Hudson-Raritan Estuary Ecosystem Restoration Feasibility Study

the WATERS we SHARE

Draft Integrated Feasibility Report & Environmental Assessment
February 2017

Prepared by the New York District
U.S. Army Corps of Engineers

THE PORT AUTHORITY OF NY & NJ

NYC Parks

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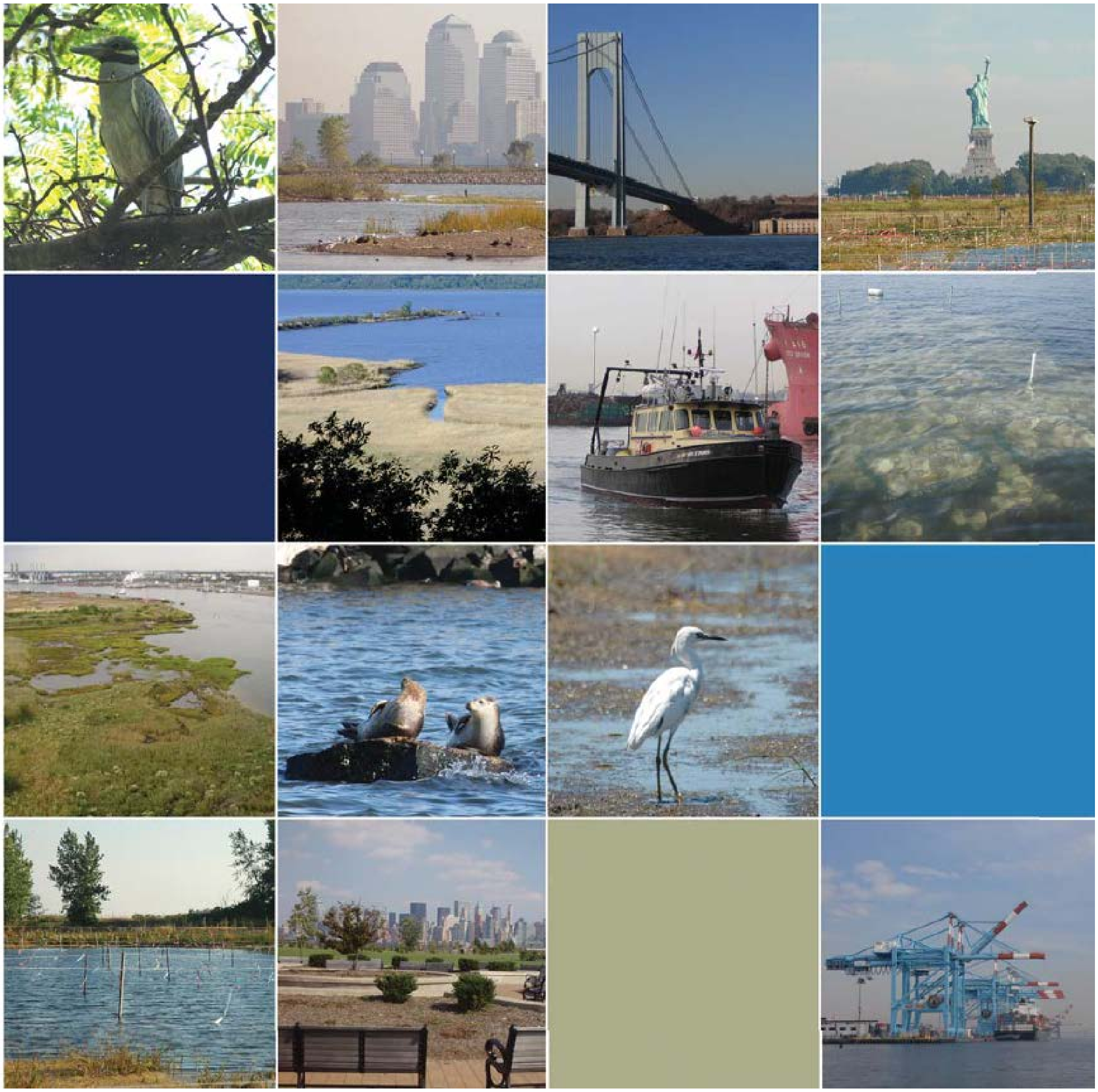


Hudson-Raritan Estuary (HRE) Ecosystem Restoration Feasibility Study Draft Integrated Feasibility Report & Environmental Assessment

THE PORT AUTHORITY OF NY & NJ

Including:

HRE-Lower Passaic River Ecosystem Restoration Feasibility Study

HRE-Hackensack Meadowlands Ecosystem Restoration Feasibility Study

Bronx River Basin Ecosystem Restoration Feasibility Study

Jamaica Bay, Marine Park, Plumb Beach Ecosystem Restoration Feasibility Study

Flushing Creek and Bay Ecosystem Restoration Feasibility Study

THE PORT AUTHORITY OF NY & NJ

This report was prepared by the New York District
U.S. Army Corps of Engineers
in partnership with the above sponsor agencies

COMMENTS AND FURTHER INFORMATION CONTACT

Send all written comments and suggestions concerning this Draft Integrated Feasibility Report and Environmental Assessment (FR/EA) to "HRE_FREA_Comments@usace.army.mil".

For submittal of comments via mail or if you have questions about the project, please contact Lisa Baron, Project Manager, U.S. Army Corps of Engineers, New York District, Programs and Project Management Division, Civil Works Programs Branch, 26 Federal Plaza, New York, NY 10279-0090; Phone: (917) 790–8306; email: lisa.a.baron@usace.army.mil.

Executive Summary

This Draft Integrated Feasibility Report and Environmental Assessment (FR/EA) for the Hudson-Raritan Estuary (HRE) Ecosystem Restoration Feasibility Study was prepared by the United States Army Corps of Engineers (USACE) and provides an interim response to the study authorities. The FR/EA includes recommendations for the:

- Construction of a suite of restoration opportunities throughout the HRE; and
- Completion of new phase future spin-off feasibility studies to be carried out under the HRE study authority or the Continuing Authorities Program, dependent upon the availability of federal and local funding, and the willingness of non-federal sponsors to partner with the USACE for such studies.

The restoration opportunities recommended for construction and future study are critical to address the ongoing long-term and large-scale ecosystem degradation within the estuary. This document presents the potential alternatives for environmental restoration within the HRE, analyzes the environmental impacts of implementing those alternatives, outlines the process used for selecting the recommended alternative at each restoration site, and concludes with recommendations for project implementation. It also documents compliance with the National Environmental Policy Act (NEPA) of 1969 as amended, and includes input from the non-federal study sponsors, natural resource agencies, USACE offices, and the public.

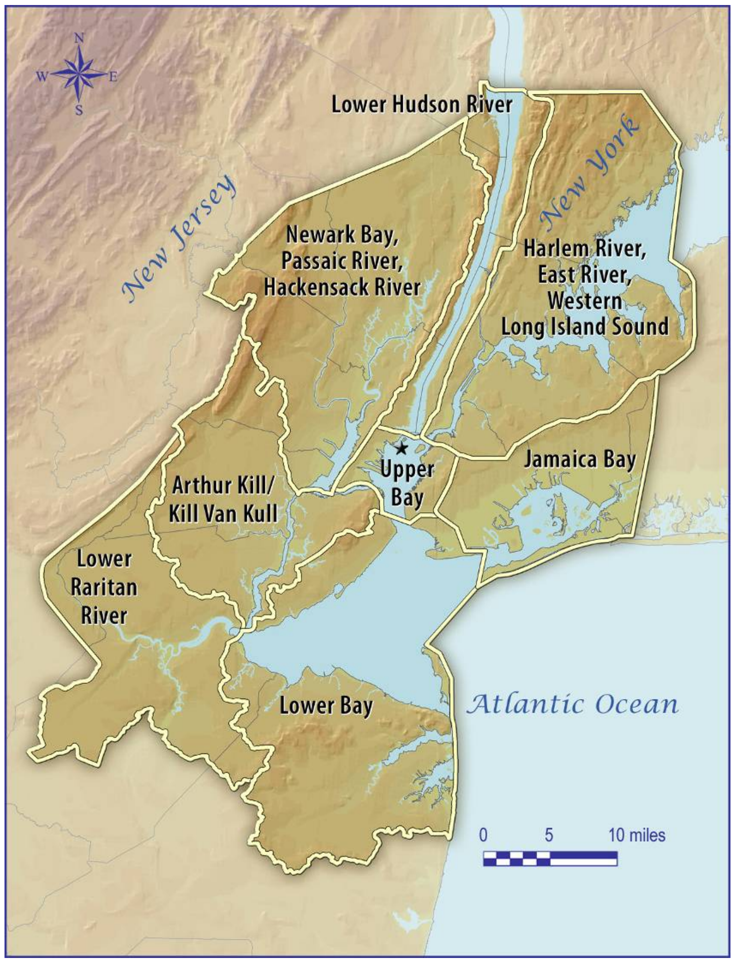
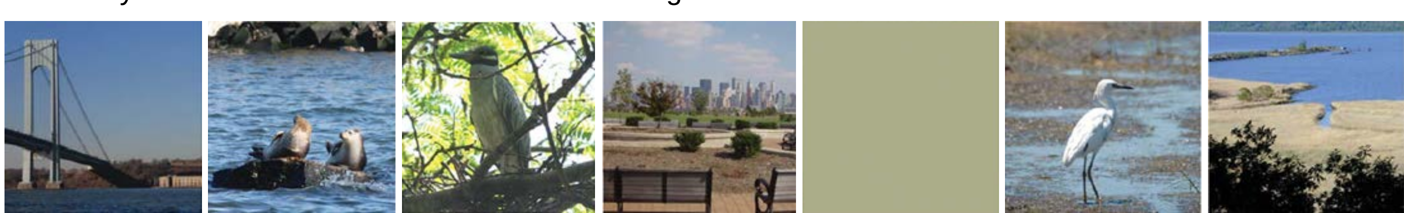


