and other activities, have the potential to have an adverse effect on structures and associated archaeological sites that are eligible or listed on the National Register. In addition, the construction of ringwalls could have an effect on archaeological resources. Evaluation of all structures identified for nonstructural measures will be assessed for their National Register eligibility prior to the implementation of any measures. Any proposed measures will be designed to avoid or minimize any adverse effects. Where adverse effects cannot be avoided, documentation of the properties and other forms of mitigation will be developed in consultation with the NYSHPO, the property owner(s), and other interested parties. In addition, an archaeological survey for retrofitting, flood-proofing and acquisition activities that have the potential to have ground disturbance would be required.

2.4.4 Native American Consultation

Within the FIMP study area is one federally-recognized Indian Tribe, the Shinnecock Indian Nation, and one New York state-recognized tribe, Unkechaug Indian Nation (Poospatuck). A third tribal group, the

Shirley-Mastics is affiliated with the Unkechaug Indian Nation. Both the Shinnecock Indian Nation and the Unkechaug Indian Nation own lands within the APE.

Meetings with representatives of both Nations were held between 2003 and 2006 to communicate the study's goals, discussion of potential impacts to cultural resources, and identification of flood-prone areas for further study. More recently, the project information, which replicated the 2006 subject of consultation, has been provided to both the Shinnecock Indian Nation and the Unkechaug Indian Nation.

3 FUTURE WITHOUT PROJECT CONDITION

3.1 General

The FWOP condition is the most-likely future conditions in the study area in the absence of a proposed project from the current study. The FWOP condition serves as the base conditions for the analyses of alternatives, including the engineering design, economic evaluation of alternatives, comparison of alternatives, as well as environmental, social and cultural impact assessment.

The FWOP condition is a forecast based upon what has actually occurred, is currently occurring, or is expected to occur in the study area if no actions are taken as a result of this study. As it is impossible to predict the future, the without-project condition represents the most likely future scenario (not the only future scenario), based upon reasoned, documentable forecasting of what is most likely to occur, and based on historic practices and trends.

The following assumptions were made to establish the framework of the FWOP:

1. Storms will occur in a manner and frequency similar to those that have historically occurred.
2. Relative sea level rise will continue and increase the impact of the storms. There is a range of RSLC that is possible in the future.
3. Future development will be undertaken consistent with existing regulations.
4. Maintenance of the navigation channels through the existing inlets (Fire Island, Moriches, and Shinnecock Inlets) and in the back bays will continue, consistent with past practices to provide navigation and bypass material.
5. It is assumed that local interests will continue to maintain the beach and dune through the use of acceptable coastal management actions, subject to approval by permitting agencies.
6. The breach within the Otis Pike High Dune Wilderness Area of the FIIS that opened during Hurricane Sandy will remain open indefinitely.
7. Periodic renourishment of the Westhampton Interim Project will continue until 2027 consistent with the terms of the legal settlement.
8. The one-time post-Hurricane Sandy FIMI Project is constructed (scheduled to be completed in 2021).
9. The one-time post-Hurricane Sandy Downtown Montauk Stabilization Project is constructed (completed in 2016).
10. The Interim Breach Contingency Plan, that includes a process to close breaches within three (3) months and which was approved as an interim action pending the outcome of the Reformulation study, will not continue. Breaches of the barrier island will continue to be closed (with the exception of the Wilderness Breach) but will take a year to close in the absence of a streamlined process for Federal participation.

In summary, the FWOP condition, which serves as the baseline for comparison of the alternatives assumes that the post-Hurricane Sandy stabilization efforts on Fire Island and Downtown Montauk are in-place, and that the existing breach in the Wilderness Breach remains open indefinitely. It is acknowledged that the NPS has a Wilderness Breach Management Plan EIS that provides provisions for closure of the Wilderness Breach, and that the breach may be closed in the future, but in this analysis the assumption is that the breach remains open. Maintenance of the three Federal navigation projects, and renourishment of the Westhampton Interim Project are all expected to continue in the future.

3.2 Physical Conditions

Future coastal conditions are likely to be shaped as much by human intervention as by natural coastal processes. Some actions, such as the renourishment period for Westhampton Interim Project, are clearly defined in existing reports or agreements. Other FWOP actions, such as breach closures or periodic beach maintenance, are anticipated based on a review of the history of such actions. For these types of projects, unless specific plans or policies are identified which would alter future conditions, it is assumed that past actions are the most reliable indicator of the FWOP.

Climate Change. The FWOP anticipates a continuation of sea level rise. The formulation of alternatives is consistent with EP 1100-2-1 Procedures to Evaluate Sea Level; Change: Impacts, Responses and Adaptation. The screening of alternatives was undertaken based upon the low-rate of RSLC, because the plan formulation is not sensitive to various RSLC rates. Because there is variability in the rate of future sea level rise, the planning considers the effectiveness of the selected plan under the intermediate and high rate of relative sea level rise. The FWOP anticipates that although the consequence of storms will increase under higher rates of RSLC, that the frequency and intensity of future storms will not change in the FWOP and that the wave climate will be similar to historic patterns. Sediment transport and rates of long-term erosion will also be similar to historic rates, with some changes due to both the maturation and deterioration of existing coastal structures. There may also be a slight change in performance under the higher rates of RSLC.

Beach and Dune Conditions. Considering the influence of the coastal processes and the human response to these processes, it is expected that the shoreline will continue to be influenced by the regional sediment framework, storm response, localized erosion hot spots, and RSLC. It is expected that the beach and dune conditions will fluctuate over the next 50 years largely dependent upon the timing and intensity of storms. This cycle of beach and dune condition is captured in the life cycle evaluations used for project design and evaluation, which recognize that the beach and dune conditions are variable over time. Two sets of beach and dune conditions have been developed to bracket the range of possible conditions over the FWOP: Baseline Conditions (BLC) and Future Vulnerable Conditions (FVC). Specifics regarding the BLC and FVC are included in the following Section, Problems and Opportunities, Sections 4.4.3.2 and 4.4.3.3.

Local Storm Risk Management Efforts. It is expected that some non-Federal coastal risk management efforts will likely continue without federal participation. These include beach nourishment projects to maintain a minimum beach width and a dune height of approximately 13 to 16 feet. The local nourishment measures will generally occur when erosion is at or near the dune line, at locations where smaller, local projects have been previously built, such as at Saltaire, Fair Harbor and Dunewood, and at Fire Island Pines. Outside of these communities it is anticipated that this storm risk management will focus on maintaining a minimum height of the dunes, and width for the barrier islands, in order to prevent breaching, and protect the east/west access, either by reducing risk to paved roads, dirt roads, or ensuring access along the beach.

While those efforts will provide some measure of future storm risk mitigation, future loss of beach width and lowering of dunes will result in increased vulnerability to storm damage. The FWOP anticipates no development will take place in the major Federal tracts of land on Fire Island and that future regulatory procedures could limit the scale and extent of development in the undeveloped areas. No significant upgrades of stormwater infrastructure or coastal storm risk management measures for individual residences (e.g. elevating homes) are anticipated without significant Federal funding being provided.

In the coastal ponds region, it is expected that the Town Trustees will continue the current practice of opening and closing the openings between the ponds and the ocean. It is expected that there will be some small-scale dune rebuilding efforts utilizing material from the flood shoals of these ponds.

Inlets. The FWOP anticipates that the Federal navigation projects at Fire Island, Moriches and Shinnecock Inlets, as well as the Federal, State, and locally maintained approach and back-bay navigation channels in the area will be maintained through periodic dredging and that these ongoing efforts will not measurably alter the existing hydrodynamics of the inlets and bays. It is expected that the past practices of beach and intertidal placement associated with dredging will continue.

Wilderness Area Breach. The FWOP anticipates that the breach within the Otis Pike High Dune Wilderness Area of FIIS that opened during Hurricane Sandy will remain open indefinitely. DOI signed a Record of Decision for the Wilderness Breach Management Plan EIS on July 23, 2018. Under the selected action identified in the ROD, the evolution, growth, and/or closure of the breach will be determined by natural barrier island processes, and human intervention to close the breach will occur only "to prevent loss of life, flooding, and other severe economic and physical damage to the Great South Bay and surrounding areas." NPS will continue to monitor the Wilderness Breach using established methods that staff and scientists have used since 2012. Monitoring is being conducted to determine if changes in the breach could elevate the risk, which could lead to a decision to close the breach.

Closing Breaches. As noted in the introduction, the FWOP assumes that breaches in the barrier islands will either close naturally or will be closed without a streamlined Breach Response Plan. The breach closure is assumed to take between 9 and 12 months, the time frame to close breaches in 1980 and 1992, prior to implementation of the 1996 Breach Contingency Plan. The FWOP also assumes that the Wilderness Breach will remain open in the Otis Pike High Dune Wilderness Area of FIIS.

3.3 Social and Institutional Conditions

The population of Suffolk County and the study area is expected to increase over the period of analysis. Continued increases in both population and income will inevitably lead to increased development, increased traffic congestion, as well as an increased demand for recreation and beach facilities. The high price and demand for shorefront property will create strong economic incentives to reconstruct buildings that have been damaged or destroyed by erosion or waves. The FWOP anticipates that of the institutional controls, the CEHA Act, is the most important constraint on rebuilding of storm damaged structures. The CEHA regulations have been instituted along the Atlantic Ocean shoreline within the project area, but do not address development along the bay shoreline. The FWOP assumes once structure damage exceeds 50 percent of the structure value (substantially damaged) the building will be rebuilt above regulated Base Flood Elevation (BFE) landward of the CEHA, where it is possible on the existing lot. If the existing lot size will not allow rebuilding landward of the CEHA, it is assumed that buildings will not be rebuilt. It is acknowledged that variances may be granted to reconstruct some substantially damaged buildings within the CEHA, but such conditions are not predicted at this time.

Implementation and enforcement of institutional controls are effective tools to restrict development in "at-risk" or environmentally sensitive areas. In general, it is anticipated that existing regulations will be enforced, and that future development will not be subject to frequent storm damage through enforcement of these regulations. The FWOP anticipates limited impacts from new regulations.

The status of other hazard mitigation programs in the study area was reviewed to establish the FWOP. Many of the communities have prepared Flood Mitigation Plans and may be eligible for FEMA grants through the Hazard Mitigation Grant Program (HMGP) administered by the NY State Emergency Management Office (SEMO). Nonstructural storm damage reduction programs that incorporate floodproofing or other building retrofit measures are the most likely hazard mitigation actions to be implemented under these programs. Following Hurricane Sandy, a number of home elevations have been implemented through these programs. The elevation of homes through these programs has been accounted for, based upon the information available from the local governments. No forecast of future elevation of floodplain structures is projected.

3.4 Environmental Resources

The environment of the FIMP study area is a complex, dynamic system that is influenced by both natural coastal processes and human policies and programs. Study area habitats will change in the FWOP in response to numerous factors including ongoing natural succession (natural change in the vegetative communities), RSLC, coastal erosion and related erosion control activities, periodic overwash and breaching, as well as land and infrastructure development. These factors may impact all of the study area habitats: Offshore, Atlantic Shoreline (nearshore, intertidal, beach, dune), Inlets, Barrier Island (maritime forest, bayside beach, terrestrial upland), Back Bay (intertidal, shoals/mudflats, tidal marsh, subtidal, SAV), and Mainland Upland.

In assessing FWOP no major changes in offshore habitats are anticipated. Localized dredging of sand for beach nourishment projects is expected to continue in a manner comparable to past practices, where borrow area locations are dredged once, and are not repetitively disturbed. This includes dredging for the Westhampton Interim Project, potential breach closures, and other locally implemented actions taken in response to continued erosion. Monitoring of prior dredging activities suggests that the benthic communities and other biological resources within these borrow sites will not be altered on a long-term basis. Even with periodic repeated dredging, benthic communities at the borrow areas would resemble those with other seafloor disturbances, such as repeated bottom disturbance by fishing with trawls; benthic communities that undergo high rates of physical disturbance, either natural or human induced, are characterized by organisms that can recover quickly (Michel et al, 2013). Other possible changes to offshore habitats and natural resources would most likely be associated with changes in fishing trends or fisheries management.

In the FWOP, the Atlantic shoreline will remain the most dynamic habitat in the study area. The ecological communities that inhabit these areas readily adapt to physical changes in the environment. Shorebirds including the Piping Plover and the Least Tern are probably the most sensitive species relying on this habitat and it is anticipated that continued efforts to protect these species will continue throughout the FWOP.

The FWOP habitats and natural resources of the barrier islands will be influenced by continued RSLC, overwash/breaching and related sediment transport, erosion control and post storm repair activities, and development and redevelopment. It is expected that these human activities would reduce the magnitude of the changes in the barrier island topography, human usage patterns and vegetation communities that would be associated with long-term erosion, storm activity and RSLC. It is expected that there will continue to be overwash and breaching, but that to different degrees these storm driven processes would be countered by human activities. As a result, it is expected that the physical features associated with overwash and breaching would be limited in magnitude due to human intervention. Over time it is expected that these areas would subsequently vegetate to a level consistent with what has been observed in the study area. The presence of bulkheading along portions of the barrier island is likely to limit the natural succession of habitat in response to sea RSLC.

In the FWOP it is expected that future changes will occur within the estuaries and along the bay shores. It is expected that changes in the estuary will continue as a result of increases in sea level, and also due to future barrier island breaches. It is noted that the future FWOP assumes that the Wilderness Breach remains open. As is the case for the barrier island condition, it is expected that the spatial and temporal magnitude of the hydrodynamic changes in the estuary due to breaching and overwash would be reduced by human intervention to reduce the potential for breaching, and through breach closure. While there may be short-term changes in the inlet regime associated with barrier island breaching, the predominant conditions affecting the bay hydrodynamics would be represented by the current inlet conditions.

These physical changes would have short-term impacts on the FWOP bay water quality. During the period of time that a large breach remained open, there would be altered tidal exchange, with the potential for increased flooding along the mainland during larger storm events due to higher storm water levels and increased waves, and also changed salinity distribution and potentially improved water quality due to increased flushing. Because the existing natural resource communities in the bays are currently subject to wide range of water quality conditions, short term hydrodynamic changes associated with breaches are not anticipated to result in long term alterations to bay habitats.

Barrier island breaching and overwash will likely increase and contribute to sediment input into the estuaries adjacent to the barrier islands while the breach remained open. The sediment input to the bay could cause short-term impacts to shellfish and SAV, while also providing needed sediment for the long-term formation of salt marsh and SAV beds. The possibility for such habitat creation or degradation is highly dependent upon the location of the breach or overwash and its temporal extent.

The greatest impact to upland habitats in the FWOP is the continued development associated with the projected increase in population. Population increases between 2010 and 2035 are projected in East Hampton (28 percent), Southampton (25 percent), and Brookhaven (22 percent) (Suffolk County Dept. of Economic Development and Planning, 2015). The need for additional housing and infrastructure is likely to result in a loss of open space and natural habitats within the study area. To some extent this development will be offset by local government efforts for zoning and acquisition of open space. Suffolk County and the Towns of Brookhaven, and Southampton and Easthampton all have strong open space preservation programs. With respect to the FIIS segment, any new development is restricted by law to the existing communities. While development will continue in this area, it is expected that virtually all of it, with the exception of a few scattered parcels, will consist of the replacement of existing structures with new or rebuilt ones.

3.5 Cultural Resources

The key cultural resources in the study area include submerged artifacts, buried artifacts, historic structures and districts.

No significant change is expected in the future, relative to submerged artifacts. Historic resources, such as shipwrecks in the offshore marine environment, are either buried or partially buried. Wooden resources may become buoyant and move, even if buried or partially buried. Future storms could adversely impact partially buried resources but probably would not have an adverse effect on those that are fully buried. Artifacts presently buried or partially buried within the active shorezone (including historic artifacts and historic land surfaces) are likely to be impacted. Future storm activity, and continued erosion within the study area are expected to expose and further the destruction of these resources.

Buildings recognized as historic structures and potentially eligible structures are likely to be impacted in the future. Recognized structures are likely to be preserved and maintained as such. It is likely that a number of the potentially eligible structures would be reduced due to renovations, replacement, or destruction of the buildings. Similar conditions are anticipated for historic districts and landscapes. Over time additional structures will meet the requirements for being evaluated for eligibility.

4 PROBLEMS AND OPPORTUNITIES

4.1 Description of the Problem

The study area comprises a complex coastal area that includes different components, including coastal headlands, barrier islands, tidal inlets back bays, and mainland, each with their specific problems that need to be evaluated for storm damage reduction that compliments and reestablishes the natural coastal processes as an interconnected system.

Nor'easters and hurricanes are the primary source of storm damage to the Atlantic Coast of Long Island, causing extensive flooding, wave attack, and erosion impacts along the barrier islands and mainland. Hurricane Sandy was a powerful reminder of the impact these storm events can have on the study area. The severity of impacts from large storms (ACE of 2 percent or greater) in the areas surrounding Great South, Moriches and Shinnecock Bays is strongly dependent on the integrity of the barrier islands from Fire Island Inlet to Southampton. In this regard, overwashing and/or breaching of the barrier islands can lead to increased storm damages as bay storm water elevations are increased. In the absence of a Federal project the height and width of the barrier islands may be reduced further due to continued shoreline erosion and rising sea level, exposing the study area to greater risks. Coastal model and economic evaluations have shown that storm damages in the bays are relatively sensitive to the condition of the barrier island and suggest that storm damages could as much as double with a 0.5 foot increase in flood elevations.

To analyze and evaluate the impacts from future storm events, this study has utilized a number of different coastal engineering models to characterize the long-term evolution of the beach and dune along the barrier island, predict the breaching of the barrier islands and the magnitude of storm water levels along the ocean and bays. Modeling efforts have been undertaken to characterize the storm response that can be expected in the future under different barrier island topographic conditions.

The storm water level modeling is the cornerstone of the study, since the model output is used to generate ocean and bay stage-frequency curves for input into economic analyses, coastal engineering design, environmental processes, and final alternative selection. A detailed description of all the coastal models applied during the study is found in Appendix A – Engineering. A summary of the three primary modeling analyses used in the study to calculate storm damages are provided in the following Sections.

4.2 Storm Surge Modeling

4.2.1 Modeling Approach

Storm water level numerical modeling was performed to determine stage frequency relationships at 49 locations throughout the study area. These 49 locations were selected to capture the variability in storm water levels along the open coast and within the three bays. The storm water level numerical modeling strategy for FIMP addressed a comprehensive list of physical processes (wind conditions, barometric pressure, astronomic tide, wave conditions, morphologic response, [namely barrier island overwash and breaching], and localized wind and wave setup) by merging hydrodynamic, wave, and sediment transport models. The integration of these modeling efforts is shown in Figure 11.

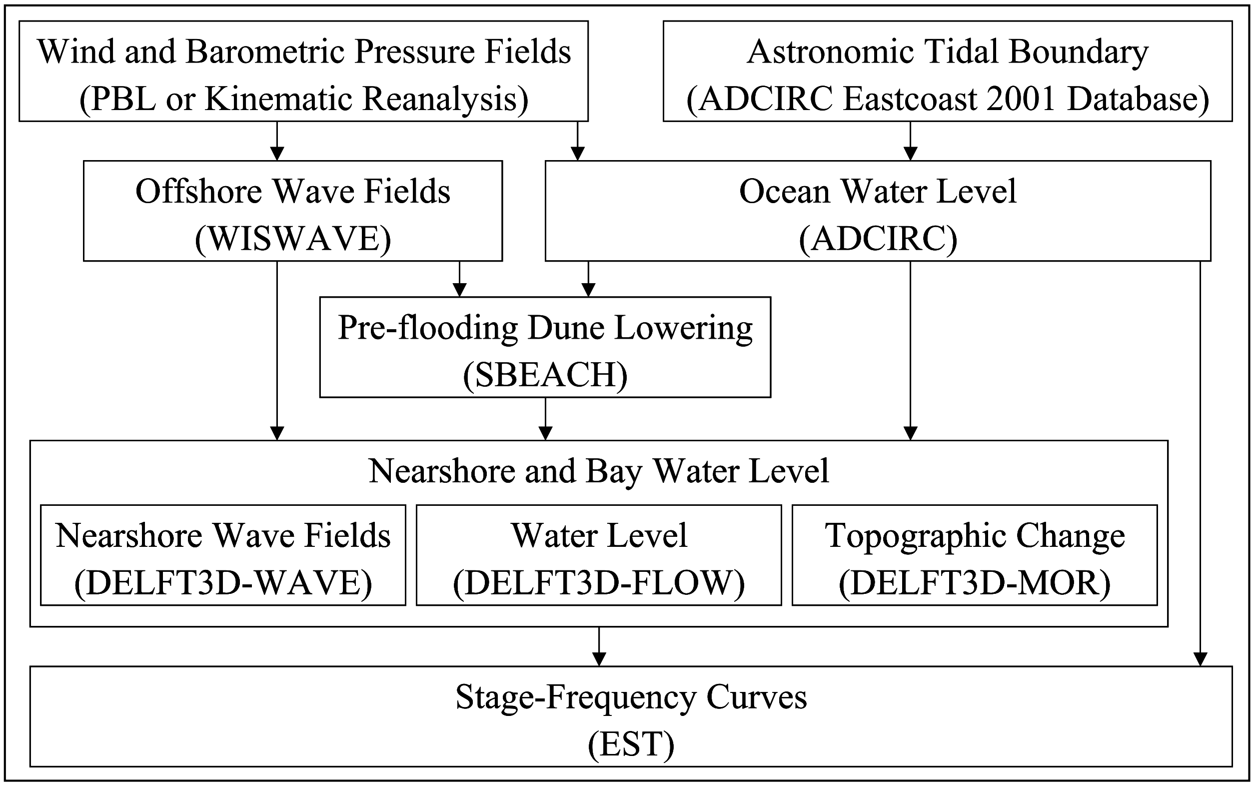

Figure 11. FIMP storm water level modeling and stage-frequency methodology

The six numerical models were applied to accomplish specific requirements for the study. Collectively, these models simulate the impact that each modeled storm has on ocean and bay water elevations, lowering of the dune during the storm, and the morphological response due to a storm. The outputs from these models were input into a statistical modeling tool to estimate the likelihood of storm occurrence. The following is a summary of the six numerical models:

1. A Planetary Boundary Layer (PBL) model for wind field simulation was used to develop wind and pressure fields for tropical storms (Thompson and Cardone, 1996).
2. An Interactive Kinematic Objective Analysis (IKOA) for wind field simulation was used to develop extratropical wind fields through data assimilation, based upon the National Center for Environmental Prediction (NCEP) database.
3. The offshore extreme storm wave conditions were generated using WISWAVE (also WAVAD) (Resio, 1981) a second generation, directional spectral wave model. WISWAVE output was used as input for the DELFT3D modeling and for SBEACH.
4. ADCIRC was used to simulate the ocean and nearshore (outside the surf zone) storm water levels (Luettich et al., 1992). ADCIRC is a long-wave hydrodynamic finite-element model that simulates water surface elevations and currents from astronomic tides, wind, and barometric pressure by solving the two-dimensional, depth-integrated momentum and continuity equations. The grid resolution varies from very coarse at the open ocean boundaries to 50-m in some nearshore locations. ADCIRC was forced with the winds and barometric pressure fields from 1 and 2 above,

to capture meteorological effects on water levels, in conjunction with astronomic tidal constituents from the ADCIRC East Coast 2001 Tidal Constituent Database.

5. SBEACH was used for the hydrodynamic modeling, and separately to evaluate the shorefront response for the design and evaluation of beachfill alternatives. In the context of the hydrodynamic modeling, SBEACH was applied to estimate dune lowering that occurred prior to a dune being overtopped. SBEACH (Larson and Kraus, 1989a; Larson, Kraus, and Byearnes, 1990) is a numerical model for predicting beach, berm, and dune erosion due to storm waves and water levels. For storm water level modeling, SBEACH storm simulations were performed for more than 200 beach profiles cut from the 2000 LIDAR topography. Dune crest elevation change just prior to inundation was extracted from the SBEACH simulation results and put into the DELFT3D topography grid to improve estimates of potential breaching and overwash processes.
6. The DELFT3D Modeling Suite (FLOW, WAVE, MOR) was used to compute the bay water levels under storm conditions, taking into account the contribution of storm surge, waves, winds, and the contribution of overwash and/or breaching. Both the ADCIRC and Delft3D hydrodynamic models underwent extensive calibration before they were used to simulate historic storm events.

Of the six models presented, two models are preferred for use by the Hydrology, Hydraulics and Coastal (HH&C) Community of Practice (CoP) (ADCIRC and SBEACH), and one model is allowed for use by the HH&C CoP (WISWAVE). The statistical process model EST is also allowed by the HH&C CoP (see the HH&C CoP Sharepoint site for model software list and Enterprise Standard (ES -08101) Software Validation for the HH&C CoP). There is no further approval needed to use these models. The Planetary Boundary Model and the Interactive Kinematic Objective Analysis is standard practice for windfield simulation and has been recently used in the North Atlantic Coast Comprehensive Model Simulations (ERDC/CHL TR-15-14, Cialone, et al.). At the time of the original modeling study, the DEFLT 3D Modeling Suite was the leading modeling package available to allow the simulation of cross-island topographic changes which contribute to barrier island variations, overwash and breaching potential. The complete storm modeling suite architecture was approved by the Coastal and Hydraulic Laboratory, and further reviewed and accepted by a Technical Review Panel (See Appendix A - Engineering and Sub-Appendix A.2 – Storm Induced Beach Erosion Response Frequency Relationships.

4.2.2 Historical Storm Set

Storms are the major drivers for storm damage within the study area. The basis for the modeling effort in this study assumes that storms will occur in a manner similar to what has occurred in the past. A total of 36 historical storm events, 14 tropical storms and 22 extratropical storms, comprise the historical storm set as described and discussed in Appendix A- Engineering . Historical tropical storms from 1930 through 2001 and extratropical storms from 1950-1998 were considered for the storm set. To develop stage-frequency relationships, several supplemental storms were selected for numerical modeling, as described in Appendix A- Engineering. These included variation in the timing of major historical events such that different astronomical tide scenarios could be considered. Although the historic storm set did not include Hurricane Sandy, it contains similar storms that capture the storm effects due to Hurricane Sandy.

4.2.3 *Stage Frequency Methodology*

The Empirical Simulation Techniques (EST) was applied to generate stage frequency curves. EST are a group of nonparametric methods for proceeding directly from hydrometeorological storm data to simulations of future storm activity and coastal impact, without introducing parametric assumptions concerning the probability law formulas and related parameters of the data (Scheffner et al., 1999).

Two EST procedures, one univariate (1-D) and the other multivariate, were used in the FIMP studies. The 1-D EST methodology, using water level as the one dimension, was employed for stage-frequency development for the FIMP study. The multivariate EST was used in conjunction with SBEACH for modeling of beach profile response and estimation of storm-induced coastal changes, primarily for economic life-cycle analyses (see Gravens et al., 1999).

For the FIMP study, the 1-D EST methodology was improved to account for other, equally probably, astronomical tide timings relative to each individual storm's timing. In order to apply this approach, 21 additional alternate tide events were run, to provide an improved estimate of the storm effects under different tide conditions. Along the open coast, the total surge generally can be added to the various tide conditions to develop the total surge effect, however, due to the complicated hydrodynamics of flows through the inlets and over the barrier island, this approach does not work well within the bays. With the inclusion of these alternate tide scenarios, final stage-frequency curves were generated to represent stage frequency relationships for the study area, at the 49 locations output from the model.

4.2.4 *Shorefront Water Levels*

Shorefront water levels are the result of the combined effects of the tide, storm surge, and waves. The storm water level offshore of the surf zone is determined based on the storm water level modeling procedures described in prior Section. This storm water level is not representative of the water elevation along the Long Island ocean shoreline where there is an additional increase in water elevation due to wave setup. Wave setup is localized increase in the water surface elevation along the coast caused by the breaking of waves. Wave setup is calculated by SBEACH, as described in Section 4.3 and is one of the 19 responses extracted from the SBEACH shorefront numerical model. Wave setup adds an additional 2 to 3 feet of water to the storm tide elevation under the storm conditions evaluated.

The combination of offshore storm water level and wave setup is intended to be representative of the still water elevation along the shoreline. The storm water level plus wave setup water elevations are used in the shorefront economic evaluation of inundation damages. It is noted that individual waves can temporarily increase or decrease water elevation and cause wave runup on sloping surfaces. However, wave runup is not included in the flood elevations used to calculate shorefront inundation damages. Figure 12 illustrates the components combining to make up the water elevation at the beach.

Runup estimates are available from SBEACH model results. However, shorefront inundation damage models are based on still water level inundation, excluding runup. This is because the actual level of inundation within the building envelope is generally limited to still water levels unless there is a structural failure of the walls. Structural failures due to wave impacts are captured as part of wave damages.

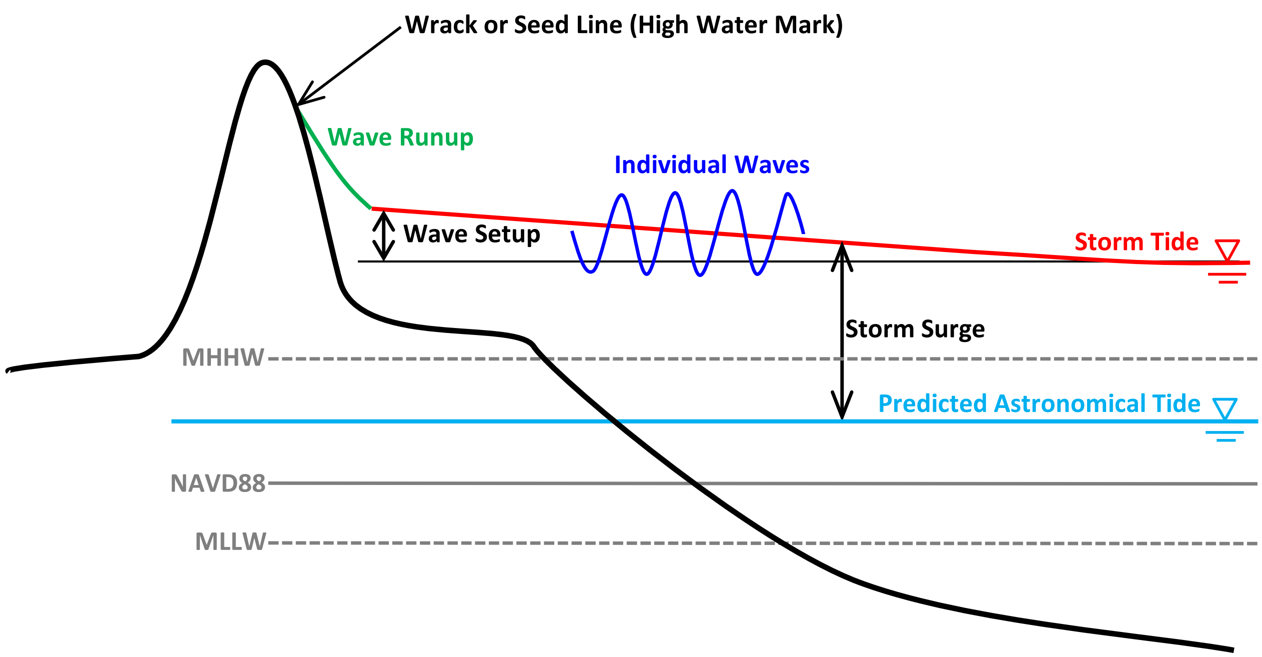

Figure 12. Shorefront Water Levels

4.3 Shorefront Erosion Modeling

An important task of this study was to evaluate storm-induced beach profile change within the study area. The USACE model SBEACH, described earlier, was applied to calculate changes to the beaches and dunes during storm events and the water levels and wave heights landward of the shoreline. Model simulations were performed for 36 storms in the historical storm set, 22 unique beach profiles representative of the variable conditions along the study area, and for a range of possible future with-project and without-project beach profile conditions. A total of 19 SBEACH responses were identified to satisfy input requirements for overtopping and economic analyses. The 19 responses describe the morphological changes to the beach and dune and the wave and water level conditions landward at the shoreline. The modeled responses are subsequently processed using the multivariate Empirical Simulation Technique (EST) (Scheffner et al. 1999), a statistical procedure involving multiple life-cycle simulations for the development of frequency-of-occurrence relationships for nondeterministic multiparameter systems. The final product of the EST analysis is a set of frequency-of-occurrence relationships (i.e. storm water level or "stage"-frequency curves) for key beach and dune erosion responses and wave and water levels at the shoreline.

SBEACH modeling captures the erosion which occurs during a storm event. However, immediately after a storm event, beaches often begin to recover when long-period waves move the sand from the nearshore back onto the beach. When determining how the study area evolves over time, it is important to estimate the amount of recovery expected. The amount of recovery, expressed as a percentage of the volume lost, depends upon a number of factors, including the sediment budget. The estimated amount of beach recovery has been established for various shoreline locations. These recovery amounts have been developed in order to match the long-term erosional trends for each location, and establish whether the area is erosional, stable or accreting in the long-term.

4.4 Overwashing and Breaching Models

As described earlier, the severity of storm impacts in the areas surrounding Great South, Moriches and Shinnecock Bays is dependent on the integrity of the barrier islands from Fire Island Inlet to Southampton. In this regard, overwashing and/or breaching of the barrier islands can lead to exacerbated storm damages as bay storm water elevations are increased. Characterizing the complicated breaching process required the application of a number of models to evaluate the likelihood of overwashing or breaching, and the concomitant impact on bay water elevations. The following elements were reflected in the modeling and engineering analyses:

- Breach vulnerability to various barrier island topographic conditions.
- Breach evolution if they are allowed to remain open.
- Breach impact on bay water levels.
- Breach impact on sediment exchange and stability of existing inlets.

The data generated is used as input to the lifecycle economic models, that project the storm damages that are expected to occur in the future. Separate economic models have been developed to consider back bay damages and shorefront damages. However, the back bay damages do consider barrier island changes, and the concomitant change in back bay water elevations. Changes to the barrier island condition, and dune conditions are governed by storm response, post-storm recovery, long-term erosional trends, and shoreline undulations. The results of these models indicate that the risk of breaching will increase in the future due to the combined impacts of RSLC and barrier island erosion.

The Delft3D model was used to compute the bay water levels under storm conditions, taking into account the contribution of storm surge, waves, winds and the contribution of overwash and/or breaching. The Delft3D model's ability for simulating barrier island overwash and breaching was assessed by comparing model results with available high water marks (HWM) and overwash and breaching data for two of the most significant storms of record: the September 1938 Hurricane and the December 1992 Nor'easter. The intent of the test was specifically to qualitatively validate the ability of the model to reproduce observed overwash and breaching. Figure 13 shows an example of the model's ability to simulate the observed breaching during the 1992 Nor'easter at Pikes Beach. Overall, the model simulations for these historic storms provide very realistic results, particularly when considering the uncertainty in the input hydrodynamic conditions and, more importantly, the pre-storm topography. A detailed description of the numerical modeling and calibration is provided in Appendix A –Engineering.

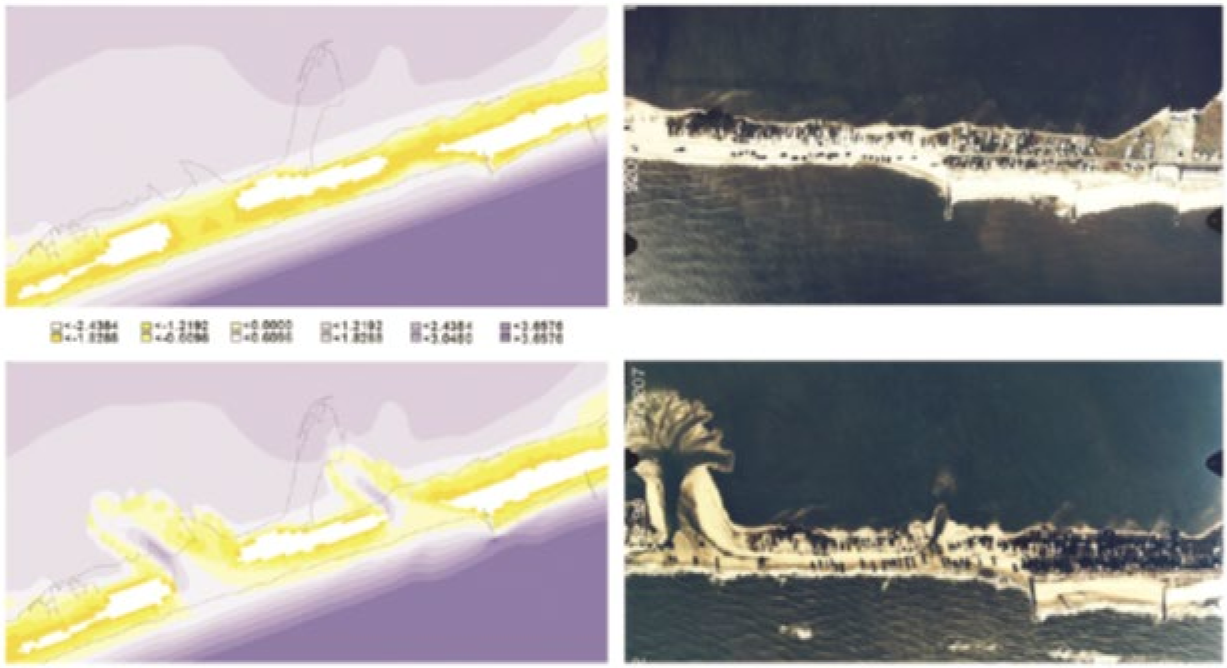

Figure 13. Simulated (left) versus observed (right) breaching during the 1992 Nor'easter at Pikes Beach

4.4.1 Breach Vulnerability

4.4.1.1 Potential Breach Locations

According to records dating to the 16th century, numerous breaches and inlets areas have existed along the study area. The recent stability of the three existing inlets is largely due to maintenance and stabilization efforts that have included dredging of navigation channels and jetty construction. In the application of the model, a number of locations were identified that met the conditions necessary to be prone to breaching, considering dune and beach conditions, and barrier island width. The lifecycle computation of breaches accounts for long-term erosion, which is important in areas with high erosion rates, notably West of Shinnecock Inlet, Smith Point County Park, and west of the Ocean Beach groins. Figure 14 shows the potential locations that are most prone to breaching, considering current dune and beach conditions, and barrier island width based on the model tests. It is noted that vulnerability varies significantly from storm to storm and the evolution of breaches is extremely difficult to predict. Uncertainty in the model predictions is addressed as part of the life cycle economic simulations by considering a range of potential breach growth rates.

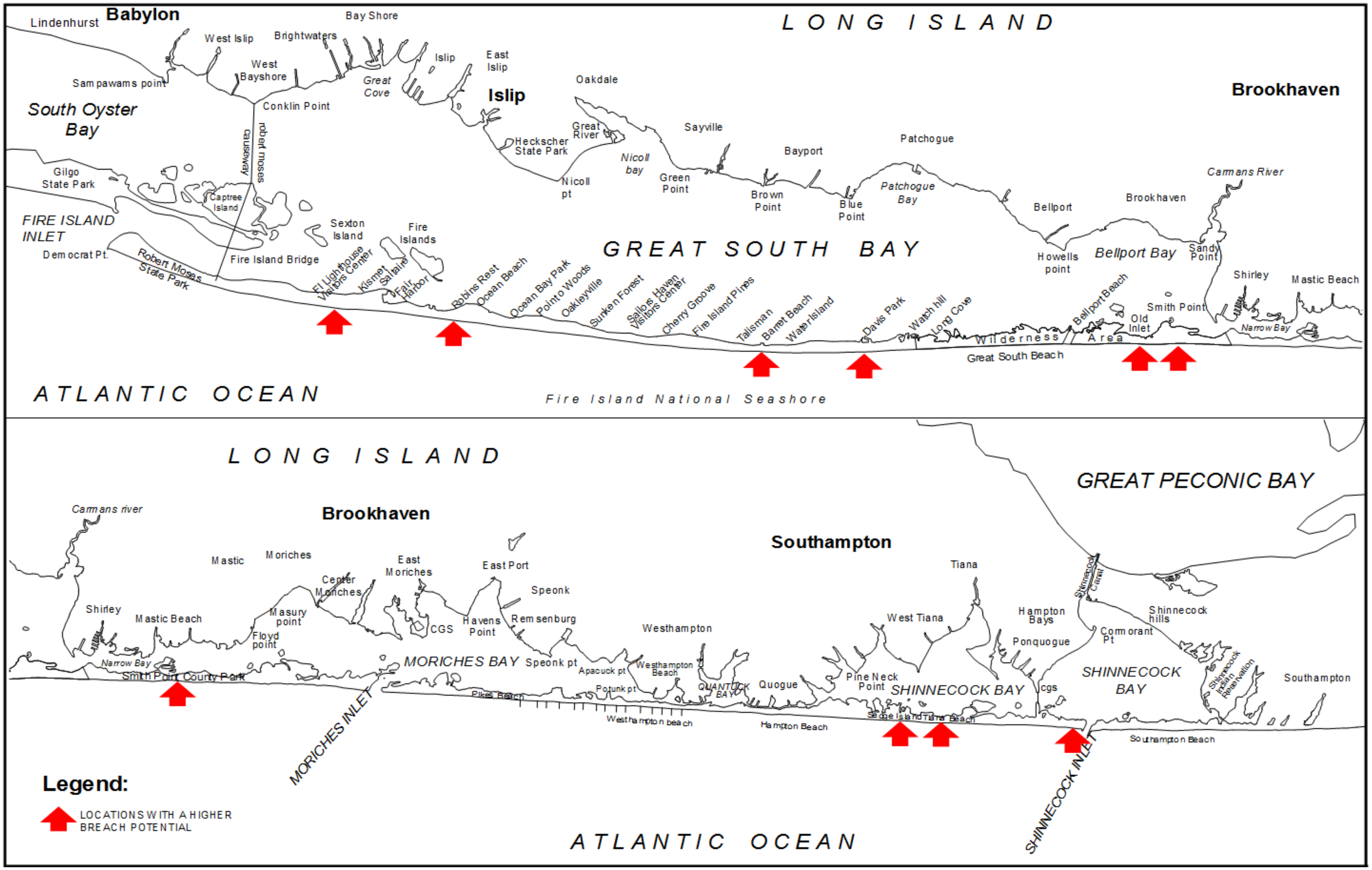

Figure 14. Vulnerable Breach Locations

These areas identified as likely breach locations are based upon recent conditions, current conditions, and reasonably foreseeable future conditions, but should not be taken to imply that other locations in the study area would not breach in the future. For purposes of analysis, however, the impact of breaching focuses on these areas. Table 9 lists the ten specific potential breach locations by Reach that are used to analyze the hydrodynamic impacts of the breaches on the back bays. One of the assumptions is that breaches that take place in the same proximity would have a similar effect on the back-bay.

Table 9. Breach Locations and Breach Reach

Breach Area	Potential Breach Locations	Breach Reach*
1	Fire Island Lighthouse Tract	Western Great South Bay
2	Kismet to Corneille States	Western Great South Bay
3	Talisman to Blue Pt. Beach	Central Great South Bay
4	Davis Park	Central Great South Bay
5	Old Inlet West	Eastern Great South Bay
6	Old Inlet East	Eastern Great South Bay
7	Smith Point County Park	Moriches Bay
8	Sedge Island	Western Shinnecock Bay
9	Tiana Beach	Western Shinnecock Bay
10	West of Shinnecock Inlet	Shinnecock Bay

* Breach reach is used to characterize the hydrodynamic response in the bays.

4.4.1.2 Probability of Overwash and Breaching

The probability of breaching was determined based on model tests accounting for the dune and beach conditions, and barrier island width and hydraulic conditions at each location. Table 10 shows the expected return periods for which overwash, partial breaching, and full breaching of the barrier island begins to occur for each of the likely breach locations. For this study, two types of breaches are used. A partial breach is a storm-induced barrier island cut that has a scoured depth between MHW and MLW while a full breach is a storm-induced barrier island cut that has a scoured depth at or below MLW. A partial breach will allow for water to exchange between the ocean and bay during a portion of the normal tidal cycle while a full breach will allow water exchange during the complete tidal cycle. A partial or full breach may develop into a permanent breach during normal tide conditions following a storm.

In the baseline condition, the probability of breaching is relatively low, but increases significantly in the FVC. This difference in response can be attributed to both dune height and beach width, although in areas where a dune is vulnerable, it appears the primary driver is beach width. In conditions where the beach is wide, there are limited forces acting on the dune. If there is no dune lowering, due to wave action, it is rare for the dune to be overtopped. This difference is well characterized in the area west of Shinnecock Inlet. In the baseline conditions, the beach is over 250 feet wide, and as a result storms result in little dune lowering, and infrequent breaching (0.3 percent flood for breaching). In theFVC, where the dune condition is similar, and the beach is more representative of a typical condition (50 feet wide), there is a much greater amount of dune lowering, and a significant increase in breach probability (breaching at a 4 percent flood).