Figure ES-1 HRE Planning Regions
Statue of Liberty Represented by a Star

The HRE is within the boundaries of the Port District of New York and New Jersey and is situated within a 25-mile radius of the Statue of Liberty National Monument. The study area includes eight (8) planning regions: 1) Jamaica Bay; 2) Harlem River, East River, and Western Long Island Sound; 3) Newark Bay, Hackensack River and Passaic River; 4) Upper Bay; 5) Lower Bay; 6) Lower Raritan River; 7) Arthur Kill/Kill Van Kull; and 8) Lower Hudson River (Figure ES-1). The HRE is located within one of the most urbanized regions in the United States, and has undergone centuries of industrial and residential development. Extensive navigation and infrastructure improvements, urbanization, and industrialization have resulted in extensive degradation of aquatic and terrestrial ecosystems, including wetlands, stream corridors, island rookeries, shellfish beds, migratory bird habitat, and resources used by federally-listed threatened and endangered species. In addition to human modifications, natural forces such as Hurricane Sandy have also resulted in habitat loss and degradation.



The purpose of the study is to evaluate the causes and effects of significant, widespread degradation in the estuary; to formulate, evaluate, and screen potential solutions to these problems; to recommend a series of projects for near-term construction that have a federal interest and are supported by a local entity willing to provide the necessary items of being a local sponsor (Appendix A); and to identify opportunities for potential future study under the HRE authority. The plan recommended for near-term construction furthers the goals of the HRE Comprehensive Restoration Plan (CRP), which was completed by the USACE in partnership with the New York-New Jersey Harbor & Estuary Program in 2009 and updated in 2016. The CRP serves as the master plan for restoring the HRE. This study compliments decades of restoration efforts by federal and state natural resource agencies, academic institutions, and non-governmental organizations.

The USACE and multiple non-federal sponsors {New York City Department of Environmental Protection (NYCDEP), Port Authority of New York and New Jersey (PANYNJ), Westchester County, New Jersey Sports and Exposition Authority (Former Hackensack Meadowlands Commission) and New Jersey Department of Transportation (NJDOT)} commenced six (6) concurrent USACE feasibility studies in the 1990s and early 2000s that focused on the restoration of different areas of the HRE. In an effort to streamline parallel efforts, and maximize efficiencies, resources, and benefits, the feasibility studies were integrated into the HRE Ecosystem Restoration Feasibility Study effort. The studies, referred to as "source" studies include:

- Jamaica Bay, Marine Park, and Plumb Beach Ecosystem Restoration Feasibility Study.
- Flushing Bay and Creek Ecosystem Restoration Feasibility Study.
- Bronx River Basin Ecosystem Restoration Feasibility Study.
- HRE Ecosystem Restoration Feasibility Study.
- HRE- Lower Passaic River Ecosystem Restoration Feasibility Study.
- HRE- Hackensack Meadowlands Ecosystem Restoration Feasibility Study.

The analyses completed as part of these "source" studies were incorporated into and informed the current planning effort. This Draft HRE FR/EA responds to all "source" studies' authorities.

Target ecosystem characteristics (TECs) were developed to focus restoration goals on distinct actions. Each TEC is an important ecosystem property or feature that is of ecological and/or societal value. The TECs are key components essential for successful restoration of healthy estuary. The TECs defined for the HRE CRP address the problems affecting the HRE and describe critical habitats and habitat complexes that have become diminished within the HRE over the past several centuries. Some TECs focus on specific habitats, others on the interconnectedness of the habitats, while still others address support structures for the estuary, contamination issues, and societal values. Of the 12 TECs, the following eight (8) are within the purview of the USACE's aquatic ecosystem restoration mission:

- Wetlands
- Habitat for Waterbirds
- Coastal and Maritime Forests
- Oyster Reefs
- Eelgrass Beds
- Shorelines and Shallows
- Habitat for Fish, Crab, and Lobsters
- Tributary Connection

The study objectives seek to benefit the entire ecosystem, with associated improvements in the delivery of broader ecosystem functions and qualities and are defined in Table ES-1.

Table ES-1: Target Ecosystem Characteristics and Sub-Objectives in the Hudson-Raritan Estuary Study Area.

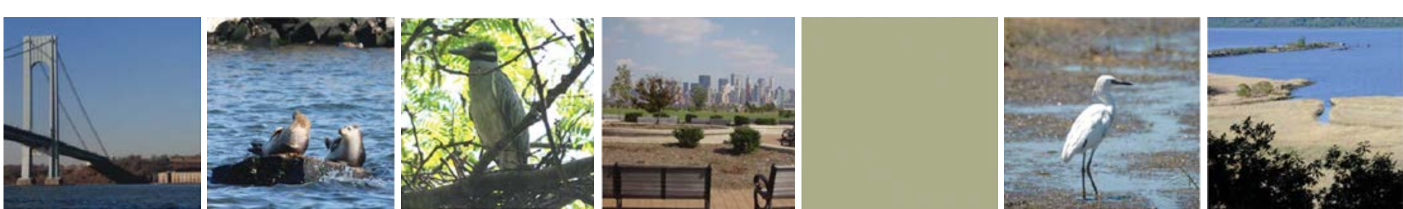
TEC	Target Statement/Sub-Objectives/Secondary Benefits
Wetlands	**Target Statement** • Create and restore coastal and freshwater wetlands, at a rate exceeding the annual loss or degradation, to produce a net gain in acreage. **Sub-Objectives** • Improve the quantity, quality, and complexity of wetland habitat. • Increase overall diversity and abundance of wetland habitat. • Increase connectivity of wetland habitats to reduce fragmentation. • Improve the hydrologic connectivity of the floodplain and the river/estuary. • Reduce shoreline erosion. • Reduce invasive species monocultures and replace with diverse native vegetation. • Restore tidal marsh systems to offset both historical and future losses. **Secondary Benefits** • Provide secondary coastal storm risk management benefits (e.g., wave attenuation, shoreline stability, and shoreline resiliency), serving as potential natural and nature-based features. • Improve water quality and storage of floodwaters.
Habitat for Waterbirds	**Target Statement** • Restore and protect roosting, nesting, and foraging habitat (i.e., inland trees, wetlands, shallow shorelines) for long-legged wading birds. **Sub-Objectives** • Improve roosting, nesting, and foraging habitat for long-legged wading birds. • Increase the number of nests and improve feeding habitat for target species.
Coastal and Maritime Forests	**Target Statement** • Create a linkage of forests accessible to avian migrants and dependent plant communities. **Sub-Objectives** • Restore maritime forest and grassland habitat to ensure the sustainability of adjacent wetlands/aquatic habitat. • Restore maritime forest and grassland habitat to the system to provide vegetated buffer and transitional zone between aquatic habitat and urban environment. • Provide habitat and food sources for bird and wildlife species, stabilize shorelines, and provide soil retention. **Secondary Benefits** • Provide secondary coastal storm risk management benefits (e.g., wave attenuation, shoreline stability, and shoreline resiliency), serving as potential natural and nature-based features.

TEC	Target Statement/Sub-Objectives/Secondary Benefits
Oyster Reefs	**Target Statement** • Establish sustainable oyster reefs at several locations. **Sub-Objectives** • Incorporate diverse habitat structure to improve feeding, breeding, and nursery grounds for fish and benthic communities. **Secondary Benefits** • Incorporate habitat structure to provide secondary coastal storm risk management benefits (e.g., wave attenuation, shoreline stability, and shoreline resiliency), serving as potential natural and nature-based features. • Improve water quality through filtration.
Eelgrass Beds	**Target Statement** • Establish eelgrass beds at several locations in the study area. **Sub-Objectives** • Provide habitat that is vertically and horizontally complex to improve diversity and density of macroinvertebrates, shellfish, and fish. • Reduce erosion, stabilize sediment, and dissipate wave and current energy. **Secondary Benefits** • Improve water quality through nutrient cycling, oxygen production.
Shorelines and Shallows	**Target Statement** • Create or restore shoreline and shallow sites with a vegetated riparian zone, an intertidal zone with a stable slope, and illuminated shallow water. **Sub-Objectives** • Soften hardened shorelines to restore transitional zones. • Restore buffer riparian zones, including littoral zones and intertidal areas, to support increased diversity and abundance of biological communities.
Habitat for Fish, Crab, and Lobsters	**Target Statement** • Create functionally related habitats in each of the eight (8) regions of the HRE. **Sub-Objectives** • Develop mosaic of diverse quality habitats to sustain fish and invertebrate populations. • Restore natural stream geomorphology. • Reduce sediment loads to improve fish, shellfish, and benthic organism habitats. • Objectives for wetland, eelgrass beds, and oyster reef habitat included.