Table 10. Return Periods for Overwash/Breaching

	Vulnerable Breach Location									
	Fire Island Lighthouse Tract	Kismet to Corneille Estates	Talisman to Blue Point Beach	Davis Park	Old Inlet, West	Old Inlet, East	Smith Point County Park	Sedge Island	Tiana Beach	West of Shinnecock Inlet
Effective Beach Widths for Input Conditions (ft.)										
Baseline	200	150	150	250	200	200	200	200	200	250
FVC	50	50	50	50	50	50	50	50	50	50
Breach Closed	35	53	50	-13	101	97	109	65	98	96
Baseline Conditions (return period in years)										
Overwash	14	9	20	22	10	5	8	25	7	18
Partial Breach	184	141	213	145	45	24	26	251	72	74
Full Breach	> 500	> 500	> 500	> 500	82	118	145	> 500	336	326
FVC (return period in years)										
Overwash	3	5	5	15	4-Jan	5	4	4	4	4
Partial Breach	34	15	12	73	7	19	9	48	30	8
Full Breach	106	34	31	288	22	84	141	291	266	25
Breach Closed (return period in years)										
Overwash	5	5	5	12	4	5	5	4	4	5
Partial Breach	21	17	39	26	12	34	20	66	44	18
Full Breach	43	37	80	108	67	191	139	291	264	60

4.4.1.3 Lifecycle Considerations

In applying these results in the lifecycle modeling, the breach response can also be considered as the total ocean still water elevation necessary to result in a morphological change. When RSLC is taken into account, a lower storm surge height would likely trigger a morphological response, suggesting that overwash and breaching would become more frequent with RSLC. Table 11 provides a summary of how these future changes will alter the risk of breaching over the period of analysis. In some locations, such as Area 2 located to the west of the Ocean Beach groins, high local erosion rates contribute to a significant increase in the risk of a breach in the future. At other locations lower erosion rates or expected future fill placement result in only moderate increases in future breach risk.

The annual breach risk is based on the average results of a large number of possible future storm sequences. When combined with the uncertainties regarding future shoreline change and RSLC, there is actually a wide range of likely future conditions. One way to express the uncertainty in future breaching is to examine the number of breaches expected over the project period of analysis. Although breaches are possible and may persist at any of the ten locations listed in Table 11, breaches too close to each other are not likely to coexist, one or the other will become dominate. Therefore the results detailing the expected number of breaches occurring during the lifecycle simulations was collated by sub-bay, as presented in Table 12. This Table does not include an estimated number of breaches in the Otis Pike High Dune Wilderness Area, since it is assumed that the existing breach in the Wilderness Area remains open over the period of analysis. These results indicate that the number of breaches that will occur in the future could vary greatly, depending on the timing and severity of future storms. It should also be noted that once a breach has occurred at a location, the relatively low closure section results in a significant risk of repeated breaching.

Table 11. Variation in Annual Breach Probability over Time

Breach Area	Potential Breach Locations	ANNUAL BREACH PROBABILITY	
		Initial Condition* 2020	Future Condition* 2070
1	Fire Island Lighthouse Tract	0%	4%
2	Kismet to Corneille States	1%	9%
3	Talisman to Blue Pt. Beach	1%	7%
4	Davis Park	0%	1%
5	Old Inlet West	2%	8%
6	Old Inlet East	2%	4%
7	Smith Point County Park	1%	5%
8	Sedge Island	0%	1%
9	Tiana Beach	0%	2%
10	West of Shinnecock Inlet	0%	1%

* Based on results of 25,000 random combinations of future storms, uncertain erosion rates, and RSLC.

Table 12. Expected Number of Breaches within a 50-year Planning Period

Breach Area	Potential Breach Locations	Sub-Bay	Expected Number (mean)	25th percentile*	75th percentile*
1	Fire Island Lighthouse Tract	WGSB	1.8	1	2
2	Kismet to Corneille States				
3	Talisman to Blue Pt. Beach	CGSB	2.4	0	3
4	Davis Park				
5	Old Inlet West	EGSB	N/A	N/A	N/A
6	Old Inlet East				
7	Smith Point County Park	MOR	1.7	1	2
8	Sedge Island	WSHN	1.2	0	2
9	Tiana Beach				
10	West of Shinnecock Inlet	SHN	1.8	0	3

*Based on results of 25,000 random combinations of future storms, uncertain erosion rates, and RSLC. Simulation percentiles are reported to the nearest whole number.

4.4.2 Breach Evolution

Evaluating the likelihood of breach growth after initial formation is a difficult due to the complex processes involved. Drawing upon past experience with breaching, numerical modeling and engineering judgment to project breach evolution, the likelihood for breach growth was evaluated at each of the three bays. These analyses established that the likelihood for a breach to grow is dependent upon the initial condition (whether it is a full breach or partial breach), and upon the time of year a breach occurred (during the winter, nor'easter season, or tropical, summer season). It is recognized that if any area has a full breach, and water is exchanging throughout the full tidal cycle, the breach will grow. However, it is also assumed that there is a limit to how many breaches can be sustained in a bay at any given time, which could limit how many breaches grow, in the instance of multiple breaches.

For a partial breach, it is recognized that there is a probability that the breach does not grow, but closes naturally. The probability that a partial breach will grow is affected by the time of year that the breach occurred. Wave conditions during the winter, extratropical season are more extreme than the typical summer month conditions. Therefore, conditions are such that a partial breach would be more likely to remain open in the winter months than in the summer months. The analysis projects a 50 percent likelihood of a partial breach closing naturally during the winter months, and a 75 percent likelihood of a partial breach closing naturally in the summer months.

Historical observations of breach growth were relied on to predict the rate of breach growth in scenarios in which a breach or partial breach is likely to grow. Observations from past breaches in 1980 at Cupsogue, 1992 at Pikes Beach (Figure 15), and 2012 in the Otis Pike High Dune Wilderness Area in the study area show that the growth rate is dependent upon the tidal prism of the back bay and can be fit to a decaying exponential curve, to project the width and cross-sectional area of the breach. Two potential breach sizes, small and large, were included for Great South Bay to reflect the uncertainty in potential breach growth.

The small breach size is based on the recent observations at the Wilderness Breach and the large breach size is based on previous observations at Cupsogue and Pikes Beach.

Based upon this analysis, projected growth rates have been developed for each of the potential breach areas, based upon the back bay conditions. The results of this analysis are shown in Table 13 and Table 14, which show the expected width and cross-sectional area for each of the potential breach locations. As described in prior Section, it is acknowledged that the breach growth rate for a particular breach is dependent upon whether or not there is another breach into the bay. For a single breach, it is assumed that it would grow to this size, for more than one breach it is assumed that the breaches collectively would grow to this size.

Figure 15. Breach Evolution after 1992 Nor'easter at Pikes Beach

Table 13. Estimated long-term potential breach widths

Project Reach	Range Value	Breach Widths (feet)				
		1 Month	3 Months	6 Months	9 Months	12 Months
GSB-Sm.	Minimum	130	340	550	690	780
	Maximum	240	550	780	870	900
GSB-Lg.	Minimum	720	1,870	3,070	3,830	4,320
	Maximum	1,340	3,070	4,320	4,820	5,030
MB	Minimum	320	830	1,360	1,690	1,910
	Maximum	750	1,600	2,080	2,220	2,270
SB	Minimum	350	920	1,500	1,880	2,120
	Maximum	840	1,770	2,300	2,470	2,510

Table 14. Estimated long-term potential breach cross-sectional areas

Project Reach	Range Value	Breach Areas (sq. feet)				
		1 Month	3 Months	6 Months	9 Months	12 Months
GSB-Sm.	Minimum	890	2,350	3,850	4,820	5,430
	Maximum	1,660	3,850	5,430	6,060	6,320
GSB-Lg.	Minimum	5,040	13,120	21,480	26,820	30,220
	Maximum	9,380	21,480	30,220	33,770	35,210
MB	Minimum	2,230	5,800	9,490	11,850	13,360
	Maximum	5,270	11,180	14,550	15,560	15,870
SB	Minimum	2,470	6,430	10,530	13,150	14,820
	Maximum	5,850	12,400	16,140	17,270	17,600

4.4.3 Breach Impact on Bay Water Elevations

As described previously, the water elevations in the bays during storms are sensitive to the barrier island conditions, which affect the influx of water from overwash and breaches. The modeling and analyses described earlier were used to generate stage frequency curves in the back bay for several different barrier island conditions. To represent the range of possible future conditions, the following scenarios were evaluated:

4.4.3.1 Pre-Hurricane Sandy Baseline Conditions

Prior to Hurricane Sandy and the Wilderness Breach, the baseline conditions were defined by three inlets and the barrier island topography captured by the September 2000 LIDAR. Dune height, berm, and barrier island width vary along the barrier island system. The 2000 LIDAR indicate lowest dune heights at Old Inlet, where the dune is about +8.5 feet NGVD 29 and at Smith Point County Park, where the dune is about +10 feet NGVD 29. Vulnerable areas in eastern and central Fire Island are characterized by dune heights around +11 to +12 feet NGVD 29 and +15 feet NGVD 29, respectively. Vulnerable areas along Shinnecock Bay are characterized by dune heights ranging from +11 to +13 feet NGVD 29.

4.4.3.2 Baseline Conditions (BLC)

The BLC conditions are an update to the pre- Hurricane Sandy baseline conditions and are used as representative of the existing condition for lifecycle modelling. The baseline condition includes the Wilderness Breach that formed during Hurricane Sandy. The remainder of the barrier island topography is based on the shoreline conditions captured by the 2000 LIDAR. The 2000 LIDAR was selected as representative of the beach condition, as opposed to more recent LIDAR, because this LIDAR set captured a relatively high dune and wide berm along many much of the barrier island. These 2000 conditions are representative of the baseline condition for the project, which assumes the construction of Post- Hurricane Sandy beach fill projects along Fire Island, Westhampton, West of Shinnecock and Downtown Montauk.

4.4.3.3 Future Vulnerable Conditions (FVC)

The FVC represent a barrier island topography that has a lower dune height and narrower berm width than the baseline condition and is reasonably expected to occur at some point during the 50-year period of analysis. Overall, the FVC proposed for the FIMP project area is not extremely different from the baseline conditions. The assumed changes are well within the range of shoreline and profile conditions observed within the past few decades (e.g. erosion and lack of natural beach berm west of Shinnecock Inlet). Weaker, more vulnerable conditions have been historically experienced at several locations, particularly from Westhampton to Moriches Inlet (e.g. conditions prior to the 1938 and 1992 storms). This condition is evaluated to consider the change in storm response under these lower, narrower beach conditions.

4.4.3.4 With Project Conditions (WP)

The WP condition represents a slightly more robust berm and dune condition than the BLC condition. The WP berm width and dune height is defined by the WP design geometry.

4.4.3.5 Breach Closed Conditions (BCC)

The Breach Closed Conditions (BCC) barrier island topography is defined as the minimum breach closure section under consideration for the FIMP study. This breach closure section is defined by a +9.5 feet NGVD 29 dune height and a barrier island width that matches the pre-breach condition. Here, the pre-breach barrier island width is taken as that on the BLC.

4.4.3.6 Breach Open Conditions (BOC)

Breach open conditions for breaches at varying locations (5 breach reaches), and of varied sizes (a breach open for 3 months, and a breach open for 12 months).

Figure 16 and Figure 17 show the differences in the stage frequency curves for a representative location in Great South Bay, Moriches Bay and Shinnecock Bay. Two sets of curves are provided for each station. The first set compares baseline conditions, with project, future vulnerable conditions, and breach closed conditions illustrating the impact the pre-storm barrier island topography has on bay water levels. The second set compares the baseline condition, pre- Hurricane Sandy baseline condition, and various breach open conditions illustrating the impact unclosed breaches on bay water levels.

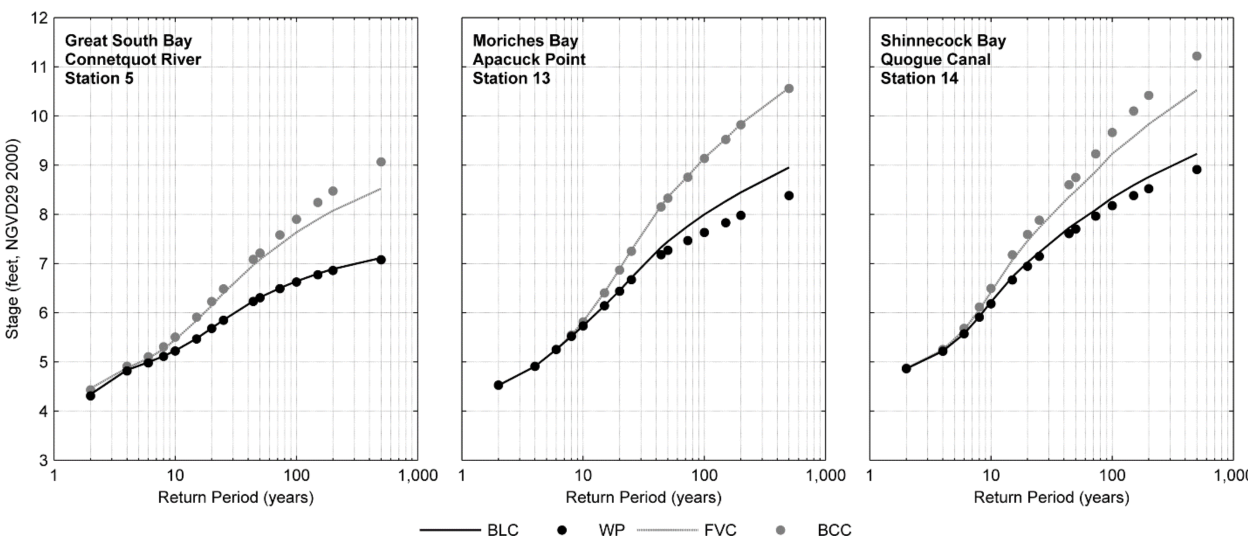

Figure 16. Comparison between BLC, FVC, WP, and BCC stage-frequency curves

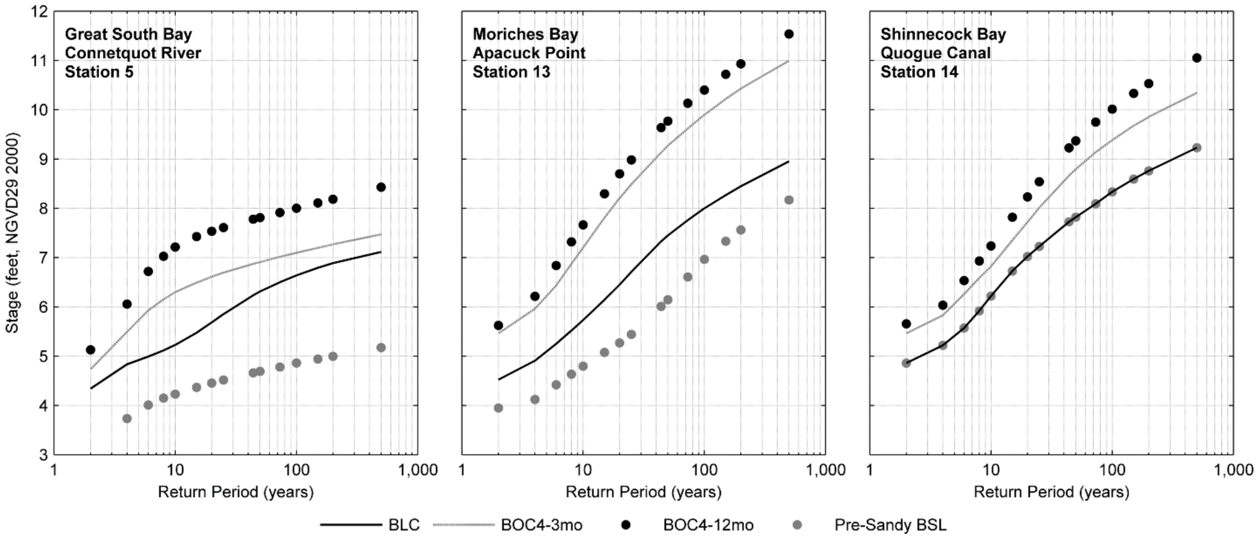

Figure 17. Comparison between BLC and BOC stage-frequency curves

The impact of the barrier island topography and breach open conditions may be described as follows:

For Great South Bay:

- Under FVC, flooding is greater than the baseline condition beginning at a 10 percent flood, and has the effect of increasing the height of flooding by 1 foot to 1.5 feet.
- Under BCC, flooding is greater than the BLC and FVC, and can have the effect of increasing flooding up to 2 feet, as compared to the BLC.
- Under BOC, additional breaches can increase this flooding up to 1.5 feet above baseline conditions
- Under Pre- Hurricane Sandy BLC flooding is 1 to 1.5 feet lower than the new, Post- Hurricane Sandy, BLC.
- Under FVC, topography and breach closed topography, the elevation of a 0.2 percent flood (+7.1 feet NGVD 29) would be experienced with a 2 percent flood.
- Under the 12-month breach-open scenarios, the equivalent of a 0.2 percent flood would be experienced by a 12.5 percent flood in Great South Bay.
- Under breach-open conditions, the expected flooding would be significantly higher than is currently accounted for in the floodplain management regulations.

For Moriches Bay:

- The baseline condition stage frequency curves have a greater range as compared to the curves in Great South Bay.
- Under a Future vulnerable condition, flooding is greater than the baseline condition beginning at a 10 percent flood, and has the effect of increasing the height of flooding by 1 to 1.5 feet.
- Under a breach-closed scenario, flooding is very similar to the baseline condition, and can have the effect of increasing flooding up to 1.5 feet.
- Under Breach Open conditions, the effect is dependent upon the location of the breach; and can result in flooding up to 2 feet above baseline conditions.

- Under Pre- Hurricane Sandy BLC, flooding is 0.5 to 1.0 foot lower than the new, Post-Hurricane Sandy, BLC.
- Under FVC topography, and breach closed topography, the elevation of a 0.2 percent flood (+8.9 feet NGVD 29) would be experienced with a 1.25 percent flood, and a one percent flood experienced with a 2.5 percent flood.
- Under breach-open scenarios, the equivalent of a 0.2 percent flood would be experienced by a 2.5 percent flood, and the equivalent of a one percent flood could be experienced by a 6.6 percent flood.

For Shinnecock Bay:

- The baseline condition stage frequency curves have a greater range as compared to the curves in Great South Bay or Moriches Bay.
- Under a Future vulnerable condition, flooding is greater than the baseline condition beginning at a 12.5 percent flood, and has the effect of increasing the height of flooding by 1 to 1.5 feet.
- Under a breach closed scenario, flooding is greater than the FVC, and can have the effect of increasing flooding of up to 2 feet.
- Under Breach Open conditions, the effect is dependent upon the location of the breach; for a single breach of the barrier island, when open for 3 months can increase flooding 1 to 2 feet above normal.
- Under Breach Open conditions, a single breach of the barrier island, when open for 12 months can increase flooding 2 to 3 feet above the baseline.
- The Wilderness Breach has no impact on flooding in Shinnecock Bay.
- Although these curves are not as flat as in Great South Bay, these scenarios have a tremendous impact on the flooding regime. Under FVC topography, and breach closed topography, the elevation of a 0.2 percent flood (+9.2 feet NGVD 29) would be experienced with a 2.5 to five percent flood, and a one percent flood experienced with a five to 10 percent flood.
- Under breach-open scenarios, the equivalent of a 0.2 percent flood would be experienced by a storms ranging from a 2.9 percent flood, and the equivalent of a one percent flood could be experienced by a 5.5 percent flood.

The best way to illustrate the mainland flooding impact is in floodplain maps. The floodplain maps are described further in the human development section of this Chapter and are as shown in Appendix. The floodplain maps illustrate the increase in inundation extent in BLC in a 50 percent flood, 10 percent flood, and one percent flood (Baseline Maps). A second set of floodplain maps illustrates the impact the barrier island conditions, FVC and BOC-4 12 months, have on the one percent flood inundation extents. These Figures illustrate flooding under a range of storm events representative of the baseline conditions as well as the change in flooding for a one percent flood, under the different barrier island conditions described on prior Section. Overall, these Figures illustrate that there are tremendous changes in the flooding that can occur along the mainland of Long Island, when there is the potential for increased water to enter into the bay during a storm that results in a breach, or when a breach is open. A third set of floodplain maps was prepared to show the impact of the Wilderness Breach on the BLC inundation extents. These maps show the increase in the one percent flood inundation extent caused by the open breach in the Otis Pike High Dune Wilderness Area.

4.4.4 Breach Impact on Sediment Exchange and Inlet Stability

4.4.4.1 Sediment Exchange

When an overwash or breach of the barrier island occurs, material moves in the cross-shore direction, which can result in the deposition of sediment into the back bay environment. When a breach occurs, the amount of sediment transport into the bay is dependent upon the location and the amount of time that a breach remains open. In modeling breaches and estimating the amount of growth of a breach over time, efforts have been undertaken to also quantify the expected amount of sediment that could be transported into the bay, the expected area of change (that includes both scour and deposition), and the resulting change in habitats that could be observed as a result of the breach being open. This information has been generated using observations from past breaches (prior to Hurricane Sandy) and interpretation of the modeling effort to provide to estimate the overall volume of material that is expected to enter into the bay, summarized in Table 15 (see Figure 10 for location of design subreaches).

This information was used in estimating the need for 4.2 million cubic yards of sediment along the barrier island bayside shoreline required to ensure no net loss of habitat, as required by a ASA(CW) policy exception (October 11, 2017).

Table 15. Estimated Bay Deposition Volumes During Breach Growth

Design Subreach		Bay Deposition (x1,000 cubic yards)				
ID	**Name**	**1 Month**	**3 Months**	**6 Months**	**9 Months**	**12 Months**
GSB-1B	FI Lighthouse Tract	320	800	1,240	1,480	1,610
GSB-2B	Town Beach to Corneille Estates (at Robins Rest)	260	650	1,000	1,190	1,300
GSB-3D	Talisman to Water Island	160	410	630	750	820
GSB-3G	Davis Park	300	740	1,150	1,370	1,490
MB-1B	Smith Point CP - East	250	570	810	900	940
SB-1B	Sedge Island	350	810	1,140	1,270	1,330
SB-1C	Tiana Beach	180	410	570	640	670
SB-2B	WOSI	160	370	520	580	600

4.4.4.2 Inlet Stability

As described previously, another likely effect of a breach of the barrier island is the change in deposition rates within the existing inlets. The stability of the inlets is based upon their efficiency and the currents, which are driven by the tidal prism within the bays. A breach of the barrier island impacts this exchange rate and is likely to increase the existing deposition rates within the inlets. This will warrant increased maintenance of the inlets, or the navigability of the inlets may be compromised.

4.5 Human Development at Risk

The modeling efforts described in the previous Sections provide the basis of assessing damages to human development within the study area. Field inspections were conducted to collect data for over 47,000 buildings in the study area and have been updated to reflect current structure values (depreciated replacement costs) and development. Details on the methodology utilized in conducting the inventory are provided in the Appendix D – Benefits.

4.5.1 Shorefront Structures at Risk

Table 16 identifies the number of shoreline structures that would be impacted in each Sub Reach (Figure 10) under the low RSLC projection by erosion associated with a 1 percent probability storm event, as well as the number of structures that could be impacted by a 1 percent probability storm event in the years 2030 and 2060 under the FWOP.

A total of 370 shoreline structures potentially at risk were identified for the base year (2028), while 947 and 1,277 shoreline structures were identified as potentially at risk in the years 2030 and 2060, based on the "low" RSLC projection. More than half of the potentially at-risk structures were on Fire Island. The number of structures at risk increases over time, indicating that many structures not currently at risk are likely to be threatened in the future.

4.5.2 Back Bay Structures at Risk

The back bay reaches include both the back bay shoreline of the barrier islands and south of Montauk Highway, where the elevations are generally below +16 feet NGVD 29. As described previously, there is extensive development in the mainland adjacent to the back bays, particularly in the western areas. Table 17 and Table 18 show the number of structures within each reach by structure type.

Table 16. Shorefront Structures Potentially at Risk from Erosion

Design Subreach/ Project Reach	Name	Baseline Erosion	2030 Erosion	2060 Erosion
GSB-1A	Robert Moses State Park	0	0	0
GSB-2A	Kismet to Lonelyville	110	184	199
GSB-2B	Town Beach to Corneille	37	55	55
GSB-2C	Ocean Beach to Seaview	28	58	68
GSB-2D	OBP to Point O'Woods	39	67	68
GSB-3A	Cherry Grove	2	36	43
GSB-3C	Fire Island Pines	25	65	84
GSB-3D	Talisman to Water Island	0	1	2
GSB-3E	Water Island	0	0	3
GSB-3F	Water Island to Davis Park	0	0	0
GSB-3G	Davis Park	0	23	31
GSB-3H	Watch Hill	0	0	0
GSB-4A	Wilderness Area West	0	0	0
GSB-4B	Old Inlet	0	0	0

Design Subreach/ Project Reach	Name	Baseline Erosion	2030 Erosion	2060 Erosion
Great South Bay		*241*	*489*	*553*
MB-1A	Smith Point CP West	0	0	0
MB-1B	Smith Point CP East	0	0	0
MB-2A	Great Gunn	0	0	0
MB-2B	Moriches Inlet West	0	0	0
MB-2C	Cupsogue Park	0	0	1
MB-2D	Pikes	0	23	125
MB-2E	Westhampton	0	0	1
Moriches Bay		*0*	*23*	*127*
SB-1A	Hampton Beach	0	19	33
SB-1B	Sedge Island	4	41	55
SB-1C	Tiana Beach	12	18	23
SB-1D	Shinnecock Inlet Park West	1	1	2
SB-2A	Ponquogue	0	0	0
SB-2B	WOSI	1	3	3
SB-2C	Shinnecock Inlet - East	0	0	0
SB-3A	Southampton Beach	0	3	5
SB-3B	Southampton	1	5	6
SB-3C	Agawam	16	27	28
Shinnecock Bay		*35*	*117*	*155*
P-1A	Wickapogue	8	13	16
P-1B	Watermill	3	13	16
P-1C	Mecox Bay	1	5	5
P-1D	Mecox to Sagaponack	8	39	50
P-1E	Sagaponack Lake	1	1	2
P-1F	Sagaponack to Potato Road	0	19	23
P-1G	Potato Road	5	22	23
P-1H	Wainscott	4	8	9
P-1I	Georgica Pond	0	0	0
P-1J	Georgica to Hook Pond	8	23	29
P-1K	Hook Pond	0	0	0
P-1L	Hook Pond to Amagansett	0	4	5
Ponds		*38*	*147*	*178*
M-1A	Amagansett	12	56	59
M-1B	**Napeague** State Park	0	0	0
M-1C	**Napeague** Beach	0	2	5
M-1D	Hither Hills SP	0	0	1
M-1E	Hither Hills to Montauk Beach	1	20	35
M-1F	Montauk Beach	7	22	38
M-1G	Montauk Beach to Ditch Plains	0	12	19
M-1H	Ditch Plains	2	50	87
M-1I	Ditch Plains to Montauk Beach	0	9	20
Montauk		*22*	*171*	*264*
Totals		**336**	**947**	**1,277**

Table 17. Structure Types in Study Area, Back Bay Mainland

Project Reach/ Sub-Bay	Structure Type				
	Residential	**Commercial**	**Industrial**	**Municipal**	**Utility**
EGSB	1,896	57	1	12	0
CGSB	6,377	489	47	48	4
WGSB	19,423	1676	111	110	11
Great South Bay	*27,696*	*2,222*	*159*	*170*	*15*
MOR	6,006	386	9	17	0
Moriches Bay	*6,006*	*386*	*9*	*17*	*0*
SHN	583	37	1	6	0
WSHN	2,431	132	5	9	1
Shinnecock Bay	*3,014*	*169*	*6*	*15*	*1*
Total Back bay	**36,716**	**2,777**	**174**	**202**	**16**
Overall Total	***39,885***				

Table 18. Structure Types in Study Area, Barrier Island Bayside

Project Reach/ Sub-Bay	Structure Type				
	Residential	**Commercial**	**Industrial**	**Municipal**	**Utility**
EGSB	0	0	0	0	0
CGSB	895	2	0	3	0
WGSB	2412	16	0	3	0
Great South Bay	*3307*	*18*	*0*	*6*	*0*
MOR	258	0	0	0	0
Moriches Bay	*258*	*0*	*0*	*0*	*0*
SHN	0	0	0	0	0
WSHN	76	0	0	0	0
Shinnecock Bay	*76*	*0*	*0*	*0*	*0*
Total Back bay	**3,641**	**18**	**0**	**6**	**0**
Overall Total	***3,665***				

Table 19 and Table 20 provide a summary of the number of structures which fall within the current floodplains under the baseline conditions in each project reach and subreach.

As presented earlier, when the impacts of RSLC and the changing conditions of the barrier islands are accounted for, the extents of the floodplains are anticipated to grow, and hence the number of buildings potentially impacted by flooding is expected to increase. Table 21 and

Table 22 show the change in the number of structures in the floodplain, under different breach scenarios (Appendix A Engineering).

Table 19. Summary of Back Bay Mainland Structures within Baseline Floodplain during Maximum Open Breach

Project Reach/ Sub-Bay	Number of Buildings	50% Flood (2 Year) Floodplain Buildings	10% Flood (10 Year) Floodplain Buildings	4% Flood (25 Year) Floodplain Buildings	1% Flood (100 Year) Floodplain Buildings	0.2% Flood (500 Year) Floodplain Buildings
EGSB	1,966	23	165	222	314	595
CGSB	6,965	228	1,016	1,067	1,394	1,478
WGSB	21,331	164	2,054	3,354	4,279	4,512
Great South Bay	*30,262*	*415*	*3,235*	*4,643*	*5,987*	*6,585*
MOR	6,418	481	1,075	1,640	1,973	2,494
Moriches Bay	*6,418*	*481*	*1,075*	*1,640*	*1,973*	*2,494*
SHN	627	35	72	132	307	408
WSHN	2,578	112	378	561	898	1,168
Shinnecock Bay	*3,205*	*147*	*450*	*693*	*1,205*	*1,576*
Total Back bay	***39,885***	***1,043***	***4,760***	***6,976***	***9,165***	***10,655***

Table 20. Summary of Back Bay Structures Along North Shore of Barrier Island within Floodplain during Maximum Open Breach

Project Reach/ Sub-Bay	Number of Buildings	50% Flood (2 Year) Floodplain Buildings	10% Flood (10 Year) Floodplain Buildings	4% Flood (25 Year) Floodplain Buildings	1% Flood (100 Year) Floodplain Buildings	0.2% Flood (500 Year) Floodplain Buildings
EGSB	0	0	0	0	0	0
CGSB	900	129	364	390	423	445
WGSB	2,431	329	1,529	1,649	1,703	1,760
Great South Bay	*3,331*	*458*	*1,893*	*2,039*	*2,126*	*2,205*
MOR	258	58	93	140	216	241
Moriches Bay	*258*	*58*	*93*	*140*	*216*	*241*
SHN	0	0	0	0	0	0
WSHN	76	48	73	76	76	76
Shinnecock Bay	*76*	*48*	*73*	*76*	*76*	*76*
Total Backbay	**3,665**	**564**	**2,059**	**2,255**	**2,418**	**2,522**

Table 21. Summary of Structures in Floodplains, Breaches Open for 12 Months in each Bay – Backbay Mainland

Planning Unit/ Sub-Bay	Number of Buildings	50% Flood (2 Year) Floodplain Buildings	10% Flood (10 Year) Floodplain Buildings	4% Flood (25 Year) Floodplain Buildings	1% Flood (100 Year) Floodplain Buildings	0.2% Flood (500 Year) Floodplain Buildings
WGSB	21,331	4,101	6,343	8,217	9,379	9,515
CGSB	6,965	1,397	2,626	2,742	3,325	3,419
EGSB	1,966	313	613	709	898	1,031
Great South Bay	*30,262*	*5,811*	*9,582*	*11,668*	*13,602*	*13,965*
MOR	6,418	1,075	2,096	2,819	3,550	4,029
Moriches Bay	*6,418*	*1,075*	*2,096*	*2,819*	*3,550*	*4,029*
WSHN	2,578	227	716	996	1,408	1,641
SHN	627	95	190	271	410	462
Shinnecock Bay	*3,205*	*322*	*906*	*1,267*	*1,818*	*2,103*
Total Backbay	***39,885***	***7,208***	***12,584***	***15,754***	***18,970***	***20,097***

Table 22. Summary of Structures in Floodplains, Breaches Open for 12 Months in each Bay – Barrier Islands Bay Side

Planning Unit/ Sub-Bay	Number of Buildings	50% Flood (2 Year) Floodplain Buildings	10% Flood (10 Year) Floodplain Buildings	4% Flood (25 Year) Floodplain Buildings	1% Flood (100 Year) Floodplain Buildings	0.2% Flood (500 Year) Floodplain Buildings
WGSB	2,431	1,703	2,144	2,160	2,250	2,263
CGSB	900	437	628	649	656	692
EGSB	0	0	0	0	0	0
Great South Bay	*3,331*	*2,140*	*2,772*	*2,809*	*2,906*	*2,955*
MOR	258	123	216	243	256	257
Moriches Bay	*258*	*123*	*216*	*243*	*256*	*257*
WSHN	76	54	76	76	76	76
SHN	0	0	0	0	0	0
Shinnecock Bay	*76*	*54*	*76*	*76*	*76*	*76*
Total Backbay	**3,665**	**2,317**	**3,064**	**3,128**	**3,238**	**3,288**

4.5.3 Future Without Project Damages

The development in the study area is vulnerable to damage from three mechanisms, inundation due to storm water levels, undermining due to storm erosion or shoreline change, and structural failure due to intense force of wave impacts.

For analysis purposes, the study area has been divided into shorefront development and non-shorefront development. Development was considered part of the shorefront analysis if it is subject to damage from inundation, plus waves and/or erosion. Shorefront development was evaluated for all three damage mechanisms for each individual structure under a full range of storm conditions that the low RSLC projection. The largest, or “critical”, damage was then identified for each building for a series of storms over the FWOP conditions. Development outside of the zone of likely erosion or wave impact was considered part of the non-shorefront analysis. The non-shorefront analysis only evaluates damage due to inundation and includes development both on the northern side of the barrier island and along the mainland areas.

The storm damage analysis considered physical damage to structures, building contents, and cars, as well as non-physical costs, such as cleanup and temporary housing expenses. Public emergency costs associated with extreme events such as barrier island breaching are also included in the analysis. Appendix D- Benefits includes details of the modeling utilized and the analyses utilized to determine the FWOP Damages. An update of the FWOP Damages post-Hurricane Sandy is provided in the following paragraphs.

The shorefront and non-shorefront models referred to in the prior Sections were developed specifically for use in the analyses. The models were approved for this single specific use following review by the National Planning Center of Expertise for Coastal Storm Risk Management (PCX-CSRM) via a memorandum from the Chief of the Office of Water Project Review, Planning and Policy Division, Directorate of Civil Works, dated January 12, 2016.

As a part of this Reformulation effort, the shorefront damage models have been revised to reflect post-Hurricane Sandy changes to the existing condition beach morphology such as the dune crest elevation (including natural beach recovery following Hurricane Sandy, and the construction of Coastal Storm risk Management Projects). The model also accounts for changes in the structure inventory due to the destruction of shorefront houses by Hurricane Sandy. Lifecycle flood inundation models were also revised to reflect post-Sandy changes to the barrier islands including the existing condition beach profile width plus accumulated RSLC in the years since the models were developed. Models used to calculate damages specifically incurred by open breaches over the 50-year period of analysis were revised to reflect current beach profile widths and RSLC as per the lifecycle inundation model but also to incorporate recently acquired data related to the maximum size of potential breaches in Great South Bay. Revisions to the breach damage model also included updated breach closure costs for all potential breach locations and current mobilization and unit costs applicable in Breach Response Plan maintenance actions.

All lifecycle simulation models assumed a project base year of 2028, the low RSLC projection, and the FY20 interest rate of 2.75 percent.

4.5.4 Shorefront Damages

For structures located along the Atlantic Ocean shorefront, wave attack and erosion combine with inundation to create frequent structural failures. Therefore, in addition to considering damage from inundation, the stability of the shorefront structures was analyzed to relate the wave forces at any depth of storm-induced water elevation to the structural failure and the potential for failure from the combined effects of long-term and storm-induced erosion, including scouring and vertical erosion.

The model simulations calculate damage for each year of the lifecycle. The damage in each year is multiplied by the present worth factor to adjust to base year values. The present worth of damage is summed and multiplied by the capital recovery factor to calculate the equivalent annual damage for each simulated lifecycle. Table 23 provides a summary of the equivalent annual damage for the 50-year period of analysis that the low RSLC projection.

This Table illustrates the areas with the highest levels of expected damages along the shorefront. When looking at these numbers, it is important to consider that the damages are aggregated over different size reaches. This Table illustrates that the largest amount of shorefront damages are along the area of Fire Island. The Table also illustrates that for the shoreline areas east of the barrier islands that the two areas of highest damage per linear feet of shoreline are the areas of Downtown Montauk (Montauk Beach) and Potato Road. This is consistent with the observed damages as a result of Hurricane Sandy.

Table 23. FWOP Shorefront Damages (October 2019 P.L.)

Project Reach		Critical Asset	Name	Approximate Length	Equivalent Annual Damage 2028-2078
GSB	GSB-1	1A	Robert Moses State Park	25,700	$0
		1B	FI Lighthouse Tract	6,700	$0
	GSB-2	2A	Kismet to Lonelyville	8,900	$2,731,400
		2B	Town Beach to Corneille States	5,100	$1,568,000
		2C	Ocean Beach & Seaview	3,800	$422,300
		2D	OBP to Point O' Woods	7,400	$730,500
		2E	Sailors Haven	8,100	$0
	GSB-3	3A	Cherry Grove	3,000	$319,800
		3B	Carrington Tract	1,500	$0
		3C	Fire Island Pines	6,600	$271,900
		3D	Talisman to Water Island	7,300	$21,800
		3E	Water Island	2,000	$34,900
		3F	Water Island to Davis Park	4,700	$800
		3G	Davis Park	4,100	$213,800
		3H	Watch Hill	5,000	$0
	GSB-4	4A	Wilderness Area - West	19,000	$0
		4B	Old Inlet	16,000	$0
				GSB Subtotal:	**$6,315,200**
MB	MB-1	1A	Smith Point CP- West	6,300	$0
		1B	Smith Point CP - East	13,500	$0
	MB-2	2A	Great Gunn	7,600	$0
		2B	Moriches Inlet - West	6,200	$0
		2C	Cupsogue Co Park	7,500	$800
		2D	Pikes	9,700	$287,200
		2E	Westhampton	18,300	$14,300
				MB Subtotal:	**$302,300**
SB	SB-1	1A	Hampton Beach	16,800	$305,500
		1B	Sedge Island	10,200	$1,699,600

Project Reach		Critical Asset	Name	Approximate Length	Equivalent Annual Damage 2028-2078
		1C	Tiana Beach	3,400	$239,400
		1D	Shinnecock Inlet Park West	6,300	$5,800
	SB-2	2A	Ponquogue	5,300	$100
		2B	WOSI	3,900	$10,800
	SB-3	2C	Shinnecock Inlet - East	9,800	$178,100
		3A	Southampton Beach	9,200	$37,100
		3B	Southampton	5,300	$203,100
		3C	Agawam	3,800	$146,700
				SB Subtotal:	**$2,826,200**
P	P-1	1A	Wickapogue	7,700	$357,900
		1B	Watermill	8,800	$227,600
		1C	Mecox Bay	1,400	$19,700
		1D	Mecox to Sagaponack	10,400	$400,200
		1E	Sagaponack Lake	1,100	$3,100
		1F	Sagaponack to Potato Road	9,300	$87,000
		1G	Potato Road	4,300	$1,935,600
		1H	Wainscott	4,600	$24,200
		1I	Georgica Pond	1,200	$0
		1J	Georgica to Hook Pond	11,200	$679,900
		1K	Hook Pond	1,100	$0
		1L	Hook Pond to Amagansett	19,200	$38,700
				Ponds Subtotal:	**$3,773,900**
M	M-1	1A	Amagansett	10,400	$205,300
		1B	Napeague State Park	9,100	$0
		1C	Napeague Beach	9,900	$101,000
		1D	Hither Hills SP	7,000	$19,900
		1E	Hither Hills to Montauk B	15,800	$1,013,400
		1F	Montauk Beach	4,700	$960,000
		1G	Montauk B to Ditch Plains	4,700	$93,500
		1H	Ditch Plains	3,400	$4,900
		1I	Ditch Plains to Montauk Pt	19,300	$179,200
				Montauk Subtotal:	**$2,577,200**
				Total	***$15,794,800***

Price Level Oct 2019, Discount Rate 2.75 percent, 50-year period of analysis

4.5.5 Non-shorefront Damages

The analysis of non-shorefront damage considers the developed areas that are not subject to direct impacts from ocean waves or erosion but are subject to inundation. The analysis includes areas on the Long Island mainland that are heavily developed, primarily with year-round residential structures, and the northern, or bayside portions of the barrier islands that are primarily developed with seasonal housing. This includes the bay shoreline areas from western Great South Bay (near the Nassau, Suffolk County border) east to Shinnecock Bay.

4.5.5.1 Bayside Damage Criteria

Previously developed relationships between depth of flooding and damage as a percent of value were used to assess the inundation damages to each non-shorefront structure to estimate damage for the full range of flood events. These relationships included a series of generalized functions for residential structure and content damage developed by the USACE-IWR based on post flood inspections. Non-physical damage, including evacuation, temporary housing, and re-occupation/cleanup costs, was related to depth and structure value using a series of 1,500 on-site interviews distributed throughout the study area. These interviews were also used to develop physical damage relationships for non-residential structures.

4.5.5.2 Bayside Damage Models

Lifecycle Simulation Models. In order to develop a true understanding of the impact of flooding, the flood stage vs. damage curves are typically combined with flood frequency data to express damage in average annual terms. Often this is completed using the HEC-FDA program, which can evaluate annual damages for both a baseline and a future condition. HEC-FDA, however, requires that changes in damage conditions occur in a predictable linear manner. Within the FIMP area, flood levels and therefore damages are expected to vary in relation to both future RSLC and barrier island conditions. Because future barrier island conditions are strongly influenced by storm activity in prior years, it was determined that a lifecycle approach was needed to allow conditions and damages to vary in response to prior storm events. All analyses assumed the low RSLC projection.

Three separate damage simulation models were developed to link the hydrodynamic modeling of flood depths to the stage vs. damage data. The first simulation model was developed to evaluate Breach Open Conditions and the impact a barrier island breach will have on storm damages. The model quantifies the change in damages if a breach is open and provides input to the second model, the Breach Lifecycle Analysis. This model simulates breach occurrence and calculates average annual closure costs (including breach maintenance costs) and breach induced increases in damage over a 50-year period of analysis. The model was developed to quantify lifecycle impacts and to compare breach management alternatives. The third model is the Lifecycle Damage Analysis, which simulates storms and bay water levels including the impacts of erosion/storms in creating FVC. Each of the models uses the @-Risk add-in to Excel to allow the calculation and processing of multiple lifecycle iterations, each representing a different series of random storms. Uncertainty in other parameters including RSLC, erosion rates, and stage damage relationships, are also reflected using Monte Carlo sampling techniques. The reported results represent the average of numerous possible future lifecycles (between 12,500 and 25,000 depending on model) to ensure the full range of conditions are reflected in the results.

The Breach Open Condition model calculates the increase in storm damage while a breach is open. The model assumes a breach has occurred and simulates breach condition/size in the following months. Peak water levels are estimated based on the breach size, predicted increase in tide range, and the increased storm water level associated with random storm events. For each peak water level the damage is identified using the stage vs. damage curves. The key inputs to the model are the breach open water levels related to breach size, breach growth and closure rates, and the stage vs. damage relationship. A total of 27 conditions were modeled for each of the 43 reaches for each breach closure alternative. These reflect combinations of five different breach location scenarios (No Breach & 4 Breach Open Conditions), breaches occurring in Tropical or Extratropical seasons, and RSLC conditions of baseline, 0.5 foot rise and 1.0 foot rise. The model results were tabulated to provide a summary of increased inundation damage for various breach conditions, closure rates and RSLC conditions.

The Breach Only Lifecycle Model was developed to evaluate the impact of barrier island breaches and alternative closure designs and response times on the average annual storm damage and closure costs. The model considers the impacts of random storm events, and both long term and short-term shoreline change at the 10 locations identified as most vulnerable to breaching. Key inputs to the model include stage frequency and storm erosion frequency relationships, post storm profile recovery rates, threshold water level elevations causing overwash, partial breaching and full breaching for various profile conditions, short term profile variability associated with shoreline undulations, and incremental damage associated with increased back bay flood elevations and undermining of barrier island development. The model uses the @-Risk add-in to Excel to simulate the random occurrence of storms in future years, and if the storm water elevation is sufficient to cause an overwash or breaching condition it calculates the associated damages, breach closure cost, or profile maintenance costs. The model tracks changes in the profile condition and relates the breach and overwash threshold water level elevations to these changes.

The Lifecycle Damage Analysis model was developed to quantify baseline and future condition non-shorefront inundation damage. The model simulates storms and water levels including the impacts of erosion/storms in creating the FVC and the associated increases in bay water levels. A FVC has been developed based on historic erosion rates, the Existing Conditions Sediment Budget, Baseline Conditions numerical modeling storm water level and morphological results, historic storm impacts, and the assumed FWOP condition regarding locally sponsored dune and berm restoration and maintenance projects. The key model inputs include the bay stage frequency relationships for Baseline, Future Vulnerable, With Project and Breach Closed Conditions. The model applies weighting factors to interpolate between Baseline and FVC. Breach water level thresholds, ocean stage frequency, storm/long term erosion and recovery rates, temporal shoreline undulations and stage vs. damage relationships are also critical to the analysis.

The model simulates the random occurrence of both tropical and extra-tropical storms and tracks the impact of storms in altering the beach profile at the 10 locations most vulnerable to overwash and breaching. As the profile at these locations approaches the FVC used to develop the FVC stage vs. frequency relationship, the model interpolates bay water levels between the Baseline condition stage and the FVC stage. For each year, storms are simulated and the damage is identified from the stage vs. damage curves.

Table 24 provides a summary of the average damages that were simulated for years 2020 and 2070. The damage in each year is multiplied by the present worth factor to adjust to base year values. The present worth of damage is summed and multiplied by the Capital Recovery Factor to calculate the equivalent annual damage for each simulated lifecycle.

This Table illustrates that damages increase over time, and that the greatest amount of damages is expected to occur in the area of Western and Central Great South Bay. Damages are also relatively high for Moriches Bay.

Table 24. Summary of Backbay Inundation Damages (October 2019 P.L.)

Economic Reach			Number of Buildings	Sub Bay	Inundation Damages		
Economic Reach	Mainland Reach ID	Name			Year 2028	Year 2078	Equivalent Annual
26.1	GSB-M-1A	Unqua Point (County Line) to Copiague Beach	1,683	WGSB	$6,441,000	$12,109,000	$8,579,000
26.2	GSB-M-1B	Copiague Beach to Venetian Shores Beach	4,674	WGSB	$4,768,000	$10,262,000	$6,673,000
26.3	GSB-M-1C	Venetian Shores Beach to Neguntatogue Creek	2,268	WGSB	$6,510,000	$12,674,000	$8,632,000
25.1	GSB-M-1D	Neguntatogue Creek to Santapogue Point	1,931	WGSB	$2,134,000	$4,390,000	$2,901,000
25.2	GSB-M-1E	Santapogue Point to Sampawams Point (Town Line)	2,404	WGSB	$5,667,000	$11,692,000	$7,835,000
24	GSB-M-2A	Sampawams Point (Town Line) to Great Cove	3,154	WGSB	$3,009,000	$6,803,000	$4,385,000
23.1	GSB-M-2B	Brightwaters	364	WGSB	$266,000	$657,000	$410,000
23.2	GSB-M-2C	Lawrence Creek to Seatuck Refuge	1,717	WGSB	$5,931,000	$12,043,000	$8,090,000
23.3	GSB-M-2D	Seatuck Refuge to Heckscher Park (Nicoll Point)	2,982	WGSB	$2,049,000	$4,243,000	$2,872,000
28		Fire Island Lighthouse to Seaview (Fire Island)	1,994	WGSB	$13,815,000	$24,920,000	$17,849,000
27.1		Ocean Bay Park to Oakleyville (Fire Island)	433	WGSB	$1,268,000	$2,302,000	$1,666,000
		Subtotal - Western Great South Bay Sub-Bay	*23,604*		*$51,859,000*	*$102,094,000*	*$69,892,000*
27.2		Sailors Haven to Water Island (Fire Island)	712	CGSB	$2,972,000	$5,517,000	$3,928,000
27.3		Water Island to Watch Hill (Fire Island)	188	CGSB	$791,000	$1,582,000	$1,080,000
22.1	GSB-M-3A	Heckscher Park (Nicoll Point) to Green Point	1,949	CGSB	$12,174,000	$21,269,000	$15,929,000
22.2	GSB-M-3B	Green Point to Blue Point (Town Line)	2,075	CGSB	$4,511,000	$8,056,000	$5,817,000
21.1	GSB-M-4A	Blue Point (Town Line to Tuthill Creek (Blue Point)	513	CGSB	$943,000	$1,871,000	$1,310,000
21.2	GSB-M-4B	Tuthill Creek to Swan River (Patchogue)	1,628	CGSB	$4,844,000	$9,232,000	$6,455,000
21.3	GSB-M-4C	Swan River to Mud Creek	751	CGSB	$736,000	$1,515,000	$1,021,000
		Subtotal - Central Great South Bay Sub-Bay	*7,816*		*$26,972,000*	*$49,042,000*	*$35,540,000*
21.4	GSB-M-5A	Mud Creek to Howell Creek	745	EGSB	$1,790,000	$3,355,000	$2,378,000
21.5	GSB-M-5B	Howell Creek to Bellport Marina	224	EGSB	$169,000	$341,000	$229,000
21.6	GSB-M-5C	Bellport Marina to Carmans River	421	EGSB	$1,163,000	$2,138,000	$1,498,000
20	GSB-M-6A	Carmans River to Smith Point Bridge	571	EGSB	$664,000	$1,300,000	$891,000
		Subtotal - Eastern Great South Bay Sub-Bay	*1,961*		*$3,786,000*	*$7,134,000*	*$4,997,000*

Economic Reach			Number of Buildings	Sub Bay	Inundation Damages		
Economic Reach	**Mainland Reach ID**	**Name**			**Year 2028**	**Year 2078**	**Equivalent Annual**
19		Moriches Inlet to Quantuck Canal (Westhampton Barrier)	241	MOR	$6,000	$14,000	$9,000
18.1	MB-M-1A	Smith Point Bridge to William Floyd Estate	3,052	MOR	$11,036,000	$18,233,000	$13,853,000
18.2	MB-M-1B	William Floyd Estate to Forge River	206	MOR	$525,000	$855,000	$661,000
18.3	MB-M-1C	Forge River to Radio Point	1,332	MOR	$6,901,000	$11,443,000	$8,656,000
17.1	MB-M-2A	Radio Point to Harts Cove	219	MOR	$1,757,000	$2,908,000	$2,239,000
17.2	MB-M-2B	Harts Cove to Seatuck Creek (Town Line)	93	MOR	$26,000	$51,000	$34,000
16.1	MB-M-3A	Seatuck Creek (Town Line) to Fish Creek	134	MOR	$435,000	$832,000	$591,000
16.2	MB-M-3B	Fish Creek to Speonk Point	317	MOR	$1,687,000	$3,041,000	$2,240,000
16.3	MB-M-3C	Speonk Point to Apacuck Point	431	MOR	$2,069,000	$3,907,000	$2,798,000
16.4	MB-M-3D	Apacuck Point to Quantuck Bay	609	MOR	$3,967,000	$6,781,000	$5,077,000
		Subtotal - Moriches Bay Sub-Bay	*6,634*		*$28,409,000*	*$48,066,000*	*$36,157,000*
15		Quantuck Canal to Village Park (Westhampton Barrier)	93	WSHN	$26,000	$66,000	$41,000
13.1	SB-M-1A	Quantuck Bay West	297	WSHN	$3,995,000	$6,374,000	$4,941,000
13.2	SB-M-1B	Quantuck Canal to Phillips Point	586	WSHN	$5,002,000	$8,407,000	$6,262,000
12	SB-M-2A	Phillips Point to Pine Neck Point	783	WSHN	$1,959,000	$3,503,000	$2,530,000
11.1	SB-M-2B	Pine Neck Point to West Point	280	WSHN	$1,180,000	$2,016,000	$1,490,000
11.2	SB-M-2C	West Point to Ponquogue Point	616	WSHN	$1,648,000	$2,985,000	$2,113,000
		Subtotal - Western Shinnecock Bay Sub-Bay	*2,655*		*$13,809,000*	*$23,350,000*	*$17,378,000*
10.1	SB-M-3A	Ponquogue Point	39	SHN	$167,000	$324,000	$226,000
10.2	SB-M-3B	Cormorant Point	6	SHN	$15,000	$24,000	$18,000
10.3	SB-M-3C	Shinnecock Canal Region	200	SHN	$948,000	$1,526,000	$1,177,000
10.4	SB-M-3D	Shinnecock Indian Reservation	258	SHN	$832,000	$1,491,000	$1,097,000
8b	SB-M-4A	Heady Creek	119	SHN	$143,000	$259,000	$190,000
		Subtotal - Shinnecock Bay Sub-Bay	*621*		$2,105,000	$3,624,000	$2,709,000
		Total: Back Bay Area	**43,291**		**$126,941,000**	**$233,311,000**	**$166,673,000**

Price Level Oct 2019, Discount Rate 2.75 percent, Period of Analysis 50 years

Table 25 provides a summary of the total FWOP damages for all damage categories. Following the Table is an explanation of each of the damage categories.

Table 25. Summary of FWOP Equivalent Annual Damages (October 2019 P.L.)

Damage Category		**FWOP Damages**
Total Project		
Tidal Inundation occurring due to inlet conditions and wave setup in back bay		
	Mainland	$118,511,000
	Barrier	$20,494,000
	Total	*$139,005,000*
Tidal Inundation occurring due to storm breaching and overwash		
	Mainland	$23,589,000
	Barrier	$4,079,000
	Total	*$27,668,000*
Total Mainland Inundation		*$142,100,000*
Total Barrier Inundation		*$24,573,000*
Total Inundation		*$166,673,000*
Damages from Inundation due to a breach remaining open		
	Inundation (Open Wilderness Breach)	$9,436,000
	Inundation (Future Breaches)	$10,902,000
Total Breach Open Damages		*$20,338,000*
Shorefront Damages		$15,795,000
Emergency Costs/Breach Closure		$3,290,000
Total Damage		***$206,096,000***

Breach-related structure failures on the barrier islands are not included in the total breach failure due to the potential for double counting of these damages with other barrier island damage categories.
Price Level October 2019, Discount Rate 2.75 percent, Period of Analysis 50 years
Damages include the effects of the historic rate of RSLC projected over the Analysis Period

4.5.5.3 Damage Categories

Inundation Damage: These occur when vulnerable structures are flooded by high tides and water levels in the back-bay, where the water levels are sensitive to the conditions of the barrier islands. This includes the combined inundation damages as a result of flooding through the inlets, setup in the bay. Inundation damages have been divided into those occurring on the back-bay mainland and those on the back-bay side of the barrier islands.

Inundation Damages due to Breach and Overwash: These damages are flooding that occurs as a result of a storm that results in breaching or overwash of the barrier island. These damages are those damages that occur as a result of the storm that causes a breach or overwash. Inundation damages have been divided into those occurring on the back-bay mainland and those on the back-bay side of the barrier islands.

Breach – Open Damages: Breach inundation damages occur when structures are flooded by increases in back-bay water elevations caused by breaches in the barrier islands remaining open for a period of time. These are damages that occur due to future storms. The damages are limited to structures in back-bay mainland areas and on the back-bay side of the barrier islands. The total breach inundation damages consist of damages due to the Wilderness Breach remaining open during the analysis period, plus future breaches occurring at the other vulnerable locations. The Wilderness Breach is considered a permanent feature and impacts flood levels throughout the project lifecycle. Future breach damages are a comparatively infrequent occurrence and are limited to a 9-12-month duration. The short duration of future breaches relative to the permanent opening at the Wilderness Breach results in lower damages over the lifecycle.

Shorefront: These damages occur only in the shorefront areas of the barrier islands and the mainland area east of the barrier island system and are not influenced by the condition of the barrier islands. Shorefront damages are caused by cross-shore erosion, wave action, ocean inundation, or combinations thereof.

Public Emergency Costs: These are costs related to efforts made by local communities and other entities to ensure the safety of the public during storm events. They can include evacuation, the provision of temporary accommodation, the use of special equipment and supplies, and the increased utilization of services of emergency personnel. Public emergency costs also include post-storm cleanup and debris removal. Public emergency costs have not been evaluated at this stage in the study.

Other Damages: There are damages to other items which have not been specifically evaluated at this stage in the study, such as damage to roads, utilities and coastal storm risk management structures, and impacts on locally-based fishing fleets.

In addition to these damage categories, there are several additional sources of benefits which are to be analyzed separately. These include an increase in recreation use value, and prevention of loss of land. It is anticipated that the inclusion of these additional benefits (along with the damage categories mentioned above which have yet to be specifically evaluated) will not alter the results of the economic analyses completed thus far.

4.6 Damage Sensitivity and Uncertainty

4.6.1 Lifecycle Analysis

As discussed in prior Section, annual damages represent the expected average or mean results. The actual amount of future damages is highly sensitive to the timing and sequence of storms, future events that cannot be predicted. For example, the random occurrence of several large storms early in the lifecycle analysis period will result in higher annual damages than if the storms occur further apart (allowing more profile recovery), or later in the period (have a lower present value). In addition to the uncertainty associated with the timing of storms, some of the model input data has uncertain values, such as the stage damage curves, whether partial breaches will remain open, and RSLC. The life cycle simulation has incorporated the uncertainty of these parameters by allowing the values to vary in each simulation.

In order to account for uncertainties in the timing and impacts of various storms, calculations are performed for a large number of lifecycles and mean or average value is reported. While the mean values are the appropriate values to use in economic assessments, such as benefit costs ratios, it is also helpful to understand the range of possible future damages. In addition to tracking the mean damages, the lifecycle models are also capable of tracking other statistics, such as the median or damage quartiles.

4.6.2 Wilderness Breach

One of the assumptions in the FWOP is the breach within the Wilderness Area of the Fire Island National Seashore (FIIS) that opened during Hurricane Sandy will remain open indefinitely. It is possible that the breach could close at some point in future, whether by natural coastal processes or mechanically through human intervention. DOI signed a Record of Decision for the Wilderness Breach Management Plan EIS on July 23, 2018. Under the selected action identified in the ROD, the evolution, growth, and/or closure of the breach will be determined by natural barrier island processes, and human intervention to close the breach will occur only "to prevent loss of life, flooding, and other severe economic and physical damage to the Great South Bay and surrounding areas." NPS will continue to monitor the Wilderness Breach using established methods that staff and scientists have used since 2012. Monitoring is being conducted to determine if changes in the breach could elevate the risk, which could lead to a decision to close the breach.

A sensitivity analysis was performed to evaluate the impact of this assumption on the FWOP damages and project benefits. Observations and modeling results have shown that, at its current size, the Wilderness Breach has not significantly altered tidal elevations in Great South Bay or Moriches Bay (Aretxabaleta et al., 2014). However, the storm surge model simulations show that the Wilderness Breach increases storm water levels within Great South Bay and Moriches Bay during storm events (See Sub-Appendix A-4 Numeral Modeling of Breach Open at Old Inlet). The storm water level model simulations with the Wilderness Breach open were used to update the BLC stage frequency curves for the study area. In some locations in Great South Bay and Moriches Bay the 1 percent annual exceedance water level increased by 1 foot or more as a result of the Wilderness Breach. Due to the relatively flat topography in many mainland communities, a 1 foot increase in the storm water levels can significantly increase the floodplain area and number of structures at risk. A detailed comparison of the Pre-Hurricane Sandy and Post-Hurricane Sandy 1 percent annual exceedance inundation extents is provided in Appendix A – Engineering.

5 PLAN FORMULATION

The efforts culminating in selecting the Recommended Plan included plan formulation, evaluation, and comparison that were spread out over the course of 24 years since the initiation of the Reformulation Study in 1994. This Chapter of the GRR contains a summary of the formulation. A detailed description of the overall plan formulation process is contained in Appendix E - Plan Formulation.

This Reformulation came about in part due to a referral to the Council on Environmental Quality in response to the 1978 EIS that was prepared for the project subsequent to passage of the National Environmental Policy Act of 1969. USACE agreed to reformulate the project with particular emphasis on identifying and evaluating alternatives that considers cumulative impacts and the overall coastal system.

Included within the study area are critical coastal habitats and environmentally sensitive areas, including the Fire Island National Seashore (FIIS). Section 8 of Public Law (P.L.) 88-587, the FIIS authorizing law provides that the authority of the Chief of Engineers to undertake or contribute to shore erosion control or beach protection measures on lands within the FIIS shall be exercised in accordance with a plan that is mutually acceptable to the Secretary of the Army and Secretary of the Interior. Mutual acceptability of actions and features extends to areas outside the geographical boundaries of FIIS, as some actions and features may have an effect on FIIS or could be influenced by the decisions within FIIS boundaries.

To assist in meeting the requirements of P.L. 88-587, a policy exception giving permission to deviate from USACE policy related to economic justification was granted by the ASA(CW) on October 11, 2017 (Appendix L). It grants an exemption to the USACE requirement to demonstrate incremental justification of features and recommend a NED plan, and allows USACE to recommend a plan mutually acceptable to the Secretary of the Army and Secretary of the Interior consistent with P.L. 88-587. The policy exception significantly impacted plan evaluation, formulation, and selection. It allowed the study team to consider and ultimately include in alternative plans measures that would have otherwise been screened from consideration.

Extensive interagency coordination was undertaken to ensure a proposed project is mutually acceptable to the Secretary of the Army and Secretary of the Interior. A MOU between the Department of the Army and the Department of Interior was signed on July 24, 2014. The MOU provides the foundation for "…developing a plan that is mutually acceptable for hurricane and storm damage reduction, including identifying and evaluating natural and nature-based measures that contribute to coastal storm damage risk reduction, in the Reformulation Study for the FIMP project" (Appendix L). In a letter dated May 3, 2017 the regional directors of the U.S. Fish and Wildlife Service (USFWS), NPS, and U.S. Geological Survey (NPS) concurrent with the USACE Deputy Commanding General for Civil and Emergency Operations memorandum that the proposed project is mutually acceptable to the Department of the Army and Department of the Interior (Appendix L). The Department of the Interior's stance was reaffirmed in a June 6, 2019 letter in which the regional directors of the USFWS, NPS, and USGS jointly stated they, "confirm the Department of the Interior's commitment and interest in continuing to work with the [USACE] in finalizing a mutually acceptable plan" (Appendix L).

Included within the study area is the Fire Island National Seashore (FIIS). The authorizing law for FIIS specifies that any plan for coastal storm risk management with the boundary of FIIS be mutually acceptable with the Secretary of the Interior and the Secretary of the Army. Given the different missions and policies of the two agencies, it was recognized by the project team that a waiver of policy might be required to achieve a "mutually acceptable" plan.

In May 2009, a draft Formulation Report was provided to the key government partners and stakeholders that identified problems, opportunities, objectives and constraints, analyzed alternatives, and proposed several alternative plans for consideration. Based on the comments received and subsequent discussions among the stakeholders and public, a TFSP was jointly identified by USACE and DOI as the plan that best achieved the coastal storm risk management objectives and was acceptable to both the Secretary of the Army and Secretary of the Interior. This TFSP was submitted to the NYSDEC, the non-Federal sponsor, for their concurrence in March 2011.

On October 29, 2012, Hurricane Sandy made landfall near Atlantic City, New Jersey, where it collided with a blast of arctic air from the north, creating conditions for an extraordinary historic 'super storm' along the East Coast with the worst coastal impacts centered on the northern New Jersey, New York City, and the Long Island coastline. Coastal erosion and damages within the FIMP study area as a result of Hurricane Sandy were severe and substantial. There were three breaches of the barrier island (Figure 1, Figure 18, and Figure 19), multiple overwashes, extensive shorefront damages, and back bay flooding. Post-Hurricane Sandy measurements of volume loss of the beach and dunes on Fire Island indicated that the beach lost 55 percent of its pre-storm volume equating to a loss of 4.5 million cubic yards. A majority of the dunes either were flattened or experienced severe erosion and scarping (Hapke, et.al. 2013).

Figure 18. Breach at Smith Point County Park


Figure 19. Breach at Cupsogue (east of Moriches Inlet)

As a result of Hurricane Sandy, there was a critical need to address the critically eroded areas along Fire Island, and in Downtown Montauk. Utilizing the authority and funding provided by the Disaster Relief Appropriations Act of 2013 (P.L. 113-2), stabilization efforts were undertaken in these areas. As a result, further refinements were needed to the TFSP to address the changed conditions post –Hurricane Sandy, which were reflected in the TSP that was included in the draft GRR/EIS that was released for public review and comment in July 2016. In response to public and agency comments there were modifications made to the Coastal Process Features (CPFs), the nonstructural plan, the groin modifications, and the Montauk Beach feeder beaches as discussed in the Sections that follow.

5.1 Plan Formulation and Evaluation Criteria

The formulation process used in this study is consistent with the national objectives as stated in the Planning Guidance Notebook (ER1105-2-100, USACE, 2000). In general, coastal storm risk management plans must contribute to the National Economic Development (NED) account consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders and other Federal planning requirements. Plans to address the needs in the study area must be formulated to provide a complete, effective, efficient, and acceptable plan of coastal storm risk management. These criteria are applied in the evaluation of each of the alternatives considered.

- **Completeness** is defined as "the extent to which a given alternative plan provides and accounts for all necessary investments of other actions to ensure the realization of the planned effects. This may require relating the plan to other types of public or private plans if the other plans are crucial to realization of the contributions of the objective."

- **Effectiveness** is defined as "the extent to which an alternative plan alleviates the specified problems and achieves the specified opportunities."
- **Efficiency** is defined as "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 defined as "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."

In addition, it was critical to obtain consensus among the key stakeholders and to integrate the policies of USACE, DOI, and the State of New York regarding the project objectives, plan formulation approach, and evaluation criteria. In order to capture the requirements for a plan to be mutually acceptable to these parties, a "Vision Statement for the Reformulation Study" (See Appendix L – Pertinent Correspondence) was developed by the three agencies as the approach for plan formulation. The Vision was intended as tool to define the criteria necessary to achieve a mutually acceptable plan. It includes the following:

- No plan can reduce all risks,
- Decisions must be based upon sound science, and current understanding of the system,
- Flooding will be addressed with site specific measures that address the various causes of flooding,
- Priority will be given to measures which both provide coastal storm risk management, and reestablish and enhance coastal processes and ecosystem integrity,
- Preference will be given to "soft" measures that reestablish coastal landforms and natural habitats,
- Project features should avoid or minimize adverse environmental impacts and address long-term demands for public resources,
- Balances dune and beach replenishment considering storm damage reduction and environmental considerations,
- Consideration will be given to alteration of existing shore stabilization structures, inlet stabilization measures, and dredging practices.

5.1.1 Goal of Reformulation Study

The goal of the Reformulation Study is to reduce storm damages and attendant loss of life from flooding, waves and erosion, including restoring the natural coastal processes to the extent possible while minimizing environmental impacts.

5.1.2 Planning Objectives

In support of the goal of the Reformulation study, the planning objectives are:

1. Reduce flooding on the mainland and barrier islands and attendant loss of life, property and economic activity.
2. Reduce damages to structures due to beach and bluff erosion in critical areas.
3. Reestablish coastal processes and utilize coastal process measures to the maximum extent possible to provide resilience and reduce storm damages.

4. Ensure that any plan for coastal storm risk management on lands within the FIIS is compatible with the goals and objectives of FIIS and is mutually acceptable to the Secretary of the Army and Secretary of the Interior, as demonstrated with the Vision Statement.

5.1.3 Planning Constraints

The formulation and evaluation of alternative plans are constrained by technical, environmental, economic, regional, social and institutional considerations. For plans analyzed in this study, the following constraints have been taken into account.

5.1.3.1 General Constraints

- Be able to be implemented with respect to financial and institutional capabilities and public consensus
- Comply with USACE environmental operating procedures

5.1.3.2 Physical Technical Constraints

- Plans shall represent sound, safe, and acceptable engineering solutions taking into account the overall littoral system effects
- Plans shall be designed to be low-maintenance
- Plans should avoid and minimize impacts to environmental resources with the potential for enhancement
- Plans shall not affect access to beach
- Plans shall take into consideration aesthetics and viewshed
- Plans shall be in compliance with USACE regulations

5.1.3.3 Economic Constraints

- Plans must be efficient, make optimal use of resources, and not adversely affect other economic systems
- Average annual benefits must exceed the average annual costs

5.1.3.4 Environmental Constraint

- Plans must avoid and minimize environmental impacts to the maximum degree practicable

5.1.3.5 Regional and Social Constraints

- All reasonable opportunities for development within the project scope must be weighed, with consideration of state and local interests
- The needs of other regions must be considered, and one area cannot be favored to the detriment of another
- Plans must maintain existing cultural resources to the maximum degree possible and produce the least possible disturbance to the community

5.1.3.6 Institutional Constraints

- Plans must be consistent with existing Federal laws
- Plans must be locally supported and signed by local authorities in the form of a Project Partnership Agreement and guarantee for all items of local cooperation including possible cost sharing
- Local interests must agree to provide public access to the shore in accordance with Federal and state guidelines and laws
- The plan must have broad overall support in the region and state

5.1.3.7 Planning Constraints Specific to the Study

- Any plan on lands within the FIIS must be compatible with the goals and objectives of FIIS and be mutually acceptable to the Secretary of the Army and Secretary of the Interior.

5.2 Plan Formulation Approach

The Vision Statement recognizes the need to achieve a plan that is mutually acceptable to the Secretary of the Army and Secretary of the Interior, and that this requires balancing storm damage reduction needs and opportunities with the environmental needs and opportunities within the study area. An important element of this approach is the concept that alternatives are developed and evaluated to manage coastal storm risks through the least intrusive means possible. In this respect, the evaluation of measures and alternatives considers the range of options starting with the least intrusive and lowest level of investment, and subsequently looks at increasing intensities of measures and alternatives to address the problems. The measures and alternatives fall into the following categories:

1. No action, as represented by the FWOP condition. This scenario is presented in the FWOP condition section, and represents what is likely to occur in the absence of a project.

2. Changes in the management of the existing system. These alternatives consider changes in the existing "management" along the shoreline. In the context of this study, this considers land-use management, and also the management of the existing inlets and the current management response to breaches. These alternatives consider coastal storm risk management which can be accomplished without major investments, but through alteration of current practices.

3. Nonstructural measures. By definition, nonstructural measures are those activities which can be undertaken to move what is being damaged out of harm's way, rather than attempting to alter the movement of water. Nonstructural measures include a variety of techniques presented further in the next Chapter, including land-use, acquisition and relocation, or retrofit of existing structures. In some cases, structural measures such as road raisings and ringwalls were identified as components of the nonstructural analysis undertaken for structures within the floodplain on the Mainland that were originally evaluated for building retrofits (i.e. elevating).

4. Soft structural measures. Soft structural measures generally are those constructed of sand, which are designed to mimic the existing natural storm risk management features. This includes beachfill and reestablishment of coastal processes through the use of sand. This category also includes measures which seek to remove or alter existing hard structures.

5. Hard structural measures. Hard structural measures, in combination with beachfill are only considered in areas after all alternatives have been investigated. In general, they are only considered as a measure of last resort.

A key element of the Vision Statement is acknowledgement that the existing environment within the project area has been degraded by past human activities, and that restoring the natural coastal processes and habitats provides coastal storm risk management benefits. The Vision recognizes the importance of reestablishing the underlying processes for the long-term sustainability and resilience of the Atlantic Coast that include:

- Alongshore sediment transport
- Cross-Island sediment transport
- Dune growth and evolution
- Bayside shoreline processes
- Circulation and water quality

Initially the coastal process features were developed and evaluated separately to evaluate their effectiveness. As the formulation proceeded, the measures were combined into plans that include complementary features for achieving storm damage reduction objectives.

5.3 Plan Evaluation Criteria

As described in further detail in the Appendix E - Plan Formulation , three sets of criteria were applied in evaluating the alternatives. Each coastal storm risk management alternative was first evaluated relative to the NED criteria, to identify the effectiveness of the proposed alternative in addressing the primary objective. The alternatives were also evaluated relative to the requirements of the Principles and Guidelines, to be complete, effective, efficient, and implementable. In addition, alternatives were evaluated with regard to the following evaluation criteria based on the Vision Statement:

- The plan or measure provides identifiable reductions in risk from future storm damage.
- The plan or measure is based on sound science and understanding of the system. Measures that may have uncertain or unintended consequences should be monitored and be readily modified or reversed.
- The plan or measure addresses the various causes of flooding, including open coast storm water levels, storm waters propagating through inlets into the bays, wind and wave setup within the bays, and flow into the bays due to periodic overwash or breaching of the barrier islands.
- The plan or measures incorporates appropriate nonstructural features, provides storm risk management and reestablishs coastal processes and ecosystem integrity.
- The plan or measure helps reestablishes coastal landforms and natural habitat.
- The plan avoids or minimizes adverse environmental impacts.
- The plan addresses long-term demands for public resources.
- Dune and beach nourishment measures consider both storm damage reduction, restoration of natural coastal processes, and environmental effects.
- The plan or measure incorporates appropriate alterations of existing shoreline stabilization structures.

- The plan or measure incorporates appropriate alterations of inlet stabilization measures and dredging practices.
- The plan or measure is efficient and represents a cost-effective use of resources.

5.4 Iterative Planning Process

The details of Phases 1, 2, and 3 are found in Appendix E - Plan Formulation, with a summary of each of these phases provided in the following Sections. The Post-Hurricane Sandy Modifications and Analysis of the Tentative Federal Selected Plan are provided in Chapter 6.

5.4.1 Phase 1 – Screening of Measures.

Phase 1 screening included both an initial and secondary screening of coastal storm risk management measures. The screening included an initial engineering, economic, and environmental evaluation of conceptual measures, to assess their viability, and need for further evaluation. This process involved Federal, State and municipal agencies in coordination meetings. Multiple meetings were also held with the five towns and incorporated villages within the study area to solicit their input on the alternatives under consideration. A specific workshop was held with all the project stakeholders to solicit input on the viability of nonstructural measures. The screening results reflect the inputs from engineering, economic, and environmental evaluation, with stakeholder input, and are described further in Appendix E - Plan Formulation.

The following measures were examined for applicability for the study area and to select those for further detailed in the development of alternatives during the subsequent study phases:

- No Action
- Nonstructural Measures
- Coastal Process Measures
- Sediment Management (including Inlet Modifications)
- Breach Response Measures
- Removal/Modification of Groins
- Beachfill and Beachfill with Dunes
- Offshore Breakwaters (including Artificial Headlands or T-Groins)
- Seawalls (Rubble-mound)
- Groins
- Dune and Berm with Structures
- Levees and Floodwalls
- Storm Closure Gates
- Land and Development Management

Based upon this initial screening, measures were either recommended for further screening, or dropped from consideration. The following were recommended for further consideration:

1. Breach Response Measures
2. Sediment Management and Inlet Modifications
3. Nonstructural Measures (Building Retrofits)
4. Beachfill and Beachfill with Dunes
5. Removal/ Modification of Groins
6. Coastal Process Features
7. Land and Development Management

5.4.2 Phase 2 – First Added Assessment of Alternative

The following is a summary of the coastal storm risk management measures recommended for detailed assessment of alternatives based on the initial Phase 1 screening. Further details to support this analysis are contained in Appendix E - Plan Formulation.

5.4.2.1 <u>Breach Closure Measures</u>

Breach response measures were considered, including plans undertaken in response to the occurrence of a breach to close a breach quickly (Reactive Breach Response Plans), or in response to conditions where a breach is imminent (Proactive Breach Response Plans), for various design cross sections.

The reduction in storm damages arising from the implementation of these breach closure alternatives was modeled to quantify back bay inundation damages resulting from open breaches in the barrier islands, and structure failure damage, which results from the loss of buildings on the barrier islands when the land on which they stand is eroded by an expanding breach. This model is also used to quantify the costs associated with closing barrier island breaches, and with maintaining the design section in the post-closure time period. The comparison of costs and benefits are provided in Appendix E – Plan Formulation. All of the alternatives were cost-effective in reducing storm damage, with the +13 feet NGVD 29 dune alternative providing the greatest storm damage reduction benefits in excess of cost. However, since there are environmental benefits of allowing cross-shore transport, the +9.5 feet and +11 feet NGVD 29 alternative were also carried forward for consideration where appropriate.

Also evaluated were similar Proactive Breach Closure Plans, which were intended to take action to prevent breaches from occurring at locations vulnerable to breaching, when a breach is imminent. Like the Reactive Breach Response plans, the Proactive Breach Response plans are not designed to prevent ocean shorefront development from overwash, wave attack or storm induced erosion losses, and allow for a greater level of overwash and dune lowering during a storm, so long as the overwash extent is below the threshold that would result in breaching.

The costs and benefits of the Proactive Breach Response Plans were very similar to the costs and benefits for the Reactive Breach Response Plan, and both plans were advanced for further consideration.

5.4.2.2 Sediment and Inlet Management Alternatives

At each of the three Inlets, Fire Island, Moriches and Shinnecock Inlets, various alternatives were considered to increase sediment bypassing, increase stability to adjacent shorelines and maintain navigability, as described in detail in the Appendix E - Plan Formulation. Eight alternatives were considered for Shinnecock Inlet, four alternatives for Moriches Inlet and four alternatives at Fire Island Inlet. At each of the Inlets the most cost-effective means to achieve bypassing is through additional dredging of the ebb shoal, outside of the navigation channel, with downdrift placement, which would be undertaken in conjunction with the scheduled Operations and Maintenance (OMRR&R) dredging of each of the inlets (See Figure 20, Figure 21, and Figure 22). Monitoring would be undertaken to ensure that dredging of the ebb shoals would not affect the alongshore sediment transport.

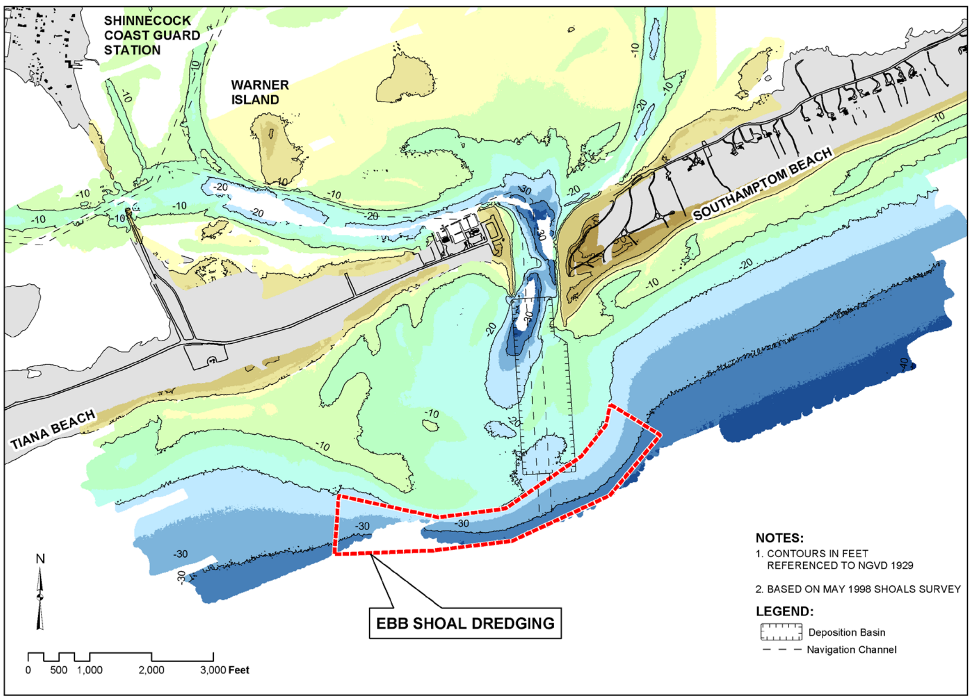

Figure 20. Recommended Alternative for Shinnecock Inlet: -16 feet MLW Detention Basin + Ebb Shoal Dredging

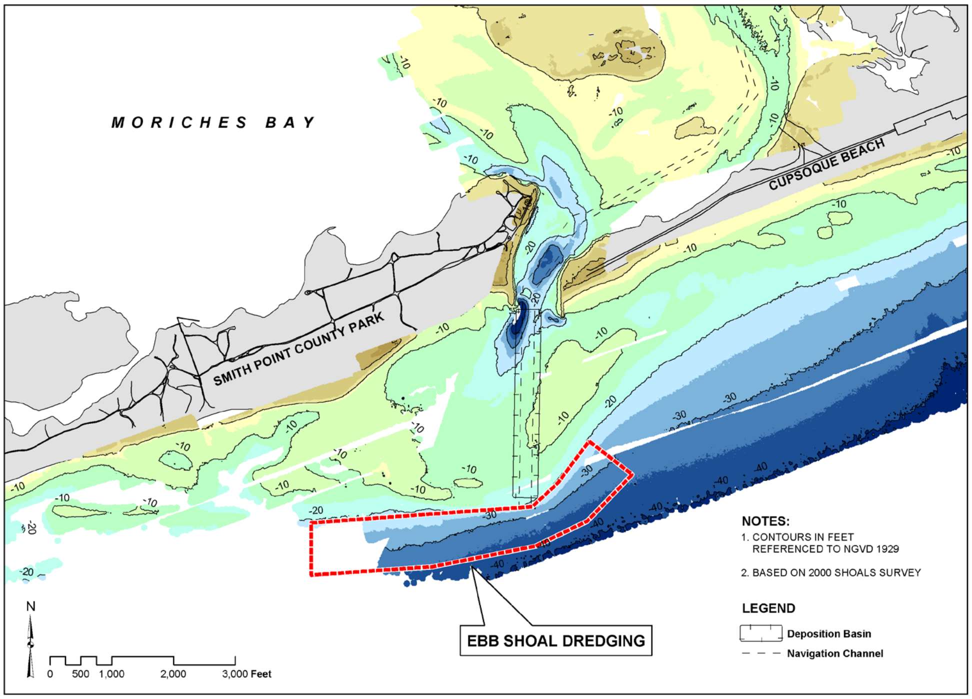

Figure 21. Recommended Alternative for Moriches Inlet: Authorized project + Ebb Shoal Dredging

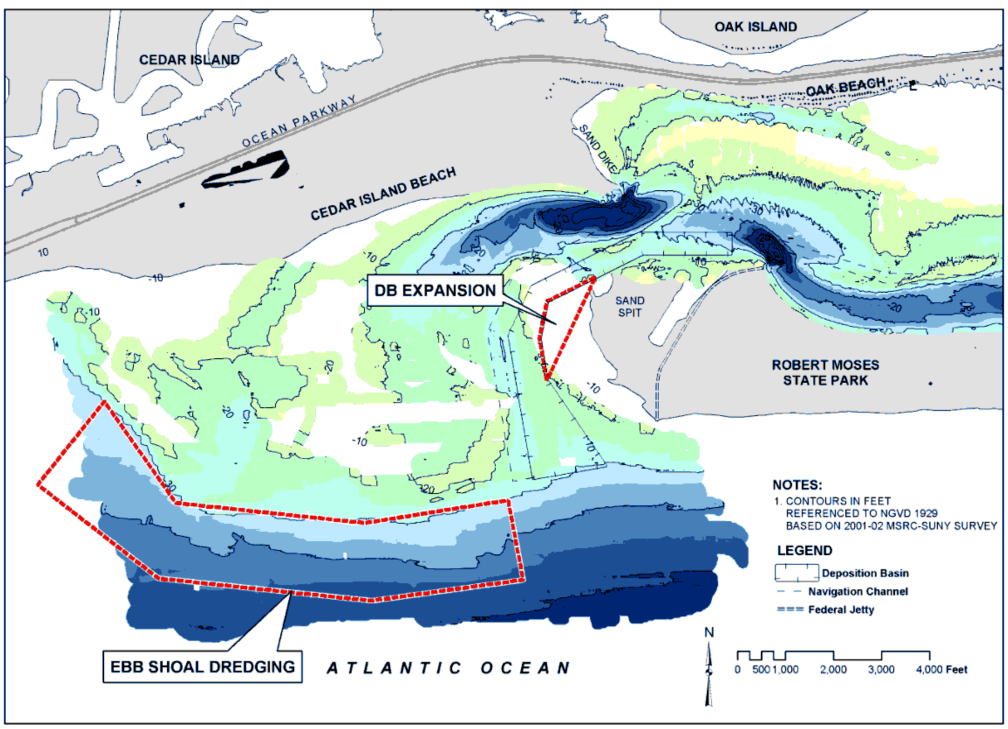

Figure 22. Recommended Alternative for Fire Island Inlet: Authorized Project P + Ebb Shoal Dredging & DB Expansion

Evaluation of Storm Damage Reduction Effectiveness

The reduction in storm damages arising from modifying the existing management practices at Fire Island, Moriches, and Shinnecock Inlets was modeled using the Lifecycle Damage Analysis Model to quantify back bay inundation damages, and the Breach Only Lifecycle Model to analyze the resulting change in breach-related damages. Changes to inlet management have been modeled by varying the rate of long-term erosion (through changes in profile recovery) from erosion and renourishment regimes at locations downdrift of the inlets.

The inlet management measures were screened to identify the most cost-effective means to accomplish the desired objective at each inlet. The comparison of costs and benefits are provided in the Plan Formulation Appendix.

As stand-alone features, sand bypassing at the inlets does not provide significant flood risk reduction, but was recommended for consideration in combined alternatives in order to achieve the goal of restoring longshore transport. Sand-bypassing also provides a cost-effective source of sand for renourishment that is often less expensive and lesser environmental impacts than removing sand from an offshore borrow area. Sand bypassing is also an integral element of reestablishing natural coastal process and achieving the Vision Objectives.

5.4.2.3 Nonstructural Measures

Nonstructural measures are permanent or contingent measures applied to a structure and/or its contents that prevent or provide resistance to damage from flooding. Nonstructural measures differ from structural measures in that they focus on reducing the consequences of flooding instead of focusing on reducing the probability of flooding. Nonstructural measures were only considered for buildings on the mainland, where the homes are mostly owner-owned and owner-occupied.

Table 26 summarizes the assumptions made in considering alternatives for six typical structure types found in the study area. In evaluating alternatives, the National Nonstructural Committee Floodproofing Matrix was used to evaluate and determine the most appropriate nonstructural measures for buildings in the backbay mainland areas. The matrix logic is presented in Table 27.

Ringwalls were considered as part of the nonstructural analysis, though they are classified as structural measures, per USACE Planning Bulletin 2016-01 "Clarification of Existing Policy for USACE Participation in Nonstructural Flood Risk Management and Coastal Storm Damage Reduction Measures" (December 22, 2015).

Five nonstructural alternatives were considered to provide at least a one percent of storm risk management corresponding to the baseline-condition landward limits of the 50 percent, 17 percent, 10 percent, 4 percent, and one percent floodplains. After evaluating the measures for each building, the most technically feasible measure was selected. The 50 percent, 17 percent, 10 percent, and 4 percent floodplain alternatives were found to be cost-effective, while the one percent floodplain alternative was determined to be cost-prohibitive and was screened out from further consideration. The cost effectiveness of each nonstructural alternative was evaluated for the group of structures, not on an individual structure basis.

Table 26. Assumptions Inherent to the Screening of Backbay Alternatives for Representative Buildings

General Assumptions	• Flood velocity is negligible. • Debris impacts will not be considered. • There are limited areas designated as "V-Zone" by FEMA, subject to 3-foot breaking waves. The majority of backbay areas are considered non-V-Zone and thus not subject to wave and erosion impacts. • All buildings selected for treatment will be designed to withstand flooding from a 0.01 exceedance level (100-year probability storm event), plus two feet • Buildings elevated in non-coastal areas will be elevated (finished floor elevation) to the 0.01 exceedance level (100-year probability storm event) plus two feet • Flooding is gradual (no flash flooding)
Foundation Walls	• All basement foundation types are assumed to be unreinforced, eight" concrete masonry units (CMUs).
Elevated Structures (Crawlspace)	• No utilities are located in the crawlspace. • Wet floodproofing of elevated structures includes the elevation of utilities only, and where necessary, the installation of vents or louvers to allow adequate venting.
Slab-On-Grade Structures	• Wet floodproofing is possible if the expected flood elevation is below the main floor (shallow flooding). This alternative includes the elevation of utilities only. • Consistent with USACE's floodproofing guidance, structures will not be dry floodproofed for flooding depths greater than 2 feet plus one foot, for a maximum 3 feet of dry floodproofing.
Structures with Basements	• All basements are unfinished and contain major utilities.
Bi-Levels	• The lower portion of the first floor walls are masonry construction. • The foundation is slab-on-grade. • The main floor can be elevated separately from the lower level by lifting off the sill of the masonry wall.
Elevated Ranches	• The first floor (lower) walls are masonry. • The foundation is slab-on-grade. • The main floor can be elevated separately from the lower level (similar to a structure with a basement).
Split-Levels	• The lower level is slab-on-grade. • The lower portion of the lower level walls are masonry construction. • The main floor level is elevated over a crawl space. • The main floor and upper level can be separated from the lower level by raising at the sill.

Table 27. National Nonstructural Committee Floodproofing Matrix Logic

Structure Type	Flood Level	Storm Risk Management Level		Measure
		Condition 1	Condition 2	
Slab-On-Grade	>= Main Floor	Ground < 3	n/a	Sealant & Closures
		Ground >= 3	n/a	Elevate Building
	< Main Floor	< Main Floor	n/a	Raise AC
		>= Main Floor	Ground < 3	Sealant & Closures
			Ground >= 3	Elevate Building
Basement-Subgrade	>= Main Floor	n/a	n/a	Elevate Building
	< Main Floor	< Main Floor	n/a	Fill Basement + Utility Room
		>= Main Floor		Elevate Building
Elevated (Crawlspace)	>= Main Floor	n/a	n/a	Elevate Building
	< Main Floor	< Main Floor	n/a	Elevated AC + Louvers
		>= Main Floor	n/a	Elevate Building
Basement-Walkout	>= Main Floor	n/a	n/a	Elevate Building
	< Main Floor	< Main Floor	Ground < 3	Interior Floodwall
			Ground >= 3	Elevated Lower Floor + Space
		>= Main Floor	n/a	Elevate Building
Bi-Level/Raised Ranch	>= Main Floor	n/a	n/a	Elevate Building
	< Main Floor	< Main Floor	Ground <= 3	Sealant & Closures
			Ground >3	Elevated Lower Floor + Space
		>= Main Floor	n/a	Elevate Building
Split Level	>= Main Floor	n/a	n/a	Elevate Building
	< Main Floor	< Main Floor	Ground < 3	Sealant & Closures
			Ground >=3	Elevate Building
		>= Main Floor	n/a	Elevate Building

Separate from the five nonstructural plans, relocation on the existing lot was considered for the backbay areas but was found to be infeasible because back bay land plots tend to be too small and flat to meet the criteria for relocation outside of the floodplain within the existing property boundaries.

Acquisition was also considered as an option for back bay structures. While generally cost-prohibitive due to high property values in the study area, there are instances where structure acquisition is a viable option, particularly when considering future RSLC projections. USACE regulations require that for the purpose of estimating benefits and costs, acquisition costs be estimated under a flood-free condition, which requires extensive appraisals. Thus, for planning purposes only, acquisition costs have been computed as the sum of the depreciated structure replacement value plus a land cost of $100,000; an administrative cost of $30,000; and a demolition cost of $15,000. The recommended measure cost was compared to the acquisition cost and acquisition was identified as the preferred measure if it was found to be the lowest cost alternative.

It is also noted that while elevation and floodproofing are voluntary, structure acquisitions are mandatory. If needed the NFS may acquire properties using eminent domain.