TEC	Target Statement/Sub-Objectives/Secondary Benefits
Tributary Connections	**Target Statement** • Reconnect and restore freshwater streams to the estuary to provide a range of quality habitats to aquatic organisms. **Sub-Objectives** • Increase connectivity of riparian habitats to reduce fragmentation in migratory corridors. • Improve the hydrologic connectivity of the floodplain and the river/estuary to improve the function of riparian habitat, reduce velocities, increase infiltration, and improve natural sediment processes. • Enhance basin and tributary bathymetry configuration to promote optimal circulation. • Reduce shoreline erosion. • Remove invasive species and replace with diverse native vegetation. • Increase habitat available for migratory fish through removal of fish passage impediment.
TECs (Limited within the USACE Mission) and Target Statements	
Enclosed and Confined Waters	**Target Statements** • Improve water quality in all enclosed waterways and tidal creeks within the estuary to match or surpass the quality of their receiving waters.
Sediment Contamination	• Isolate or remove one or more sediment zone(s) that is contaminated until such time as all HRE sediments are considered uncontaminated based on the all related
Public Access	• Improve direct access to the water and create linkages to other recreational areas, as well as provide increased opportunities for fishing, boating, swimming, hiking, education, or passive recreation.
Acquisition	• Protect ecologically valuable coastal lands throughout the HRE from future development through land acquisition.

The HRE CRP identified 296 sites for restoration, 275 of which are within the purview of the USACE ecosystem restoration mission. The initial array of sites was screened per the plan formulation strategy and processes outlined in each “source” study to identify the focused array of sites. The site selection process identified 33 sites recommended for construction authorization. Cost effective plans that maximize net ecosystem benefits at each site are presented as the tentatively selected plan (TSP). The 33 sites (Figure ES-2) span five (5) planning regions and would allow for the restoration of diverse native habitat throughout the estuary that support the HRE program goal, "to develop a mosaic of habitats that provides society with renewed and increased benefits from the estuary environment" (Table ES-2).

Various restoration measures and techniques were evaluated at each site. The recommended combinations of measures for estuarine and freshwater riverine restoration sites reflect the “best buy” plan as identified using cost effectiveness/incremental cost analysis (CE/ICA). The TSP (Table ES-3) is



a suite of ecosystem restoration sites within the HRE that address long-term and large-scale degradation of aquatic habitat. The TSP provides restoration of up to 360 acres of estuarine wetland habitat, 12 acres of freshwater riverine wetland habitat (1,970 average annual functional capacity units [AAFCUs]), 81 acres of coastal and maritime forest habitat, 5.5 acres of riparian forest habitat, and 57 acres of oyster habitat. Two (2) fish ladders would be installed and three (3) weirs would be modified to re-introduce or expand fish passage along the Bronx River along with 3.83 miles of bank stabilization and 2.35 miles of stream channel restoration for the freshwater sites. Table ES-4 displays the total first cost is $644,170,000 (October 2016 price level).

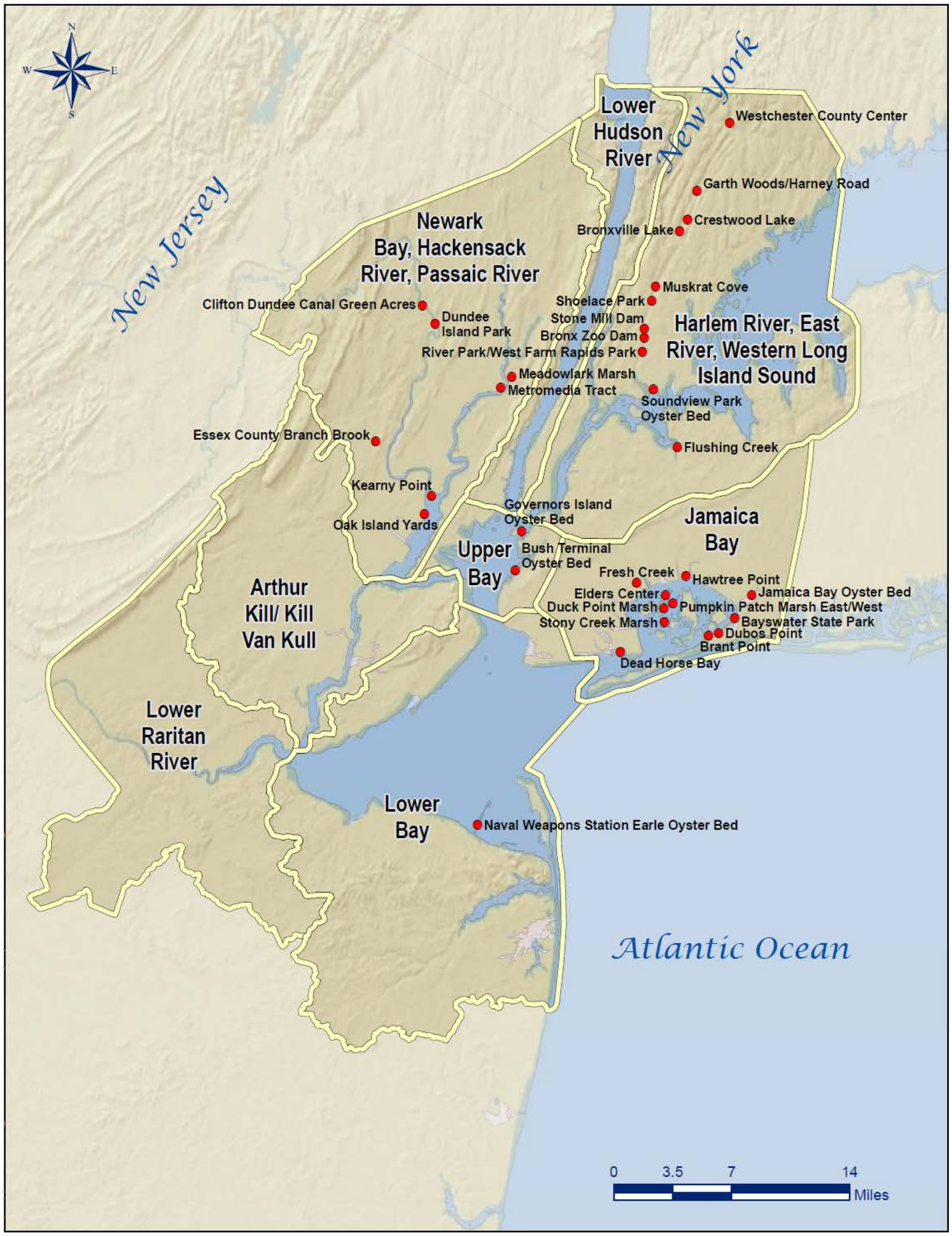


Figure ES-2: Recommended sites in the TSP within the Hudson Raritan Estuary

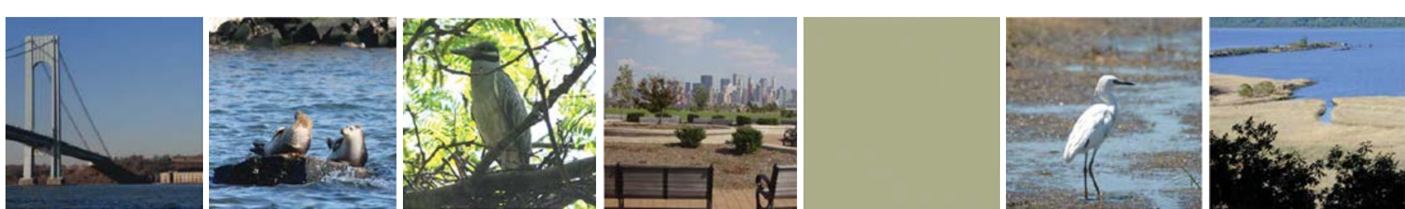
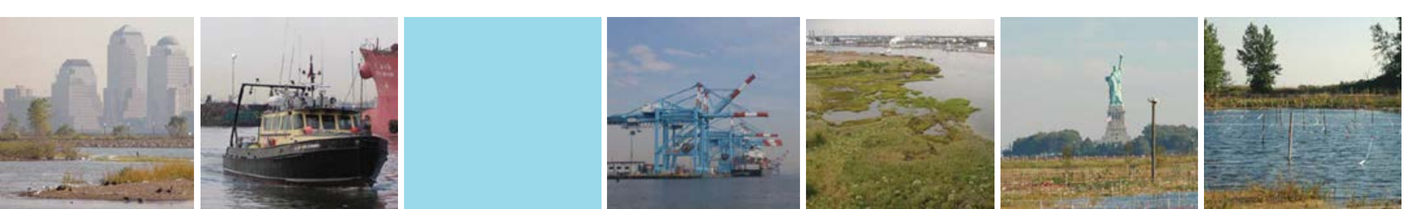
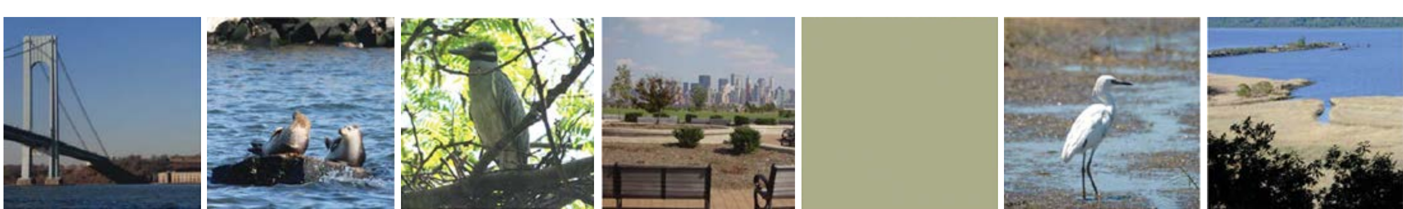


Table ES-2: Recommended sites and restoration measures in the TSP by planning region, and major waterbody or location.

Restoration Site	Restoration Measures														
	Atoll terrace creation	Beach/dune creation	Coastal scrub/shrub and grassland restoration	Dune creation	High marsh restoration	Low marsh restoration	Scrub/shrub wetland restoration	Wetland protection	Invasive species removal and native plantings	Landfill removal	Maritime forest restoration	Meadow restoration	Public access improvement	Tidal channel/basin/pool restoration	Oyster Reef Creation
Jamaica Bay Planning Region															
Dead Horse Bay				28.0 ac.	7.0 ac.	31.0 ac.				31.0 ac	61.0 ac			4.0 ac.	
Fresh Creek					2.5 ac.	13.6 ac.					11.3 ac.			43.0 ac.	
Hawtree Point			1.7 ac.		0.07 ac.										
Bayswater Point State Park		0.7 ac.			0.4 ac.	2.5 ac.								0.81 ac.	
Dubos Point					0.9 ac.	3.3 ac.					2.0 ac.			0.7 ac.	
Brant Point						0.7 ac.		1.2 ac.			2.4 ac.	2.5 ac.			
Stony Creek					25.3 ac.	26.0 ac.									
Duck Point	9.0 ac.				12.5 ac.	15.4 ac.									
Elders Point Center					7.5 ac.	8.5 ac.									
Pumpkin Patch West					5.5 ac.	10.8 ac.									
Pumpkin Patch East					16.8 ac.	18.5 ac.									
Harlem River, East River, and Western Long Island Sound Planning Region															
Flushing Creek						2.4 ac.									
Soundview															.97 ac.



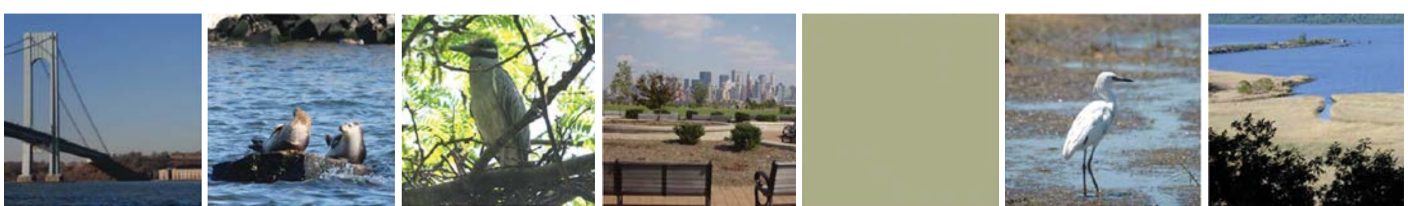
Restoration Site	Restoration Measures														
	Atoll terrace creation	Beach/dune creation	Coastal scrub/shrub and grassland restoration	Dune creation	High marsh restoration	Low marsh restoration	Scrub/shrub wetland restoration	Wetland protection	Invasive species removal and native plantings	Landfill removal	Maritime forest restoration	Meadow restoration	Public access improvement	Tidal channel/basin/pool restoration	Oyster Reef Creation
Newark Bay, Hackensack River, and Passaic River Planning Region															
Oak Island Yards, Tier 2						7.1 ac.			4.0 ac.					1,821 LF	
Kearny Point, Tier 2						8.8 ac			2.5 ac.				4,455 LF	0.49 ac.	
Metromedia Tract					4.1 ac.	50.6 ac.	3.5 ac.				1.1 ac.				
Meadowlark Marsh					4.6 ac.	60.2 ac.			1.9 ac.		3.2 ac.			12.7 ac.	
Upper Bay															
Bush Terminal															43.8 ac.
Governors Island															4.18 ac.
Lower Bay															
Naval Weapons Station Earle															55.58 ac.



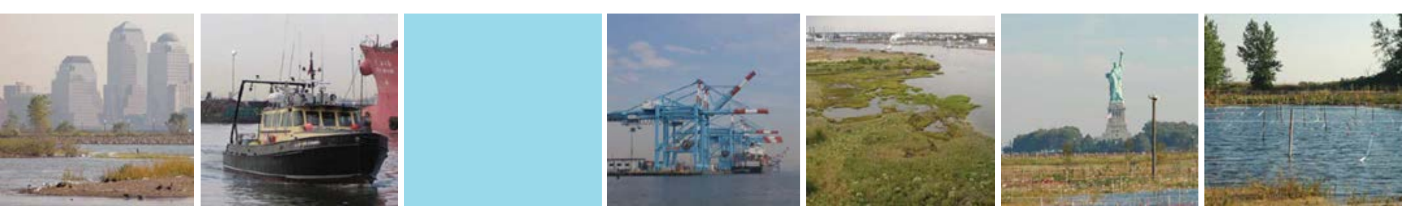
Restoration Site	Restoration Measures														
	Bank stabilization	Shoreline softening	Bed restoration	Channel dredging/ modification/realignment	Instream structures	Emergent wetland restoration	Forested and scrub/shrub wetland restoration	Fish ladder installation	Invasive species removal	Native plantings	Riparian forest restoration	Riprap forebay installation	Sediment control BMP installation	Water quality BMP installation	Weir modification for fish passage
Harlem River, East River, and Western Long Island Sound Planning Region															
River Park/West Farm Rapids Park		0.31 ac.	0.83 ac.			0.04 ac.					0.2 ac.				
Bronx Zoo and Dam						0.54 ac.					0.56 ac.				
Stone Mill Dam															
Shoelace Park	11,620 LF			6,680 LF					6.5 ac.						
Muskrat Cove	1,350 LF			1.2 ac.					0.49 ac.						
Bronxville Lake			1.3 ac.			0.59 ac.	2.9 ac.		1.4 ac.			0.43 ac.	0.24 ac.		
Crestwood Lake				1.2 ac.		4.8 ac.			1.3 ac.						
Garth Woods/Harney Road		190 LF		0.85 ac.		0.79 ac.	0.03 ac.		0.22 ac.						
Westchester County Center	285 LF			0.83 ac.		2.6 ac.			3.7 ac.						
Newark Bay, Hackensack River, and Passaic River Planning Region															
Essex County Branch Brook Park	10,320 LF			23.5 ac.						10, 320 LF/13.7 ac.					
Dundee Island Park	0.71 ac.								1.2 ac.						
Clifton Dundee Canal Green Acres						0.1 ac.			2.8 ac.		5.5 ac.		0.11 ac.		

Table ES-3: Pertinent Data – Benefits, Costs and Cost Allocation Summary for Recommended Sites in the TSP

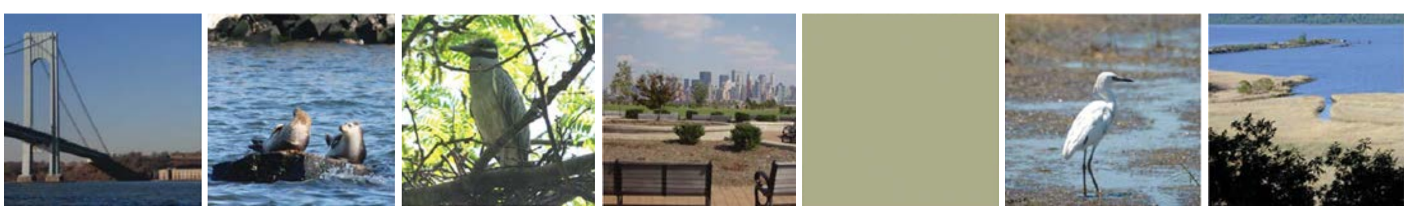
Planning Region	Restoration Site	Measures/TEC	Benefits	Costs				Non-Federal Sponsors
			AAFCU	Average Annual Cost $	Federal Costs	Non-Federal Costs	Total First Cost $	
Jamaica Bay	**Perimeter Sites**							
	Dead Horse Bay	Tidal channel Wetlands (low marsh) Wetlands (high marsh) Dunes Maritime forest (beneficial use of sand) Removal of landfill	413[1]	$3,274,464	53,799,850	28,969,150	$82,769,000	NYCDEP, NYC Parks, NYSDEC
	Fresh Creek	Wetland (low marsh) Wetland (high marsh) Tidal creek/pool Maritime forest Shallow water habitat through channel regrading	246[1]	$1,933,316	29,557,450	15,915,550	$45,473,000	NYCDEP, NYC Parks, NYSDEC
	Hawtree Point	Coastal scrub/shrub and grassland Wetlands	6.5[1]	$57,878	950,950	512,050	$1,463,000	NYCDEP, NYC Parks, NYSDEC
	Bayswater Point State Park	Wetlands (low marsh) Wetlands (high marsh) Beach/dune Tidal channel Tidal pool	76[1]	$230,050	3,779,750	2,035,250	$5,815,000	NYS Department of Parks and Recreation
	Dubos Point	Wetlands (low marsh) Wetlands (high marsh) Tidal creek/pool Maritime forest	58[1]	$378,208	6,214,000	3,346,000	$9,560,000	NYCDEP, NYC Parks, NYSDEC