Evaluation of Storm Damage Reduction Effectiveness

A range of four nonstructural plans covering structures in incrementally larger floodplains were evaluated during the original formulation. The formulation was based on the overall economic justification of groups of structures in each floodplain and did not explicitly evaluate the benefits for individual structures.

The reduction in storm damages arising from retrofit measure or other actions applied directly to individual structures was modeled using the Lifecycle Damage Analysis Model, with the stage-damage relationships in each reach modified to reflect the application of the nonstructural methodology described in earlier Sections. The detailed analyses of the nonstructural alternative costs and benefits are provided in Appendix E - Plan Formulation. Since Plans NS-2 (structures within the 17 percent floodplain) and NS-3 (structures within 10-percent floodplain) provided similar net benefits based on the pre- Hurricane Sandy analyses, they were both carried into the next phase. Also evaluated were structural measures, such as road raisings, in certain mainland back bay residential areas to achieve additional coastal storm risk management.

Table 28 presents a summary of the number of structures that would receive nonstructural measure types by Reach under the NS-3 Plan, based on additional post- Hurricane Sandy analyses. Up to 4,432 structures are included in the nonstructural component of the plan.

Table 28. Number of Structures to receive Nonstructural Measures under Plan NS-3

Measure	Number of Structures			
	Great South Bay	**Moriches Bay**	**Shinnecock Bay**	**Total**
Elevation	2,317	954	404	3,675
Floodproofing	541	83	26	650
Ringwall	76	10	7	93
Acquisition	0	14	0	14
Sub Bay Total	*2,935*	*1,064*	*437*	*4,432*
Project Total	**4,432**			

* Though ringwalls are structural measures, they were considered as part of the nonstructural analysis.

The nonstructural retrofit measures (elevating and floodproofing) are implemented on a voluntary basis. For evaluation purposes the benefits, and costs are shown for all structures which fall within the footprint of the nonstructural plan. This represents the maximum reduction in damages associated with this project feature. The actual reduction in flood damages depends upon the extent of participation in the program.

5.4.2.4 Beachfill and Beachfill with Dunes

Beachfill (berm only) and beachfill with dunes alternatives have been considered for areas where there is either a risk of breaching or where there are shorefront structures at risk. The alternative design sections considered include:

- “Lower” level of Risk Management: a berm width of 90 feet at elevation +9.5 feet NGVD 29 and a low dune with a crest width of 25 feet at an elevation of +13 feet NGVD 29;
- “Medium” level of Risk Management: a berm width of 90 feet at an elevation +9.5 feet NGVD 29 and medium dune with a crest width of 25 feet at an elevation of +15 feet NGVD 29;

- “Large” level of Risk Management: a design section that includes a dune at an elevation of +17 to +19 feet NGVD 29 with a 25 feet crest width. Design berm width is 90 feet or 120 feet depending on the Project Reach.

As described in detail in Appendix A- Engineering and Appendix E - Plan Formulation , the location of the proposed dune and berm was evaluated based on three fill alignments. The Unconstrained (UC) Baseline was developed to be not constrained by real estate issues or recent beachfill projects, and is the farthest landward fill alignment, and generally matches the existing topography. A Minimum Real Estate Impacts (MREI) Baseline was defined that includes a realignment of the dune farther seaward in areas where multiple structures would need to be relocated or acquired in a more landward alignment. A third baseline, the Middle (MID) Baseline, is located between these two alignments and is aimed at optimizing the dune alignment in areas where a few structures appear to be located significantly farther seaward than adjacent ones thus pushing the whole beachfill alignment seaward. As described in Appendix E – Plan Formulation, both the MREI alignment, and the MID alignment had comparable costs, when comparing the quantity of sand required over the 50-year period of analysis, and the real estate costs. Since the FIMI stabilization project utilized the MID alignment, the MID alignment was included in the TSP.

Evaluation of Storm Damage Reduction Effectiveness

The reduction in storm damages resulting from alternatives that involve the placement of beachfill along the length of the project shorefront have been modeled using the Lifecycle Damage Analysis Model, with appropriate revisions to threshold water levels for breach and overwash, and the effect of the beachfill on back bay stage-frequency relationships. The Breach Only Lifecycle Model was also used to analyze the resulting change in breach-related damages. The three beachfill alternatives evaluated represent dune crest elevations of +13’, +15’ and +17’/+19’ NGVD 29, all on a baseline selected for MREI. This is the first set of alternatives which is designed to reduce damages along the shorefront areas. Appendix E – Plan Formulation presents the modeled annual damages resulting from the implementation of the three beachfill alternatives. In addition to quantified storm damage reduction benefits, the beachfill alternatives will eliminate the need for the numerous local renourishment projects that have averaged 234,000 Cubic yards per year of beach fill in the Great South Bay Planning Unit. The value of these cost avoided benefits are included in the BCR.

Appendix E – Plan Formulation includes the comparison of alternatives for the total project and also by reach. The +15 feet NGVD 29 dune, was the most economically efficient plan, in comparison with the other alternative cross-sections. Only those alternatives involving beachfill along the Great South Bay and Moriches Bay Project Reaches return benefits in excess of costs when considered on an individual basis. Beachfill was not economically justified along Shinnecock Bay, the Ponds Reach or Montauk Reach. The +15 feet NGVD 29 dune beachfill plan is recommended as a shorefront feature along the Great South Bay and Moriches Bay reaches. For Shinnecock Bay, Ponds and Montauk Reaches, sediment management measures, instead of berms and berm-dunes would be considered to address areas of high residual risk.

5.4.2.5 Groin Modifications

Groin modifications were considered at Georgica Pond in East Hampton, the existing groin field at Westhampton, and the existing State Groins at Ocean Beach, Fire Island.

Georgica Pond, East Hampton

There are four rubble mound groins east of Georgica Pond along the shoreline of East Hampton. In 1959, the State of New York constructed two 275 feet long groins, one 700 feet east of Georgica Pond and the other 12,000 feet east of Georgica Pond, in the vicinity of Hook Pond. USACE constructed two additional groins east of the state groin at Georgica Pond in 1964 and 1965. These groins were 480 feet. long from the landward crest, elevation +14.0 MSL to the seaward crest at elevation +1.5 MSL (NGVD 29). In 1960, the state placed 370,000 Cubic yards over a 9800 feet length of beach at Georgica Pond.

The State and Federal groins at Georgica Pond have not had any maintenance since their construction. The structures have lost their trapezoidal shape and armor stone interlocking but are still functioning. The East Hampton Town Trustees regularly open and close the inlet to Georgica Pond, for environmental and flood risk management purposes. In some years, the inlet is breached naturally by a storm event, and can also close naturally due to littoral transport of sand.

Based on the recommendations of a technical report commissioned by Suffolk County, report titled "Historical evaluation of shoreline change for the Georgica Pond region, Suffolk County, Long Island, New York", no modifications to the four Georgica Pond groins are recommended at this time. Instead a monitoring program is recommended to determine the long-term effect of the groins at Georgica Pond and possible future modification.

Westhampton Groin Field

Eleven groins were constructed in 1965 by USACE and an additional four groins were constructed in 1969 - 1970 under provisions of the original project. The groins, spaced approximately 1250 feet apart, function as intended and continue to provide coastal storm risk management to a once vulnerable reach of barrier island shoreline approximately 2.8 miles in length. The Westhampton groin field had, however, contributed to accelerated erosion directly west of the westernmost groin, culminating in two breaches, Pikes Inlet and Little Pikes Inlet, during the nor'easter of December 1992.

The Westhampton Interim Project was designed to mitigate erosion problems occurring downdrift of the Westhampton groin field. The Interim Project provides for beachfill placement, dune construction west of the groin field, periodic renourishment, the shortening and lowering of the final two groins on the western edge and the construction of one additional groin. A tapered groin system was implemented to promote littoral drift between the wide beaches within the groin field and the areas downdrift. Groins 14 and 15, originally 480 feet in length were shortened to 417 feet and 337 feet, respectively. Groin 14A, constructed between groins 14 and 15 in 1997, is 417 feet in length. Groins 1 through 13 are 480 feet long.

The Westhampton Interim Project also provides for renourishment within the groin field and the western beach and dune portion. A renourishment cycle of three years was originally planned and has been recently only been required every four years. Renourishment material placed within the groin field plays two roles: (1) decrease impoundment capacity within the groin field to allow littoral transport to bypass the groin field; and (2) supplies additional renourishment material to downdrift beaches as it erodes from the groin field and enters the littoral system.

In the area within the groin field, the performance of the constructed groins has exceeded expectations, resulting in an accretive beach and stable dunes. Similarly, the Westhampton Interim Project has exceeded performance expectations, as indicated by the accretive dunes west of the groin field, the longer than expected renourishment cycle and the decrease in needed renourishment volume.

Given the relatively consistent health of the beach contained within the Westhampton groin field and the beneficial performance of the groin tapering and renourishment provisions of the Westhampton Interim Project, it is recognized that the shortening of groins 1 through 13 has the potential to release a substantial amount of sediment back into the littoral system without diminishing the amount of risk reduction provided by the existing beach and dune. In addition, groin shortening would provide an opportunity to repair the seaward end of these groins, which have not received maintenance since original construction, thereby maintaining functional stability. Tapering along the western mid-portion of the groin field (groins 9 to 13) will also improve transport between the feeder beach and downdrift areas.

These modifications would entail the removal of 70 to 100 feet of stone from the seaward end of 13 groins at an estimated cost of $5,000,000 (Sep 2007 PL). With a minimum of 500,000 cubic yards of sand estimated to be released, the value of the sand released into the system is about $6,000,000assuming a purchase price of $12 per cubic yard.

During the comment period there were significant objections to the Westhampton groin modifications from local residents and also from State, County, and Town officials. Based upon subsequent coordination among the partner agencies and an updated cost estimate to modify the groins, it was agreed that modifications to the Westhampton groin field be eliminated from the mutually agreeable plan.

Ocean Beach Groins

Two shore perpendicular structures were constructed in the winter of 1970 within the Village of Ocean Beach, on Fire Island. Originally these groins were only constructed of tetrapods, which are concrete armor units, with five lower legs and one upper leg. The tetrapods have a base width of approximately ten feet and a total height of approximately eight feet. The groins were constructed in an area of higher erosion, to add stability to the ocean shoreline seaward of the Ocean Beach water tower and pumping stations (wells). The water tower has since been moved north to Village owned land and there are plans to relocate the three village owned wells in conjunction with the FIMI project.

The groin modification alternatives considered included shortening and lowering of the groins and total removal, neither of which were economically justified. Since removal/modification of the groin would significantly improve longshore transport, it was considered a necessary component of the Mutually Acceptable Plan.

A policy exception was granted by the ASA(CW) on October 11, 2017 to include the removal of the Ocean Beach Groins as a feature of the Mutually Agreeable Plan.

5.4.2.6 Land and Development Management

The enforcement of Federal, state, and local laws that restrict development in the highly vulnerable storm risk areas of Long Island’s Atlantic Coast is important to ensure the project’s long- term success and sustainability. Land and development management alternatives include land use regulations and acquisition alternatives that could be implemented to reduce the risk of coastal storm damages to existing development in high risk areas, and to reduce development pressure in those areas.

Within the study area there are existing land use regulations to address building and rebuilding in the high hazard areas along the coast. State and local agencies have authority to restrict development within shoreline areas through zoning or special district restrictions.

5.4.2.7 Reestablishing Natural Coastal Processes

Appendix E – Plan Formulation identified the evaluation processes undertaken for reestablishing natural coastal processes. Prior to Hurricane Sandy, and in the screening phase of the project, habitat restoration was a project objective and the initial identification and screening of sites utilized Restoration criteria for plan development and selection. To avoid confusion, this initial screening has not been included within this report.

Subsequent to Hurricane Sandy, P.L. 113-2 requires that the project be justified based upon coastal storm risk management. The CPFs were developed using these criteria and the initially identified sites were reevaluated in terms of achieving only CSRM goals, while also being evaluated in terms of compliance with the Endangered Species Act.

The process followed for the development and selection of CPFs is described further in Appendix E – Plan Formulation.

5.4.2.8 Project Measure Analysis

Table 29 provides a summary of the degree to which each of the Storm Management measures satisfies the interagency vision evaluation criteria. This Table shows that there is not one alternative that completely addresses the problems within the project area, or completely addresses the Vision criteria. A combination of alternatives is necessary to address the problems and to meet the Vision objectives.

5.4.2.9 Summary of First Added Assessment of Alternatives

The analysis of each of these alternatives as stand-alone alternatives, and their effectiveness in managing coastal storm risks in the current framework has been used to identify which of these alternatives are to be carried forward for consideration in developing comprehensive alternative plans. These alternative plans are developed by combining alternatives and allowing for a range of solutions along a Project Reach, and consideration of performance for the entire system.

Table 29. Project Measure Analysis

Evaluation Criteria	Breach Closure	Inlet Management	Non Structural Retrofit	Beach Fill	Groin Modification	Coastal Process Features
The plan or measure provides identifiable reductions in risk from future storm damage.	Full	Full	Full	Full	Partial	No
The plan or measure is based on sound science and understanding of the system. Measures that may have uncertain consequences should be monitored and be readily modified or reversed. Measures that could have unintended consequences, based upon available science are considered a lower priority.	Full	Full	Full	Full	Partial	Full
The plan or measure addresses the various causes of flooding, including open coast water levels, water propagating through inlets into the bays, wind and wave setup within the bays, and flow into the bays due to periodic overwash or breaching of the barrier islands.	Partial	Partial	Full	Partial	Partial	Partial
The plan or measures incorporate appropriate "soft" features that provide coastal storm risk management consistent with natural coastal processes and ecosystem integrity.	No	Full	Partial	N/A	N/A	Full
The plan or measure helps protect and reestablish coastal landforms and natural habitat.	Partial	Full	No	Partial	Partial	Full
The plan avoids or minimizes adverse environmental impacts.	Partial	Full	Full	Partial	Full	Full
The plan addresses long-term demands for public resources.	Partial	Partial	Full	Full	Full	Full
Dune and beach nourishment measures consider both storm damage reduction, restoration of natural coastal processes, and environmental effects.	Full	Full	No	Partial	N/A	Partial
The plan or measure incorporates appropriate alterations of existing shoreline stabilization structures.	N/A	N/A	No	Partial	Full	N/A
The plan or measure incorporates appropriate alterations of inlet stabilization measures and dredging practices.	No	Full	No	N/A	N/A	N/A
The plan or measure is efficient and represents a cost-effective use of resources.	Full	Partial	Full	Partial	Partial	Full
The plan or measure reduces risks to public safety.	Full	Full	No	Full	Partial	N/A

Based upon the results of the analyses of individual alternatives, the following were recommended to be carried forward for consideration as input into combined alternative plans.

- Breach Response Plan – +13 feet dune
- Breach Response Plan – + 9.5 feet cross-section (primarily for environmentally sensitive areas)
- Inlet bypassing
- Nonstructural Alternative 2
- Nonstructural Alternative 3
- Nonstructural Alternative 2 with Road Raising
- Nonstructural Alternative 3 with Road Raising
- Beachfill Alternative +15 feet for Great South Bay and Moriches Bay Reaches
- Groin Modification Alternatives at Westhampton
- Coastal Process Features remaining from Phase 2 screening

In addition, Sediment Management Measures would be considered in the Ponds and Montauk Reaches.

5.4.3 Phase 3 – Incremental Alternative Plan Development and Assessment

The NED analyses during Phase 2 identified several cost-effective alternatives for coastal storm risk management. As described in more detail in Appendix E – Plan Formulation, no one alternative addresses all the coastal storm risk management needs, and therefore a combination of alternatives is needed in order to achieve the planning objectives. The evaluation of coastal process features identified various alternatives that could be complimentary to, or compatible with other features, and improve the overall resilience and sustainability of the system.

The recommended approach gives first priority to management options, particularly options that reestablish natural coastal processes. The second priority is to include nonstructural alternatives, with beach nourishment or other structural alternatives considered last. This formulation approach is consistent with the approach taken in the policies and procedures of the NY State Coastal Zone Management Program, and also places a priority on avoiding or minimizing any negative environmental impacts. This approach also considers the entire area as a system.

Based on the evaluation of the individual alternatives, combined plans were developed. First, Second and Third added plans were developed by incrementally adding Management Alternatives (Plan 1), Nonstructural Alternatives (Plan 2), and Structural Alternatives (Plan 3). It was concluded that Plans 1 and 2 did not achieve the project vision objectives of fully addressing the needs for storm risk management and restoring the natural coastal processes. The analysis identified alternative 3A as the plan that provides the greatest net benefits, and plan 3g as the plan that balances the CSRM objectives and Vision objectives.

After evaluating these plans, additional plan features were considered to improve the overall functioning of the plan, as discussed in detail in the following Section, and in Appendix E – Plan Formulation. Figure 23 illustrates the conceptual layout of alternative Plans 3a to 3g.

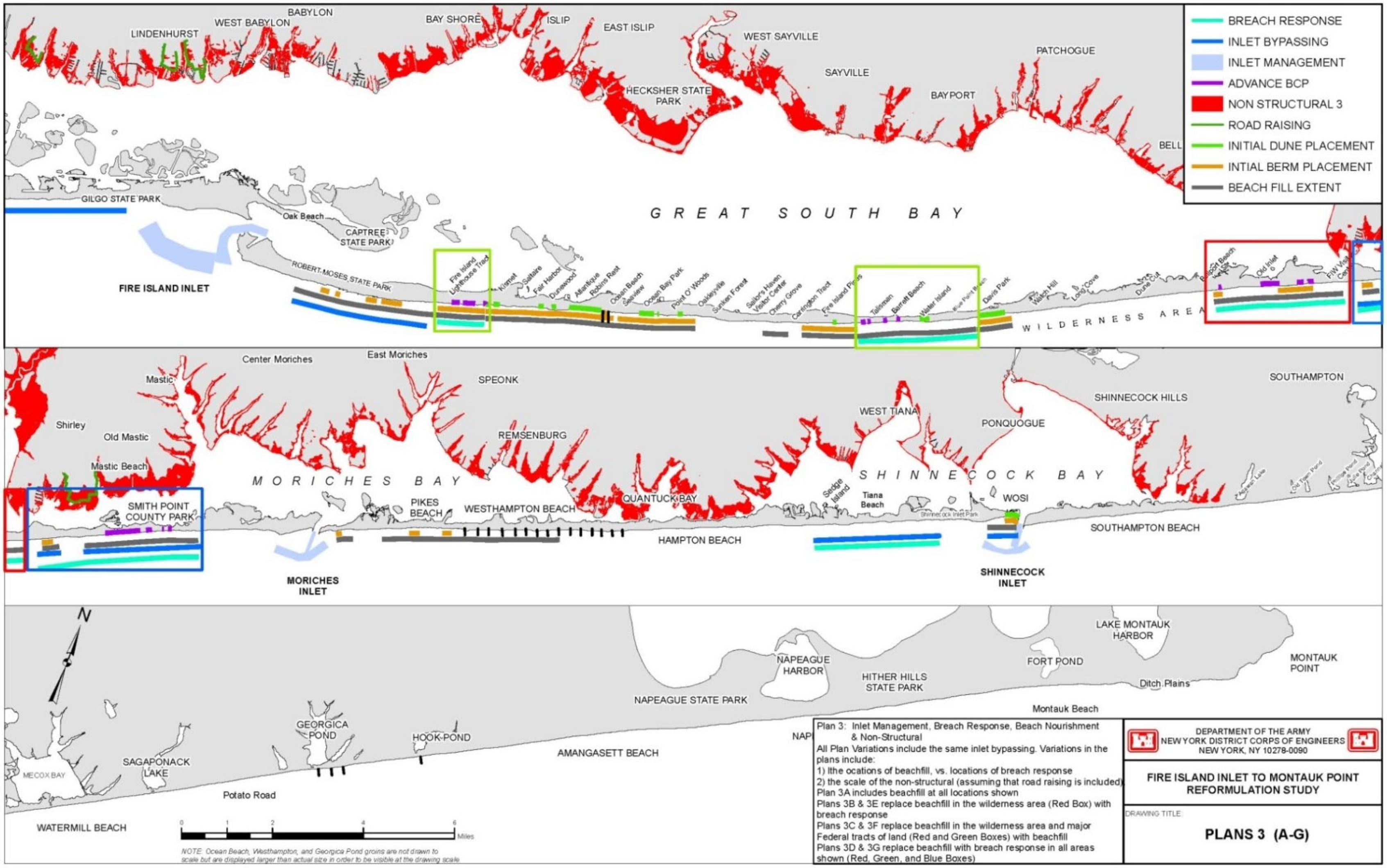

Figure 23. Alternative Plan 3 Overview

5.5 Integration of Features to Advance the Vision Objectives

Plan 3a was the plan that appears to best accomplish the coastal storm risk management objectives, while Plan 3g was the plan that best balances the coastal storm risk management, the Principles and Guidelines criteria, and also the Vision Criteria. Plan 3g was identified as the preferred solution because it is efficient in reducing storm damages and it satisfies the requirements for a plan to be mutually acceptable to the Secretary of Interior and Secretary of the Army. Neither plan, however, fully satisfies the Vision Criteria to reestablish the natural coastal processes to the extent possible by altering existing shore stabilization structures and reestablishing natural coastal processes. To satisfy these Vision requirements, the plan also integrated the following features to improve the overall functioning and coastal resilience:

- Groin modifications
  - Shortening the Westhampton groin field by 70-100 feet to reduce renourishment requirement to the shoreline to the west
  - Modifying groins at Ocean Beach in conjunction with relocation of the water supply.
  - Monitoring groins in the area of Georgica to determine if any structure modification is warranted.
- Restoration of Natural Coastal Processes
  - Sand by-passing
  - Inclusion of sediment management features in Downtown Montauk (Montauk Beach) and Potato Road
  - Bayside coastal process features
- Integration of Appropriate Land Use and Development Management Measures
- Integration of Considerations of Climate Change and Adaptive Management

5.6 Identification of the Tentative Federally Supported Plan

Based on public meetings and input received from DOI on the 2009 Formulation Report, a TFSP was identified as modified Plan 3g that included the following:

- Inlet Management –including the optimized Inlet management plans for Fire Island, Moriches, and Shinnecock Inlets
- Breach Response Plan with +13 feet NGVD 29 dune, proactive response for Shinnecock Bay reach, +9.5 feet NGVD 29 berm, response within the Otis Pike High Dune Wilderness Area, Major Federal Tracts, and Smith Point County Park;
- Nonstructural Plan NS3R, which provides for floodproofing structures within 10 percent floodplain along with optimized road raising plan at 4 locations;
- Beach berm (90 feet.) with +15 feet NGVD 29 dune crest along barrier beaches within Great South Bay and Moriches Bay Reaches;
- Groin modifications at Westhampton Beach and Ocean Beach
- Sediment Management Features at Downtown Montauk (Montauk Beach) and Potato Road
- Inclusion of Coastal Process Features that help reestablish the natural coastal processes.
- Land Management recommendations
- Periodic renourishment for 30 years after the date of initiation of construction

- An adaptive management strategy over the 50-year period of analysis to address the uncertainties in project implementation

5.7 Post-Hurricane Sandy Modifications to TFSP and Release of Draft GRR/ EIS

Based upon the May 2009 Report, and subsequent coordination between the Army and DOI, in March 2011, USACE and DOI reached agreement on a Tentative Federally Supported Plan (TFSP). The TFSP was the modified Plan 3g which included refinements to ensure the plan was mutually acceptable to USACE and DOI. The TFSP was identified as such, since this is the plan that maximized net benefits, and satisfied the requirement (constraint) to be mutually acceptable with the Secretary of the Army and Secretary of Interior.

In March 2011, USACE and DOI transmitted a summary of the TFSP to the State of New York to request their concurrence. By letter dated December 29, 2011, the State provided comments on the TFSP and requested clarification and further detail of the proposed project features and implementation steps.

Coordination was ongoing when Hurricane Sandy struck on October 29, 2012, and caused extensive damage to the project area, including extensive overwash, three breaches of the barrier island, and widespread flooding damages along the barrier island and mainland shorelines. Two of the breaches were closed. The breach within the Otis Pike High Dune Wilderness Area remains open. DOI signed a Record of Decision for the Wilderness Breach Management Plan EIS on July 23, 2018. Under the selected action identified in the ROD, the evolution, growth, and/or closure of the breach will be determined by natural barrier island processes, and human intervention to close the breach will occur only "to prevent loss of life, flooding, and other severe economic and physical damage to the Great South Bay and surrounding areas." NPS will continue to monitor the Wilderness Breach using established methods that staff and scientists have used since 2012. Monitoring is being conducted to determine if changes in the breach could elevate the risk, which could lead to a decision to close the breach.

Following Hurricane Sandy, the following actions were taken to update the TFSP:

- Updated the structure inventory and shoreline conditions, based upon post-Hurricane Sandy changes
- Updated the hydrodynamic modeling that was done previously, to account for the Wilderness Breach
- Updated the economics life-cycle model to account for the existing breach in the Otis Pike High Dune Wilderness Area, and also to reflect the new information available about observed / expected breach growth rates
- Accounted for post-Hurricane Sandy efforts undertaken by USACE and others. This includes repair of the existing projects, the FIMI and Downtown Montauk Stabilization Projects, and nonstructural plans that have been implemented in the project area.

This resulted in the following changes made to the post-Hurricane Sandy TFSP:

- Provided a dune alignment further landward (along the Middle alignment) that reflects the post-Hurricane Sandy beach and dune condition. (This alignment is consistent with the FIMI stabilization project, that included the acquisition/ relocation of approximately 40 homes located within the dune).

- Refined the Proactive Breach Response Plan in Smith Point County Park and in the Lighthouse Tract to the two heavily impacted areas that are similar in scale to the project features constructed as part of the FIMI Stabilization Project.
- Provides 30 years of renourishment after the date of initial construction
- Provides a Breach Response Plan to be implemented for 50 years
- Defines a conditional breach response within the Federal tracts of FIIS (with the exception of the Lighthouse tract) that allows for the mechanical closure of the breach if it does not close naturally within 60 days.
- Acknowledges that improvements in land management regulations to be implemented by others are needed to complement the FIMP project.
- Includes coastal process features (CPFs) that improve the overall functioning and resilience of the plan.
- Includes monitoring and adaptive management of the project features for effective long-term management of the system.

In July 2016, the draft GRR and EIS were released for public and agency review (See Chapter 10 for discussion of public coordination). Consistent with the USACE planning process, USACE, the State and DOI agreed to use the public and agency review process as a means of refining the TSP in order to achieve the required mutually acceptable Plan to the Secretary of the Army and Secretary of the Interior. The draft GRR/EIS indicated that the partner agencies would continue to discuss and refine the following TSP features:

- Coastal Process Features (CPFs)
- Breach response protocols
- Adaptive Management
- Land Management

5.8 Summary of Plan Changes from 2016 Draft Report

The following is a summary of plan refinements to the TSP made in response to the comments received to the draft report (see Section 10 – Public Involvement) and subsequent coordination with NYS, partner agencies, HQUSACE, and the Office of the ASA(CW):

- The plan has been updated to reflect current conditions, with updated costs and benefits.
- Road raising features along the mainland have been eliminated and replaced with nonstructural measures for structures within the 10 percent floodplain.
- In several mainland locations, acquisition of structures and reestablishment of floodplain function is recommended instead of building retrofits.
- The specific criteria for breach response have been updated and clarified for each location. Breach Response Plans have been identified, including a response plan specific to the Otis Pike High Dune Wilderness Area.
- The Potato Road sediment management feature in the Village of Sagaponack has been removed from the plan, based upon changes in the FWOP condition, as well as public access concerns.

- The Downtown Montauk sediment management feature has been refined to increase the volume for initial construction and renourishment, and to incorporate the existing geotextile-reinforced dune as part of the project.
- The plans for further modification of the Westhampton Groins have been removed from the plan.
- The Ocean Beach groins are recommended to be removed, rather than modified.
- The number and nature of Coastal Process Features have been updated and refined based upon public and agency input.

5.9 Office of the Assistant Secretary of the Army (Civil Works) Policy Exception to Achieve Mutually Acceptable Plan

Consistent with the policy exception granted by the ASA(CW) on October 11, 2017, the Recommended Plan includes features that are not incrementally justified as typically required by USACE guidance, but are necessary in order to achieve mutual acceptability between the Secretary of the Army and the Secretary of the Interior as required by P.L. 88-587. Table 30 provides a comparison of the Recommended Mutually Agreeable Plan and the National Economic Development Plan for the FIMP Coastal Storm Management project. It shows the specific study features in the Recommended Plan that require a policy exception. Please note, mutual acceptability of actions and features extends to areas outside the geographical boundaries of FIIS, as some actions and features may have an effect on FIIS or could be influenced by the decisions within FIIS boundaries. This includes sand bypassing, mainland nonstructural features, and coastal process features.

Sand Bypassing – Ebb shoal dredging of inlets needed to provide adequate bypassing of sand is not incrementally justified. The policy exception supports consistency with the MOU and Vision Statement that a mutually acceptable plan minimizes interruption of the natural coastal processes, which is supported by sand bypassing. Although work may be undertaken outside the boundary of FIIS, this features directly influences the FIIS properties.

Mainland Nonstructural Measures – The extent of the mainland nonstructural plan is not incrementally justified. The plan provides nonstructural measures to homes within the 10 percent floodplain, which provides for nonstructural measures to a greater number of homes than the 17 percent floodplain, which is the NED plan feature. The policy exception recognizes the consistency with the interagency agreement to lessen risk through features which offset the dependency upon continuing renourishment of vulnerable areas and provide robustness to coastal storm risk management features. The policy exception also recognizes the need for acquisition of high-risk structures that are subject to very frequent flooding due to RSLC. Further, the policy exception recognizes the potential impacts of RSLC and that the recommended 10 percent floodplain for the nonstructural measures contributes resilience in the study area. Although this work is located outside of the boundary of FIIS, the plan is being implemented to compensate for the smaller project features included within FIIS.

Groin Removal – Removal of the Ocean Beach groin field is not incrementally justified. The policy exception supports consistency with the MOU and Vision Statement that a mutually acceptable plan minimizes interruption of the natural coastal processes; the Ocean Beach groin field currently interrupts coastal processes. The groin modification is also consistent with Regional Sediment Management best practices and will reduce the renourishment requirements to maintain performance of the beachfill features.

Coastal Process Features – A Department of the Interior objective is that priority be given to measures that provide both coastal storm risk management, as well as reestablish and enhance natural coastal processes and ecosystem integrity. Such prioritization is not typical of all USACE coastal storm risk management studies, and these are not incrementally justified. The CPFs add height or width to the coastal system through sediment placement designed to mimic the coastal process of sediment overwash and ensure no net loss of sand on the bayside that would otherwise result from the reduction in breaches and overwash with the project in place. A subset of the CPF's are located outside of the FIIS, and are required to provide a spatial distribution of features, and to achieve the no net loss.

Table 30. Comparison of Recommended Mutually Agreeable Plan and NED Plan

Plan Feature	Mutually Acceptable Plan (MAP)	National Economic Development (NED) Plan	Basis of Mutually Acceptability	Policy Exception Required?
Sand Bypassing @ Fire Island, Moriches, and Shinnecock Inlets	Bypass sand from ebb shoals from each Inlet, in conjunction with Inlet maintenance dredging; berm template + 9 feet. NGVD	Sand by-passing not incrementally justified	Sand Bypassing is needed to achieve goal of restoring the longshore transport coastal process that will enhance natural resilience and reduce the likelihood of breaching. Bypassing is also a cost-effective source of sand for dune and berm construction and renourishment.	Yes
Breach Response	*Proactive Breach Response* with 13 feet. dune/90 feet. berm. *Reactive Breach Response* with 9.5 ft. berm (no dune) *Conditional Breach Response* with 9.5 ft. berm (no dune) *Wilderness Breach* Response with 9.5 ft. berm (no dune)	Proactive Breach Response with 13 ft. dune/90 ft. berm	Smaller Breach Response Plan in environmentally sensitive areas still economically justified and is needed to achieve goals of interagency vision statement and MOU between DOI and Dept. of the Army. Additional breach response features are required for the MAP because the beachfill component provides less sand than the NED plan.	No
Mainland Nonstructural Renourishment	Includes elevating homes within the *10 percent floodplain* and acquisitions for future restoration (up to 4,432 structures)	Includes elevating homes within the *17 percent floodplain* (approximately 2,992 structures)	MOU and Vision statement specify that features be robust under intermediate and high rate of RSLC. The 3 and10 year NS plan features were developed utilizing "historic" RSLC projections. The 10 year NS plan is incrementally justified when using the "intermediate" RSLC.	Yes
Beachfill on Barrier Islands	+15 ft dune/90 ft berm along developed shorefront in GSB & MB reaches Breach response in undeveloped areas	Continuous +15 ft dune/90 ft berm along GSB & MB reaches	DOI objects to sand placement on federal tracts. No policy exception needed since MAP is economically justified with a lower cost	No
	Proactive Breach Response west of Shinnecock Inlet	Proactive Breach Response west of Shinnecock Inlet		
Renourishment Duration	30 years of nourishment plus 20 years of breach response	50 years of nourishment	No exemption needed since 30 years renourishment is economically justified.	No
Sediment Management	Feeder Beach at Montauk Beach	Feeder Beach at Montauk Beach and Potato Road	Feeder beaches were incrementally analyzed as last added plan element to address residual risk and are incrementally justified. Both were included in TSP. Potato Road was dropped due to local objections.	No
Groin Modification	Remove two Ocean Beach groins	No groin modification	DOI requested removal of Ocean Beach groins as critical feature to reestablish longshore sediment transport within FIIS	Yes
Coastal Process Features (CPFs)	Provides for 12 barrier island CPFs to offset loss of ESA habitat (piping plover) and also to ensure no net loss of sediment to the bay by placement of 4.2 million cy of sand over the 50-year period of analysis. Also provides for two mainland CPFs that will reestablish floodplain function	CPFs are not NED compliant	CPFs required to achieve no net loss of sediment to the back bays. Policy exception required.	Yes

6 IDENTIFICATION OF THE RECOMMENDED PLAN

The alternative development described in Section 5 highlighted prior reports. Pertinent parts of these reports are provided in Appendix E – Plan Formulation. The Recommended Plan takes into account the comments received on the Draft GRR and EIS, released in July 2016, and incorporates the subsequent coordination with DOI and the State of New York to develop a mutually acceptable plan, as required per Section 8 of P.L. 88-587. Consistent with the policy exception granted by the ASA(CW) on October 11, 2017, the Recommended Plan includes features that are not incrementally justified as typically required by USACE guidance but are necessary in order to achieve mutual acceptability between the Secretary of the Army and the Secretary of the Interior as required by P.L. 88-587. A chronology of discussions and agreements related to mutual acceptability of the Plan is included in Appendix L – Pertinent Correspondence.

This Section describes the details of the Recommended Plan, including the first cost and residual damages.

6.1 Overview

The Recommended Plan for the Fire Island to Montauk Point New York Hurricane Sandy project area provides a systems approach for CSRM that balances the risks to human life and property, while maintaining and restoring the natural coastal processes and ecosystem integrity.

The current plan reflects modifications and refinements to the TSP that was proposed in the June 2016 Draft HSGRR/EIS, based on public and agency review comments, and subsequent discussions to identify the USACE/DOI mutually acceptable plan, and subsequent coordination with the local sponsor.

The Recommended Plan is shown in Figure 24 and Figure 25 and summarized below and in Table 31.

Inlet Sand Bypassing

- Provides for sufficient sand bypassing across Fire Island, Moriches, and Shinnecock Inlets to reestablish the natural longshore transport of sand along the barrier island for 50 years. Scheduled OMRR&R dredging of the authorized navigation channel and deposition basin with sand placement on the barrier island will be supplemented, as needed, by dredging from the adjacent ebb shoals of each inlet to obtain the required volume of sand needed for bypassing.
- The bypassed sand will be placed in a berm template at elevation +9.5 feet NGVD 29 in identified placement areas.
- Monitoring is included to facilitate adaptive management changes.

Mainland Nonstructural Measures

- Includes up to 4,432 structures within the 10 percent floodplain using nonstructural measures, primarily, structural elevations and building retrofits, based upon structure type and condition.
- Ringwalls are provided for 93 structures that are not suitable for nonstructural measures. The ringwalls will meet all requirements of structural measures.
- Includes acquisition of 14 structures in areas subject to high frequency flooding, and reestablishment of natural floodplain function.

Breach Response on Barrier Islands

- Proactive Breach Response – is an action that is triggered when the level of project performance at the shoreline falls below the condition under which the four percent flood would be capable of breaching the barrier island.
- Reactive Breach Response – is an action that is triggered when a breach has occurred, and there is an exchange of ocean and bay water during normal tidal conditions. It is applicable to locations where there is agreement that a breach should be mechanically closed quickly, such as the Talisman Federal tract, where there is an acknowledgement of the high vulnerability of breaching, deep water in the back bay, and new infrastructure that connects communities east and west of this location.
- Conditional Breach Response – is an action that is triggered when a breach has occurred, and there is an exchange of ocean and bay water during normal tidal conditions. It is applicable to most Federally-owned tracts within FIIS. A decision about potential breach closure will be made by the Breach Closure Team. Mechanical closure of the breach will take place if the breach does not close naturally within 60 days of opening.
- Wilderness Breach Response – is an action that is triggered when a breach has occurred, and there is an exchange of ocean and bay water during normal tidal conditions. It is applicable to the Federally-owned Wilderness tracts within FIIS, and is consistent with the Wilderness Breach Management Plan/EIS prepared by NPS. A decision about potential breach closure will be made by the Breach Closure Team. Mechanical closure of the breach may take place if decided by the Breach Closure Team.

Beach and Dune Fill on Shorefront

- Provides for a 90 foot wide berm and +15 foot dune along the developed shorefront areas on Fire Island and Westhampton barrier islands.
- All dunes will be planted with dune grass except where noted in Table 31.
- On Fire Island the post- Hurricane Sandy optimized alignment is followed and includes overfill in the developed locations to minimize tapers into Federal tracts.
- Renourishment takes place approximately every 4 years for up to 30 years after project completion; while proactive breach response takes place from years 31 to 50. (NOTE: The project sponsor, the NY State Department of Environmental Conservation, requested that the renourishment period be limited to 30 years)
- Provides for adaptive management to ensure the volume and placement configuration accomplishes the design objectives of offsetting long-term erosion.
- Provides for construction of a feeder beach every 4 years for up to 30 years at Montauk Beach.

Groin Modifications

- Provides for removal of the existing Ocean Beach groins.

Coastal Process Features (CPFs)

- Provides for 12 barrier island sites and two mainland sites that would help reestablish the cross-island sediment transport processes and floodplain function of the coastal system and provide habitat for protected species.
- Includes placement of approximately 4.2 million cubic yards of sediment in accordance with the policy exception granted by the Office of the ASA(CW) on October 11, 2017. Sediment will be placed along the barrier island bayside shoreline over the 50-year period of analysis that reestablishes the coastal processes consistent with the reformulation objective of no net loss of habitat or sediment. The placement of sediment along the bay shoreline will be conducted in conjunction with other nearby beach fill operations undertaken on the barrier island shorefront.

- The CPFs will compensate for reductions in cross-island transport and sediment input to the Bay, offset Endangered Species Act impacts from the placement of sediment along the barrier island shorefront, augment the resilience and enhance the overall barrier island and the natural coastal processes.

Adaptive Management

- Provides for monitoring and the ability to adjust specific project features to improve effectiveness and achieve project objectives.
- Climate change will be accounted for with the monitoring of climate change parameters, identification of the effect of climate change on the project design and identification of adaptation measures that are necessary to accommodate climate changes as it relates to all the project elements.

Integration of Local Land Use Regulations and Management

- Upon project completion, USACE's Annual Inspection of Completed Works (ICW) program provides for monitoring and reporting of any new development within the project area to the appropriate Federal, state, and local entities responsible for enforcing applicable land use regulations.

Table 31 summarizes the shorefront Recommended Plan features and includes a description of the Recommended Plan for each of the project sub-reaches, the type of Breach Response Plan, and the Life Cycle Plan following project construction for Years 1-30 (Figure 24) and Years 31-50 (Figure 25).

A detailed description of each of the plan components follows.

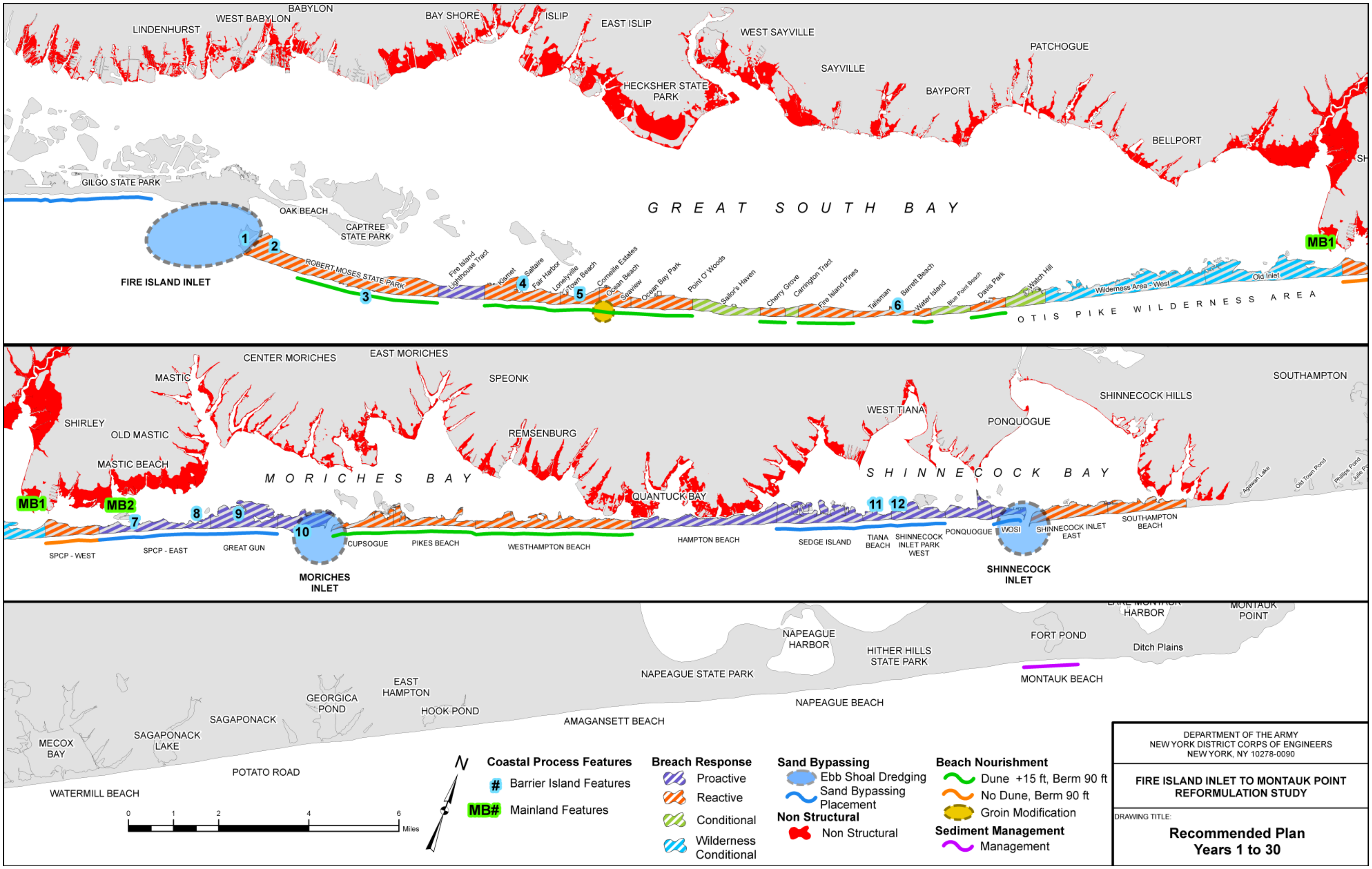

Figure 24. Recommended Plan (Years 1 to 30)

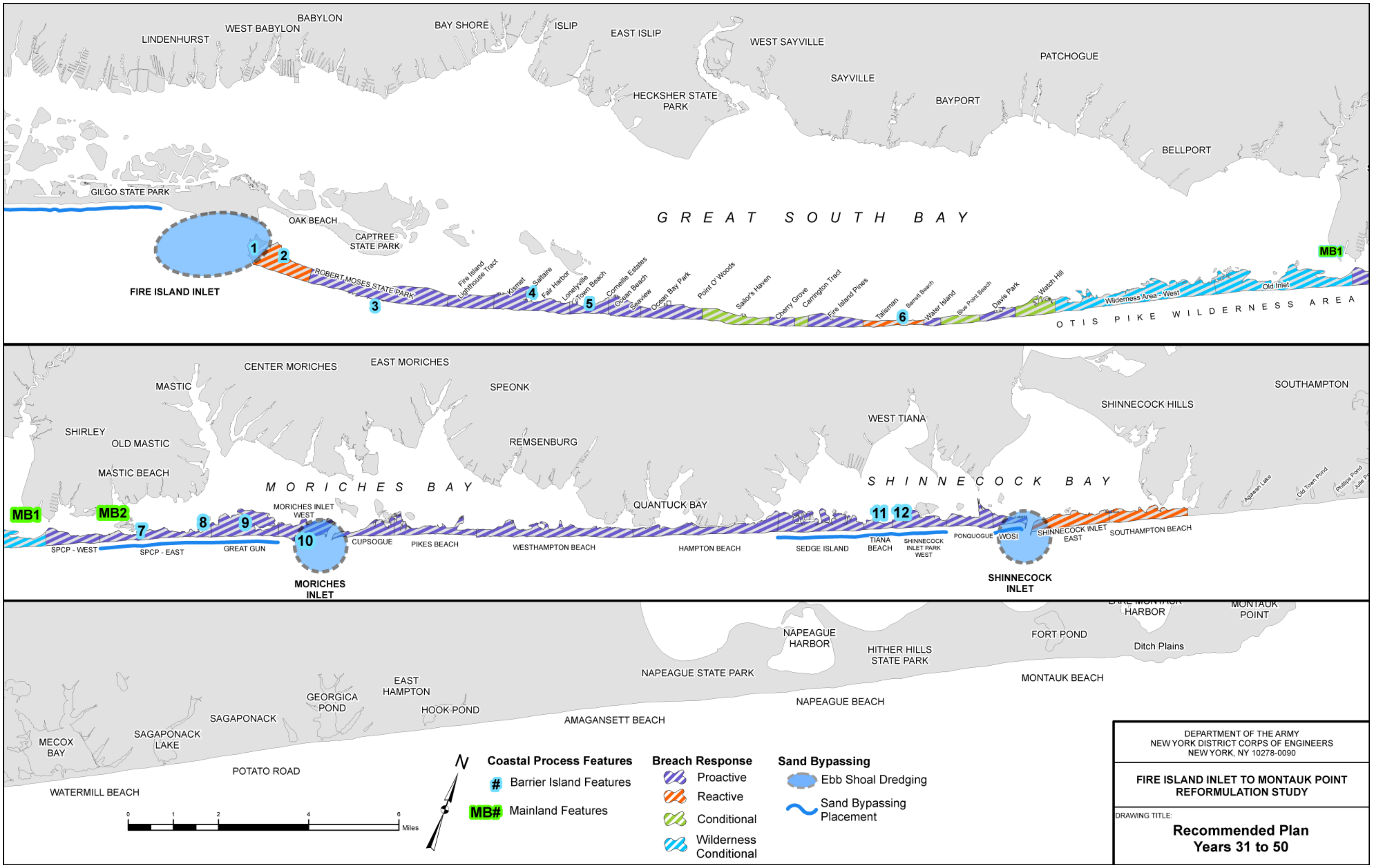

Figure 25. Recommended Plan (Years 31 to 50)

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Table 31. FIMP Recommended Plan Shorefront Reach Features

				Subreach Recommended Plan			Breach Response Plan		Coastal Process Features		Lifecycle Plan		
Project Reach	**Design Subreach**	**Sub-Reach Name**	**Length (ft)**	**Plan**	**Berm (Ht. and width)**	**Dune**	**Breach Response**	**Breach Response Plan**	**CPF located in Sub-reach**	**Purpose (CSRM, ESA)**	**Lifecycle Response Years 1-30**	**Lifecycle Response Years 31-50**	**Years 31-50 Dune Height**
GSB (Great South Bay)		Fire Island Inlet and Gilgo Beach	N/A	Inlet Dredging and bypassing (FI)	+9.5 ft berm section	No Dune	NA	NA			FI Inlet bypassing, 2 yr cycle	FI Inlet bypassing, 2 yr cycle	No dune
	1A	Robert Moses State Park - West (need Plate -from Parkway to Jetty)	6,700	No Action	+9.5 ft, 90 ft wide	No Dune	Reactive	9.5 ft berm, 90 ft wide	1 Democrat Point West 2 Democrat Point East	ESA ESA	Reactive Breach Response	Reactive Breach Response	No dune
	1A	Robert Moses State Park - East	19,000	Beach, Dune, Berm, Renourishment	+9.5 ft, 90 ft wide	15 ft dune	Reactive	15 ft dune, 9.5 ft berm, 90 ft wide	3 Dunefield West of Field 4	ESA	Periodic renourishment (approx. 4 year cycle)	Proactive Breach respone	13 ft dune
	1B	FI Lighthouse Tract	6,700	Proactive Breach Response	+9.5 ft, 90 ft wide	13 ft dune, no planting	Proactive	13 ft dune, 9.5 ft berm, 90 ft wide			Proactive Breach respone	Proactive Breach respone	13 ft dune
	2A	Kismet to Lonelyville	8,900	Beach, Dune and Renourishment	+9.5 ft, 90 ft wide	15 ft dune	Reactive	15 ft dune, 9.5 ft berm, 90 ft wide	4 Clam Pond	CSRM, ESA	Periodic renourishment (approx. 4 year cycle)	Proactive Breach respone	13 ft dune
	2B	Town Beach to Corneille Estates	5,100	Beach, Dune and Renourishment	+9.5 ft, 90 ft wide	15 ft dune	Reactive	15 ft dune, 9.5 ft berm, 90 ft wide	5Atlantique to Corneille	CSRM, ESA	Periodic renourishment (approx. 4 year cycle)	Proactive Breach respone	13 ft dune
	2C	Ocean Beach & Seaview	3,800	Beach, Dune, Renourish, Groin Modification	+9.5 ft, 90 ft wide	15 ft dune	Reactive	15 ft dune, 9.5 ft berm, 90 ft wide			Periodic renourishment (approx. 4 year cycle)	Proactive Breach respone	13 ft dune
	2D	OBP to Point O' Woods	7,400	Beach, Dune and Renourishment	+9.5 ft, 90 ft wide	15 ft dune	Reactive	15 ft dune, 9.5 ft berm, 90 ft wide		CSRM, ESA	Periodic renourishment (approx. 4 year cycle)	Proactive Breach respone	13 ft dune
	2E	Sailors Haven	8,100	Conditional Breach Response	+9.5 ft closure section (max berm ht.)	No Dune	Conditional	No dune. Berm closure width to taper to adjacent area.		CSRM, ESA	Conditional Breach Closure	Conditional Breach Closure	No dune
	3A	Cherry Grove	3,000	Beach, Dune and Renourishment	+9.5 ft, 90 ft wide	15 ft dune	Reactive	15 ft dune, 9.5 ft berm, 90 ft wide			Periodic renourishment (approx. 4 year cycle)	Proactive Breach respone	13 ft dune
	3B	`Carrington Tract	1,500	Conditional Breach Response	+9.5 ft closure section (max berm ht.)	No Dune	Conditional	No dune. Berm closure width to taper to adjacent area.		CSRM, ESA	Conditional Breach Closure	Conditional Breach Closure	No dune
	3C	Fire Island Pines	6,600	Beach, Dune and Renourishment	+9.5 ft, 90 ft wide	15 ft dune	Reactive	15 ft dune, 9.5 ft berm, 90 ft wide			Periodic renourishment (approx. 4 year cycle)	Proactive Breach respone	13 ft dune
	3D	Talisman to Water Island	7,300	Reactive Breach Response	+9.5 ft, 90 ft wide	No Dune	Reactive	No dune. Maximum berm height 9.5 ft. Berm closure width to taper to adjacent area.	6 Talisman	CSRM, ESA CSRM, ESA	Reactive Breach Closure	Reactive Breach Closure	No dune
	3E	Water Island	2,000	Beach, Dune and Renourishment	+9.5 ft, 90 ft wide	15 ft dune	Reactive	15 ft dune, 9.5 ft berm, 90 ft wide			Periodic renourishment (approx. 4 year cycle)	Proactive Breach respone	13 ft dune
	3F	Water Island to Davis Park	4,700	Conditional Breach Response	+9.5 ft closure section (max berm ht.)	No Dune	Conditional	No dune. Berm closure width to taper to adjacent area.			Conditional Breach Closure	Conditional Breach Closure	No dune
	3G	Davis Park	4,100	Beach, Dune and Renourishment	+9.5 ft, 90 ft wide	15 ft dune	Reactive	15 ft dune, 9.5 ft berm, 90 ft wide			Periodic renourishment (approx. 4 year cycle)	Proactive Breach respone	13 ft dune
	3H	Watch Hill	5,000	Conditional Breach Response	+9.5 ft closure section (max berm ht.)	No Dune	Conditional	No dune. Berm closure width to taper to adjacent area.			Conditional Breach Closure	Conditional Breach Closure	No dune
	4A	Wilderness Area - West	19,000	Wilderness Conditional Breach Response	+9.5 ft closure section (max berm ht.)	No Dune	Conditional	No dune. Berm closure width to taper to adjacent area.			Wilderness Conditional Closure	Wilderness Conditional Closure	No dune
	4B	Old Inlet	16,000	Wilderness Conditional Breach Response	+9.5 ft closure section (max berm ht.)	No Dune	Conditional	No dune. Berm closure width to taper to adjacent area.			Wilderness Conditional Closure	Wilderness Conditional Closure	No dune

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				Subreach Recommended Plan			Breach Response Plan		Coastal Process Features		Lifecycle Plan		
Project Reach	Design Subreach	Sub-Reach Name	Length (ft)	Proposed Plan	Berm (Ht. and width)	Dune	Breach Response	Breach Response Plan	CPF located in Sub-reach	Purpose (CSRM, ESA)	Lifecycle Response Years 1-30	Lifecycle Response Years 31-50	Years 31-50 Dune Height
MB (Moriches Bay)	1A	Smith Point CP- West	6,300	Reactive Breach Response and nourishment	+9.5 ft closure section (max berm ht.)	No Dune	Reactive	No dune. Berm closure width to taper to adjacent area.			Periodic renourishment (approx. 4 year cycle)	Proactive Breach respone	13 ft dune
	1B	Smith Point CP - East	13,500	Proactive Breach Response, sand bypassing	+9.5 ft, 90 ft wide	13 ft dune	Proactive	13 ft dune, 9.5 ft berm, 90 ft wide	7 Pattersquash Reach 8 New Made Is. Reach	CSRM, ESA; CSRM, ESA	Moriches Inlet sand bypassing placement- 1-yr cycle, and proactive response	Moriches Inlet sand bypassing placement- 1-yr cycle, and proactive response	13 ft dune
	2A	Great Gun	7,600	Proactive Breach Response, sand bypassing	+9.5 ft, 90 ft wide	13 ft dune	Proactive	13 ft dune, 9.5 ft berm, 90 ft wide	9 Smith Point County Park Marsh	CSRM	Moriches Inlet sand bypassing placement- 1-yr cycle, and proactive response	Moriches Inlet sand bypassing placement- 1-yr cycle, and proactive response	13 ft dune
	2B	Moriches Inlet - West	6,200	Proactive Breach Response	+9.5 ft, 90 ft wide	13 ft dune	Proactive	13 ft dune, 9.5 ft berm, 90 ft wide	10 Great Gun	ESA	Proactive Breach respone (actual dimentsions to conform with Great Gunn FIMI CPF)	Proactive Breach respone (actual dimentsions to conform with Great Gunn FIMI CPF)	13 ft dune
		Moriches Inlet		Inlet Dredging and bypassing - 1-yr cycle	+9.5 ft, 90 ft wide						Inlet Dredging and bypassing - 1-yr cycle	Inlet Dredging and bypassing - 1-yr cycle	
	2C	Cupsogue Co Park	7,500	Beach, Dune and Renourishment	+9.5 ft, 90 ft wide	15 ft dune	Reactive	15 ft dune, 9.5 ft berm, 90 ft wide		ESA	Periodic renourishment (approx. 4 year cycle)	Proactive Breach respone	13 ft dune
	2D	Pikes	9,700	Beach, Dune and Renourishment	+9.5 ft, 90 ft wide	15 ft dune	Reactive	15 ft dune, 9.5 ft berm, 90 ft wide			Periodic renourishment (approx. 4 year cycle)	Proactive Breach respone	13 ft dune
	2E	Westhampton	18,300	Beach, Dune, Renourishment	+9.5 ft, 90 ft wide	15 ft dune	Reactive	15 ft dune, 9.5 ft berm, 90 ft wide			Periodic renourishment (approx. 4 year cycle)	Proactive Breach respone	13 ft dune
SB (Shinecock Bay)	1A	Hampton Beach	16,800	Proactive Breach Response	+9.5 ft, 90 ft wide	13 ft dune	Proactive	13 ft dune, 9.5 ft berm, 90 ft wide			Proactive Breach respone	Proactive Breach respone	13 ft dune
	1B	Sedge Island	10,200	Shinnecock Inlet bypassing placement; Proactive Breach Response	+9.5 ft, 90 ft wide	13 ft dune	Proactive	13 ft dune, 9.5 ft berm, 90 ft wide	11 Dune Road, East Quogue	CSRM	Shinnecock sand bypassing placement - 2 yr cycle, and proactive breach respone	Shinnecock sand bypassing placement - 2 yr cycle, and proactive breach respone	13 ft dune
	1C	Tiana Beach	3,400	Shinnecock Inlet bypassing placement; Proactive Breach Response	+9.5 ft, 90 ft wide	13 ft dune	Proactive	13 ft dune, 9.5 ft berm, 90 ft wide	12 Tiana Bayside Park	CSRM	Shinnecock sand bypassing placement - 2 yr cycle, and proactive breach respone	Shinnecock sand bypassing placement - 2 yr cycle, and proactive breach respone	13 ft dune
	1D	Shinnecock Inlet Park West	6,300	Shinnecock Inlet bypassing placement; Proactive Breach Response	+9.5 ft, 90 ft wide	13 ft dune	Proactive	13 ft dune, 9.5 ft berm, 90 ft wide			Shinnecock sand bypassing placement - 2 yr cycle, and proactive breach respone	Shinnecock sand bypassing placement - 2 yr cycle, and proactive breach respone	13 ft dune
	2A	Ponquogue	5,300	Proactive Breach Response	+9.5 ft, 90 ft wide	13 ft dune	Proactive	13 ft dune, 9.5 ft berm, 90 ft wide			Proactive Breach respone	Proactive Breach respone	13 ft dune
	2B	WOSI	3,900	Shinnecock Inlet bypassing placement; Proactive Breach Response	+9.5 ft, 90 ft wide	13 ft dune	Proactive	13 ft dune, 9.5 ft berm, 90 ft wide			Shinnecock sand bypassing placement - 2 yr cycle, and proactive breach respone	Shinnecock sand bypassing placement - 2 yr cycle, and proactive breach respone	13 ft dune
		Shinnecock Inlet		Inlet Dredging and bypassing - 2-yr cycle							Inlet Dredging and bypassing - 2-yr cycle	Inlet Dredging and bypassing - 2-yr cycle	13 ft dune
	2C	Shinnecock Inlet - East	9,800	Reactive Breach Response	+9.5 ft, 90 ft wide	13 ft dune	Reactive	13 ft dune, 9.5 ft berm, 90 ft wide			Reactive breach response, initial 30 yrs	Reactive breach response, Years 31-50	13 ft dune
	3A	Southampton Beach	9,200	Reactive Breach Response	+9.5 ft, 90 ft wide	13 ft dune	Reactive	13 ft dune, 9.5 ft berm, 90 ft wide			Reactive breach response, initial 30 yrs	Reactive breach response, Years 31-50	13 ft dune
	3B	Southampton	5,300	No Federal Action									
	3C	Agawam	3,800	No Federal Action									

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				TSP Description			Breach Response Plan		Coastal Process Features		Lifecycle Plan		
Project Reach	**Design Subreach**	**Sub-Reach Name**	**Length (ft)**	**Proposed Plan**	**Berm (Ht. and width)**	**Dune**	**Breach Response**	**Breach Response Plan**	**CPF located in Sub-reach**	**Purpose (CSRM, ESA)**	**Lifecycle Response Years 1-30**	**Lifecycle Response Years 31-50**	**Years 31-50 Dune Height**
P (Ponds)	1A	Wickapogue	7,700	No Federal Action									
	1B	Watermill	8,800	No Federal Action									
	1C	Mecox Bay	1,400	No Federal Action									
	1D	Mecox to Sagaponack	10,400	No Federal Action									
	1E	Sagaponack Lake	1,100	No Federal Action									
	1F	Sagaponack to Potato Rd	9,300	No Federal Action									
	1G	Potato Rd	4,300	No Federal Action									
	1H	Wainscott	4,600	No Federal Action									
	1I	Georgica Pond	1,200	No Federal Action									
	1J	Georgica to Hook Pond	11,200	No Federal Action									
	1K	Hook Pond	1,100	No Federal Action									
	1L	Hook Pond to Amagansett	19,200	No Federal Action									
M (Montauk)	1A	Amagansett	10,400	No Federal Action									
	1B	Napeague State Park	9,100	No Federal Action									
	1C	Napeague Beach	9,900	No Federal Action									
	1D	Hither Hills SP	7,000	No Federal Action									
	1E	Hither Hills to Montauk B	15,800	No Federal Action									
	1F	Montauk Beach	4,700	Sediment Management	+9.5 ft feeder beach	No dune	NA	NA	NA		Renourishment, approx. 4 yr cycle	None	
	1G	Montauk Beach to Ditch Plains	4,700	No Federal Action									
	1H	Ditch Plains	3,400	No Federal Action									
	1I	Ditch Plains to Montauk Pt	19,300	No Federal Action									

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6.2 Inlet Sand Bypassing

The Project's inlet management plans at all three inlets consists of dredging the ebb shoals and placing the material on downdrift berms in the quantities needed to reestablish littoral transport of sediment across the inlets for 50 years. No dunes will be constructed with the sediment. Ebb shoal dredging would be undertaken in conjunction with scheduled/authorized navigational Operations and Maintenance (OMRR&R) dredging of the inlets and would increase sediment bypassing and reduce future renourishment fill requirements. These inlet bypassing features are designed to complement the existing navigation projects.

Fire Island Inlet

- OMRR&R maintenance dredging of authorized channel and deposition basin to take place on a 2-year interval, as authorized
- 379,000 Cubic yards (per OMRR&R event) dredged from the ebb shoal (as needed to offset sediment deficit) and placed downdrift at Gilgo Beach

Moriches Inlet

- OMRR&R maintenance dredging of authorized channel to take place on a 1-year interval (as authorized)
- Approximately 73,000 Cubic yards (per OMRR&R event) dredged from the from ebb shoal (as needed to offset sediment deficit) and placed downdrift at Smith Point County Park

Shinnecock Inlet

- OMRR&R maintenance dredging of authorized channel to take place on a 2- year interval as authorized)
- 105,000 Cubic yards (per OMRR&R event) dredged from channel/deposition basin, and from ebb shoal (as needed to offset sediment deficit) and placed downdrift at Sedge Island, Tiana Beach, and West of Shinnecock (WOSI)

6.2.1 Inlet Management – Initial Construction

Initial construction quantities for the Inlet Management measures include the estimated quantity to restore the channel to its authorized dimensions as well as dredging of the ebb shoal for bypassing. Initial construction quantities were estimated based on expected sedimentation in the authorized channel over the period between the last anticipated OMRR&R dredging operation prior to start of FIMP construction.

Table 32 shows the anticipated date of the last OMRR&R dredging event prior to the start of FIMP and the number of years in which sedimentation may occur.

Table 32. Number of Years between Last Inlet OMRR&R Dredging Operation and FIMP Start

Inlet	Sedimentation (years)	Anticipated Dredging Event prior to FIMP Start
Fire Island Inlet	1.75	Q2 2019
Moriches Inlet	2.5	Q1 2019
Shinnecock Inlet	7.25	Q2 2014

Expected initial construction dredging volumes at each inlet are presented in Table 33. As noted on the Table, sediment will be used for beachfill, Proactive Breach Response Plan, and CPFs. Sedimentation rates at the three inlets are based on the Existing Conditions sediment budget at each inlet as document in the 2007 Inlet Modifications Report (see Sub-Appendix A3 – Tidal Inlet Investigations. Actual dredging volumes and distribution of the fill placement will be refined during PED based surveys of the inlets and beach prior to construction.

Table 33. Inlet Management (Initial Construction)

Location	Subreach	Fill Length (ft)	Volume per Operation (cy)
Fire Island Inlet – 2-year Dredging Cycle			
Gilgo Beach (Bypassing)		12,700	701,048
RMSP (Beachfill)	GSB-1A	12,000	536,327
			1,237,375
Moriches Inlet – 1-year Dredging Cycle			
SPCP-West (Beachfill-Bypassing)	MB-1A	6,900	129,317
SPCP-East (PBRP and CPFs)	MB-1B	13,100	188,683
			318,000
Shinnecock Inlet – 2-year Dredging Cycle			
WOSI (PRBP)	SB-2B	2,700	700,000
			700,000

6.2.2 Inlet Management – Life cycle

Following the initial dredging of the inlets to authorized depths, future bypassing quantities and placement locations are shown in Table 34.

Table 34. Inlet Management (Life Cycle)

Location	Subreach	Fill Length (ft)	Volume per Operation (cy)
Fire Island Inlet – 2-year Dredging Cycle			
Gilgo Beach (Bypassing)		12,700	1,145,469
RMSP (Beachfill) (only Y1 to Y30)	GSB-1A	12,000	214,531
			1,360,000
Moriches Inlet – 1-year Dredging Cycle			
SPCP-West (Beachfill-Bypassing)	MB-1A	6,900	40,959
SPCP-East (PBRP and CPFs)	MB-1B	13,100	96,261
Great Gun (PBRP and CPFs)	MB-2A	4,500	33,780
			171,000
Shinnecock Inlet – 2-year Dredging Cycle			
Sedge Island (PBRP and CPFs)	SB-1B	5,600	45,296
Tiana Beach (PBRP and CPFs)	SB-1C	3,400	41,699
SPW (PBRP)	SB-1D	3,400	18,005
WOSI (PBRP)	SB-2B	2,700	170,000
			275,000

6.3 Mainland Nonstructural Measures

The plan for the mainland provides for coastal storm risk management for up to 4,432 structures that are located within the existing ten percent floodplain. Of these 3,675 would be elevated, 650 would be floodproofed, and 14 would be acquired. In addition, ringwalls are provided for 93 structures that are not suitable for nonstructural measures. Though ringwalls are classified as structural measures, they were considered as part of the nonstructural analysis, and are thus summarized here. The locations are conceptually shown in Figure 24 in red within the 10 percent floodplain. The number of nonstructural measures by Township are as follows:

Babylon	1,522
Islip	942
Brookhaven	1,263
Southampton	705

Participation Rate

There is great interest and activity in the study area in elevating and floodproofing homes. Many property owners have participated in elevation programs administered by FEMA and USHUD since Hurricane Sandy. It is recognized that the rate of participation is based upon the frequency of flooding, the last time a homeowner suffered a major flood, and the cost-sharing for the project. Based on coordination with local agencies and community groups, a high rate of participation is assumed for voluntary nonstructural measures. The assumption of 100 percent participation is conservative, as those who are likely to participate are those who are most vulnerable to damages from coastal storms and therefore, the BCR would likely only increase if fewer people participate in retrofitting homes. The analysis provided in the Benefits Appendix (Appendix D) illustrates that the structural project features are economically justified on their own, as are the nonstructural features. Therefore the rate of participation does not impact project is economically justified regardless of participation rate.

Target Design Elevation

The target design elevation is the final height of structures to be elevated. The Hurricane Sandy Rebuilding Task Force (TF) required that all Hurricane Sandy-related rebuilding projects funded by P.L. 113-2 must meet a single uniform flood risk reduction standard (FRRS) of one foot above the best available and most recent BFE) information provided by FEMA. The base flood is an event that has a one percent chance of occurrence in any given year (commonly known as a 100-year flood). The FRRS takes into account the increased risk to the region from extreme weather events, sea level rise and other impacts of climate change; is informed by the best science and best practices, including assessments taken following Hurricane Sandy; and brings the Federal standard into alignment with many state and local standards already in place. Where Federal, state and local standards exceed this standard, Federal agencies will be guided by the higher standard. The FRRS applies to USACE vertical infrastructure and nonstructural flood proofing projects located in the Sandy recovery area as described by the guidelines presented in Engineering and Construction Bulletin (ECB) 2013-33 "Application of Flood Risk Reduction Standard for Sandy Rebuilding Projects" (December 17, 2015). New York State Building Codes require that all new or retrofitted construction in floodprone areas have a target design elevation of two feet above the BFE. The target design elevation of all structure elevations is thus two feet above the BFE.

Note that the referenced BFE is the current effective BFE, and does not reflect potential changes to this target elevation. It is assumed that FEMA will not update the BFEs in the study area during the period of project construction. Section 7.4.2 provides further analysis of the target elevations, and the effect of target elevations on the performance of the nonstructural plan component. Section 7.4.2 further describes the adaptation that is expected to occur throughout the implementation of the nonstructural plan. In the PED and construction phase, the target elevations will be revisited based upon observed and projected data, to determine if project performance can be improved for the nonstructural plan components.

PED Refinements

Following Hurricane Sandy, multiple post-disaster recovery programs made available grants for the implementation of nonstructural measures within the study area. Such recovery work is still ongoing. Because of this, the specific nonstructural measures will be reviewed and refined in the Preconstruction Engineering and Design (PED) phase to ensure that the proposed measures is appropriately identified.

6.4 Breach Response Plans

Breach Response Plans are actions that will adaptively manage the potential impacts of future barrier island breaches. The plans include potential actions that will be undertaken when determined thresholds are met. Preliminary thresholds are detailed in this report; final thresholds will ultimately be determined by the Breach Response Team during PED. The Breach Response Plans consider field and modeling data related to physical shoreline parameters (e.g., beach and dune heights and widths), land use (e.g., wilderness area, managed parkland, residential), and breach characteristics. Four types of Breach Response Plans are applicable to different extents of the study area, and at different timeframes through the 50-year period of analysis. Figure 24 and Figure 25 illustrate the Breach Response Plan types at different locations in the study area. Table 31 summarizes Breach Response Plans for each project reach. Project costs associated with breach management would be incurred when barrier island conditions degrade to the point at which

Breach Response Plans are implemented to restore the barrier island, and also to close breaches that may occur due to severe storms. Table 35 compares the estimated costs to close breaches at the most vulnerable sites under the FWOP, which assumes no Breach Response Plans are in effect. The closure costs presented in the Table are those for the Breach Response Plans included in the Recommended Plan.

Proactive breach costs for the project are similarly generated by the lifecycle analysis since they are also dependent on their magnitude and uncertain frequency of occurrence. This cost is based on proactive beach maintenance actions at five locations during the full 50-year period of economic analysis, and additionally at the three proposed beachfill locations during the last 20 years of the analysis period following the termination of renourishment activities 30 years after the base year. As shown in Table 31, the Recommended Plan includes four types of Breach Response Plans.

Table 35. Breach Closure Cost by Breach Response Plan Location and Design Template (Large & Standard Breach) (October 2018 P.L.)

Location	Construction Alternative Resulting in Lowest Total Cost	FWOP Closure Cost	BRP Closure Cost
FI Lighthouse Tract	Hopper Dredge	$38,987,425	$31,689,217
Town Beach to Corneille Estates	Cutterhead Dredge	$36,837,420	$18,612,316
Talisman to Water Island	Cutterhead Dredge	$28,710,076	$13,889,596
Davis Park	Cutterhead Dredge	$28,737,131	$13,899,421
Smith Point County Park	Hopper Dredge	$24,599,965	$18,208,062
Sedge Island	Cutterhead Dredge	$16,710,948	$10,254,929
Tiana Beach	Cutterhead Dredge	$16,194,807	$10,033,388
WOSI	Hopper Dredge	$19,159,535	$15,374,275
FI Lighthouse Tract	Hopper Dredge	$10,919,328	$8,647,621
Town Beach to Corneille Estates	Cutterhead Dredge	$10,746,227	$7,340,820
Talisman to Water Island	Cutterhead Dredge	$9,340,158	$6,677,611
Davis Park	Cutterhead Dredge	$9,345,042	$6,679,387

The total annualized cost of reactive breach closure actions for all locations generated by the lifecycle analyses under the recommended Plan is $839,000 based on an average of five breaches in total occurring during the 50-year analysis period.

6.4.1 Proactive Breach Response Plan

The Proactive Breach Response Plan is an action that is triggered when the level of project performance at the shoreline falls below the condition under which the four percent flood would be capable of breaching the barrier island. It provides for restoration of a dune at a height of +13 feet NGVD 29, and a 90-foot berm. The Proactive Breach Response Plan allows for overwash and dune lowering during storms. As a result, ocean shorefront development would be more vulnerable to wave attack and storm-induced erosion. A typical Proactive Breach Response Plan cross section is shown in Figure 26.

6.4.1.1 Initial Construction

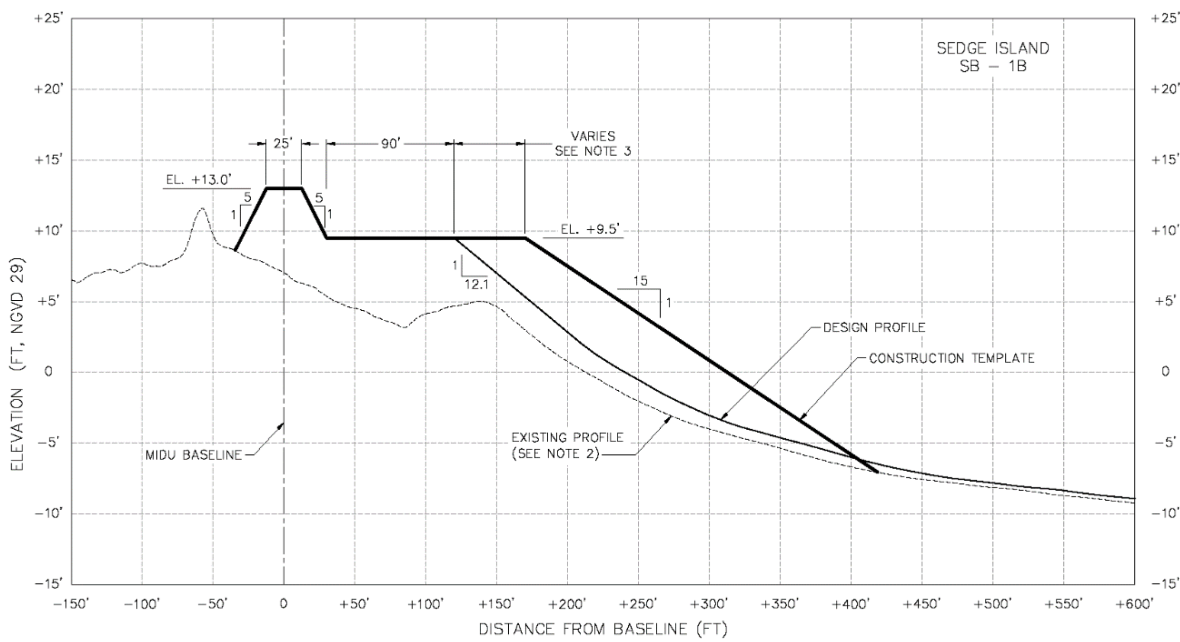
Four reaches identified for this type of Breach Respons Plan were recently renourished as part of the FIMI (Fire Island Lighthouse Tract (FILT), Smith Point County Park (SPCP) East, and Great Gunn)and the West of Shinnecock Inlet Interim Project (WOSI). Due to the relatively low erosion rates at FILT, SPCP-East, and Great Gunn, it is not expected that Proactive Breach Response Plan would be required at any of these locations at the time of initial construction. However, due to the relatively high erosion rates at WOSI, initial beach fill placement is assumed at this location as part of the Proactive Breach Response Plan. Initial construction volumes at WOSI were estimated following the same approach based on predicted losses. Based on the Proactive Breach Response Plan thresholds being reached in reaches MB-1B, SB-2B, SB-1B, SB-1C, and SB-1D, approximately 2.4 million cubic yards of sand would be placed during initial construction.

Initial construction volumes for the other Proactive Breach Response Plan reaches along Shinnecock Bay, Sedge Island, Tiana Beach, and Shinnecock Inlet Park West, were determined based on LiDAR data collected by USACE on November 14, 2012 (two weeks following Hurricane Sandy), plus additional data collection since 2012. All Proactive Breach Response Plan quantities include 15 percent overfill and 15 percent contingency/tolerance. No advance fill is included in the Proactive Breach Response Plan.

A summary of the initial construction quantities for the Proactive Breach Response Plan is provided in Table 36.

Table 36. Proactive Breach Response Plan Initial Construction Quantities

Location	Subreach	Sediment Source	Fill Length (ft.)	Volume (cy)
Sedge Island	SB-1B	BA 5Bexp	10,200	1,037,000
Tiana Beach	SB-1C	BA 5Bexp	3,400	207,000
SIPW	SB-1D	BA 5Bexp	3,400	427,000
			Total	**1,671,000**



C / C-133 TYPICAL PROACTIVE BREACH CLOSURE SECTION – STATION 2261+43

Figure 26. Typical Proactive Breach Response Plan Section

6.4.1.2 Proactive Breach Response Triggers

Proactive Breach Response triggers have been developed based on dimensions than will be measured and monitored, as described in Appendix J Adaptive Management and Monitoring. These triggers are reach-specific and consider historic breaching/overwash data, modeling results, and overall understanding of the hydraulic "conductivity" at each location. Breach response is a multidimensional problem, so there is not one single measurement than can be monitored and used as threshold for action. Therefore, the following relevant dimensions are measured and considered instead:

1. Barrier island width: distance between bay and ocean MHW contours
2. Elevation: generally characterized by volume/area above +10 feet NGVD29
3. Beach width: distance between baseline (generally the natural dune alignment) and the MHW contour

Specific Proactive Breach Response Plan thresholds by reach are summarized in Table 37. If one of the thresholds is met over a relatively small area but the barrier island is generally in good condition otherwise, the risk of breaching is significantly less than if the threshold is met over a large area. Therefore, the response triggers recommended in Table 37 are based on both widespread but not necessarily contiguous weakness within a reach and smaller, localized, but potentially weaker spots.

Table 37. Summary of Proposed Proactive Breach Response (PBR) Triggers

Reach			Barrier Island Width		Area Above +10 feet NGVD 29					Beach Width			
ID	Name	Length (ft)	Contiguous		Total		Contiguous			Total		Contiguous	
			Length	Island Width	Length	Width above +10	Length	Width above +10	Beach Width	Length	Beach Width	Length	Beach Width
GSB-1B	Fire Island Lighthouse (FILT)	6,700	200	1,000	2,000	50	100	50	100	3,000	100	1,000	100
MB-1B	Smith Point County Park (SPCP) East	13,500	200	400	2,000	100	100	100	150	6,000	150	500	100
MB-2A	Great Gun	7,600	200	400	2,000	100	100	100	150	4,000	150	500	100
MB-2B	Moriches Inlet - West	6,200	200	1,200	2,000	50	100	50	100	3,000	100	1,000	100
SB-1A	Hampton Beach	16,800	200	600	2,000	50	100	50	100	8,000	100	1,000	100
SB-1B	Sedge Island	12,200	200	500	2,000	100	100	100	150	6,000	100	500	100
SB-1C	Tiana Beach	3,400	200	400	2,000	100	100	100	150	2,000	100	500	100
SB-1D	Shinnecock Park West (SPW)	6,300	200	600	2,000	50	100	50	100	3,000	100	500	100
SB-2A	Ponquogue	5,300	200	600	2,000	50	100	50	100	3,000	100	1,000	100
SB-2B	West of Shinnecock (WOSI)	3,900	100	350	2,000	100	100	100	150	2,000	100	300	100
SB-2C	Shinnecock Inlet - East	9,800	200	800	2,000	50	100	50	100	5,000	100	1,000	100
SB-3A	Southampt on Beach	9,200	200	600	2,000	50	100	50	100	5,000	100	1,000	100

6.4.2 Reactive Breach Response Plan

The Reactive Breach Response Plan is an action that is triggered when a breach has occurred, and there is an exchange of ocean and bay water during normal tidal conditions. It is applicable to locations where there is agreement that a breach should be mechanically closed quickly, such as Robert Moses State Park and the Talisman Federal tract. A typical Reactive Breach Response Plan cross section is shown in Figure 27.

The Reactive Breach Response Plan template would restore the design beachfill template in locations where beachfill is recommended (dune at +15 feet NGVD 29 and 90-foot wide berm at +9.5 feet NGVD 29). At Talisman, where breach response does not include a dune and the berm width would match conditions in adjacent areas. A typical breach closure section at Robert Moses State Park is shown in Figure 27. The design foreshore slope is 1 on 12, which is also the same slope defined for the beach fill design templates. The design profile below MHW would match the representative morphological profile corresponding to each specific location. At a minimum, bayside slopes and shorelines would generally match the preexisting adjacent shorelines. Based on the existing topography the bayside design slope was selected as 1 on 20 from the bayside crest of the berm to an elevation of +6 feet NGVD 29. The specific layout will be developed as part of the breach closure plan at the time of the closure operation and may include more placement of sediment along the bay shoreline than existed prior to the breach in order to replicate cross-island sediment transport, and to achieve the project goals of no net loss of sediment.

6.4.3 Conditional Breach Response Plan

The Conditional Breach Response Plan is an action that is triggered when a breach has occurred, and there is an exchange of ocean and bay water during normal tidal conditions. It is applicable to locations where there is agreement that a breach should be mechanically closed quickly, such as the Talisman Federal tract, where there is an acknowledgement of the high vulnerability of breaching, deep water in the back bay, and new infrastructure that connects communities east and west of this location. It applies to most FIIS tracts, as shown in Figure 24 and Figure 25. A typical Conditional Breach Response Plan cross section is shown in Figure 26.

The breach closure template have a berm with height of +9.5 feet NGVD 29 and no dune. A typical breach closure section is shown in Figure 27. The intent of the conditional response template is to match the berm width with conditions prior to the breach and within adjacent areas. The design foreshore slope and bayside slopes and shorelines would generally match the preexisting adjacent shorelines. The specific dimensions and configuration will be developed as part of the breach closure plan at the time of the closure operation and may include more placement of sediment along the bay shoreline than existed prior to the breach in order to replicate cross-island sediment transport, and to achieve the project goals of no net loss of sediment.

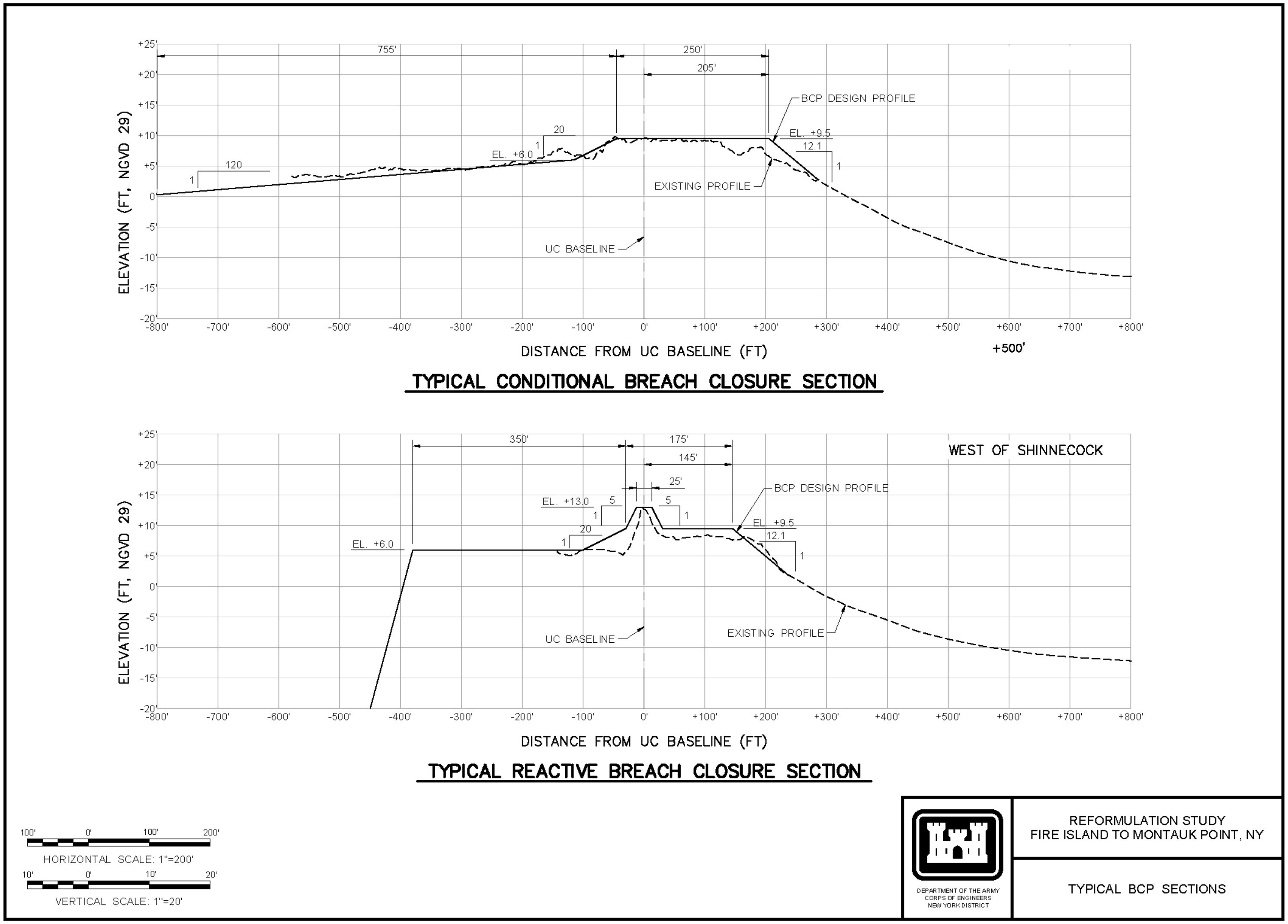


Figure 27. Typical Breach Closure Sections

6.4.4 Wilderness Breach Response Plan

The Wilderness Breach Response Plan is an action that is triggered when a breach has occurred, and there is an exchange of ocean and bay water during normal tidal conditions. It is applicable to the Federally-owned Otis Pike High Dune Wilderness within FIIS. A decision about potential breach closure will be made by the Breach Closure Team. Mechanical closure of the breach may take place if decided by the Breach Closure Team. The wilderness response plan is consistent with the Wilderness Breach Management Plan/EIS, and Record of Decision which was signed by the NPS on July 23, 2018. Mechanical closure of the breach will take place if breach closure is needed to prevent loss of life, flooding, and other severe economic damages to the Great South Bay and surrounding areas. The criteria that will be used to understand the Wilderness Breach risks are: 1) geologic controls, 2) cross-sectional area, and 3) water level as measured by tide gauges.

The breach closure template has a berm with height of +9.5 feet NGVD 29 and no dune. A typical breach closure cross section is shown in Figure 27. The intent of the conditional response template is to match the berm width with conditions prior to the breach and within adjacent areas. The design foreshore slope and bayside slopes and shorelines would generally match the preexisting adjacent shorelines. The specific dimensions and configuration will be developed as part of the breach closure plan at the time of the closure operation, and may include more placement of sediment along the bay shoreline than existed prior to the breach in order to replicate cross-island sediment transport, and to achieve the project goals of no net loss of sediment.

6.4.5 Implementation of Breach Response Plans

This Section generally describes the activities that would be undertaken to implement these response actions, particularly the efforts associated with wilderness response. It is expected that these strategies will be further refined in PED, as part of a detailed Monitoring and Adaptive Management Plan. Therefore, the details presented in this Section are subject to change. This Section generally describes:

- The two-tiered team, including the decision-making team, and science and engineering team
- Actions to be undertaken in the design phase
- Annual evaluations of barrier island conditions and vulnerabilities
- Pre-storm activities
- Post-storm activities

Breach Response Team. A two-tiered breach response team is envisioned for implementing breach response, including the decision-makers, and the technical advisory team, consisting for scientists and engineers.

The Decision Team consists of: Superintendent, FIIS; Commissioner, New York State Department of Environmental Conservation; County Executive, Suffolk County; Colonel, USACE, New York District; Regional Administrator, U.S. Fish and Wildlife Service. The specific composition will be established in PED, and updated as appropriate.

The Science and Engineering Advisory Team will include representatives from the NPS, USACE, U.S. Geological Survey, the U.S. Fish and Wildlife Service, New York State Department of Environment Conservation, New York State Department of State, and Suffolk County. The specific composition will be established in PED, and updated as appropriate.

Actions to be undertaken during PED. During PED, a Bayesian Model will be developed to aid in the determination of likelihood of natural closure of breaches in the large, publicly-owned tracts on Fire Island, and specifically the wilderness area. Using a probabilistic, Bayesian approach, based on empirical physical, climatological and hydraulic data, time of year considerations, etc. a decision tool will be created for use by the Science and Engineering Advisory Team in their role in advising the decision makers specifically regarding Wilderness Breach closure actions. Development and use of a Bayesian model will determine the likelihood of natural closure and confidence values for that likelihood. All available appropriate data will be used in the development of the Bayesian model, including data from USGS and its modeling efforts. Tabletop exercises will be conducted at the time of model development to run through multiple breaching and closing scenarios, to validate the modeling process for the Fire Island barrier island.

Data collection of conditions will be necessary to continually improve the validity of the Bayesian model as a tool for assessing the likelihood of natural closure, and to act as an aid for adaptive management. The majority of the data that would be used in the Bayesian model would be physical and meteorological data. Data collection requirements for this effort will be included in the final Monitoring and Adaptive Management Plan, which will be finalized during PED.

The Bayesian model would primarily be used to aid in decision-making associated with a wilderness area breach. This model will be exercised prior to and/or in the event of a breach by the Science and Engineering Advisory Team, and the model outcomes will be used to guide the closure activities.

Annual evaluations of barrier island conditions and vulnerabilities. Brief "letter" report will be annually prepared to document the condition of the barrier islands of the Atlantic Coast of New York, from Fire Island Inlet to Southampton. The letter report will summarize the highly vulnerable locations along the barrier island system with respect to barrier island breaching. The annual survey will characterize the coastal barriers with physical parameters such as cross section width, height, and volume. Locations that fall below a threshold percentile for each reach will be identified. The threshold for reporting vulnerable locations will be determined and may not be uniform among different reaches. Reports should be clear that potential breaches are not limited to the identified locations and will identify the breach response type of the vulnerable areas.

The letter report will describe the breach closure protocols and reference all the required permits and coordination. It will provide information needed to enact the breach closure protocols, if necessary. The letter report will be sent to the Breach Protocol Team in preparation for the summer hurricane season, and the fall-winter nor'easter season.