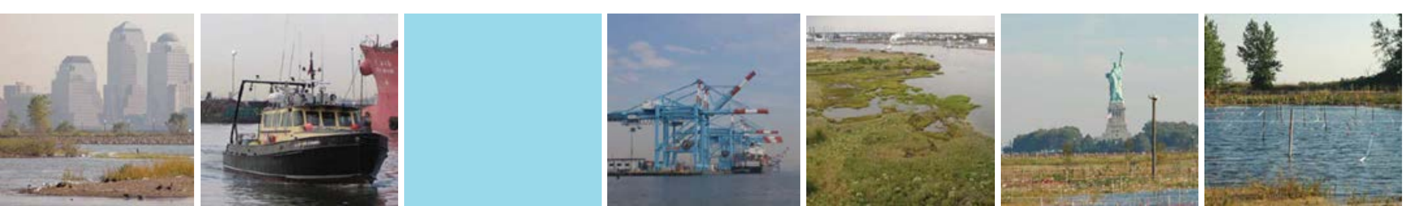
Planning Region	Restoration Site	Measures/TEC	Benefits	Costs				Non-Federal Sponsors
			AAFCU	Average Annual Cost $	Federal Costs	Non-Federal Costs	Total First Cost $	
Jamaica Bay	Brant Point	Wetlands (existing) Wetlands (low marsh) Meadow Maritime forest	27[1]	$295,920	4,862,000	2,618,000	$7,480,000	NYCDEP, NYC Parks, NYSDEC
		Total	**826.5**				**$152,560,000**	
	Marsh Islands							
	Stony Creek	Wetlands	124.44	$1,209,526	19,838,800	10,682,200	$30,520,000	NYSDEC, NYCDEP
	Duck Point	Wetlands	57.99	$1,100,935	18,057,000	9,723,000	$27,780,000	NYSDEC, NYCDEP
	Elders Point Center	Wetlands	39.92	$821,542	13,474,500	7,255,500	$20,730,000	NYSDEC, NYCDEP
	Pumpkin Patch West	Wetlands	40.54	$794,197	13,026,000	7,014,000	$20,040,000	NYSDEC, NYCDEP
	Pumpkin Patch East	Wetlands	69.31	$1,503,981	24,667,500	13,282,500	$37,950,000	NYSDEC, NYCDEP
		Total	**332.2**				**$137,020,000**	
Harlem River, East River, and Western Long Island Sound	Flushing Creek	Wetlands	12.5	$233,000	3,835,000	2,065,000	$5,900,000	NYCDEP
	Bronx River							
	River Park/West Farm Rapids Park	Shoreline softening Emergent wetlands Bed restoration Invasive removal/native plantings Riverbed restoration	0.379	$152,870	2,600,000	1,400,000	$4,000,000	NYCDEP, NYC Parks



Planning Region	Restoration Site	Measures/TEC	Benefits	Costs				Non-Federal Sponsors
			AAFCU	Average Annual Cost $	Federal Costs	Non-Federal Costs	Total First Cost $	
Harlem River, East River, and Western Long Island Sound	Bronx Zoo and Dam	Invasive removal/native plantings Fish ladder Sediment trap Emergent wetlands	1.369	$147,140	2,502,500	1,347,500	$3,850,000	NYCDEP, NYC Parks
	Stone Mill Dam	Fish ladder	NA	$27,855	468,000	252,000	$720,000	NYCDEP, NYC Parks
	Shoelace Park	Channel realignment w/in-stream structures Bank stabilization Invasive removal/native plantings Sediment load reduction/ rain gardens/ bioretention basins	3.304	$959,250	16,256,500	8,753,500	$25,010,000	NYCDEP, NYC Parks
	Muskrat Cove	Channel modification River bank stabilization Installation of sediment basins for load reduction Invasive removal/native plantings	0.757	$300,700	5,096,000	2,744,000	$7,840,000	NYCDEP, NYC Parks

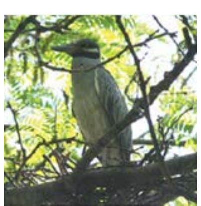
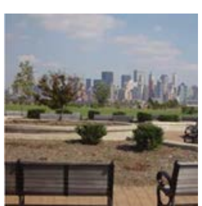
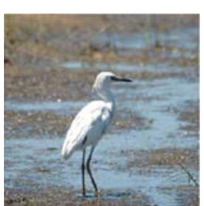
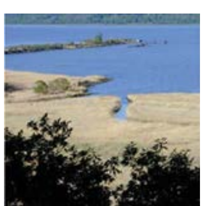


Planning Region	Restoration Site	Measures/TEC	Benefits	Costs				Non-Federal Sponsors
			AAFCU	Average Annual Cost $	Federal Costs	Non-Federal Costs	Total First Cost $	
Harlem River, East River, and Western Long Island Sound	Bronxville Lake	Native plantings Rip rap forebay Channel bed restoration Emergent wetlands Forested scrub/shrub wetlands Modification of rock weir for fish passage Invasive removal and native plantings Sediment dredging Sediment load reduction/ vegetated swales/ retention basins/rain gardens	5.342	$565,750	10,094,500	5,435,500	$14,530,000	Westchester County Planning
	Crestwood Lake	Modification of existing rock weir for fish passage Creation of emergent wetlands Channel realignment, bed material construction, 11 instream cross vanes Two (2) riprap forebays Invasive removal/ native planting	13.267	$1,058,970	17,946,500	9,663,500	$27,610,000	Westchester County Planning

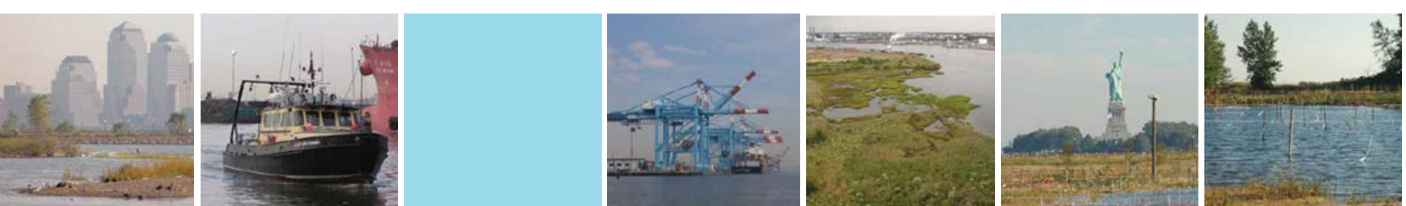


Planning Region	Restoration Site	Measures/TEC	Benefits	Costs				Non-Federal Sponsors
			AAFCU	Average Annual Cost $	Federal Costs	Non-Federal Costs	Total First Cost $	
Harlem River, East River, and Western Long Island Sound	Garth Woods/Harney Park	Modification of weir for fish passage River channel modification (15 in-stream cross vanes) Shoreline softening Rain gardens/bioretention area Invasive removal/native planting Emergent wetlands Garth Woods: forested scrub/shrub wetlands	3.227	$275,830	4,680,000	2,520,000	$7,200,000	Westchester County Planning
	Westchester County Center	Emergent wetlands Bank stabilization In-stream structures, 10 cross vanes and six (6) J-hooks, channel modification Invasive species removal/ native planting	7.259	$555,590	9,438,000	5,082,000	$14,520,000	Westchester County Planning
		Total	**34.904**				**$105,280,000**	
Newark Bay, Hackensack River, and Passaic	**Hackensack River**							
	Metromedia Tract	• Low marsh restoration • High marsh restoration • Scrub/shrub habitat • Maritime upland	198.37	$1,285,268	21,131,500	11,378,500	$32,510,000	NJSEA, NJDEP

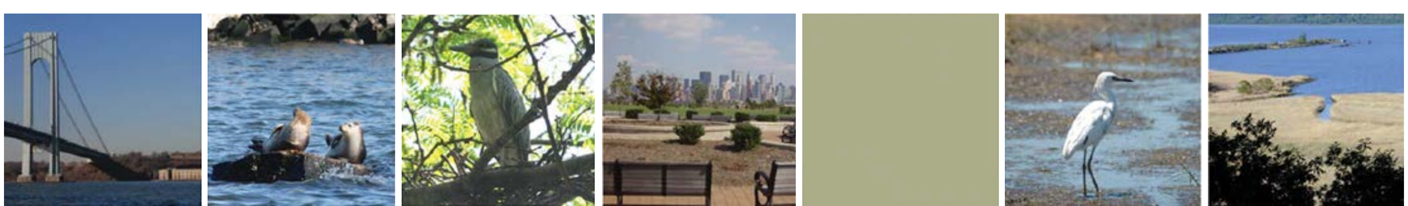


Planning Region	Restoration Site	Measures/TEC	Benefits	Costs				Non-Federal Sponsors
			AAFCU	Average Annual Cost $	Federal Costs	Non-Federal Costs	Total First Cost $	
River	Meadowlark Marsh	Low marsh restoration High marsh restoration Restore mudflats, tidal channels and interior marsh Invasive removal/native plantings Maritime forest	294.22	$1,618,870	27,079,000	14,581,000	$41,660,000	NJSEA, NJDEP
	Total		**492.59**				**$74,170,000**	
	Lower Passaic River "Tier 2" Sites							
	Deferred site: Oak Island Yards	Restoration low marsh Creation of new tidal channels Invasive removal/native plantings	30.77	$1,134,140	19,266,000	10,374,000	$29,640,000	NJDEP
Newark Bay, Hackensack River, and Passaic River	Deferred site: Kearny Point	Restoration low marsh Invasive removal/native plantings Restoration of new tidal channels Public access/path	125.27	$2,245,670	37,563,500	20,226,500	$57,790,000	NJDEP
	Table		**156.04**				**$87,430,000**	
	Lower Passaic River "Tier 1" Sites							
	Essex County Branch Brook Park	Invasive removal/native plantings Channel dredging to restore freshwater stream and floodplain Erosion control of banks/plantings	99.70	$849,610	14,228,500	7,661,500	$21,890,000	NJDEP