Pre-Storm Actions**.** Upon the incipient occurrence of a breach, monitoring of critical areas with possibilities of breaching identified either in the annual assessment or additional pre-storm information will begin during pre-storm preparations. Both the Decision Team and the Science and Engineering Advisory Team will be activated at the incipient occurrence of a storm that may have breaching potential (predicted water levels and wave heights higher than a four percent flood event). A protocol for data collection, methods of vulnerability assessments, and a clear plan for how these data and analyses will be disseminated to the group will be developed during PED.

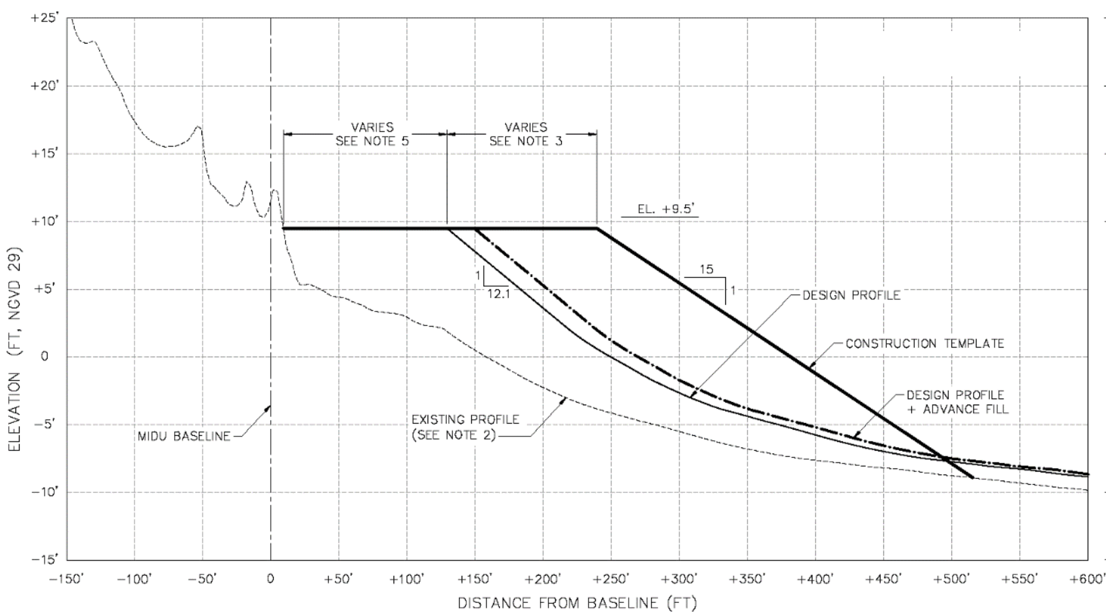
Post-Storm Actions. Under a scenario with significant changes to topography alongshore resulting in a full breach or partial breach, the Science and Engineering Advisory Team will come together to exercise the probabilistic Bayesian model of breach closure, to predict natural breach closure or growth within fourteen days of breach occurrence for any breach in the Wilderness Area. The Science and Engineering Advisory Team will report the results of the probabilistic model (with confidence limits) within twenty-one days of the breach occurrence. The Bayesian model may be exercised multiple times if the breach naturally remains open through a storm season. Breach response will be exercised in accordance with the annual plan report. Post-storm monitoring will be conducted as described in the Monitoring and Adaptive Management Plan.

6.5 Sand Placement on Barrier Islands

Specific locations for sand placement are outlined in Figure 24 and Figure 25.

The design template on the barrier islands typically have a dune with a crest width of 25 feet and dune elevation of +15 feet NGVD 29 and a berm width of 90 feet at elevation +9.5 feet NGVD 29. The proposed design (not construction) foreshore slope (from +9.5 to +2 feet NGVD 29) is roughly 12.1 on 1. Below MHW (roughly +2 feet NGVD 29) the submerged morphological profile, representative of each specific reach, is translated and used as the design profile. Figure 28 shows typical design section for the *Berm Only* and Figure 29 shows the typical design section for the design template with the +15 feet NGVD 29 dune plan.

The *Berm Only* template is applicable to areas in which the existing condition dune elevation and width reduce the risk of breaching but have eroded beach berm conditions. The 90 foot design berm (width) provides coastal storm risk management to the existing dunes and ensures vehicular access during emergency response and evacuation.



A C-105 TYPICAL BEACH FILL SECTION WITHOUT DUNE AND 90 FT BERM – STATION 122+00

Figure 28. Berm Only Beach fill Design Profile

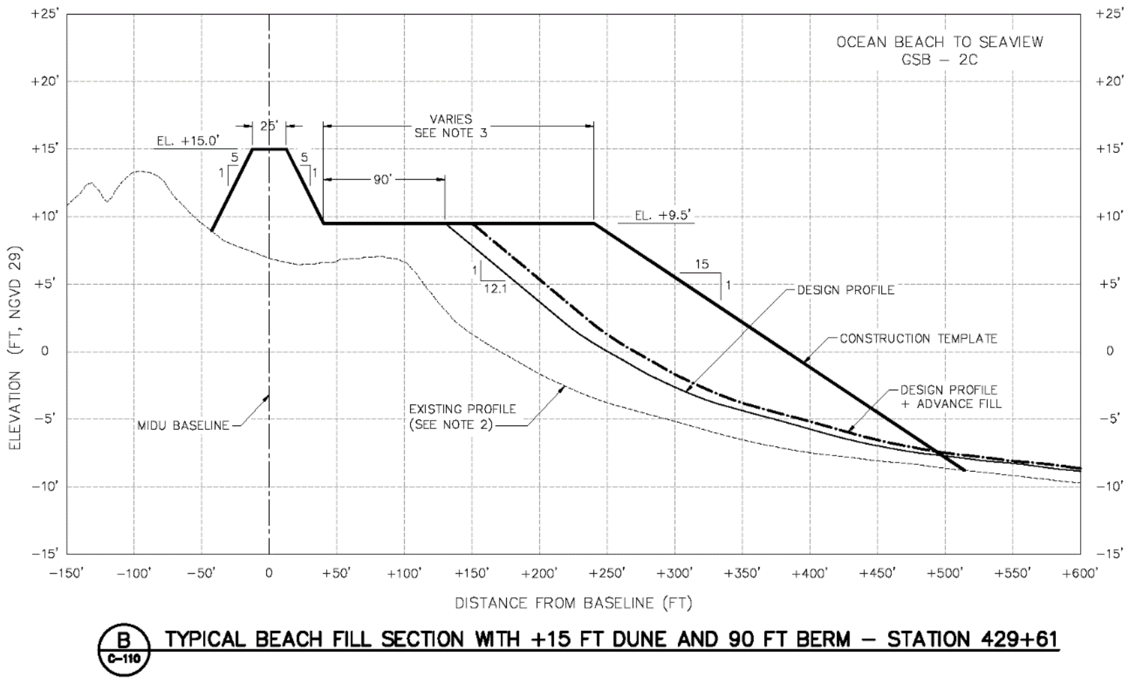


Figure 29. Beach fill Design Template

The Beach fill Plan includes taper (transition) to reduce end losses and increase the longevity of the fill. The taper lengths along Fire Island are consistent with the plans for FIMI. Tapers are accounted for in initial and renourishment volume estimates. In the major NPS Federal tracts (including the Otis Pike Wilderness area), the baseline will be allowed to migrate landward. Outside the Federal tracts the established FIMP dune alignment will generally be maintained, within an adaptive management framework.

6.5.1 Beach fill Plan – Initial Construction

With the exception of Cupsogue, all of the beach fill design reaches have been recently constructed or are under construction as part of FIMI Project or Westhampton Interim Project. Therefore, it is not possible to use the existing beach conditions to estimate initial construction beach fill volumes at the start of the FIMP project. Instead, initial beach fill volumes were estimated based on predicted sediment losses following the completion of the FIMI and Westhampton Interim Project. Placement of sand in the FIMI area will be deferred to the first nourishment cycle in year 4.

It is noted that advance fill was included in the design and construction of FIMI and the Westhampton Interim Project. Therefore, by restoring sediment losses, the initial construction estimates for FIMP indirectly include advance fill. All beach fill quantity estimates include advance fill, 15 percent overfill, and 15 percent for contingency/tolerance. A summary of the initial construction quantities for the Beach fill Plan is shown in Table 38.

Table 38. Beach fill Plan Initial Construction Quantities

Location	Subreach	Sediment Source	Fill Length (ft.)	Volume (cy)
Kismet to Lonelyville	GSB-2A	2C	8,900	deferred
Town Beach to Corneille Estates	GSB-2B	2C	4,500	deferred
Ocean Beach to Seaview	GSB-2C	2C	3,800	deferred
OBP to POW	GSB-2D	2C	7,300	deferred
Cherry Grove	GSB-3A	2H	3,400	deferred
Fire Island Pines	GSB-3C	2H	7,000	deferred
Water Island	GSB-3E	2H	1,600	deferred
Davis Park	GSB-3G	2H	5,000	deferred
			Fire Island Subtotal	**0**
Cupsogue	MB-2C	4C	2,000	156,000
Pikes	MB-2D	4C	9,600	232,000
Westhampton	MB-2E	4C	10,900	176,000
			Westhampton Subtotal	**564,000**
			Total	**564,000**

Notes: RMSP and SPCP-West are not shown here because the required fill material is coming from inlet dredging. Initial fill along Fire Island (1,582,000 Cubic yards) deferred to Year 4 with first renourishment event.

6.5.2 Beach fill Plan – Year 1 to Year 30

The required renourishment fill volumes have been computed based on representative erosion rates and expected renourishment interval of approximately every 4 years. The representative erosion rates were calculated based on the historical sediment budget, volumetric changes in measured profiles between 1988 and 2012, the performance of recent beach fill projects and anticipated beach fill spreading. All beach fill quantity estimates include advance fill, 15 percent overfill, and 15 percent for contingency/tolerance. A summary of the renourishment quantities for the Beach fill Plan is provided Table 39.

Table 39. Beach fill Plan - Renourishment Quantities Per Operation

Location[1]	Subreach	Sediment Source	Fill Length (ft.)	Volume (cy)
Kismet to Lonelyville	GSB-2A	2C	8,900	319,000
Town Beach to Corneille Estates	GSB-2B	2C	4,500	162.000
Ocean Beach to Seaview	GSB-2C	2C	3,800	134,000
OBP to POW	GSB-2D	2C	7,300	262,000
Cherry Grove	GSB-3A	2H	3,400	48,000
Fire Island Pines	GSB-3C	2H	7,000	500,000
Water Island	GSB-3E	2H	1,600	64,000
Davis Park	GSB-3G	2H	5,000	669,000
			Fire Island Subtotal	**1.897,000**
Cupsogue	MB-2C	4C	2,000	41,000
Pikes	MB-2D	4C	9,600	620,000
Westhampton	MB-2E	4C	10,900	468,000
			Westhampton Subtotal	**1,159,000**
			Total	**3,057,000**

[1]RMSP and SPCP-West are not shown here because the required fill material is coming from inlet dredging.

6.6 Sediment Management: Montauk Beach Feeder Beach

As part of the public and agency review there were a number of comments regarding the use of feeder beaches at Potato Road and Downtown Montauk. The objective of these project features was to provide a source of material to mitigate the erosive effect of the increase in sediment transport from east to west, and to place the material at locations where the fill would provide the maximum beneficial effects in managing coastal storm risks. At Potato Road, a number of the comments focused on the locally constructed beach nourishment project that has addressed the existing risks in this area, and public access concerns including the limited number of parking spaces and the requirements for public beach access. At Montauk a number of the comments focused on whether the volume of the proposed feeder beach was sufficient to keep the feeder beach in place for the entire proposed 4-year placement interval. The concern was whether there would be adequate sand to prevent the existing geotextile structure, that was placed as part of the Montauk Beach Stabilization project in 2015, from becoming exposed to damaging waves. Preventing exposure of that structure will also maintain a beach suitable for recreation. Other comments questioned why recreation benefits were excluded from the analysis of the feeder beach.

Following the release of the Draft GRR/EIS, the project team reassessed the feeder beach location and volumes. It was determined that the Potato Road feeder beach was no longer needed. The project team reassessed the length, width, and volume of fill to be placed at Montauk Beach utilizing the diffusion analysis that developed as part of the stabilization project. The diffusion analysis provides insight into how beachfill adjusts (erodes) over time in relation to the length and width of the fill area. The further seaward from the existing shoreline sand is placed the more quickly it will erode as wave energy becomes focused on this irregular shoreline. For the Montauk Beach area berm widths of 34 feet and 151 feet were evaluated using diffusion analysis and resulted in erosion rates ranging from 9.5 cubic yards per linear foot of shoreline per year (cy/lf/year) to 27 cy/lf/year.

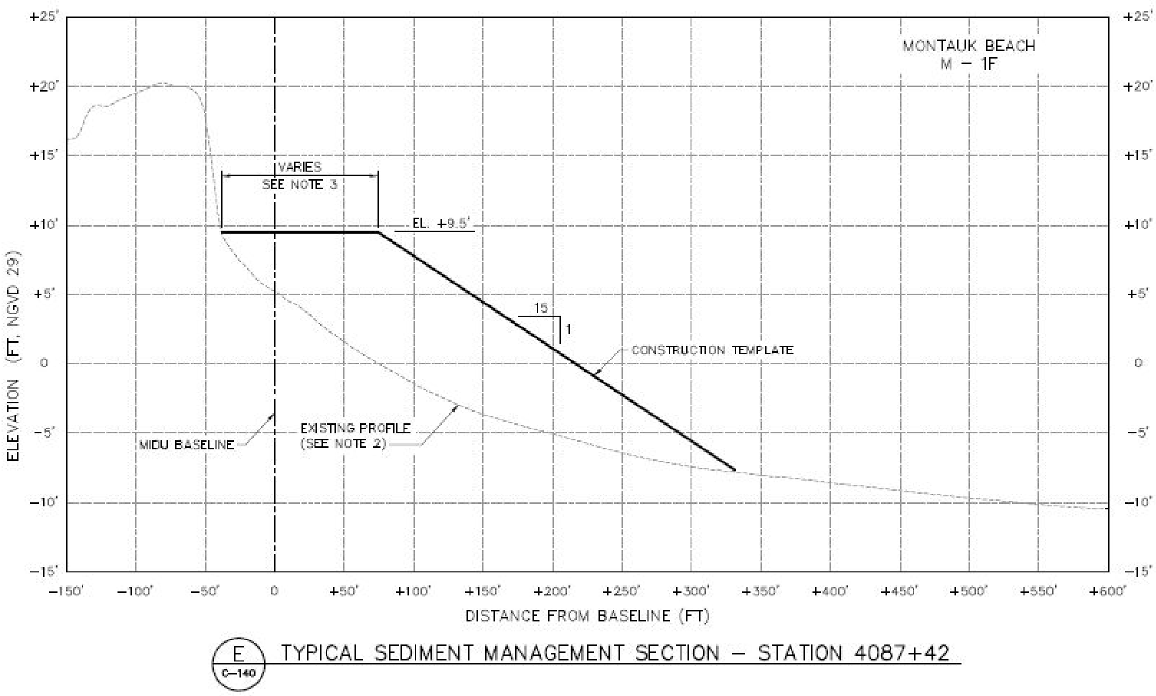
Alternative initial feeder beach volumes of 300,000 cubic yards, 450,000 cubic yards and 600,000 cubics yard were considered. The length of the fill was increased to 6,000 feet, which is the approximate length of the Downtown Montauk reach. Using an overfill factor of 10 percent and a fill density of 1.35 cubic yards per linear foot to add a foot of beach width (based on a 35 foot active profile), the three feeder beach fill volumes considered would add about 35 feet, 50, feet and 65 feet of beach width. These areas would erode fairly rapidly and the additional width provided by the feeder beach at the end of the four-year placement cycle would be negligible for the 300,000 cubic yards alternative, less than 10 feet for the 450,000 cubic yards alternative and less than 20 feet for the 600,000 cubic yards alternative.

These analyses concluded that placement of 400,000 to 450,000 cubic yards of beachfill at Montauk Beach is sufficient meet the design objective of providing a feeder beach on a 4-year nourishment cycle that is intended to provide sufficient sand into the system to maintain the existing natural berm width. The existing natural berm provides a reasonable level of risk reduction, and it is not cost-effective or economically justified to construct and maintain a larger, traditional beachfill project. The feeder beach is not designed to maintain a specific beach width, or to account for seasonal variability in the beach. It is also recognized the existing geotextile structures may periodically be exposed between fill placement actions.

The feeder beach is designed to work in conjunction with the existing geotextile bag structure constructed as part of the Downtown Montauk Stabilization. During design and implementation of the stabilization project, a portion of the existing geotextile bag structure was relocated seaward, in order to minimize real estate to be acquired for the project, in order to expedite construction. This re-alignment has resulted in a greater level of exposure of the bags, along this portion of the project. As part of the FIMP Project, the necessary real estate may be acquired landward of the structure to allow for the partial reconstruction of the geotextile revetment in a more landward, sustainable location.

As discussed, the feeder beach is not designed to provide any specific beach width nor to account for seasonal variability. The beach width is expected to vary seasonally and in response to storm events and long-term erosion. The construction template is a berm with a width of approximately 60 feet at an elevation of +9.5 feet NGVD 29. Based upon the expected erosional losses over the 4-year renourishment interval, this would provide sufficient volume of sand to offset the long-term erosion rate. The initial construction volume is estimated as 450,000 Cubic Yards. The renourishment volume is estimated as 400,000 Cubic yards every four years. These volumes are estimates and will be based upon site conditions at the time of construction, and revisited over time, based upon observed performance.

A typical section of the sediment management feature at Montauk Beach is shown in Figure 30.



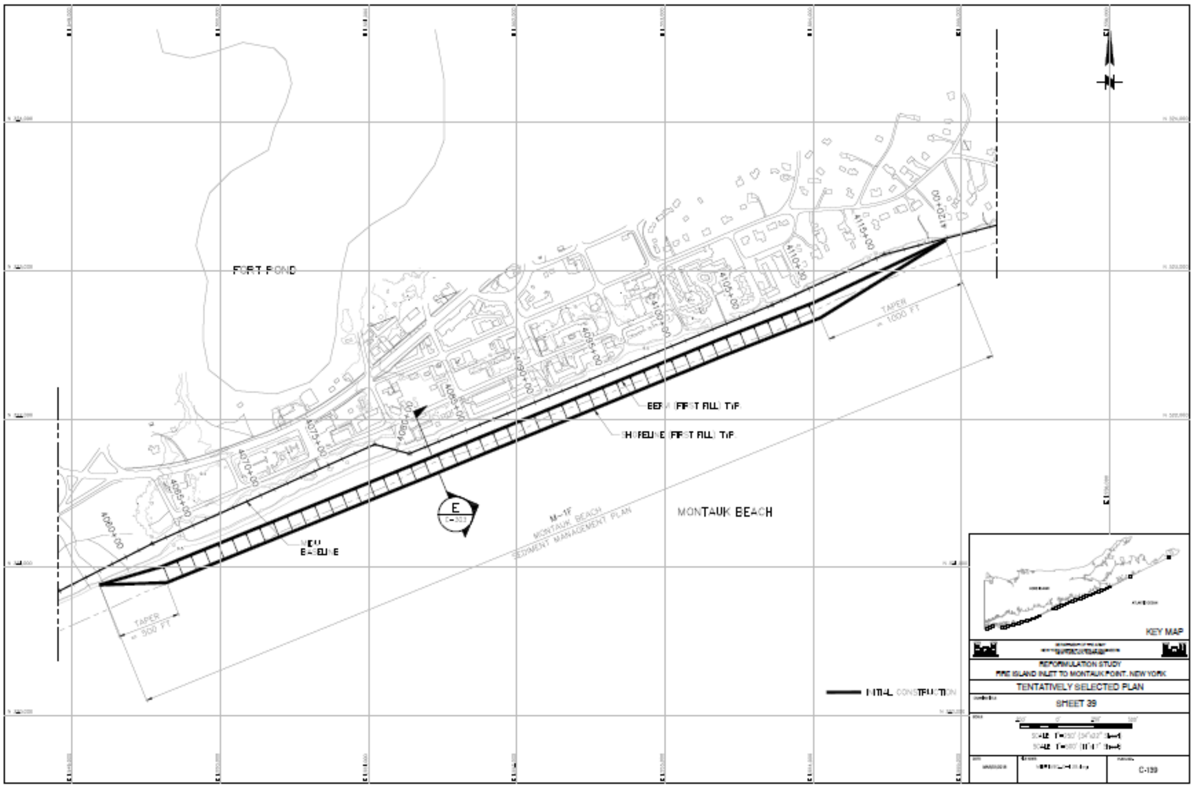


Figure 30. Montauk Beach Feeder Beach location and typical Sediment Management Construction Template

6.7 Groin Modification Plan

As part of the public and agency review there were comments objecting to the proposed modifications to the Westhampton Beach groins, including objections by the non-Federal sponsor. The modification of the Westhampton Beach groin field was removed as a project feature, based upon an updated cost analysis that indicated the benefits of groin modification did not outweigh the costs. In addition, the DOI requested that the mutually agreeable plan include the complete removal of the 2 groins at Ocean Beach. Although not incrementally justified, the policy exception granted by the ASA(CW) on October 11, 2017 provides for the complete removal of the Ocean Beach groins.

6.8 Coastal Process Features

A key objective of the FIMP project is to reestablish the natural coastal processes that have been impacted by past development of the barrier island, including: 1) Longshore transport, 2) Cross-island transport, 3) Dune growth and evolution, 4) Bay shoreline processes, and 5) Estuarine circulation and water quality. USACE has committed to achieving a “no net loss of habitat” resulting from construction of the project and has agreed to place an estimated 4.2 million cubic yards of sediment within CPFs, that will also include areas to offset potential endangered species impacts along the bayside shoreline. To achieve these objectives and to provide offsets for potential endangered species impacts and also provide CSRM benefits, the project includes 12 Barrier Island CPFs and two Mainland CPFs that are shown in Figure 31, and described in greater detail in Appendix I – Coastal Process Features.

Six of the 12 barrier island CPFs provide CSRM benefits and address the project goal of restoring the natural cross barrier island transport through sediment input into the back bays; four of the barrier island sites offset ESA impacts by providing habitat for the endangered piping plover; and two of the barrier island sites provide both CSRM and ESA functions. The two mainland locations provide CSRM benefits by acquiring 14 homes in low-lying areas and restoring the natural floodplain. Inclusion of the CPFs as project features was included in the policy exception granted by the Office of the ASA(CW) on October 11, 2017.

The dynamic nature and changing nature of the areas created related to the endangered species offsets makes it impracticable to accurately predict necessary elevations, planting locations and success criteria. As such, pursuant to P.L. 88-587, USACE has committed to generalized placement and natural dispersal of the sediment along the shoreline, along with natural plant recruitment that would mimic the natural processes within those areas. Sand placement at the CPF sites can be performed in coordination with re-nourishment cycles of the beach fill features, and will be subject to monitoring to ensure the project objectives are being met and in compliance with ESA Section 7 coordination. No vegetation management or manipulation of the sites will be completed by USACE, unless it is conducted as an incidental action associated with future sediment placement and subject to funding availability.

An interagency team consisting of federal, state and local agencies, as well as the landowner, will meet at least bi-annually (before and after the season). The team will discuss and make recommendations, among other things, on the:

1. physical monitoring of CPF processes;
2. biological monitoring of endangered species usage within the CPFs;
3. need for predator management for endangered species within the CPFs;
4. topographic management of CPFs will be addressed during the next scheduled renourishment cycle.

Detailed information about the interagency team is found in Appendix J – Monitoring and Adaptive Management Plan.

All CPFs would be implemented on federal lands under DOI's jurisdiction, or on non-Federal public lands. No permanent easements would be held by the state or local governments over private lands with respect to the CPFs.

As CPF sites are advanced to the PED phase, conceptual profiles for each CPF site that more accurately depict existing and proposed gradients at each site will be developed. Some locations for CPFs may be changed (some dropped, others added), and the type and/or configuration of CPFs selected may also change over time through adaptive management, if needed. PED efforts would consider if the scope of the current efforts should be revised, or if there are additional locations where these types of efforts would be warranted. In addition to stakeholder and community outreach, the PED phase will include field studies, surveys and data collection inputs to a more detailed design of CPFs. Accordingly, the concept-level plans included in this report simply illustrate the features to be achieved at the identified sites.

6.8.1 Barrier Island Coastal Process Features

The CSRM sites address the expected sediment deficit into the bay system from the implementation of the beachfill plan components. The expected reduction in the number of island breaches and overtopping events during the life of the project will reduce the amount of sediment and associated overwash fan habitat that would have been introduced into the bay system if the project was not in place. Based on the cross-island transport analyses, it is estimated that the total reduced sediment volume to the backbay system is approximately 4.2 million cubic yards of sediment over the 50-year period of analysis. This shortfall will be offset by placing sediment in the CSRM CPFs by taking into account the expected site-specific erosion rates at each CSRM CPF. Sand placement in the CPFs will be constructed in conjunction with the construction of other project features, and renourished when the beachfill features are nourished, currently estimated to be approximately a 4-year cycle.

The ESA CPFs seek to produce no net loss of habitat for ESA species of concern – specifically piping plovers. Both nesting and foraging habitat have been considered based on criteria established by the FWS during the plan development process. FWS criteria include, among others, shoreline slope, elevation, vegetation cover, buffers, and predator control. Each CPF has been evaluated for ESA offsets based on these criteria, and the total portfolio of CPFs provides the required total acreage offset as determined by FWS.

Specific criteria values under consideration include nesting habitat between elevations +4 and +9 feet NGVD 29, foraging habitat between the locally determined lowest astronomical tide (LAT) and highest astronomical tide (HAT) elevation, beach slope no steeper than 4 percent, vegetation coverage less than 17 percent to qualify for full credit, and various buffer distances based on the adjacent upland land cover.

ESA CPF construction activities include a combination of regrading existing on-site sand to meet the target slopes and elevations and devegetation of upland areas to meet the target cover goals. Regrading will occur through use of standard earthmoving equipment. Devegetation will occur either via mechanical processes or the targeted application of herbicides.

All barrier island CPFs will be evaluated for ESA offsets during the project's monitoring and adaptive management phase.

CPF initial construction will coincide with the adjacent beach fill initial construction. CPF maintenance activities are expected to follow the beach fill's anticipated four-year nourishment cycle. Adaptive management principles will be applied to the CPFs during each maintenance cycle, including CPF design criteria such as fill template elevations, and the need for living shoreline features.

Table 40 summarizes the recommended CPFs and identifies the sediment requirements for initial construction and for renourishment. The details for each of the 12 barrier island CPF sites provided in Appendix I – Coastal Process Features. The estimated sediment placement does not meet the 4.2 million cubic yards requirement over a period of 30 years. In order to meet the 4.2 million cubic yards requirements, USACE is committed to adaptive management of the project. The adaptive management will include the following considerations for achieving no net loss of habitat or sediment, and the 4.2 million cubic yards volume requirement:

1) Acknowledgement that “no net loss” is not just a matter of sediment quantity, but habitat type and extent. Site-specific objectives related to habitat type, extent, and location must be considered during design and construction of the CPFs.
2) Since inlet bypassing is recommended to continue for 50 years, renourishment of CPFs in proximity to inlet bypassing activities would continue beyond 30 years, and can achieve the quantity requirements, with no other modifications.
3) As part of adaptive management, the size and scope of each site will be revisited and assessed if additional quantity during renourishment would achieve the volumetric requirements.
4) There are several sites along Fire Island that were eliminated from consideration, due to land owner concerns. These sites could be revisited through the adaptive management process to achieve the sediment objectives.
5) If there is the need for a breach closure action, there is an opportunity to place an additional quantity of sand on the bay shoreline as part of this closure operation, which is not accounted for, and would increase the amount of sediment placed. The first option is currently included within the project cost estimate.

6.8.2 Mainland Coastal Process Features

The nonstructural plans have been updated to incorporate restoration of natural systems to create a more effective CSRM plan. In a letter dated October 11, 2017, the Assistant Secretary of the Army (Civil Works) concurred that the FIMP Mutually Acceptable Plan with the Department of the Interior may provide these features, stating: "Localized acquisition would be included in areas subject to high frequency flooding, with reestablishment of natural floodplain functions."

Working with partner agencies, USACE has identified two sites on the Mastic Beach Peninsula along the Long Island mainland (Figure 31) where the natural protective features are not functioning to reduce damages, or are functioning at reduced capacity and could be reestablished. Factors contributing to the reduced CPF functions may include but are not limited to: loss of the habitat feature through erosion or past human activities; encroachment of development; or ecosystem degradation, possibly attributable to excessive nutrient loading, invasive species, alteration of hydrology or sea-level changes. Although two sites are identified in this report, as part of the PED process for developing nonstructural alternatives, additional areas will be revisited to assess if acquisition may be warranted, or if the scale of the current proposal should be increased, based upon improved data, regarding ground elevation, building characteristics, and updated costs for the recommended measures.

For each site, USACE compared the cost of the currently proposed nonstructural retrofit plan to the cost of acquiring the properties to provide expanded CPF restoration opportunities. Preliminary concept level plans for re-establishing the protective features of natural areas at these locations have been developed. The mainland nonstructural CPFs would be implemented by the acquisition of buildings where the ground elevation is relatively low, and susceptible to very frequent inundation due to RSLC. The acquisition of these buildings provides a vacant area for reestablishing floodplain function. The mainland CPF sites also contain privately and publicly-owned vacant lands. Real estate interests will need to be acquired on these adjacent vacant lands, in order to provide a continuous, connected site for reestablishing floodplain function.

Figure 32 show the concept plan for the Mastic Beach 1 CPF. The details for both Mastic Beach 1 and Mastic Beach 2 provided in Appendix I – Coastal Process Features. For Mastic Beach 1, eight homes at or below +3.3 feet NGVD 29 have been identified for acquisition, while six homes at or below +3.3 feet NGVD 29 have been identified for acquisition in Mastic Beach 2. These plans will be further refined in the design phase to account for more specific site conditions.

For each site, USACE compared the cost of the nonstructural retrofit plan to the cost of acquiring the properties to provide expanded CPF restoration opportunities. Preliminary concept level plans for re-establishing the protective features of natural areas at these locations have been developed. The mainland CPF restoration concepts were developed to provide both CSRM benefits by providing a buffer to reduce wave energy and impacts to the developed areas and to provide sustainable natural habitats. There are two basic design profiles:

- Some parts of the sites have a typical tidal marsh profile, in which low marsh vegetation lines the shore within the intertidal zone between MLW and MHW. High marsh would be located at roughly the high tide line (HTL) and would extend to a little above mean higher high water (MHHW), with high marsh grasses found at the lower elevation in this zone and high marsh shrubs dominating the higher elevations. The high marsh shrubs would form a mosaic with upland forest species in the transition zone above tidal influence, yielding to a dominant upland forest community.

- Other parts of the sites currently have higher elevation areas along the shoreline. Although this may be from historic filling associated with development, removal of fill and lowering of the elevation would be counter to the intended objective of providing CPF. This existing condition gives a different profile of CPFs when viewed from the shoreline. At these locations a maritime forest community would border the shoreline, followed by a high marsh shrub, high marsh grasses and low marsh. The transition would be reversed leading to an upland forest community toward the mainland. Locations with interior tidal channels or creeks may have a similar profile.

Table 40. Proposed Barrier Island and Mainland Coastal Process Features

CPF Number	CPF Name	CPF Purpose	CPF Description	Construction Contract	Initial Volume (Cubic yards)	Renourish volume (4-year) (Cubic yards)
1	Democrat Point West	ESA	Regrade and devegetate; modify pond to improve functionality of existing wetland/create new foraging habitat; conserve on site sand volume.	FI Inlet bypassing	n/a	n/a
2	Democrat Point East	ESA	Regrade and devegetate bay side; modify sand stockpiles to form barrier between recreation and ESA areas; conserve on site sand volume.	FI Inlet bypassing	n/a	n/a
3	Dunefield West of Field 4	ESA	Devegetate ocean side; maintain vegetation buffer with road on north side.	FI Inlet bypassing	n/a	n/a
4	Clam Pond	CSRM	Bay side fill placement to simulate cross island transport; possible living shoreline on north side per adaptive management plan.	Fire Island Renourishment	deferred to Year 4	123,000
5	Atlantique to Corneille	CSRM	Bay side fill placement to simulate cross island transport.	Fire Island Renourishment	deferred to Year 4	162,000
6	Talisman	CSRM	Bay side fill placement to simulate cross island transport.	Fire Island Renourishment	deferred to Year 4	221,000
7	Pattersquash Reach	CSRM/ESA	Devegetate bay side; shallow water bay side fill placement; south boundary follows Burma Road alignment, includes physical barrier.	Moriches Inlet Bypassing	26,000	15,000
8	New Made Island Reach	CSRM/ESA	Devegetate bay side; shallow water bay side fill placement; south boundary follows Burma Road alignment, includes physical barrier.	Moriches Inlet Bypassing	133,000	29,000
9	Smith Point County Park Marsh	CSRM	Bay side marsh restoration; fill placement to simulate cross island transport; regrade marsh elevation filling ditches and creating channels for tidal exchange.	Moriches Inlet Bypassing	343,000	18,000
10	Great Gun	ESA	Devegetate ocean side parcel.	Moriches Inlet Bypassing	n/a	n/a
11	Dune Road Bayside Shoreline	CSRM	Bay side fill placement; bulkhead/groin removal; possible additional fill within offshore channel.	Shinnecock Inlet bypassing / PBRP	66,000	31,000
12	Tiana Bayside Park	CSRM	Bay side fill placement at east side of site; PED will determine fate of existing gabions.	Shinnecock Inlet bypassing / PBRP	48,000	47,000
				TOTAL VOLUME	**616,000**	**425,000**
MB 1	Mastic Beach 1	CSRM	Regrade and vegetate in conjunction with NS acquisition	Nonstructural Contract	n/a	n/a
MB 2	Mastic Beach 2	CSRM	Regrade and vegetate in conjunction with NS acquisition	Nonstructural Contract	n/a	n/a

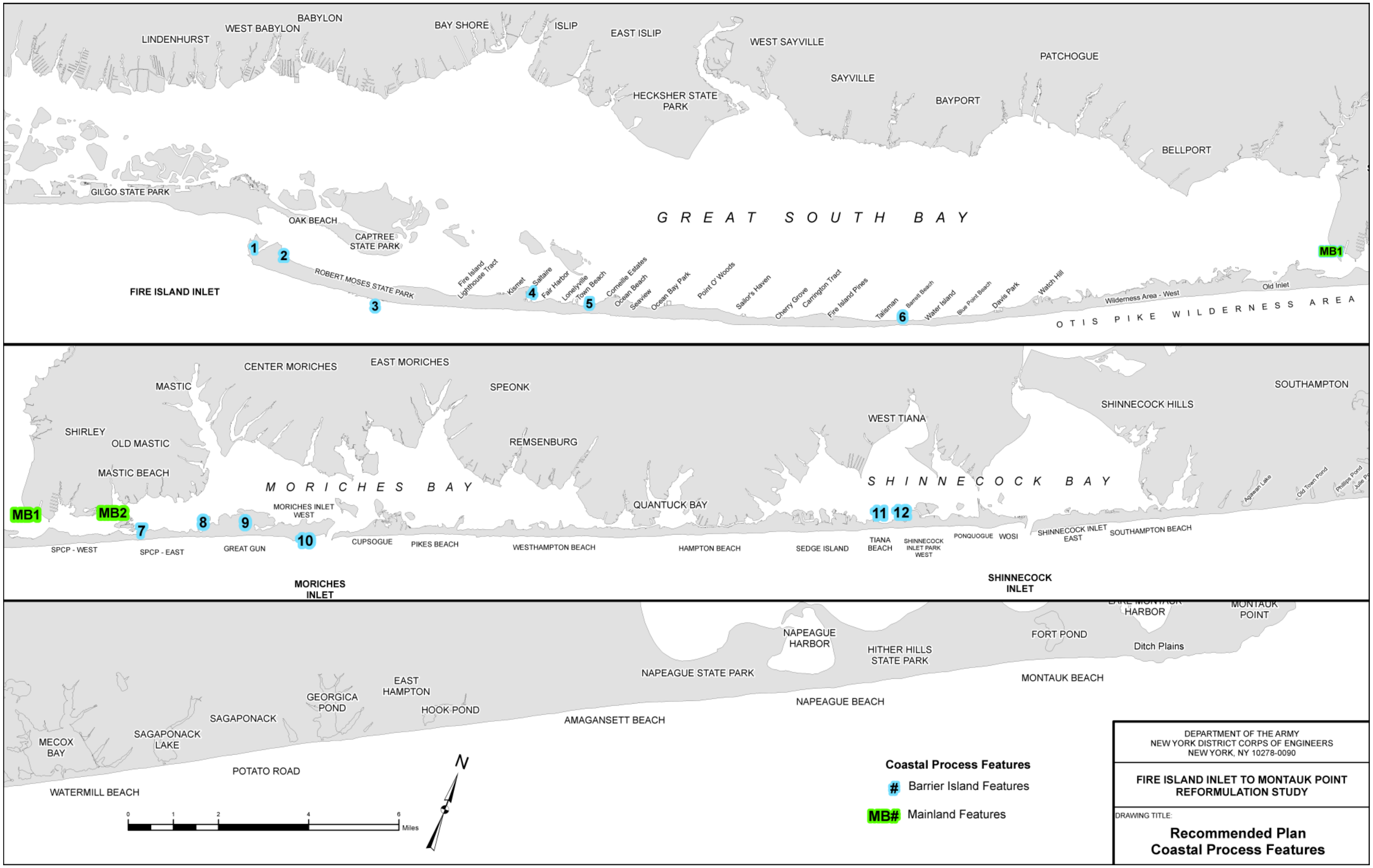


Figure 31. Location of Coastal Process Features

6.9 Monitoring and Adaptive Management

A MAMP is presented in Appendix J – Monitoring and Adaptive Management. This plan identifies and describes the monitoring and adaptive management activities proposed for the various features that comprise the FIMP Project and where possible, estimates their cost and duration. The MAMP will be further developed in PED phase as specific design details are made available. NYS, DOI, and other agencies will be participatory partners in finalizing the details included the MAMP.

Climate Change Adaptability

Climate change and variability, both observed and as projected for the future, are important drivers of change that may have significant impacts to project performance and residual risk. It is USACE policy to integrate climate change adaptation planning and actions into the agency's missions, operations, programs, and projects. The plan includes estimated costs for continuing construction in the future to account for RSLC projections. However, as part of adaptive management planning and finalization of the MAMP, the Adaptive Management Team will consult with USACE-internal and external experts to ensure that climate change is incorporated into the structured decision making included in the MAMP. A central part of doing so is recognizing the important role in climate change adaptability in achieving project goals in the long-term. The MAMP will be finalized in coordination with national USACE experts within the Flood Risk Management Program, Coastal Storm Risk Management Planning Center of Expertise, and Climate Preparedness and Resilience Community of Practice, as well as from outside the agency.

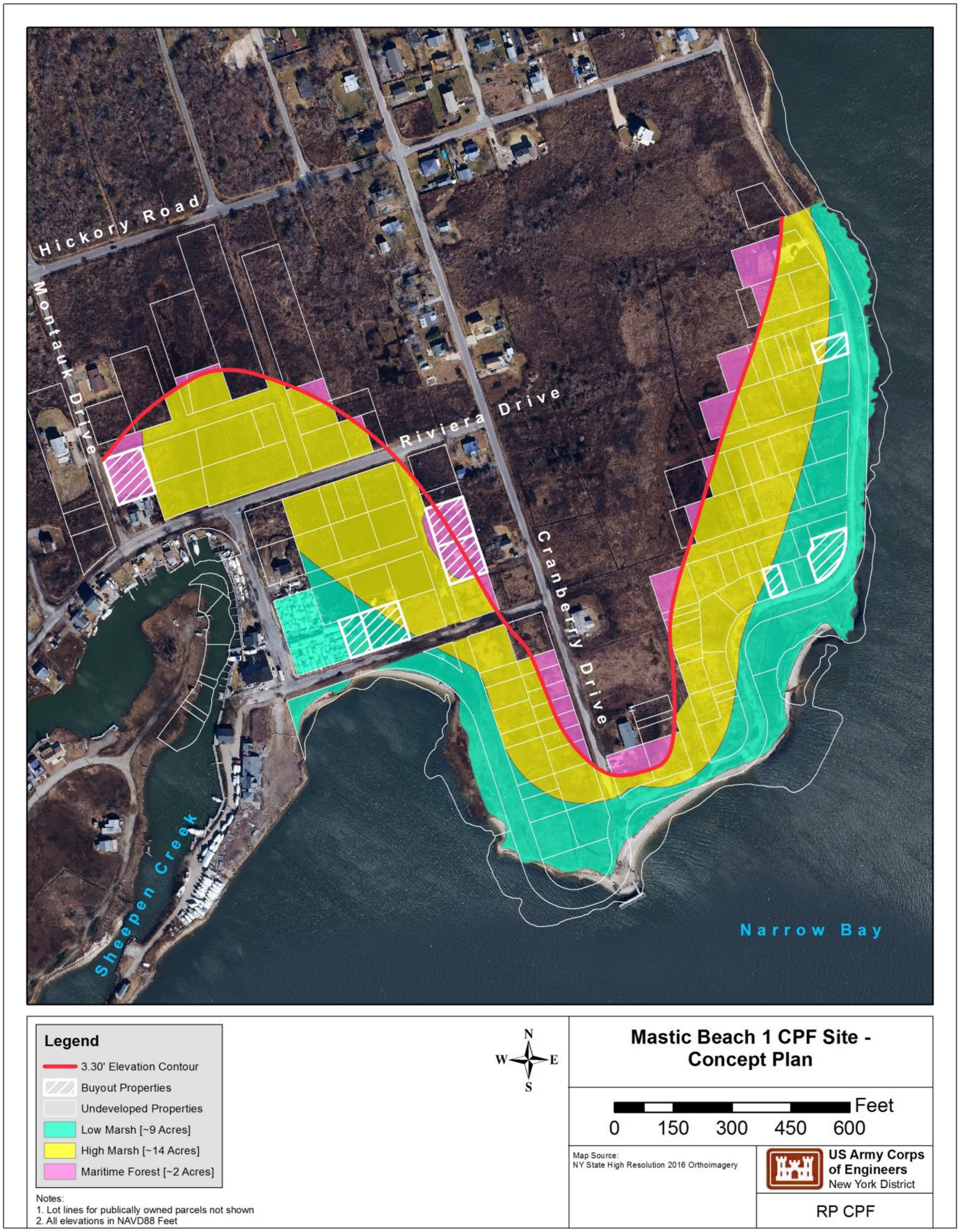


Figure 32. Mastic Beach 1 CPF Site – Concept Plan

6.10 Integration of Local Land Use Regulations and Management

The NPS enforces regulations regarding zoning and development within the boundaries of FIIS and is committed to working with municipalities on Fire Island to ensure their compliance with building and zoning codes. Development within municipalities outside FIIS have the same or similar building and zoning codes. Suffolk County municipalities participate in the National Flood Insurance Program, which provides requirements to reduce flood risk. Before construction of any USACE project for coastal storm risk management (CSRM), the non-Federal sponsor must agree to participate in and comply with Federal floodplain management.

Development restrictions exist within the easements for beachfill projects. These are enforceable restrictions. The proposed construction of the CSRM features, including a beach and dune will require the acquisition of permanent easements along the shorefront. These easements preclude future development on lands within the beach and dune footprint. These easements would be enforced by state and local authorities to ensure no development within the easements.

Additionally, within the study area there are existing land use regulations to address building and rebuilding in the high hazard areas along the coast. State and local agencies have authority to restrict development within shoreline areas through zoning or special district restrictions. While USACE has no authority to enforce other entities' laws and regulations, it does have authority to enforce FIMP project agreements and easements. Development restrictions exist within the easements that will be acquired for the project and these are enforceable restrictions. USACE can discourage development within the project area through annual inspections and monitoring of the completed project in accordance with the project's Easement Language, Project Partnership Agreement (PPA) and Operation, Maintenance, Repair, Rehabilitation and Replacement (OMRR&R) manual that are prepared in cooperation and coordination with the non-Federal sponsor and cooperating agencies.

USACE would monitor the enforcement of these easements through the Inspection of Completed Works (ICW) program to ensure that permanent easements identified for the project to function as designed, would remain undeveloped. Failure for these easements to remain undeveloped for the project life may result in the project being removed from the ICW program and also limit USACE's ability to renourish the project. A project that is removed from the ICW program is not eligible for federal disaster funding under P.L. 84-99 that provides for project repair (to design standards) as a result of a disaster declaration. These inspections and reporting would continue for the life of the project and to ensure enforcement of project agreements and responsibilities by all project partners. Outside of these project areas, USACE has no authority to require compliance with State or local laws and policies.

6.11 Environmental Consequences

Table 41 provides a summary of the environmental impacts of the Recommended Plan for each of the Resource areas considered to avoid, lessen, and compensate for any impacts. On Fire Island with the recommended coastal storm risk management features implemented, overwash will be less likely to occur in the communities, but more likely to occur in the unpopulated areas where only a conditional Breach Response Plan is provided.

Chapter 5 of the EIS discusses compliance and consistency of the Recommended Plan with major relevant policies including:

National Environmental Policy Act
- Fire Island National Seashore Act and General Management Plan
- Endangered and Threatened Species Act
- Coastal Barrier Resources Act of 1982 and Coastal Barrier Improvement Act of 1990
- Coastal Zone Management Act of 1972
- Section 106 of the National Historic Preservation Act of 1966, as amended
- Clean Water Act of 1977
- Clean Air Act of 1972
- New York State Coastal Erosion Hazard Areas Act

Table 41. Summary of Environmental Impacts of the Recommended Plan

Resource	Environmental Impact	Measures to avoid, lessen, mitigate or compensate for environmental impact
Topography, Land Formation, Key Geologic Characteristic	Potential for breaching/overwash will be reduced.	Coastal process features will enhance overall natural coastal processes
	Borrow Areas – bottom profile will be changed	Utilization plan is designed to minimize impacts on possible onshore movement of sediments. Recommended plan also provides for monitoring and adaptive management.
Water Resources	Temporary, short term increase in suspended sediments and turbidity in surface waters adjacent to project.	Any impacts would be minor and localized during construction.
	Increased barrier island stability and implementation of Breach Response Plan will reduce breaches, associated flushing of bay waters and related water quality improvements.	The Conditional and Wilderness Breach Response components of the RP, together with the OMRR&R dredging of the inlets and supplemental dredging of the ebb shoals will lessen the indirect impact to water quality.
	Temporary impact on DO at borrow sites	BMP to be utilized to minimize creation of anoxic zones

Resource	Environmental Impact	Measures to avoid, lessen, mitigate or compensate for environmental impact
Wetlands	Reduced risk of coastal storm damages to wetlands. Except for several CPF locations, the Recommended Plan would not directly impact any vegetated wetlands. The CPF material placement areas would mimic natural processes, including fill placement in the shallow estuarine waters and tidal wetlands in some locations of the back bay; however, the impact would be incurred over the 50-year period of analysis and would facilitate the natural formation of marshes and SAV beds. Net positive impact to estuarine and forested wetlands by reducing barrier island breaching and overwash.	Placement of 4.2 million cubic yards of sand on CPFs will ensure no net loss of sediment to the Bay side of barrier islands; direct material placement in wetlands would be minimized.
Vegetation	Net positive impact to vegetation communities by reducing the risk of coastal storm damages. The CPF component would offset the loss of sediment input to the bayside, simulating conditions for establishment of barrier island vegetation.	Implement BMPs during construction to avoid impacts to vegetation.
Fish and Wildlife	Temporary, short term disturbance during construction. Benefits associated with reduced storm impact to species and habitats and through CPFs.	Implement BMPs during construction to avoid impacts to wildlife. Have a process in-place for rescue of wildlife if necessary.
Rare Species and Habitats	Plants: Seabeach Amaranth – temporary construction impacts Birds: Piping plover – potential impacts, addressed through CPFs Not likely to adversely affect Red knot. No impacts to roseate tern are anticipated	Overall habitat suitability will likely increase along affected beachfront. Barrier island CPFs Sites will provide suitable habitat. Measures identified through USFWS coordination and detailed in the Biological Opinion (FEIS Appendix B) will be taken to minimize impacts. Monitoring and adaptive management and coordination with the USFWS will continue.

Resource	Environmental Impact	Measures to avoid, lessen, mitigate or compensate for environmental impact
Cultural	Potential adverse impacts to historic properties from nonstructural measures, use of borrow areas, sand placement areas, and construction of coastal processes feature sites.	Programmatic Agreement executed to identify historic properties, determine the effect to the properties by project elements, and determine and implement appropriate measures to avoid, minimize or mitigate any adverse effects.
Land Use and Development, Policy, and Zoning	Recommended Plan is consistent and supportive of Federal, state, and local land use planning and zoning mechanisms.	N/A
Recreational Resources	Placement of Beachfill would provide storm risk management to existing recreational uses by minimizing beach erosion and storm-induced breaching of barrier island and would have a positive impact on recreation-related economic activity.	N/A
Socioeconomic Conditions and Environmental Justice	By reducing risk of coastal storm damages, Recommended Plan will have positive impact on community services and economic conditions No Environmental Justice impacts	N/A N/A
Visual Resources	Insignificant short-term direct impacts	N/A
Transportation	By reducing the risk of coastal storm damages, the Recommended Plan would have a positive impact on transportation resources within study area.	N/A
Air Quality and Noise	The Recommended Plan would temporarily emit diesel fuel emissions during dredging and construction activities. Through protection of vegetation, consolidated approach to beach fill measures and reduced need for emergency responses, a net benefit to air quality is anticipated with the Recommended Plan over the long term.	The Recommended Plan will comply with the General Conformity requirement
	Construction activities would result in short-term minor increases in noise generation. No long-term significant impacts would occur.	N/A

6.12 Real Estate Requirements

This Section details the real estate needs for the construction of the new proposed elements for the project. Due to the breadth of real estate already acquired for the previously constructed projects subsumed into FIMP, those real estate interests will only be summarized.

I. **Fee (Standard Estate No. 1)** – The mainland coastal process features of this project includes the fee acquisition of fourteen residential structures encompassing approximately 2.73 acres of land within 14 parcels, held by 14 owners, 12 private and 2 public. As the fee acquisition of the properties is mandatory, P.L. 91-646 benefits may be available to property owners. See paragraph 12 for further detail. There is a questionable structure that may need to be acquired; details about this structure will be resolved in PED phase. In addition, there are 76.98 acres of vacant land within 212 parcels, held by 58 owners, being 2 public and 60 private, as well as approximately 9.62 acres within paper streets, which will need to be acquired to provide a continuous, connected site for reestablishing the floodplain function.

II. **Perpetual Beach Storm Damage Reduction Easement (Standard Estate No. 26)** – Perpetual Beach Storm Damage Reduction Easements must be acquired over approximately 826.48 acres of land, impacting 535 parcels, being 331 private and 204 public. The location of the Permanent Easements is identified in Exhibit B. Due to State of New York restrictions on the alienation of public land, requisite access to public lands will be authorized through Access Agreements. See paragraph 20(b) for further detail.

III. **Non-Standard Estates** – While no non-standard estates are currently proposed for use in real estate acquisition for the Project, there may be a need during PED to consider whether the use of the perpetual beach storm damage reduction easement is the best estate for the strictly ESA driven CPFs, being CPFs 1, 2, 3, & 10. There may be a need to change to fee acquisition or a non-standard estate. Given that CPFs 1, 2, & 3 are owned by the NFS, changing the estate for those does not make sense. CPF 10 is owned by Suffolk County. The State of New York has statutory restrictions on acquiring from public owners. This Real Estate Plan has addressed that restriction by stating access agreements would be used between the NFS and public owners, which has been done on prior projects. However, a fee acquisition would not be an option, which leaves a non-standard estate as the sole possible alternative to be considered in PED.

IV. **Nonstructural Floodproofing Agreement** – A Nonstructural Floodproofing Agreement (the Agreement) must be executed between the Sponsor and the property owner wherever nonstructural measures will be implemented. The purpose of the Agreement is twofold: to serve as a contract between property owner and government, and to restrict future development of the site below a stated elevation. Nonstructural building retrofit measures will be offered to owners of eligible structures on a voluntary basis. Structures identified as eligible will, in addition, have to meet the following criteria as will be determined during PED:

- Owner is willing to participate in the nonstructural program and execute a Floodproofing Agreement containing a restrictive covenant limiting development of the property below the determined elevation.

- Structure is safe, decent and sanitary condition
- Owner possesses clear title to the property
- Structure and appurtenant land is not contaminated with hazardous, toxic or radioactive waste or materials
- Owner does not owe taxes or other debts to any state or local government entity or to the Federal Government
- Owner has not previously received any disaster assistance for the elevation of the structure
- Property owner is willing to expend costs that may be necessary in connection with the elevation of the structure which are not eligible costs covered by the program. A list of non-eligible costs is included in Appendix M – Nonstructural Implementation.

Structures categorized within the voluntary program will be elevated or floodproofed only with the owner's consent. Where owners are willing to participate, but structures do not meet the program criteria, if cure is possible, owners will be afforded the opportunity to cure any defect in the structure, otherwise applications for ineligible structures will be denied.

Eminent domain authority will not be used to require landowners in this category to participate in the program; however, tenants who reside in structures to be elevated may be eligible for certain benefits in the accordance with Uniform Relocation Assistance and Real Property Acquisition Policies for Federal and Federally Assisted Programs of 1970. See 49 C.F.R. 24.101(a)(2) for additional detail.

Where owners of eligible properties elect to participate in the Project, the following process shall be implemented:

- Property owner deliver a completed application for structure elevation to the Project Partner. The application must be signed by all owners and lien-holders of the property and structure;
- Project Partner shall ensure property meets all eligibility criteria;
- Property owner shall submit to Project Partner proof of ownership and a current Elevation Certificate;
- Project Partner shall conduct a title search to verify clear title;
- Project Partner shall conduct a Phase I HTRW/asbestos investigation. All asbestos must be abated and disposed of properly.
- Floodproofing Agreement is executed by property owner and Project Partner and recorded with the county clerk.
- Elevation of structure is completed.

V. **Temporary Work Area Easement (Standard Estate No. 15) –** Temporary work areas may be necessary for this project but have not yet been identified. The need for temporary work areas will be identified during the Plans and Specs phase. The proposed temporary work areas are typically adjacent to land to be acquired for Project construction. These easements have also been identified as the appropriate easement in the future for the purpose of reactive or conditional breach response, where the construction is undertaken as a one-time action.

VI. **Borrow Area** – The Project proposes to nourish the beach using sand from the navigation inlets/ebb shoals, and also several offshore borrow areas located New York State waters. NYSDEC will provide USACE with authorization to use the Borrow Areas as a sand source through a New York Environmental Conservation Law Section 401 Water Quality Certificate ("WQC"). A permit will also be obtained from the New York State Office of Government Services (OGS). USACE has obtained water quality certificates from NYS DEC in support of other projects.

Table 42 summarizes the required Lands, easements and rights of way (LER) for the Project.

Table 42. Required Lands, Easements, and Rights of Way (Oct 2019 P.L.)

Required Interest	Required Acres	Acres Below the MHWM	Number of Parcels		Number of Owners		Acquisition Cost
			Private	Public	Private	Public	
Beachfill and Breach Contingency Plan							
Perpetual Beach Storm Damage Reduction Easement	826.48	149.42	331	178	312	10	**$57,803,718**
Nonstructural							
Nonstructural Floodproofing Agreement	N/A	N/A	4,432				**$0.00**
Rights-of-Entry	N/A	N/A	4,432				**$0.00**
Coastal Process Features							
Fee	79.71	0.00	127	85	72	4	**$5,317,050**
Perpetual Beach Storm Damage Reduction Easement	759.26	108.07	8	34	8	8	**$504,896**

Language to the recommended estates are provided in Exhibit "C", which are required to be included, as written, in the body of their respective easement agreement between the Sponsor and property owner. Since, as of this report, the Project is at a feasibility level study, the size of the real estate interests required are preliminary estimates based only on available Geographic Information System (GIS) data. The precise size and location of the required real estate interests will be determined during pre-engineering and design (PED) when plans, specifications and detailed drawings are prepared. As a result, the real estate requirements for the Project as identified in this REP are not final and are subject to change with project refinements and property boundary surveys.

Once the real estate requirements are finalized, prior to real estate acquisition, the Sponsor will need to obtain property boundary surveys with a corresponding legal description for each required easement to delineate the precise boundary and to mitigate against potential boundary disputes. Additionally, the Sponsor is advised to obtain a chain of title and title insurance on all acquired property to identify potential encumbrances and to protect against "defects" in title. A Subordination of Mortgage is required for all easements on properties that have an existing mortgage to ensure the easement will remain in effect in the event of a foreclosure. The Sponsor will need to work with property owners and their mortgage lender to sign an agreement allowing the mortgage to be subordinate to the easement.

Prior to project construction and USACE's Certification of Real Estate, all recorded easements (and Subordination of Mortgage Agreement if finalized) must be delivered to USACE with the Sponsor's Authorization for Entry for Construction. Easements acquired by the Sponsor must contain the necessary standard estate language and covenants to run with the land therein. In some instances, more than one estate is required over the lands of the same owner.

6.12.1 Appraisal

Consistent with USACE Real Estate Policy Guidance Letter No. 31 – Real Estate Support to Civil Works Planning Paradigm (3x3x3), the New York District as valued the real estate requirements through a cost estimate as the real estate costs will total less than 10 percent of the total project costs. A 20 percent contingency is added to the incidental costs of the project to account for uncertainty in progress of the real estate acquisition for a high-profile project, and the possibility that the need for condemnation may arise.

Appraised of the required LER $63,625,664
Date of Value .... January 11, 2019

6.12.2 LERRD Owned by the Non-Federal Sponsor

The non-Federal sponsor, the State of New York via NYSDEC owns 674.67 acres of land required for the Project, including lands below the mean high water line. In addition, NYSDEC served as the non-Federal sponsor on the previously constructed Federal projects in this area. The lands acquired for the previously constructed projects are held by NYSDEC's local sponsor, the County of Suffolk. The County of Suffolk owns 610.80 acres of land required for the Project, including lands previously acquired for Federal projects. Other local sponsors for this Project are the Towns of Babylon, Brookhaven, East Hampton, Islip, and Southampton who collectively own 147.71 acres of land required for the Project. The non-Federal sponsor and local sponsors shall not receive credit for lands acquired for previously constructed projects. Similarly, the non-Federal sponsor and local sponsors shall not receive credit for publicly owned lands required for the Project.

6.12.3 LERRD and Incidental Costs

The following is a summary of the costs for the Lands, Easements, Rights-of-Way, Relocations, and Disposals ("LERRD") required for new elements of the Project:

a. The Project's total real estate costs is captured in the Project's 01-Lands and Damage cost account and amounts to approximately $153,276,565, which includes Federal and non-Federal costs.
b. The Project's LERRD costs is approximately $69,870,768. LERRD costs account for the Sponsor's upfront costs and consists of the non-Federal costs provided in the 01-Lands and Damages and the 02-Relocations cost accounts. LERRD is the Sponsor's responsibility to perform (in accordance with the PPA) prior to project construction.

The following is the Sponsor's estimated creditable LERRD costs:

LERRD Costs	
LER	$67,770,768
Relocations	$2,100,000
Disposals	$0.00
Total LERRD	***$69,870,768***
Incidental Costs	$37,139,831
Total Creditable Project Costs	**$107,010,599**

The 20 percent contingency is added to the overall real estate costs excluding the Land Payments, and is shown in line item 01B1 of each contract's the BCERE because a contingency for Land Payments is separately provided in the appraisal cost estimate.

The following is a summary of the incidental costs and related contingency costs by contract:

Contract	Incidental Costs	Incidental Cost Contingency	Total
1	$7,500	$1,500	$9,000
3	$12,109,740	$2,831,948	$14,941,688
4	$3,938,409	$1,053,682	$4,992,091
Mainland CPFs	$4,771,982	$1,304,396	$6,076,378
Nonstructural	$48,752,000	$9,750,400	$58,502,400
Total	**$69,579,631**	**$14,941,926**	**$84,521,557**

6.13 Monitoring and Adaptive Management

The detailed Monitoring and Adaptive Management plan is provided in Appendix J – Monitoring and Adaptive Management, which includes coastal engineering and biological monitoring that begins during the preconstruction design phase and continues into the future. These actions are typical of USACE coastal projects to measure project success through the completion of pre- and post-construction monitoring, execute continuing construction, verify the effects analysis described in the FEIS, and comply with regulatory provisions. In addition, monitoring is needed to meet the requirements of mutual acceptability. As part of this project, the MAMP commits to a formal decision-making process, involving the agencies and stakeholders, to reduce the uncertainty of the proposed actions, and improve the quality of the decisions being made as part of continuing construction.

The details of the plan will be updated in coordination with NYS, DOI, and other partners during PED. The estimated cost of the biological monitoring over 50 years is approximately $110,331,000, while the estimated cost of the physical monitoring is about $88,916,000 (FY20 P.L.). Both of these costs are included in the continuing construction costs for renourishment. On an annualized basis, the annual costs of biological and physical monitoring are approximately $2,326,000 and $1,805,000, respectively (FY20 P.L.).

6.14 Project First Costs

For the detailed cost estimate, project quantities were developed for both the initial construction and future renourishment and assumed the intermediate RSLC projection. The cost estimate was compiled using the Micro-Computer Aided Cost Estimating System, Second Generation (MCACES 2nd Generation or MII). Dredging costs were calculated using USACE's Dredge Estimating Program (CEDEP). The detailed cost estimate for the Recommended Plan is a based on combination of MII's Cost Book, estimator-created site-specific cost items, local subcontractor quotations, and local material suppliers' quotations.

The individual components in the cost estimate are outlined in Appendix C – Cost Engineering. Cost contingencies were developed through a standard Cost and Schedule Risk Analysis (CSRA). Table 43 shows the Total Project Cost Summary of the initial construction and subsequent renourishment/breach response and monitoring.

Table 43. FIMP Total Project Cost Summary in $1,000 (Oct 2019 P.L.)

WBS	Feature	Cost	Contingency	Total Cost
06	FISH & WILDLIFE FACILITIES	$793	$240	$1,033
10	BREAKWATER & SEAWALLS	$3,954	$1,197	$5,151
17	BEACH REPLENISHMENT (Initial Beachfill Only)	$81,510	$24,665	$106,175
17	BEACH REPLENISHMENT (Initial CPF Only)	$18,507	$5,600	$24,107
18	CULTURAL RESOURCE PRESERVATION	$11,545	$3,493	$15,038
19	BUILDINGS, GROUNDS & UTILITIES	$655,613	$198,388	$854,001
	CONSTRUCTION ESTIMATE TOTALS:	**$771,922**	**$233,584**	**$1,005,506**
01	LANDS AND DAMAGES	$127,730	$25,546	$153,277
30	PLANNING, ENGINEERING & DESIGN	$224,492	$67,931	$292,423
31	CONSTRUCTION MANAGEMENT	$69,688	$21,088	$90,776
	PROJECT COST TOTALS:	**$1,193,832**	**$348,148**	**$1,541,981**
	Renourishment/Monitoring/Breach Closure Costs			
06	FISH & WILDLIFE FACILITIES	$86,137	$26,065	$112,202
17	BEACH REPLENISHMENT (Breach Closure Costs)	$78,248	$23,678	$101,926
17	BEACH REPLENISHMENT (Beachfill Renourishment)	$629,762	$190,566	$820,328
17	BEACH REPLENISHMENT (CPF Renourishment)	$124,724	$37,741	$162,466
17	BEACH REPLENISHMENT (SLC Adaptation)	$20,629	$6,242	$26,871
	E&D and S&A			
30	PLANNING, ENGINEERING & DESIGN	$140,916	$42,641	$183,558
31	CONSTRUCTION MANAGEMENT	$60,267	$18,237	$78,503
	RENOURISHMENT COST TOTALS:	**$1,140,683**	**$345,171**	**$1,485,853**

6.15 Periodic Renourishment/Breach Response Costs

The estimated post-construction costs (Oct 2019 PL) for periodic renourishment, breach responses, and physical and biological monitoring are $1,485,853,000. As discussed in Section 6.5.2, renourishment is expected to take place about every 4 years until year 30. The first renourishment is expected to take place in year 4 with about 7.4 million cubic yards to be placed. Approximately 5.5 million cubic yards would be placed for each of the following 4 cycles (Years 8, 12, 16 & 20), while about 8.2 million cubic yards place would be placed in the last 2 cycles (Years 24 and 28). The subsequent six cycles would be sand placement associated with the sand bypassing of the three Inlets. (See Appendix A- Engineering and Appendix C – Cost for additional details).

Also included in the renourishment costs are sand placement in the CPFs to achieve the 4.2 million cubic yards of sand required to offset the loss of sand in the back bays. As discussed in Section 6.8, the sand placement in the CPFs would be performed in conjunction with a renourishment cycle. Also included are breach response costs based on simulations of reaching the proactive breach triggers and also the occurrence of breaches requiring a breach response. Since the costs were originally developed for the historic rate of SLC, annual adaptation costs of $643,000 were also included for the intermediate rate of SLC. Biological monitoring and physical monitoring costs will be funded in conjunction with the 13 cycles of sand placement over 50 years are also included in the estimate.

6.16 Major Rehabilitation

Major rehabilitation costs are for restoring the design profile due to significant storm events beyond those that were designed for in the renourishment cycle. The threshold at which major rehabilitation costs are incurred in based on the storm event that causes the erosion volume to exceed 145 cubic yards/linear foot along the beach front. This is the average renourishment volume anticipated to be available at the midpoint of the renourishment cycle because the significant storm event has a 50 percent chance of occurring earlier or later than the cycle midpoint. The estimated total annualized major rehabilitation costs, which are included as cost-shared costs, are $1,893,000 as shown in Table 45 and in Appendix C – Cost Engineering.

6.17 Operations and Maintenance

The Operation, Maintenance, Repair, Replacement and Rehabilitation (OMRR&R) requirements are included in Appendix K – OMRR&R, which identifies the responsibilities of the non-Federal sponsor(s) under the Project Partnership Agreement (PPA) to ensure that the project is maintained to perform during extreme events. It includes the requirements for maintaining the dunes, beaches and groins and for performing periodic inspections and beach monitoring. The estimated annualized OMRR&R costs are $677,000 as shown in Table 45 and in Appendix C – Cost.

Local interests, including Beach Erosion Control Districts, could supplement the beach fill provided by the project, particularly after year 30, to maintain the design template. Such activities should be coordinated with USACE and the non-Federal sponsor to ensure no violation of environmental regulations. Fill greater than the design template would be considered on a case by case basis and would be subject to the regulatory permit process.

6.18 Residual Damages under the Recommended Plan

The evaluation of damages for all the alternatives and the Final Array of Plans was performed by modifying various inputs to the FWOP damage analysis. Each of the measures included in the Recommended Plan reduced annual damages as described below. Inlet Bypassing primarily reduces storm damages by reducing long term erosion rates. The impact of nonstructural plans is to alter damages to the individual structures and reduce the aggregate damages occurring at each flood stage. Figure 33 provides a sample stage vs damage relationship comparison with and with-out the nonstructural measures for Reach 17.1 which contains about 325 structures located in Moriches Bay. It is important to note that the nonstructural measures that target the more frequently flooded structures have the greatest impact at the lower flood stages. Even though the first-floor structure itself may be elevated above the flood levels, the building foundation and other property such as cars, garages, and outbuildings will still be flooded and will suffer damage.

The various breach response measures contained in the Recommended Plan reduce storm damages in several ways. The Recommended Plan provides for accelerated breach closures relative to the FWOP condition. By responding and closing breaches more rapidly the breach dimensions will be smaller, allowing the closure to be completed more quickly and at lower cost. By reducing the length of time that a breach is open, there is also a reduction in the potential for higher water levels and flood damage in the bays. The Proactive Response Measures will reduce the likelihood of a breach occurring at those locations and therefore reduce the number and cost of breach closure activities as well as flood stages in the bay.

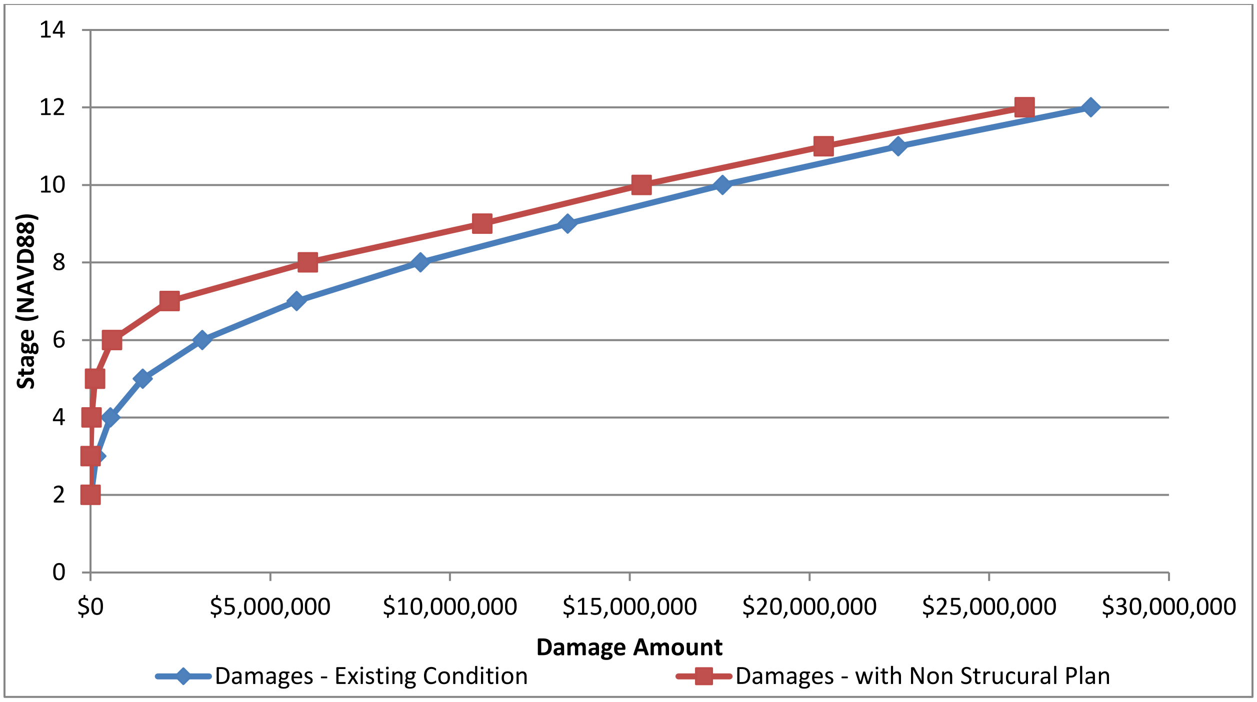


Figure 33. Average Stage Damage Comparison for Reach 17.1

The placement and maintenance of beach and dune nourishment provides direct reductions in wave propagation and erosion distance for the properties along the ocean shorefront, reduces the volumes of barrier overwash, which in turn reduces flood stages in the bays and the potential for breaching of the barrier islands. The placement of beach nourishment or feeder beaches will offset long term erosion at the placement site and reduce long term erosion rates in the downdrift areas.

Table 44 provides a summary of the FWP and FWOP damages for the project area, based on the low RSLC projection. Overall the average annual damages are reduced from $206,096,000 to $100,008,000 with the Recommended Plan in place. Under the existing conditions (FWOP), most of the damages ($166,673,000) are due to tidal inundation with about 83 percent of those damages due to inlet conditions and wave setup in the backbays, and 17 percent associated with storm breaches and overwash. Damages to the Mainland comprise $142,100,000 of the $166,673,000 in damages from storm surge inundation. Total Breach Open damages, shorefront damages (includes damages from erosion, and wave damage), and emergency costs associated with breach closure comprise the other $39,423,000 in damages. The Wilderness area breach is considered a permanent feature and impacts flood levels throughout the project lifecycle.

Table 44. Summary of Without and With Project Damages (Low RSLC Projection) (October 2019 P.L.)

Damage Category	**FWOP Equivalent Annual Damage**	**With Project Equivalent Annual Damage Recommended Plan**
Total Project		
Storm surge Inundation occurring due to inlet conditions and wave setup in back bay		
Mainland	$118,511,000	$48,115,000
Barrier Island	$20,494,000	$19,827,000
Total	*$139,005,000*	*$67,942,000*
Storm surge Inundation occurring due to storm breaching and overwash		
Mainland	$23,589,000	$9,577,000
Barrier Island	$4,079,000	$3,946,000
Total	*$27,668,000*	*$13,523,000*
Total Mainland Inundation	*$142,100,000*	*$57,692,000*
Total Barrier Island Inundation	*$24,573,000*	*$23,773,000*
Total Inundation	*$166,673,000*	*$81,465,000*
Damages from Inundation due to a breach remaining open		
Inundation (Open Breach at Wilderness Area)	$9,436,000	$9,436,000
Inundation (Future Breaches)	$10,902,000	$297,000
Total Breach Open Damages	*$20,338,000*	*$9,733,000*
Shorefront Damages (includes damages from erosion, and wave damage)	$15,795,000	$7,217,000
Emergency Costs/Breach Closure	$3,290,000	$1,593,000
Total Damage	***$206,096,000***	***$100,008,000***

October 2019 PL, Discount Rate 2.75 percent, Base Year 2028, Period of Analysis 50 years

Under the With Project Condition, damages due to tidal inundation are reduced to $81,465,000 with about 71 percent of those damages due to inlet conditions and wave setup in the backbays, and 29 percent associated with storm breaches and overwash. Remaining residual damages to the Mainland under the with-project condition comprise $57,692,000 of the total $81,465,000 in residual damages from storm surge inundation. Total Breach Open damages, shorefront damages (includes damages from erosion, and wave damage), and emergency costs associated with breach closure comprise the other $18,543,000 in remaining residual damages. The reduced likelihood and duration of future breaches relative to the permanent opening at the Wilderness Breach results in lower damages over the lifecycle. The Recommended Plan reduces about 60 percent of the damages in the back bay, with about 40 percent in residual risks remaining. It also reduces damages associated with breaches remaining open. Shorefront damages are reduced by about 54 percent, with about 46 percent in residual risks remaining.

6.19 Actions by Others

State and local agencies, and private interests have undertaken coastal storm risk management and erosion control work in the study area for many years. Activities such as beach nourishment, dredging, and the construction and modification of groins and other coastal features by local interests have modified the landscape. It is acknowledged that local interests will continue to undertake such work in the study area.

In order to ensure that USACE projects such as project continue to provide their intended benefits to the public, Congress mandated that any use or alteration of a USACE Civil Works project by another party is subject to the approval of USACE. This requirement was established in Section 14 of the Rivers and Harbors Act of 1899, which has since been amended several times and is codified at 33 USC 408 (Section 408). Section 408 provides that USACE may grant permission for another party to alter an USACE Civil Works project upon a determination that the alteration proposed will not be injurious to the public interest and will not impair the usefulness of the Civil Works project.

State and local agencies should consult with USACE about any proposed work to ensure compliance with 33 USC 408 (Section 408), and project-related requirement set forth by Federal and state agencies (i.e., Biological Opinion). Such proposed work may include beach nourishment; dune construction; modification of beach dimensions (e.g., removal of escarpments, scraping, raking); dredging; construction or removal of dune fencing; and the construction and modification of jetties, groins, outfall pipes, and other coastal features. Depending on the nature and scope of proposed work, local interested may also need to coordinate with other regulatory agencies such as NYSDEC for applicable permits.

7 ECONOMIC ANALYSIS OF THE RECOMMENDED PLAN

7.1 Annualized Costs

The prior Chapter provided the basis for the initial project cost and also the cost of periodic nourishment/breach response over the 50-year period of analysis. Table 45 shows the annualized project cost The IDC is calculated by computing interest at the applicable project discount rate on the monthly expenditures from the start of detailed design to the completion of the project. The specific calculation of the IDC is found in Appendix C – Cost.

Also shown in Table 45 are the amortized costs of the 30 years of periodic nourishments of the project, breach responses over the 50-year period of analysis, and physical and biological monitoring over the 50-year period of analysis, under the intermediate RSLC projection. Also included in the Total Annualized Cost are the amortized costs of Operations and Maintenance and major rehabilitation, as discussed in Sections 6.16 and 6.17. Please note the annualized costs are shown assuming the intermediate rate of RSLC.

Table 45. Annualized Project Cost (Oct 2019 P.L.)

Project First Cost	*$1,541,980,700*
IDC	$28,372,100
Total Investment	*$1,570,352,800*
Annualized Investment Cost*	$58,167,000
Periodic Renourishment for 30 years	$20,738,000
Inlet Bypassing+	$9,336,000
Proactive Breach Response	$636,000
Breach Closure	$1,162,000
Coastal Engineering Monitoring	$1,805,000
Environmental Monitoring	$2,326,000
OMRR&R	$677,000
Emergency Beach Fill	$1,893,000
RSLC Adaptation	$643,000
Project Annual Cost *	**$97,383,000**

* Annualized over the 50-year period of analysis using the federal discount rate of 2.75 percent, Oct 2019 price level

7.2 Annualized Benefits

The project benefits shown in Table 46 are a combination of reduced storm damages, future costs avoided, increased recreation use value and non-federal renourishment cost avoided, under the intermediate RSLC projection.

Storm damage reduction is simply the difference in the expected annual damages with and FWOP costs avoided benefits include the full value of FWOP breach closures. With project breach closures are considered a part of the project costs. Also, non-federal interests currently place an average of 234,000 cubic yards of sand/year on Fire Island. The annualized cost over the 50-year period of analysis is about $3,143,000. With the project in place these costs would no longer be incurred; hence the cost avoided benefit.

Recreation benefits are based on recreation use and contingent valuation surveys and reflect both the higher values per visit at renourished beaches and the increase in the number of beach visitors. Benefits have only been evaluated for locations that will be receiving both initial and renourishment fill, specifically the community beaches and Smith Point County Park on Fire Island. Because the renourishment fill is only anticipated to be provided for a period 30 years, the total present value of recreation benefits for the 30-year renourishment period have been multiplied by the 50-year capital recovery factor to provide an equivalent annual value over the 50-year period of analysis.

Table 46. Summary of Annualized Benefits (October 2019 P.L.)

Plan Summary	Recommended Plan
Cost Avoided – Breach Closure	$4,489,000
Benefits – Breach Open	$34,765,000
Total Breach Closure Benefits	$39,254,000
Benefits – Back Bay Inundation	$139,316,000
Benefits – Shorefront	$8,662,000
Total Storm Damage Reduction Benefits	*$182,743,000*
Non-Federal Renourishment Cost Avoided	$3,143,000
Recreation Benefits	$25,731,000
Total Benefits	**$216,106,000**

Notes:
1. Price Level 2019. Benefits Annualized over the 50-year period of analysis using the federal discount rate of 2.75 percent.
2. Benefits assumed 2028 base year.

7.3 Feasibility Assessment

An economic comparison of the annual costs and benefits as presented in Table 47 demonstrates that the NED Plan is a feasible Coastal Storm Risk Management Solution. With Net Benefits of $118,723,000 per year and a Benefit to Cost ratio of 2.2, the Recommended Plan in this provides a feasible solution that meets the planning objectives and NED criteria.

Table 47. Feasibility Assessment (October 2019 P.L.)

Annual Benefits	$216,106,000
Annual Costs	$97,383,000
Net Benefits	$118,723,000
BCR	2.2
Economically Justified	**Yes**

Discount Rate 2.75 percent, Period of Analysis 50 years, Price Level October 2019

7.4 Sensitivity Testing

7.4.1 Relative Sea Level Change

ER 1165-2-8162 and EP 1100-2-1 require that proposed alternatives should be formulated and evaluated for a range of possible future relative RSLC projections. The USACE "low," "intermediate," and "high" RSLC projections correspond over the period of analysis (2028 – 2078) to 0.64 feet, 1.18 feet, and 2.90 feet from 2028 – 2078, respectively. Considering the 100-year adaptation horizon (2028 – 2128), RSLC is expected to increase by 1.28 feet, 2.81 feet, and 7.66 feet under the low, intermediate, and high rates of RSLC projections, respectively.

Table 48 compares the project costs, benefits and residual damages for Recommended Plan under the baseline RSLC with the intermediate and high rates derived from modified National Research Council (NRC) Curves I and III. For this study the estimated intermediate and high rates 1.18 foot and 2.81 foot increases, respectively over the 50-year period of analysis.

HEC-FDA was utilized to calculate the equivalent annual damages under the three RSLC projections. The initial and renourishment costs shown below are the same under the three RSLC scenarios. The additional costs attributed to differences in RSLC are reflected in the proactive and reactive breach response costs and are also included under RSLC adaptation. The RSLC adaptation captures the additional renourishment required in the Beach fill Plan to offset losses from RSLC based on the Bruun Rule, this also accounts for increasing the height of the berm and dune, to account for corresponding increases in RSLC. The table below illustrates that the annual renourishment cost would increase by $643,000 under the intermediate rate of RSLC, and increase by $3,112,000 under the high rate of RSLC. These volumes represent a 3% and 15% increase, respectively, and account for renourishment over the first 30 years of the project. The cost estimates show a much greater change in breach response costs under the intermediate and high rate of RSLC. Taken collectively, there is an increased annual cost of $323,000 for breach response under intermediate RSLC, and an increased annual cost of $1,868,000 under the high rate of RSLC, which represent an increase of 18% and 130% respectively.

The total annualized project benefits would increase from $136,555,000 under the low RSLC projection to $216,106,000 under the intermediate RSLC projection, and to $854,824,000 under the high RSLC projection. Storm risk reduction benefits account for essentially all of the increase in benefits. The residual damages would also increase from $98,416,700 under the low RSLC projection to $121,590,000 under the intermediate RSLC projection, and to $427,478,000 under the high RSLC projection. Net benefits would increase from $40,089,100 under the low RSLC projection to $118,723,000 under the intermediate RSLC projection, and to $753,242,000 under the high RSLC projection.

Table 48. Cost, Damages and Benefits Summary for RP with SLC Scenarios (October 2019 P.L.)

	Project Feature	Selected Plan		
		Low RSLC[1]	Intermediate RSLC[1]	High RSLC[1]
Initial Cost	06 Fish & Wildlife Facilities	$1,033,300	$1,033,300	$1,033,300
	10 Breakwater & Seawalls	$5,151,000	$5,151,000	$5,151,000
	17 Beach Replenishment	$130,282,400	$130,282,400	$130,282,400
	18 Cultural Resources	$15,038,200	$15,038,200	$15,038,200
	19 Buildings, Grounds & Utilities	$854,000,900	$854,000,900	$854,000,900
	Construction Estimate Totals	*$1,005,505,800*	*$1,005,505,800*	*$1,005,505,800*
	01 Land and Damages	$153,276,600	$153,276,600	$153,276,600
	30 Planning, Engineering & Design	$292,422,700	$292,422,700	$292,422,700
	31 Construction Management	$90,775,600	$90,775,600	$90,775,600
	Project Cost Totals	*$1,541,980,700*	*$1,541,980,700*	*$1,541,980,700*
	IDC	$28,372,100	$28,372,100	$28,372,100
	Investment Cost	**$1,570,352,800**	**$1,570,352,800**	**$1,570,352,800**
Annualized Cost	Investment Cost	$58,167,000	$58,167,000	$58,167,000
	Periodic Renourishment for 30 years	$20,738,000	$20,738,000	$20,738,000
	Inlet Bypassing for 50 years	$9,336,000	$9,336,000	$9,336,000
	Proactive Breach Closure	$685,000	$636,000	$468,000
	Breach Closure Costs	$839,000	$1,162,000	$3,060,000
	Coastal/Engineering Monitoring	$1,805,000	$1,805,000	$1,805,000
	Environmental Monitoring	$2,326,000	$2,326,000	$2,326,000
	OMRR&R	$677,000	$677,000	$677,000
	Major Rehab	$1,893,000	$1,893,000	$1,893,000
	SLC Adaptation	$0	$643,000	$3,112,000
	Total Annual Cost	**$96,466,000**	**$97,383,000**	**$101,582,000**
Residual Damages	Damages – Breach Open	$9,734,000	$28,214,000	$145,340,000
	Damages – Back Bay Inundation	$81,466,000	$85,012,000	$268,083,000
	Damages – Shorefront	$7,216,700	$8,364,000	$14,055,000
	Total Residual Damages	**$98,416,700**	**$121,590,000**	**$427,478,000**
Annualized Benefits				
	Cost Avoided – Breach Closure	$3,290,000	$4,489,000	$12,078,000
	Benefits – Breach Open	$10,605,000	$34,765,000	$503,896,000
	Total Breach Closure Benefits	$13,895,000	$39,254,000	$515,974,000
	Benefits – Back Bay Inundation	$85,208,000	$139,316,000	$301,693,000
	Benefits – Shorefront	$8,578,100	$8,662,000	$8,283,000
	Total Storm Damage Reduction Benefits	*$104,391,100*	*$182,743,000*	*$813,872,000*
	Non-Federal Renourishment Cost Avoided	$3,143,000	$3,143,000	$3,143,000
	Recreation Benefits	$25,731,000	$25,731,000	$25,731,000
	Total Benefits	**$136,555,100**	**$216,106,000**	**$854,824,000**
	Net Benefits	**$40,089,100**	**$118,723,000**	**$753,242,000**
BCR		**1.4**	**2.2**	**8.4**

1. Low RSLC, Int. RSLC, and High RSLC based on USACE guidance. ETL, dated June 30, 2014.
2. Price level October 2019, federal discount rate 2.75 percent, Base year 2028
3. Total Residual damages do not include Emergency/breach closure costs

7.4.2 Expected and Probabilistic Values of Damage Reduced

ER 1105-2-101, "Risk Analysis for Flood Damage Reduction Studies (USACE, July 17, 2017), requires the economic performance of the Recommended Plan to be reported for expected and probabilistic values. This has been computed for the low RSLC projection, and the results are presented in Table 49.

Table 49: Expected and Probabilistic Values of Damage Reduced (October 2019 P.L.)

	Low RSLC Projection	**Probability that Damage Exceeds the Indicated Values**		
		Mean	**Mean**	**Mean**
	Total Annual Cost	**$96,466,000**	**$96,466,000**	**$96,466,000**
		75%	**Mean**	**25%**
Damages	Damages – Breach Open	$7,821,000	$9,733,000	$11,027,000
	Damages – Back Bay Inundation	$55,617,000	$81,426,000	$98,489,000
	Damages – Shorefront	$4,466,000	$7,222,000	$9,994,000
	Total Damages	***$67,904,000***	***$98,381,000***	***$119,510,000***
Benefits	Cost Avoided – Breach Closure	$1,381,000	$3,290,000	$4,713,000
	Benefits – Breach Open	$5,688,000	$10,605,000	$14,745,000
	Total Breach Closure Benefits	*$7,069,000*	*$13,895,000*	*$19,458,000*
	Benefits – Back Bay Inundation	$78,345,000	$81,571,000	$88,912,000
	Benefits – Shorefront	$7,481,000	$8,293,000	$9,090,000
	Total Storm Damage Reduction Benefits	*$91,514,000*	*$100,469,000*	*$112,747,000*
	Non-Federal Renourishment Cost Avoided[1]	$3,143,000	$3,143,000	$3,143,000
	Recreation Benefits[2]	$22,692,000	$25,731,000	$28,769,000
	Total Benefits	**$118,730,000**	**$132,633,000**	**$149,372,000**
	Net Benefits	**$22,264,000**	**$36,167,000**	**$52,906,000**
BCR		**1.2**	**1.4**	**1.5**

Notes: 1. Confidence intervals for recreation benefits are 95 percent and five percent.

Figure 34, Figure 35 and Figure 36 illustrates the impacts that higher rates of RSLC are projected to have on the performance of the recommended plan, and the residual risk associated with components of the Recommended Plan. Figure 34 illustrates how the target design elevation (8.9 ft NGVD) of 2 feet above the current one percent flood water surface elevation relates to projected RSLC in the study area. It is expected that elevated structures may experience flooding by a one percent flood (backbay water surface elevation) by the year 2100, considering the low RSLC projection. By 2072 and 2060 the elevation will be exceeded by the under the intermediate and high projections, respectively. These figures illustrate that even if the increase in RSLC follows the high curve, that the plans still provide a high level of risk reduction, although the plan may not provide risk reduction to the 1 percent level.

Figure 35 demonstrates how the nonstructural level of performance in the same reach progressively declines from greater than 0.2 percent flood to the four percent flood by the year 2120 under the intermediate RSLC projection. For the high RSLC projection, the level of performance declines from greater than 0.2 percent flood to less than 50 percent flood in the dame timeframe, as illustrated by Figure 36.