Planning Region	Restoration Site	Measures/TEC	Benefits	Costs				Non-Federal Sponsors
			AAFCU	Average Annual Cost $	Federal Costs	Non-Federal Costs	Total First Cost $	
Newark Bay, Hackensack River, and Passaic River	Dundee Island Park	Riparian restoration (invasive removal/native planting) Bank stabilization/shoreline softening	1.29	$106,247	1,768,000	952,000	$2,720,000	NJDEP
	Clifton Dundee Canal Green Acres Site	Emergent wetland Invasive removal/native planting Restoration/stabilization of riparian forest Sediment basin	14.43	$457,250	7,767,500	4,182,500	$11,950,000	NJDEP
		Total	**115.42**				**$36,560,000**	
	Oyster Restoration Sites							
Jamaica Bay	Jamaica Bay, Head of Bay	Oyster beds (1.5 ac) Hanging trays (>0.5 ac)	NA	$31,190	533,000	287,000	$820,000	NYCDEP
Harlem River, East River, and Western Long Island Sound	Soundview Park	Spat on shell (0.83 ac) Gabion blocks (0.14 ac)	NA	$28,940	494,000	266,000	$760,000	NY/NJ Baykeeper, Hudson River Foundation
Upper Bay	Bush Terminal	Spat on shell (31.65 ac) Gabion blocks (8.48 ac) Oyster condos (3.49 ac) Hanging trays (0.1 ac)	NA	$1,274,635	21,417,500	11,532,500	$32,950,000	NY Harbor Foundation/School
	Governors Island	Gabion blocks 1.66 ac) Oyster condos (1.79 ac) Hanging trays (0.68 ac)	NA	$188,130	3,172,000	1,708,000	$4,880,000	NY Harbor Foundation/School



Planning Region	Restoration Site	Measures/TEC	Benefits	Costs				Non-Federal Sponsors
			AAFCU	Average Annual Cost $	Federal Costs	Non-Federal Costs	Total First Cost $	
Lower Bay	Naval Weapons Station Earle	Spat on shell (3.1 ac) Gabion blocks (3.2 ac) Reef balls (1.3 ac)	NA	$285,657	4,823,000	2,597,000	$7,420,000	NY/NJ Baykeeper
		Total	**NA**				**$46,830,000**	
		GRAND TOTAL	**1970.135**				**$644,170,000**	

1: Evaluation of Planned Wetland (EPW) Average Annual Functional Capacity Units (AAFCUs) are from preliminary 2010 Jamaica Bay, Marine Park, and Plumb Beach Feasibility Study. EPW results were verified by the East Rockaway/Jamaica Bay Reformulation Study Team in 2016.
NA: Not Applicable

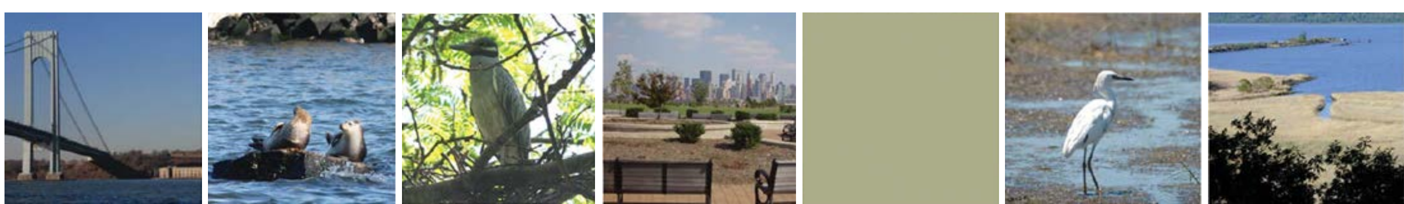
Table ES-4 shows the total cost of construction by planning region.

Table ES-4: Total Cost by Planning Region (FY 2016)

Planning Region	Total Cost
Jamaica Bay	$289,580,000
Harlem River, East River, and Western Long Island Sound	$111,180,000
Newark Bay, Hackensack River, and Lower Passaic River	$198,160,000
Upper Bay	$37,830,000
Lower Bay	$7,420,000
Total	$644,170,000

The expected environmental effects of implementing the TSP would be overwhelmingly beneficial to the flora, fauna, and people in the study area. Implementation of the TSP would restore ecosystem function while recognizing the urban nature of the existing environment. It would provide the ability for anadromous and catadromous species to access the full length of the Bronx River for first time in centuries. Eleven marsh islands in Jamaica Bay would be restored. Creation of eastern oyster (*Crassostrea virginica*) reefs in the estuary would reintroduce the once-omnipresent keystone species. As the proposed actions involve construction activities, implementation of the TSP would result in some short-term, negative impacts to the environment; however, these impacts would be temporary and localized. All restoration measures would be implemented in accordance with regulatory agency stipulations and construction contractors would employ best management practices (BMPs) at all times (e.g., use of silt curtains and adherence to sediment and erosion control plans). Implementation of the TSP may also have cumulative effects when combined with other similar actions occurring in the region of influence. When determining whether a particular activity could contribute cumulatively and significantly to the effects of the TSP, geographical distribution, intensity, duration, and the historical effects of similar activities were considered. As the purpose of the proposed action is to restore degraded habitat and ecosystem function, USACE believes that these activities would result in positive significant cumulative effects, considering both the context and intensity of effects resulting from individual actions.

Significant support was garnered as a result of coordination during the preparation of the Draft FR/EA with long-term partners and stakeholders. As highlighted in the CRP, implementing the TSP would advance the region's highest priorities. The TSP supports HRE program objectives and restoration goals in the HRE (Table ES-1) and all non-federal study sponsors, and additional non-federal construction sponsors are committed to advancing restoration of the HRE. Implementation of the TSP would complement past, ongoing, and planned restoration work by the USACE and other parties within the region as described in the HRE Comprehensive Restoration Plan (CRP).



Hudson-Raritan Estuary Ecosystem Restoration Feasibility Study

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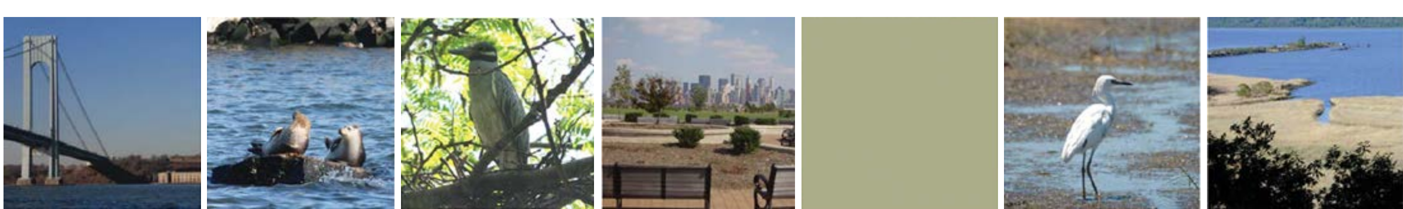

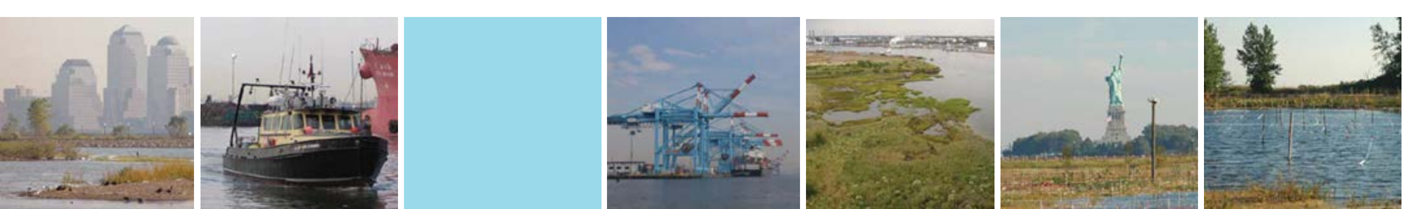

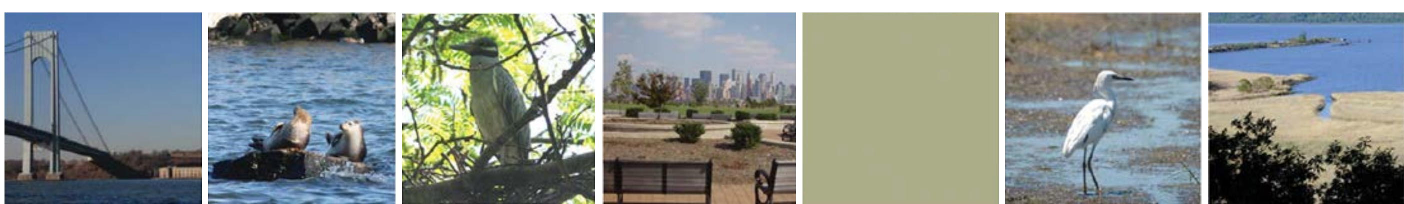

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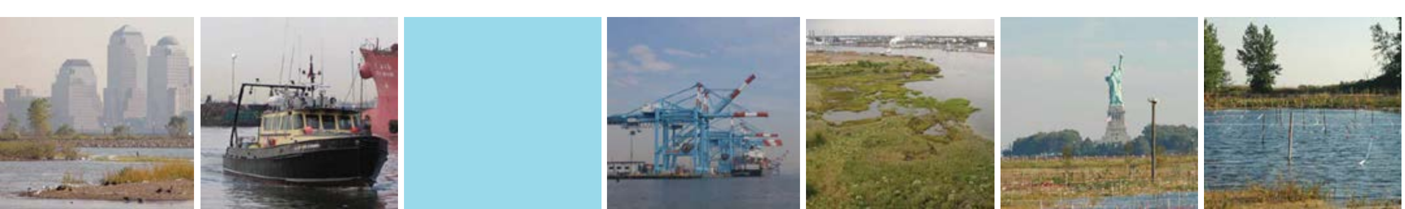

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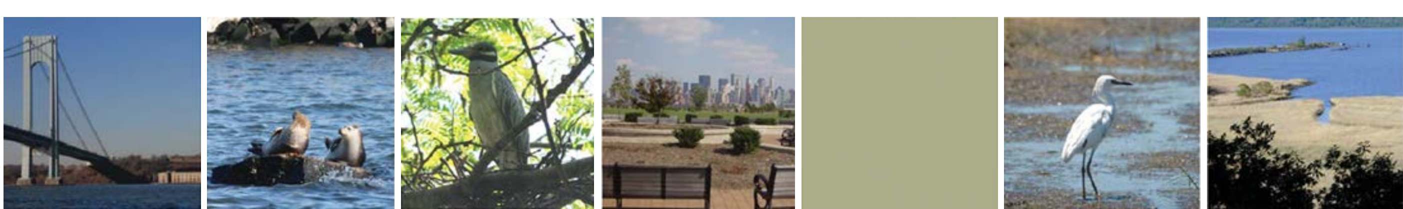


Appendices

Acronyms and Abbreviations

AAFCU	Average Annual Functional Capacity Unit
ACHP	Advisory Council on Historic Preservation
ALS	American Littoral Society
AOC	Administrative Order on Consent
AWOIS	Automated Wreck and Obstruction Information System
BMP	Best Management Practice
CAA	Clean Air Act
CAG	Community Advisory Group
CARP	Contaminant Assessment and Reduction Project
CCPR	Committee on Climate Preparedness and Resilience
CE/ICA	Cost Effectiveness/Incremental Cost Analysis
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CPG	Cooperating Parties Group
CRP	Hudson-Raritan Estuary Comprehensive Restoration Plan
CSO	combined sewer outfall
CSRM	Coastal Storm Risk Management
CUNY	City University of New York
CWA	Clean Water Act
CWP	Comprehensive Waterfront Plan
CY	Cubic Yards
CZMA	Coastal Zone Management Act
DDT	Dichloro-diphenyl-trichloroethane
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
EO	Executive Order
EOP	Environmental Operating Principles
EPW	Evaluation of Planned Wetlands
ESA	Endangered Species Act
FAA	Federal Aviation Administration
FCI	Functional Capacity Index
FCSA	Feasibility Cost Share Agreement
FCU	Functional Capacity Unit
FL	Fish
FR/EA	Integrated Feasibility Report and Environmental Assessment
FWCA	Fish and Wildlife Coordination Act
GHG	Greenhouse gas
GIS	Geographic Information System
GNRA	Gateway National Recreation Area
HARS	Historic Area Remediation Site
HDP	Harbor Deepening Project
HEP	New York-New Jersey Harbor & Estuary Program
HHMT	Howland Hook Marine Terminal
HRE	Hudson-Raritan Estuary
HTRW	Hazardous, Toxic, and Radioactive Wastes
ICA	Incremental Cost Analysis
ICC	Ironbound Community Corporation

JFK	John F. Kennedy International Airport
LERRD	Lands, Easements, Right-of-way, and Disposal Sites
LF	Linear Feet
MESIC	Meadowlands Environmental Site Information Compilation
MFCMA	Magnuson-Stevens Fishery Conservation and management Act
MLW	Mean Low Water
MMPA	Marine Mammal Protection Act
NEPA	National Environmental Policy Act
NGO	Non-Governmental Organizations
NJDEP	New Jersey Department of Environmental Protection
NJDOT	New Jersey Department of Transportation
NJMC	New Jersey Meadowlands Commission
NJSEC	New Jersey Sports and Exposition Authority
NJSHPO	New Jersey State Historic Preservation Office
NMFS	National Marine Fisheries Service
NNBF	Natural and Nature Based Features
NOAA	National Oceanic Atmospheric Administration
NRCS	National Resource Conservation Service
NYC Parks	New York City Department of Parks and Recreation
NYCDEP	New York City Department of Environmental Protection
NYCLPC	New York City Landmarks Preservation Commission
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
OMRR&R	Operation Maintenance, Repair, Replacement, and Rehabilitation
PA	Programmatic Agreements
PAH	Polycyclic Aromatic Hydrocarbon
PANYNJ	Port Authority of New York and New Jersey
PCB	Polychlorinated Biphenyl
PED	Planning, Engineering and Design
ppt	parts per thousand
PRC	Passaic River Coalition
PRP	Potential Responsible Parties
PVSC	Passaic Valley Sewerage Commission
RI/FS	Remedial Investigation/Feasibility Study
RM	River Mile
RWG	Restoration Work Group
SB	Shoreline Bank Erosion Control
SHPO	State Historic Preservation Office
SLR	Sea Level Rise
SNWA	Special Natural Waterfront Area
SRIJB	Science & Resilience Institute at Jamaica Bay
SS	Sediment Stabilization
SVAP	Stream Visual Assessment Protocol
TEC	Target Ecosystem Characteristic
TSP	Tentatively Selected Plan
UAO	Unilateral Administrative Order
URRI	Urban River Restoration Initiative
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency

UWFP	Urban Waters Federal Partnership
WL	Wildlife
WQ	Water Quality
WRDA	Water Resources Development Act

Chapter 1: Introduction

The United States Army Corps of Engineers (USACE), New York District has prepared this Draft Integrated Feasibility Report and Environmental Assessment (FR/EA) for the Hudson-Raritan Estuary (HRE) Ecosystem Restoration Feasibility Study to provide an interim response to the study authorization. This FR/EA includes recommendations for the:

- Construction of a suite of restoration opportunities throughout the HRE (New York/New Jersey Port District.
- Completion of new phase future spin-off feasibility studies to be carried out under the HRE study authority or the Continuing Authorities Program, dependent upon the availability of federal and local funding, and the willingness of non-federal sponsors to partner with the USACE for such studies.

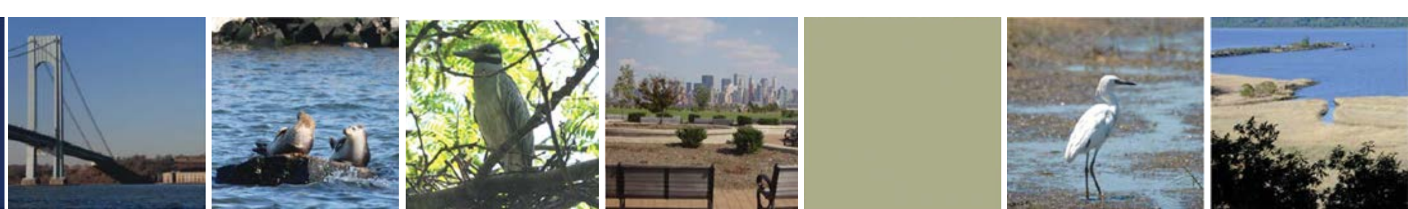
The restoration opportunities recommended for construction and future study are critical to address the ongoing long-term and large-scale ecosystem degradation within the estuary. This document presents the potential alternatives for environmental restoration within the HRE, analyzes the environmental impacts of implementing those alternatives, outlines the process used for selecting the recommended alternative at each restoration site, and concludes with recommendations for project implementation. It also documents compliance with the National Environmental Policy Act (NEPA) of 1969, and includes input from the non-federal study sponsors, natural resource agencies, and the public.

- Chapter 1 Introduction*
- Chapter 2 Affected Environment*
- Chapter 3 Plan Formulation*
- Chapter 4 The Tentatively Selected Plan and Implementation
- Chapter 5 Environmental Consequences of the Alternatives*
- Chapter 6 Cumulative Effects*
- Chapter 7 Environmental Compliance with Environmental Statutes*
- Chapter 8 Summary of Coordination, Public Views, and Comments
- Chapter 9 Recommendations
- Chapter 10 References
- Chapter 11 Preparers*

The report sections marked with an asterisk (*) include required content for compliance with NEPA.

1.1 Study Purpose and Scope

The HRE is within the boundaries of the Port District of New York and New Jersey and is situated within a 25-mile radius of the Statue of Liberty National Monument. The HRE study area includes eight (8) planning regions: 1) Jamaica Bay; 2) Harlem River, East River, and Western Long Island Sound; 3) Newark Bay, Hackensack River and Passaic River; 4) Upper Bay; 5) Lower Bay; 6) Lower Raritan River; 7) Arthur Kill/Kill Van Kull ; and 8) Lower Hudson River . The HRE is located within one of the most urbanized regions in the United States, and has undergone centuries of industrial and residential development. Extensive navigation and infrastructure improvements, urbanization, and industrialization have resulted in extensive degradation of aquatic and terrestrial ecosystems, including wetlands, stream corridors, island rookeries, shellfish beds, migratory bird habitat, and resources used by federally-listed threatened and endangered species.