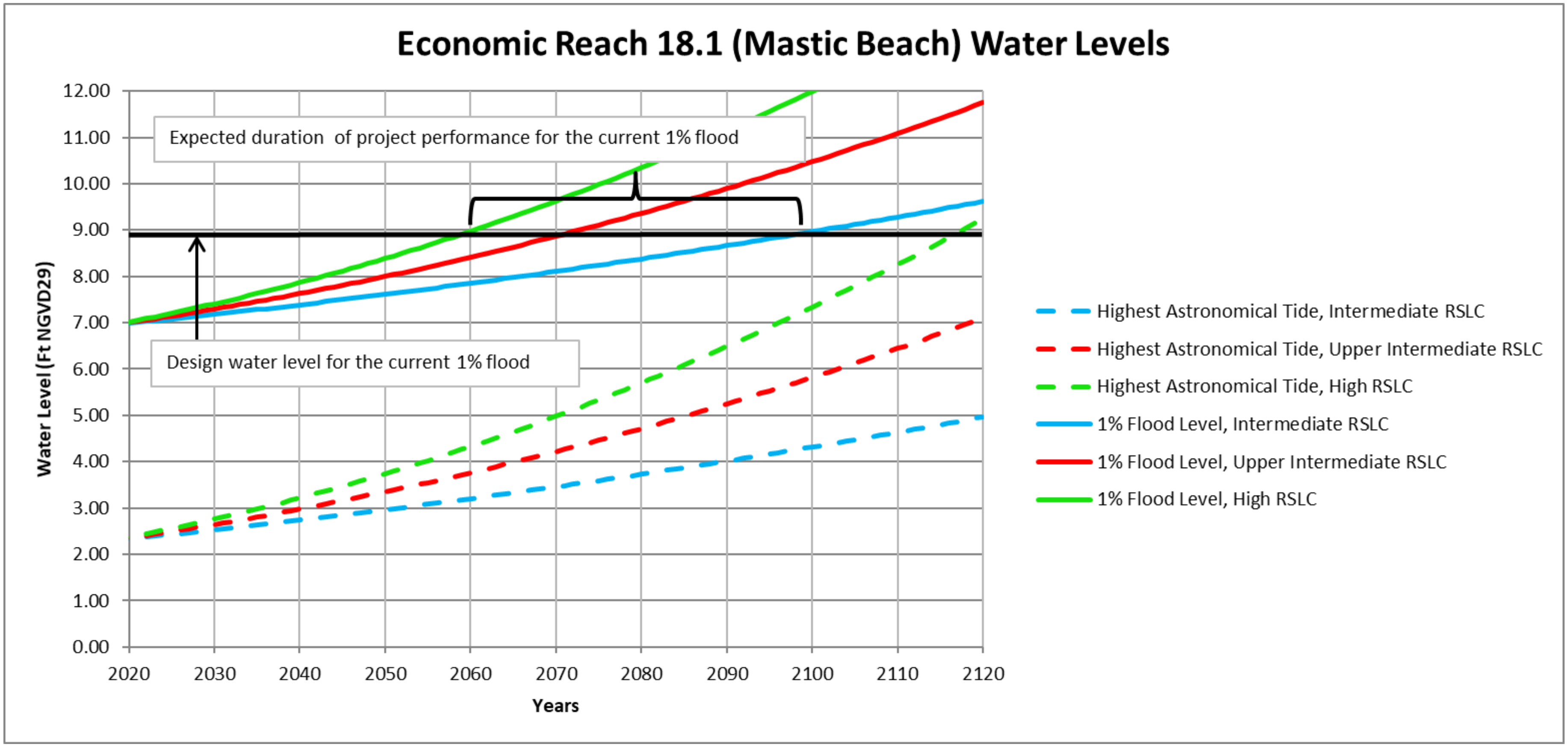


Figure 34. Project Performance over Time Due to Relative Sea Level Change

Performance Level (Water Level for Different Flood Stages)
Economic Reach 18.1: Mastic Beach
Water Surface Elevations in Feet NGVD29

Year	50%	17%	10%	4%	2%	1%	0.5%	0.2%
2020	3.9	4.7	5.3	6.1	6.6	6.9	7.2	7.5
2025	4.0	4.8	5.4	6.2	6.7	7.0	7.3	7.6
2030	4.1	4.9	5.5	6.3	6.8	7.1	7.4	7.7
2035	4.2	5.0	5.6	6.4	6.9	7.2	7.5	7.8
2040	4.3	5.1	5.7	6.5	7.0	7.3	7.6	7.9
2045	4.4	5.2	5.8	6.6	7.1	7.4	7.7	8.0
2050	4.5	5.3	5.9	6.7	7.2	7.5	7.8	8.1
2055	4.6	5.4	6.0	6.8	7.3	7.6	7.9	8.2
2060	4.8	5.6	6.2	7.0	7.5	7.8	8.1	8.4
2065	4.9	5.7	6.3	7.1	7.6	7.9	8.2	8.5
2070	5.0	5.8	6.4	7.2	7.7	8.0	8.3	8.6
2075	5.2	6.0	6.6	7.4	7.9	8.2	8.5	8.8
2080	5.3	6.1	6.7	7.5	8.0	8.3	8.6	8.9
2085	5.4	6.2	6.8	7.6	8.1	8.4	8.7	9.0
2090	5.6	6.4	7.0	7.8	8.3	8.6	8.9	9.2
2095	5.7	6.5	7.1	7.9	8.4	8.7	9.0	9.3
2100	5.9	6.7	7.3	8.1	8.6	8.9	9.2	9.5
2105	6.0	6.8	7.4	8.2	8.7	9.0	9.3	9.6
2110	6.2	7.0	7.6	8.4	8.91	9.2	9.5	9.8
2115	6.4	7.2	7.8	8.6	9.1	9.4	9.7	10.0
2120	6.5	7.3	7.9	8.7	9.2	9.5	9.8	10.1

Figure 35. Project Performance of Nonstructural Measures Over Time Due to Relative Sea Level Change (Intermediate Projection)

Performance Level (Water Level for Different Flood Stages)
Economic Reach 18.1: Mastic Beach
Water Surface Elevations in Feet NGVD29

Year	50%	17%	10%	4%	2%	1%	0.5%	0.2%
2020	3.9	4.7	5.3	6.1	6.6	6.9	7.2	7.5
2025	4.1	4.9	5.5	6.3	6.8	7.1	7.4	7.7
2030	4.3	5.1	5.7	6.5	7.0	7.3	7.6	7.9
2035	4.5	5.3	5.9	6.7	7.2	7.5	7.8	8.1
2040	4.7	5.5	6.1	6.9	7.4	7.7	8.0	8.3
2045	5.0	5.8	6.4	7.2	7.7	8.0	8.3	8.6
2050	5.3	6.1	6.7	7.5	8.0	8.3	8.6	8.9
2055	5.6	6.4	7.0	7.8	8.3	8.6	8.9	9.2
2060	5.9	6.7	7.3	8.1	8.6	8.9	9.2	9.5
2065	6.2	7.0	7.6	8.4	8.9	9.2	9.5	9.8
2070	6.5	7.3	7.9	8.7	9.2	9.5	9.8	10.1
2075	6.9	7.7	8.3	9.1	9.6	9.9	10.2	10.5
2080	7.2	8.0	8.6	9.4	9.9	10.2	10.5	10.8
2085	7.6	8.4	9.0	9.8	10.3	10.6	10.9	11.2
2090	8.0	8.8	9.4	10.2	10.7	11.0	11.3	11.6
2095	8.4	9.2	9.8	10.6	11.1	11.4	11.7	12.0
2100	8.9	9.7	10.3	11.1	11.6	11.9	12.2	12.5
2105	9.3	10.1	10.7	11.5	12.0	12.3	12.6	12.9
2110	9.8	10.6	11.2	12.0	12.5	12.8	13.1	13.4
2115	10.3	11.1	11.7	12.5	13.0	13.3	13.6	13.9
2120	10.8	11.6	12.2	13.0	13.5	13.8	14.1	14.4

Figure 36. Project Performance of Nonstructural Measures Over Time Due to Relative Sea Level Change (High Projection)

Figure 37 illustrates the impact of RSLC on the probability of barrier island breaching, at a representative location where the Recommended Plan includes beachfill and renourishment after 30 yearsafter initial construction, followed by a proactive breach closure plan for the remainder of the 50 year period of analysis. This Figure demonstrates that the beachfill component provides breach risk management for ocean stages at the 0.5 percent flood for the full duration of the planned renourishment period under the low and intermediate RSLC projections, but only up to 2042 under the high RSLC projection. After 30 years, when planned renourishment is scheduled to end and the proactive breach closure plan comes into effect, the annual probability of a storm creating a full breach increases to approximately two percent (two percent flood) under the low RSLC projection. This figure illustrates that the effectiveness of breach response may be the most sensitive to changes in RSLC. This would be expected, since this component of the plan has a lower level of performance, and since this plan is expected to continue for 50 years, when RSLC could be greater.

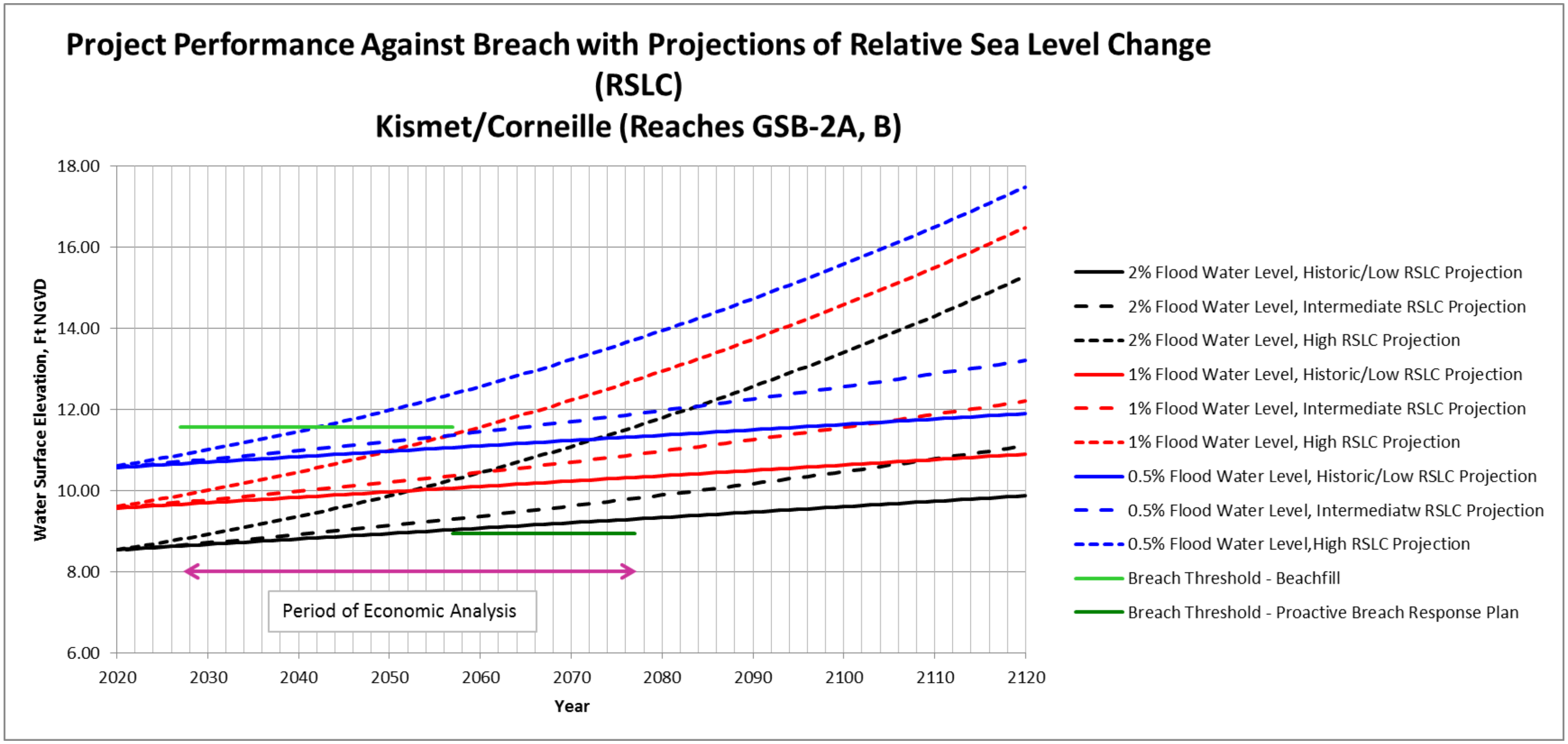


Figure 37. Project Performance over Time Due to Relative Sea Level Change

In summary, these analyses demonstrate that the need for CSRM solutions increases, and the economic outputs increase when considering the intermediate and high RSLC projection. This also indicates that there is an expected increase in the cost for continuing construction of the project. As described below, the recommended plan performs well against all RSLC projections, and the project features are adaptable in response to potential increases in relative sea level. Project adaptation is recommended in the future to account for RSLC.

The effects of higher sea level changes on the inlet modification components of the recommended plan are slight increases in accretion in the inlet systems. The inlet bypassing will be monitored, and the bypassing quantities can be adjusted if RSLC is shown to change the accretion rates.

The effects of higher sea level changes on the nonstructural mainland component of the recommended plan are minimal, since the design already incorporates the historic rate and an additional 2 feet, as contained in the NYS building code. Design exceedence would remain relatively rare with these water surface elevation “buffers” in place. It is acknowledged that homeowner’s who elect to participate in the nonstructural program have a desire to guarantee that these elevations remain above the 1 percent flood level. As the project proceeds into PED, the design elevations selected for treatment will be revisited to ensure that they consider the potential for increased water surface elevations in the future, both due to RSLC conditions and any change in breach potential that would impact bay water surface elevations. This analysis may also affect the recommended treatment methods, particularly in low-lying areas, where ground elevations could be below monthly high tides. Further, it is acknowledged that the construction of these non-structural features will require a number of years to implement. It is recommended that each year, the RSLC trends be evaluated, to determine if the target design levels be revisited to account for observed data.

Sea level rise is expected to have the largest effect on the breach response component of the project. The effects of higher sea level changes on the proactive breach response component of the recommended plan are lower annual costs, from less frequent beach placement. The effects of higher sea level changes on the reactive breach response, conditional breach response, and wilderness conditional breach response components of the recommended plan is higher annual costs, due to more frequent breaching events. As an example, if in present day, a storm with a certain water surface elevation would cause a breach; with higher sea level changes, that same water surface elevation would be expected to occur more frequently; thus more frequent breaches. Taken collectively, this indicates that under increased RSLC conditions the proactive breach response is less effective. There are fewer opportunities to address breach vulnerabilities prior to a breach occurring, and more closure actions. This indicates that the proactive breach response should be adaptively managed in the future. The thresholds for a proactive response, and the design sections should be revisited. These criteria are based upon current water surface elevations. Since the proactive breach response is intended to take action when the area is vulnerable to breaching by a 4 percent storm, it is designed to take action when the risk is relatively high. As illustrated in Figure 37, when increasing RSLC is not factored into the proactive breach response, the level of performance drops. It is recommended that the breach response features be adapted to RSLC, and that the berm and dune height be adjusted to account for RSLC. As part of the MAMP, the thresholds for breach response should be revisited. The evaluation of breach threshold should consider improved science, and understanding of breach processes, and the effect these plans have on the amount of cross-island sediment transport, and the need to compensate for that effect.

The effects of higher sea level changes on the beach and dune fill on shorefront component of the recommended plan would be slightly higher renourishment quantities which is captured in the Sea Level Change Adaptation line in Table 48 of the FGRR. As described above, it is recommended that the beach berm height, and dune height be adjusted in the future to account for the observed change in sea level rise. These features could be increased up to 3 feet, based upon the observed data.

There are no changes from effects of higher sea level changes on the groin modification component of the recommended plan, as the plan is removal of the groins.

The effects of higher sea level changes on the coastal process features are unknown at this time, however, the sediment needs of each shall be evaluated as per the adaptive management plan. It is expected that the sediment needs would change, similar to the beachfill and breach response plans, with increasing heights and renourishment needs. The cost impacts for modifying these existing features are expected to be negligible because the total amount of fill needed is a small percentage of the total fill required for the beach and dune fill, and are to be constructed/adapted in conjunction when dredging and placement of fill is to be placed in the same reach. It is acknowledged that under higher rates of RSLC, there could be a greater amount of breaching, and breach response; and that the adaptations to the breach response plan could alter the impacts on cross-island sediment transport and the volumetric needs to maintain no net loss of cross-island sediment transport.

The above paragraphs describe the proposed adaptation, by project feature. The project includes a MAMP to provide for a formal decision-making process to allow for project adaption over time, based upon monitoring results. Project adaptation for climate change is well-suited to be addressed by MAMP. The cost estimates have been itemized to account for the increased cost for renourishment as a line-item for RSLC Adaptation costs. This accounts for increasing the volume of renouirshment, and increasing the height of the berm and dune to account for observed increases in sea level rise. It is recommended that in order to implement the adaptive management that the rate of RSLC be included as part of monitoring, and that the height of the project features be adjusted, based when the 5 month average RSLC condition exceeds the threshold for elevation increases. Given the projected rate of RSLC, the project features could be adjusted by up to 3 feet over the 50 year of continuing construction. It is acknowledged that given the potential for RSLC greater than the low RSLC projection, that authorizing the adaptation cost would be warranted. Specific modifications to the project would be addressed through the MAMP. The MAMP acknowledges that further analysis may be required to implement changes. It is possible that if greater than anticipated RSLC is realized that project reevaluation / reformulation may need to be considered. This may be warranted for considering the plan to manage the system after year 30, if the threat of CSRM is greater because of increased RSLC.

In summary, these analyses demonstrate that the need for CSRM solutions increases, and the economic outputs increase when considering the intermediate and high RSLC projections. The Recommended Plan performs well against all RSLC projections, and the project features are adaptable in response to potential increases in relative sea level. Potential adaptation actions are detailed in Appendix J – Monitoring and Adaptive Management Plan, and may include changes to the berm height, width, and/or timing of renourishment. The cost estimates have been itemized to account for the increased cost for renourishment as a line-item for RSLC Adaptation costs. The project includes a MAMP to allow for project adaption. Adaptation to RSLC is a component of this MAMP. It is acknowledged that given the potential for RSLC greater than the LOW RSLC projection, that authorizing an adaptation cost would be warranted, and a cost for the intermediate rate of RSLC is included. Specific modifications to the project would be addressed through the MAMP adaptive management, and may require further analysis, if determined to be outside the project scope of this GRR and EIS.

8 EXECUTIVE ORDER (EO) 11988 AND PUBLIC LAW 113-2 CONSIDERATIONS

This study has considered the requirements of EO 11988, Flood Plain Management and P.L. 113-2, the Disaster Relief Appropriations Act of 2013. Specifically, this Section of the report addresses:

- The Water Resources Council Floodplain Management implementing guidelines for EO 11988;
- The specific requirements necessary to demonstrate that the project is economically justified, technically feasible, and environmentally acceptable, per P.L. 113-2;
- The specific requirements necessary to demonstrate resilience, sustainability, and consistency with the North Atlantic Coast Comprehensive Study (NACCS), per P.L. 113-2.

8.1 EO 11988

Executive Order 11988 requires Federal agencies avoid, to the extent possible, the long- and short-term adverse impacts associated with the occupancy and modification of 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 reestablish 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 as follows:

1. **Determine if a proposed action is in the base floodplain (that area which has a one percent of greater chance of flooding in any given year).** The proposed action is within the base floodplain. However, the project is designed to reduce damages to existing infrastructure located landward of the proposed project.

2. **If the action is in the base floodplain, identify and evaluate practicable alternatives to the action or to location of the action in the base floodplain.** Chapter 5 of this document presents an analysis of potential alternatives. Practicable measures and alternatives were formulated and evaluated against USACE guidance, including nonstructural measures such as retreat, demolition and land acquisition.

3. **If the action must be in the 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. Once the draft report is released, public meetings will be scheduled in the study area during the public review period.

4. **Identify beneficial and adverse impacts due to the action and any expected losses of natural and beneficial 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 Selected Plan are summarized in Chapters

5 and 6 of this report. The project would not alter or impact the natural or beneficial floodplain values.

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. Nonstructural components of the project, and real estate requirements required for construction of the project will reduce the level of development that is at risk.

6. **As part of the planning process under the Principles and Guidelines, determine viable methods to minimize any adverse impacts of the action including any likely induced development for which there is no practicable alternative and methods to reestablish 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 Selected Plan. The project would not induce development in the floodplain and the project will not impact the natural or beneficial floodplain values. Chapter 6 of this report summarizes the alternative identification, screening and selection process. The "no action" alternative 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 Draft Interim Feasibility Report and Environmental Impact Statement will be provided for public review and public meetings will be scheduled during the public review period. Each comment received will be addressed and, if appropriate, incorporated into the Final Report. A record of all comments received will also be included in the Appendix L - Pertinent Correspondence.

8. **Recommend the plan most responsive to the planning objectives established by the study and consistent with the requirements of the Executive Order.** The Recommended Plan is the most responsive to all of the study objectives and the most consistent with the executive order.

8.2 Resilience, Sustainability, and Consistency with the NACCS

This Section has been prepared to address how the NED Plan contributes to the resilience of the study area; how it affects the sustainability of environmental conditions in the affected area; and how it will be consistent with the findings and recommendations of the North Atlantic Coast Comprehensive Study (NACCS).

Resilience is defined in the February 2013 USACE-NOAA Infrastructures Systems Rebuilding Principles white paper as the ability to adapt to changing conditions and withstand, and rapidly recover from disruption due to emergencies. Sustainability is defined as the ability to continue (in existence or a certain state, or in force or intensity), without interruption or diminution.

8.2.1 Resilience

Resilience is defined in the May 2016 USACE Resilience Initiative Roadmap as the ability of a system to prepare for, resist, recover and adapt to achieve functional performance under the stress of disturbances through time. Increasingly frequent extreme events, such as natural disasters, amplified by increasing urbanization and impacts from climate change, result in severe and costly impacts wherever they occur. Resilience – of a person, project, system, and/or communities of any size – can help reduce negative consequences from adverse events.

The Recommended Plan is a resilient solution to coastal storm damages in the study area. The plan includes the maintenance and restoration of natural coastal processes by utilizing nature-based measures to the maximum extent possible. Each of the project features have been designed to enhance the resilience of the natural coastal system, particularly with consideration of climate change and projected future RSLC. Engineered beaches such as that included in the Recommended Plan are designed, constructed, and periodically renourished to reduce the risk of economic losses arising from coastal storms, primarily along communities with high-value public and private infrastructure immediately landward of the beach. The intent is to replicate the natural coastal processes to the extent possible and enhance their natural ability to provide resilience and reduce storm damage. Storms reduce the degree of storm risk management provided by the beach fill project; elevated water levels and larger-than-normal waves displace sand from the berm and dune portions of the engineered beach profile and transport it principally in the offshore direction. After the storm, normal tide and wave conditions return, typically resulting in onshore-directed sand transport that rebuilds at least a portion of the berm (i.e., beach). This natural recovery of the beach berm occurs over a period that may range from days to months. Natural rebuilding of the dune is a process that requires years to decades, given its dependence on wind transport and an adequate sand supply on the beach. In the period between the storm and the partial natural recovery, an increased level of storm damage risk exists due to the eroded condition of the project berm and dune relative to the level of risk associated with a constructed, fully maintained project. Consequently, repair of an engineered beach to its design dimensions is usually accomplished as a planned renourishment, which is included in the authorized period of analysis cycle, or as an emergency activity under the USACE Flood Control and Coastal Emergencies authority (P.L. 84-99), to restore the storm damage risk reduction function for which the project was authorized. This post-storm repair is necessary because the engineered beach may not otherwise fully recover to its authorized dimensions naturally, or at least not in a time frame that would minimize risks due to the deteriorated condition. In this regard, it is apparent that storm risk management projects involving beach replenishment possess intrinsic resilience, in light of the large volume of sediment that remains within the system after a major disturbance and the associated repair or replenishment that is included to restore the project design dimensions.

8.2.2 Sustainability & Adaptability

Sustainability is achieved across the USACE Civil Works Program by efficiently investing the resources (time, human capital, funding, etc.) needed to sustain human well-being, ecosystem integrity, and national security as functional outcomes delivered by water resources projects and programs for the benefit of current and future generations. The Recommended Plan is a sustainable and adaptable plan. The plan allows for the accommodations in design and operation due to stressors such as climate change and RSLC.

While the initial construction costs are 100 percent Federal, per P.L. 113-2, the renourishment, monitoring, and adaptive management costs are cost shared over the project life with the State of New York, Suffolk County and the local towns. Economic principles are used in benefit calculations, plan formulation ranking, and project justification by their contributions to the National Economic Development account. Environmental concerns are evaluated in the EIS and through coordination and review by the resource agencies including the Environmental Protection Agency (EPA), DOI, and the NYSDEC as part of the feasibility process. Social accounts are intrinsic in beach nourishment projects since they maintain habitat for beach patrons. The nexus of these three pillars indicates that a project is sustainable.

8.2.3 Consistency with the North Atlantic Coast Comprehensive Study (NACCS)

The NACCS report 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 (USACE, 2015). In particular it encourages planning for resilient coastal communities that incorporates wherever possible sustainable coastal landscape systems that takes into account, future RSLC projections 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 RSLC and climate change. The Recommended Plan echoes many of the principles of the NACCS, in that it considers the entire area as a system, the formulation considered multiple plan components to address the multiple risks, the plan incorporates nonstructural components, reestablishes the natural coastal processes, and has been developed in recognition of balancing the needs for coastal storm risk management with the requirements of the partner agencies.

9 PLAN IMPLEMENTATION

The completion of this report is the first step toward implementing the design and construction of the Fire Island to Montauk Point Coastal Storm Risk Management Project. Upon approval by the ASA(CW), the project will be considered for design and construction with funding made available through P.L. 113-2. As an "authorized, but unconstructed" project, the FIMP Reformulation study is being completed with funds authorized by P.L. 113-2 at full Federal expense, subject to the availability of P.L. 113-2 funds. Additional costs would require cost sharing. As specified in P.L. 113-2, the initial project construction is eligible for 100 percent Federal funding, subject to approval of the Report, execution of a Project Partnership Agreement, and availability of funds.

9.1 Project Partnership – Non-Federal Sponsor's Responsibilities

The initial project cost of the FIMP Project will be funded 100 percent by the Federal Government, consistent with P.L. 113-2. Chapter 4 of P.L. 113-2 authorizes USACE "For an additional amount for "Construction" for necessary expenses related to the consequences of Hurricane Sandy, $3,461,000,000, to remain available until expended to rehabilitate, repair and construct United States Army Corps of Engineers projects: Provided, That $2,902,000,000 of the funds provided under this heading shall be used to reduce future flood risk in ways that will support the long-term sustainability of the coastal ecosystem and communities and reduce the economic costs and risks associated with large-scale flood and storm events in areas along the Atlantic Coast within the boundaries of the North Atlantic Division of the Corps that were affected by Hurricane Sandy…"

As specified in P.L. 113-2, the initial project construction is eligible for 100 percent Federal funding, subject to approval of the Report, execution of a Project Partnership Agreement, and availability of funds. A Project Partnership Agreement (PPA) package will be prepared, coordinated and executed subsequent to the approval of this document. The PPA serves as the agreement for the next phase of the project. The PPA reflects the recommendations of this General Reevaluation Report. The non-Federal sponsor, NYSDEC, has indicated support for recommendations presented in this document and its desire to execute a PPA for the FIMP Project Selected Plan by letter dated June 2013.

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

a. Provide a minimum of 35 percent of initial project costs assigned to coastal and storm damage reduction, and 50 percent of the costs of periodic renourishment in the constructed Moriches to Shinnecock Reach (Westhampton Reach), plus 100 percent of initial project costs assigned to protecting undeveloped private lands and other private shores which do not provide public benefits, and 50 percent of periodic nourishment costs assigned to coastal and storm damage reduction, plus 100 percent of periodic nourishment costs assigned to protecting undeveloped private lands and other private shores which do provide public benefits, and as further defined below:

(1) Provide, during design, 35 percent of design costs allocated to coastal and storm damage reduction in accordance with the terms of a design agreement entered into prior to commencement of design work for the project;

(2) Provide all lands, easements, rights-of-way, including suitable borrow areas, and perform or assure performance of all relocations, including utility relocations, as determined by the Federal government to be necessary for the initial construction, periodic nourishment or operation and maintenance of the project;

(3) Provide, during construction, any additional amounts necessary to make its total contribution equal to 35 percent of initial project costs assigned to coastal and storm damage reduction plus 100 percent of initial project costs assigned to protecting undeveloped private lands and other private shores which do not provide public benefits;

b. Prevent obstructions or encroachments on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) such as any new developments on project lands, easements, and rights-of-way or the addition of facilities which might reduce the outputs produced by the project, hinder operation and maintenance of the project, or interfere with the project's proper function;

c. Inform affected interests, at least yearly, of the extent of protection afforded by the flood risk management features; participate in and comply with applicable federal floodplain management and flood insurance programs; comply with Section 402 of the Water Resources Development Act of 1986, as amended (33 U.S.C. 701b-12); and publicize floodplain information in the area concerned and provide this information to zoning and other regulatory agencies for their use in adopting regulations, or taking other actions, to prevent unwise future development and to ensure compatibility with protection levels provided by the flood risk management features;

d. Operate, maintain, repair, replace, and rehabilitate the completed project, or function portion of the project, at no cost to the Federal government, in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and state laws and regulations and any specific directions prescribed by the Federal government;

e. For so long as the project remains authorized, ensure continued conditions of public ownership and use of the shore upon which the amount of Federal participation is based;

f. Provide and maintain necessary access roads, parking areas, and other public use facilities, open and available to all on equal terms;

g. At least twice annually and after storm events, perform surveillance of the beach to determine losses of nourishment material from the project design section and provide the results of such surveillance to the Federal government;

h. Give the Federal government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal sponsor owns or controls for access to the project for the purpose of completing, inspecting, operating, maintaining, repairing, rehabilitating, or replacing the project;

i. Hold and save the United States free from all damages arising from the initial construction, periodic nourishment, operation, maintenance, repair, replacement, and rehabilitation of the project, except for damages due to the fault or negligence of the United States or its contractors;

j. Keep, and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project, for a minimum of 3 years after completion of the accounting for which such books, records, documents, and other evidence are required, to the extent and in such detail as will properly reflect total cost of the project, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and local governments at 32 CFR, Section 33.20;

k. Perform, or ensure performance of, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 USC 9601-9675, that may exist in, on, or under lands, easements, or rights-of-way that the Federal government determines to be necessary for the initial construction, periodic nourishment, operation and maintenance of the project;

l. Assume, as between the Federal government and the non-Federal sponsor, complete financial responsibility for all necessary cleanup and response costs of any hazardous substances regulated under CERCLA that are located in, on, or under lands, easements, or rights-of-way required for the initial construction, periodic nourishment, or operation and maintenance of the project;

m. Agree, as between the Federal government and the non-Federal sponsor, that the non-Federal sponsor shall be considered the operator of the project for the purpose of CERCLA liability, and, to the maximum extent practicable, operate, maintain, repair, replace, and rehabilitate the project in a manner that will not cause liability to arise under CERCLA;

n. Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended, (42 U.S.C. 1962d-5b) and Section 101(e) of the WRDA 86, Public Law 99-662, as amended, (33 U.S.C. 2211(e)) which provide that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until the non-Federal sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element;

o. Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended, (42 U.S.C. 4601-4655) and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way necessary for construction, operation, and maintenance of the project including those necessary for relocations, the borrowing of material, or the disposal of dredged or excavated material; and inform all affected persons of applicable benefits, policies, and procedures in connection with said act;

p. Comply with all applicable Federal and state laws and regulations, including, but not limited to: Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d), and Department of

Defense Directive 5500.11 issued pursuant thereto; Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army"; and all applicable Federal labor standards requirements including, but not limited to, 40 U.S.C. 3141-3148 and 40 U.S.C. 3701-3708 (revising, codifying and enacting without substantive change the provisions of the Davis-Bacon Act (formerly 40 U.S.C. 276a et seq.), the Contract Work Hours and Safety Standards Act (formerly 40 U.S.C. 327 et seq.), and the Copeland Anti-Kickback Act (formerly 40 U.S.C. 276c); and

q. 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 construction may be initiated, this report must be approved and submitted to the Office of Management & Budget, and Congress. Sufficient authority exists to proceed with initial construction, but there are portions of the project (notably the Moriches Inlet to Shinnecock Inlet Reach) that would require congressional authorization of renourishment to construct all elements of the project described herein. Further, the PPA must be executed by USACE and the non-Federal sponsor. In accordance with guidance pursuant to P.L. 113-2, the PPA may be structured so that those elements that are currently authorized upon ASA approval are advanced, prior to congressional authorization of future renourishment. The following is the current schedule for study approval and PPA execution:

Chief of Engineer's Report to Assistant Secretary of the Army (Civil Works)	April 2020
Execute PPA	February 2021
Start construction contracts (details in Table 50)	September 2021
Construction complete	October 2027

Table 50 provides a description of the construction contracts, including the projected duration and schedule for initial construction, that assumes this report is approved and a PPA executed in a timely manner. A detailed project schedule is presented in Appendix C - Cost.

Table 50. FIMP Initial Construction Contracts

Contract Number	Contract name	Description of work	Duration (Mo.)	Contract Start (NTP)	Finish
1	Inlet Dredging: Fire Island	Restore authorized channel dimensions and also dredge ebb shoal with placement downdrift beach at Gilgo Beach to offset deficit, and also at Robert Moses State Park	7	13 Nov 2020	6 Jun 2021
2	Inlet Dredging: Moriches, Shinnecock	Restore authorized channel dimensions in Moriches Inlet and also dredge ebb shoal with placement downdrift at Smith Point County Park and Great Gunn to offset sand deficit; restore authorized channel dimensions in Shinnecock Inlet and also dredge ebb shoal with placement downdrift at Shinnecock Park West and WOSI to offset sand deficit and also to place sand in CPFs	6	9 Apr 2021	1 Oct 2021
3	Tiana Beach/Montauk Beach	Place sand obtained from offshore borrow sources to construct PBRP profile at Sedge Island and Tiana Beach; also construct feeder beach at Montauk Beach by placing sand obtained from an offshore borrow site at each location. Construct coastal process features	8	13 Nov 2020	19 Jun 2021
4	Smith Point/ Westhampton	Place sand obtained from offshore borrow sources to construct beachfill profile at Cupsogue, Pikes, and Westhampton. Construct coastal process features	9	8 Jun - 2021	7 Feb-2022
Deferred	Beach fill: Fire Island	Place sand obtained from offshore borrow sources to construct beachfill profile at Fire Island communities from Kismet to Davis Park (Construct coastal process features at Sunken Forest, Reagan property, and Corneille			
5	Groin Modifications: Ocean Beach	Shorten the 2 groins at Ocean Beach	7	12 Jul 2021	30 Jan 2022
6	Mainland Non Structural - Year 1 Building Retrofits	Retrofit approximately 500 homes on the Mainland	15	21 Apr 2023	27Nov 2023
7	Mainland Non Structural - Year 2 Building Retrofits	Retrofit approximately 1,000 homes on the Mainland	15	12Apr 2024	11Nov 2024
8	Mainland Non Structural - Year 3 Building Retrofits	Retrofit approximately 1250 homes on the Mainland	14	7 Apr 2025	3 Nov 2025
9	Mainland Non Structural - Year 4 Building Retrofits	Retrofit approximately 1250 homes on the Mainland	14	30 Mar 2026	23 Oct 2026

Contract Number	Contract name	Description of work	Duration (Mo.)	Contract Start (NTP)	Finish
10	Mainland Non Structural - Year 5 Building Retrofits	Retrofit approximately 450 homes on the Mainland	14	1 Apr-2027	25 Oct 2027

9.3 Cost Sharing

As specified in P.L. 113-2, the initial project construction is eligible for 100 percent Federal funding, subject to approval of the Report, execution of a Project Partnership Agreement, and availability of funds. Chapter 4 of P.L. 113-2 authorizes USACE "For an additional amount for "Construction" for necessary expenses related to the consequences of Hurricane Sandy, $3,461,000,000, to remain available until expended to rehabilitate, repair and construct United States Army Corps of Engineers projects: Provided, That $2,902,000,000 of the funds provided under this heading shall be used to reduce future flood risk in ways that will support the long-term sustainability of the coastal ecosystem and communities and reduce the economic costs and risks associated with large-scale flood and storm events in areas along the Atlantic Coast within the boundaries of the North Atlantic Division of the Corps that were affected by Hurricane Sandy…" Accordingly, initial construction of the project will be funded at 100 percent full Federal expense (Table 51).

As described in Section 6.6, the total construction cost includes periodic renourishment approximately every 4 years over a 30 year period, and unscheduled renourishment until year 50 in the form of breach response; this cost is shared 50 percent Federal and 50 percent non-Federal, with one exception. The cost share for renourishment in the constructed Moriches to Shinnecock Reach (Westhampton Reach) is cost-shared 50 percent Federal and 50 percent non-Federal until 2027. The Westhampton Reach was originally constructed in 1965. Specific authorization included in WRDA 1986 and WRDA 1992 extended the renourishment period for this area until 2027. Based upon a review of project authorizations and cost-sharing, there is sufficient authority for renourishment in all reaches (cost-shared 50 percent Federal and 50 percent non-Federal), other than Westhampton; the latter would require new authorization for renourishment (cost-shared 50 percent Federal and 50 percent non-Federal).

The non-Federal sponsor is responsible for fully funding all LERRD costs and OMRR&R costs, but will be reimbursed or credited for those costs, pursuant to P.L. 113-2 guidance. Monitoring and adaptive management actions associated with future renourishment will be cost shared 50 percent Federal and 50 percent non-Federal.

Table 51. Cost Apportionment (Oct 2019 P.L.)

	Federal	Non-Federal	Total
PROJECT FIRST COSTS			
Cash Contribution	$1,388,704,000	-	$1,388,704,000
LERRD	$153,277,000	-	$153,277,000
TOTAL FIRST COST	**$1,541,981,000**	**-**	**$1,541,981,000**
CONTINUING CONSTRUCTION FIRST COST			
Scheduled Beach Renourishment (a)	$572,564,000	$572,564,000	$1,145,128,000
Environmental Monitoring (b)	$56,101,000	$56,101,000	$112,202,000
Engineering Monitoring	$40,515,000	$40,515,000	$81,030,000
SLC Adaptation	$13,436,000	$13,436,000	$26,871,000
Breach Closure (c)	$60,311,000	$60,311,000	$120,622,000
SUBTOTAL CONTINUING CONSTRUCTION COST	**$742,927,000**	**$742,926,000**	**$1,485,853,000**
TOTAL CUMULATIVE CONSTRUCTION COST(d)	**$2,284,908,000**	**$742,926,000**	**$3,027,834,000**
Emergency Beach Fill(e)	$28,165,000	$28,165,000	$56,330,000
Annual Beach & Groin Maintenance	-	$677,000	$677,000
TOTAL ANNUAL OMRR&R COSTS	**-**	**$677,000**	**$ 677,000**

(a) Beach Renourishment = roughly every 4-year cycle; cost share 50% Federal, 50% Non-Federal
(b) Environmental Monitoring varies yearly and is broken down in the Environmental Monitoring Cost Table
(c) Both Proactive and Reactive breach closure costs
(d) Cumulative Costs include Total First Cost and Cumulative Construction
(e) Emergency Beach Fill = Assumed to occur every 4 years similar to renourishment

9.4 OMRR&R

Operation, Maintenance, Repair, Replacement, and Rehabilitation (OMRR&R) of the project includes inspections, maintenance of project features, and replacement of features due to expected degradation. Annual beach and groin maintenance is estimated to be $677,000. The total annual OMRR&R costs are estimated to be $677,000 (October 2019 PL) (Table 51).

A summary of OMRR&R requirements for the project is included as Appendix K - OMRR&R. An OMRR&R manual will be finalized prior to construction, in coordination with the non-Federal sponsor. The manual will detail administrative, maintenance, and operational responsibilities, as well as a description of OMRR&R actions.

The Breach Response Plan, and Monitoring and Adaptive Management Plan are cost-shared as ongoing construction and are separate in scope and cost from expected OMRR&R actions.

9.5 Actions by Others

State and local agencies, and private interests, including Erosion Control Districts may supplement the beachfill provided by the project, particularly after year 30, to maintain the design template or expand the project footprint. State and local agencies should consult with USACE about any proposed work to ensure compliance with 33 USC 408 (Section 408), and project-related requirement set forth by Federal and state agencies (i.e., Biological Opinion). Depending on the nature and scope of proposed work, local interested may also need to coordinate with other regulatory agencies such as NYSDEC for applicable permits.

The Breach Response Plan in the absence of USACE action doesn't preclude a municipality's eligibility for FEMA grant funding for disaster mitigation or response work.

9.6 Views of Non-Federal Partners and Other Agencies

USACE has coordinated with the interagency study team and project Executive Steering Committee throughout the study, including DOI, NPS, USGS, PPA, and USFWS; New York State, including NYSDEC and NYSDOS; and Suffolk County, including the Suffolk County Department of Public Works (SCDPW) and Suffolk County Parks. In addition, there has been extensive coordination with the regulatory agencies that would be involved in the permitting of this project, as well as agencies that are undertaking similar efforts within the study area. There also has been extensive coordination with local municipalities and the public, as summarized in Chapter 10. Agency comments and agreements are included in FGRR Appendix L – Pertinent Correspondence and FEIS Appendix - Correspondence. A summary of public comments and public information meetings are included in FEIS Appendix O.

The NYSDEC stated its support for the Recommended Plan presented in this report, in a letter dated August 20, 2019. DOI stated in a letter dated June 6, 2019 its support and commitment to continuing its collaboration with USACE throughout the feasibility phase, PED, construction, and adaptive management of the project.

10 PUBLIC INVOLVEMENT

NEPA and the USACE planning process provide people, organizations, and governments the opportunity to review and comment on proposed Federal actions. Public involvement occurs throughout the planning process, beginning with study scoping and continuing through comment periods for draft decision documents such as this GRR and accompanying EIS. Public input is accepted and considered throughout the planning process.

USACE, NYSDEC, and local partners have facilitated extensive public involvement throughout the study. Public participation commenced with the study NEPA scoping process and continues through project construction. This Chapter summarizes public involvement undertaken in the timeframe between the release of the draft version of this GRR to the date of this report.

The DGRR and DEIS were made available for public review from July 21, 2016 until October 19, 2016. The report's availability was advertised in a Notice of Availability published in the Federal Register, as well as by email, website, social media, and press release. Federal, state, and local stakeholders received copies of the DGRR and DEIS.

A series of public information meetings were held in Suffolk County in order for the study team to receive public feedback. The meetings were held on:

- September 14, 2016: Town of Islip Auditorium, Islip, New York
- September 20, 2026: Patchogue-Watch Hill Ferry Terminal, Patchogue, New York
- September 27, 2016: SUNY Stony Brook Southampton Campus, Southampton, New York
- September 28, 2016: Montauk Playhouse, Montauk, New York

Written and oral testimonies were shared at the public information meetings. In addition, emails and letters were received by the study team. Over 1,280 public comments were received during the public review period, including those from local entities, organizations, and home and business owners. A summary of the public information meetings, and the public comments received during the public review period are included in FEIS Appendix O. Most comments can be grouped into four themes:

- Commenters expressed support for the Project;
- Commenters advocated for even greater coastal storm risk management measures;
- Commenters requested additional information and details regarding the potential impacts of and features included in the potential project, including coastal process features, structure elevations, road raisings, acquisitions, dune/berm elevation, recovery action, RSLC, beach replenishment, and sewer systems;
- Commenters requested an extension of the comment period and additional public meetings in which formal comments could be stated and officially recorded.

The study team reviewed and considered every public comment during plan refinement and finalization. In addition to the public comments, comments were also received from Federal, State, and Local agencies, which are also included within Appendix O. Public coordination will continue through construction.

11 RECOMMENDATIONS

11.1 Prefatory Statement

In making the following recommendations, I have given consideration to all significant aspects of the study area. The aspects considered include engineering feasibility, economic justification, environmental acceptability, social concerns, and compatibility of the project with the policies, desires, and capabilities of the non-Federal sponsor, Federal government, and other interested parties.

11.2 Recommendations

A number of alternatives have been examined as part of the study and a Recommended Plan has been identified and considered. The Recommended Plan achieves the most responsive coastal storm risk management plan for the study area while meeting both Department of the Army and Department of the Interior missions. Section 8 of P.L. 88-587 provides that the authority of the Chief of Engineers to undertake or contribute to shore erosion control or beach protection measures on lands within the Fire Island National Seashore shall be exercised in accordance with a plan that is mutually acceptable to the Secretary of the Interior and the Secretary of the Army. To assist in meeting the requirements set forth in P.L. 88-587, a policy exception granting permission to deviate from USACE policy related to economic justification was granted by the Office of the Assistant Secretary (Civil Works) (ASA[CW]) (Appendix L – Pertinent Correspondence). The memorandum grants an exception to the requirement to recommend a NED plan and allows USACE to recommend the mutually acceptable plan consistent with requirements of the Fire Island National Seashore authorizing law (P.L. 88-587). In a letter dated May 3, 2017 from the regional directors of the U.S. Fish and Wildlife Service (USFWS), National Park Service (NPS), and U.S. Geological Survey (USGS), the Recommended Plan presented in the Deputy Commanding General for Civil and Emergency Operations memorandum is mutually acceptable to the Department of the Interior (Appendix L – Pertinent Correspondence). The Department of the Interior's stance was reaffirmed in a June 6, 2019 letter in which the regional directors of the USFWS, NPS, and USGS jointly stated they, "confirm the Department of the Interior's commitment and interest in continuing to work with the [USACE] in finalizing a mutually acceptable plan" (Appendix L).

Some features of the Recommended Plan are necessary to achieve mutual acceptability with the Department of the Interior but are not incrementally justified, as required by Engineer Regulation (ER) 1105-2-100. These features include sand bypassing at Fire Island, Moriches, and Shinnecock Inlets; sediment placement that mimics and bolsters natural processes (Coastal Process Features); and modification of the Ocean Beach groin field. Additionally, the NED plan included a nonstructural component within the 17 percent floodplain that reasonably maximizes net benefit. The Recommended Plan includes a larger nonstructural component located within the 10 percent floodplain, with acquisition of the most at-risk structures for future restoration opportunities.

Consistent with the policy exception granted by the ASA(CW) on October 11, 2017, the Recommended Plan includes features that are not incrementally justified as typically required by USACE guidance, but are necessary in order to achieve mutual acceptability between the Secretary of the Army and the Secretary of the Interior, as required by P.L. 88-587. The Recommended Plan was developed in accordance with the guidance outlined in P.L. 113-2, current Planning Guidance, and the exception of policies approved by the Office of ASA(CW) on October 11, 2017.

The Recommended Plan is acceptable to the non-Federal sponsor, agencies, and stakeholders as a coastal storm risk management project.

I make this recommendation based on findings that the plan constitutes engineering feasibility, economic justification, and environmental acceptability. Based on October 2019 price levels, the estimated total first cost of the Recommended Plan is $1,541,981,000. P.L. 113-2 states that "the completion of ongoing construction projects receiving funds provided by this division shall be at full Federal expense with respect to such funds." Initial construction of the project will be funded at 100 percent full Federal expense. The continuing construction cost of $1,485,853,000 includes periodic renourishment approximately every 4 years over a 30 year period, inlet bypassing for 50 years, and unscheduled renourishment until year 50 in the form of breach response; this cost is shared 50 percent Federal and 50 percent non-Federal. Monitoring and adaptive management actions associated with future renourishment are included in the continuing construction cost, and will be cost shared the same as renourishment. My recommendation is subject to the non-Federal interests agreeing to execute and comply with the terms of a Project Partnership Agreement following approval of this report. The non-Federal sponsor is responsible for fully funding all LERRD costs totaling $153,277,000, but will be reimbursed or credited for those costs, pursuant to P.L. 113-2 guidance. The non-Federal sponsor would also be responsible for the operation, maintenance, repair, replacement and rehabilitation OMRR&R of the project after construction, as an average annual cost currently estimated at $677,000 over the 50-year period of analysis.

11.3 Disclaimer

The recommendations contained herein reflect the information available at this time and current USACE policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of the 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 higher authority as proposals for authorization and/or implementation funding.

Thomas D. Asbery
Colonel, U.S. Army
Commander

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