The purpose of the study is to evaluate the causes and effects of significant, widespread degradation in the estuary; to formulate, evaluate, and screen potential solutions to these problems; to recommend a series of projects for near-term construction that have a federal interest and are supported by a local entity willing to provide the necessary items of being a local sponsor (Appendix A); and to identify opportunities for potential future study under the HRE authority. The plan recommended for near-term construction furthers the goals of the HRE Comprehensive Restoration Plan (CRP), which was completed by the USACE in partnership with the New York-New Jersey Harbor & Estuary Program (HEP) in 2009 and updated in 2016. The CRP serves as the master plan for restoring the HRE. This study compliments decades of restoration efforts by federal and state natural resource agencies, academic institutions, and non-governmental organizations.

The USACE and multiple non-federal sponsors commenced six (6) concurrent USACE feasibility studies in the 1990s and early 2000s that focused on the restoration of different areas of the HRE. In an effort to streamline parallel efforts, and maximize efficiencies, resources, and benefits, the feasibility studies were integrated into the HRE Ecosystem Restoration Feasibility Study effort. The studies, referred to as “source” studies include:

- Jamaica Bay, Marine Park, and Plumb Beach Ecosystem Restoration Feasibility Study;
- Flushing Bay and Creek Ecosystem Restoration Feasibility Study;
- Bronx River Basin Ecosystem Restoration Feasibility Study;
- HRE Ecosystem Restoration Feasibility Study;
- HRE- Lower Passaic River Ecosystem Restoration Feasibility Study; and
- HRE- Hackensack Meadowlands Ecosystem Restoration Feasibility Study.

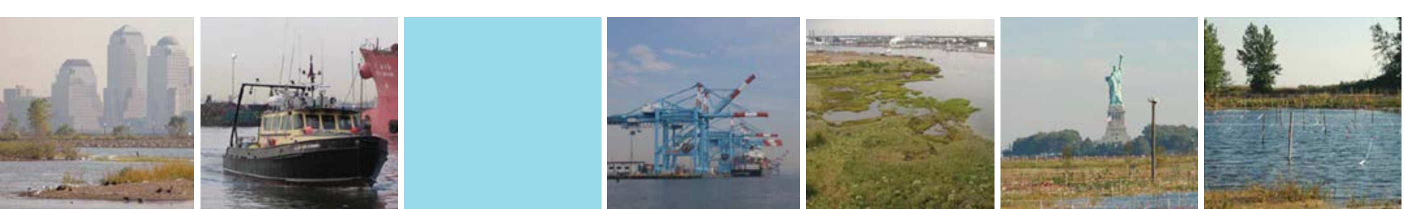
The analyses completed as part of these “source” studies were incorporated into and informed the current planning effort. This Draft HRE FR/EA responds to all “source” studies’ authorities.

1.2 Study Authorities*

This FR/EA satisfies the multiple resolutions by the United States House of Representatives. Each of six (6) “source” feasibility studies was authorized by different Congressional resolutions, with three (3) “source” studies authorized by the same HRE resolution (Table 1-1). Because the “source” feasibility studies were integrated into the overall HRE study, all of the authorizations are pertinent to this effort.

Table 1-1: Study Authorities.

Planning Region	Authorization	“Source” Feasibility Study*
Jamaica Bay	August 1, 1990 Resolution by the United States House of Representatives Committee on Public Works and Transportation	Jamaica Bay, Marine Park, and Plumb Beach Ecosystem Restoration Feasibility Study
East River, Harlem River, Western Long Island Sound	September 28, 1994 Resolution by the United States House of Representatives Committee on Public Works and Transportation	Flushing Bay and Creek Ecosystem Restoration Feasibility Study
	March 24, 1998 Resolution by the United States House of Representatives Committee on Transportation and Infrastructure	Bronx River Basin Ecosystem Restoration Feasibility Study



Planning Region	Authorization	"Source" Feasibility Study*
All	April 15, 1999 Resolution by the United States House of Representatives Committee on Transportation and Infrastructure	HRE Ecosystem Restoration Feasibility Study
Newark Bay, Hackensack River and Passaic River		Lower Passaic River Ecosystem Restoration Feasibility Study
		Hackensack Meadowlands Ecosystem Restoration Feasibility Study

*see section 1.3.5 for status of each "source" study

The Jamaica Bay, Marine Park, and Plumb Beach Ecosystem Restoration Feasibility Study was authorized by a resolution adopted by the Committee on Public Works and Transportation on August 1, 1990 stating:

> *Resolved by the Committee on Public Works and Transportation of the United States House of Representatives, that the Board of Engineers for Rivers and Harbors, is requested to review the report of the Chief of Engineers on the Atlantic Coast of New York City from East Rockaway Inlet and Jamaica Bay, New York published as House Document 215, Eighty-ninth Congress, First Session, and other pertinent reports, to determine whether modification of the recommendation contained therein are advisable at this time, to determine the feasibility of improvements for beach erosion control, hurricane protection and environmental improvements in Jamaica Bay including environmentally sensitive areas along Plumb Beach, Brooklyn, New York.*

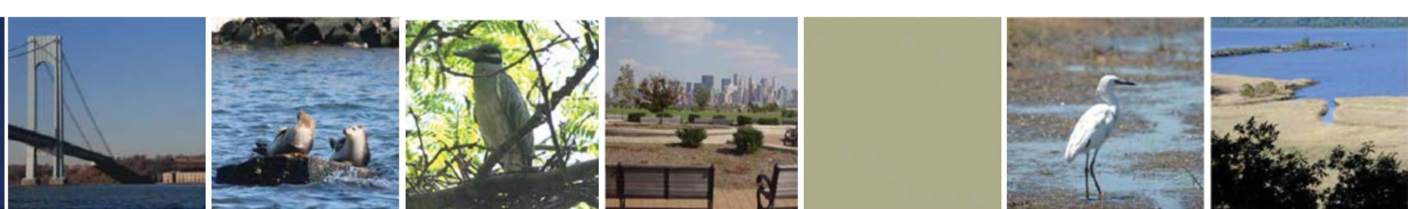
The Flushing Creek and Bay Ecosystem Restoration Feasibility Study was authorized by a resolution of the Committee on Public Works and Transportation of the United States House of Representatives, dated September 28, 1994. The study authorization states:

> *Resolved by the Committee on Public Works and Transportation of the United States House of Representatives, That the Secretary of the Army, is requested to review the Report of the Chief of Engineers on Flushing Bay and Creek, New York, published as House Document 551, Eighty-seventh Congress, 2nd Session, and other pertinent reports, to determine whether modifications of the recommendations contained therein are advisable at the present time, in the interest of water quality and other purposes, for Flushing Bay, New York.*

The Bronx River Basin Ecosystem Restoration Feasibility Study was authorized by a resolution of the Committee on Transportation and Infrastructure, dated March 24, 1998:

> *Resolved by the Committee on Transportation and Infrastructure of the United States House of Representatives, That the Secretary of the Army is requested to review the report of the Chief of Engineers on the Bronx River, New York, published as House Document 897, 62nd Congress, 2nd Session, and other pertinent reports, to determine whether any modifications of the recommendations contained therein are advisable at the present time, in the interest of water resources development, including flood control, environmental restoration and protection and other related purposes.*

The HRE, Lower Passaic River, and Hackensack Meadowlands Ecosystem Restoration Feasibility Studies were authorized by a resolution of the Committee on Transportation and Infrastructure of the United States House of Representatives, dated April 15, 1999. The resolution provides USACE with



broad authority to evaluate comprehensive ecosystem restoration opportunities within the entire Port of New York and New Jersey. The study authorization states:

> *Resolved by the Committee on Transportation and Infrastructure of the United States House of Representatives, That, the Secretary of the Army is requested to review the reports of the Chief of Engineers on the New York and New Jersey Channels, published as House Document 133, 74th Congress, 1st Session; the New York and New Jersey Harbor Entrance Channels and Anchorage Areas, published as Senate Document 45, 84th Congress, 1st Session; and the New York Harbor, NY Anchorage Channel, published as House Document 18, 71st Congress, 2nd Session, as well as other related reports with a view to determining the feasibility of environmental restoration and protection relating to water resources and sediment quality within the New York and New Jersey Port District, including but not limited to creation, enhancement, and restoration of aquatic, wetland, and adjacent upland habitats.*

A HRE Reconnaissance Report was completed in January 2001 under the April 15, 1999 United States House of Representatives authorization. The report detailed a federal interest in restoring the HRE. Additional reconnaissance reports were also prepared for:

- *Jamaica Bay* which demonstrated that there was a federal interest in addressing shore protection, storm damage reduction, hurricane protection and environmental restoration objectives (USACE, 1994).
- *Flushing Bay and Creek* which demonstrated that there is a federal interest in ecosystem restoration and related water quality improvements for Flushing Bay and Creek (USACE, 1996).
- *Bronx River* Basin established federal interest for potential ecosystem restoration measures in the Bronx River Basin (USACE, 1999).

This FR/EA is an interim response to the above study authorities. This report includes a recommendation for 1) the construction of a suite of restoration opportunities throughout the New York/New Jersey Port District, and 2) the completion of new phase future spin-off feasibility studies to be carried out under the study authority, dependent upon the availability of federal and local funding, and the willingness of non-federal sponsors to partner with the USACE for such studies. The actions recommended for near-term construction will not provide completed comprehensive restoration of the HRE, but rather the immediate restoration of highly significant sites. The restoration of areas not included in the interim recommendation will continue to be in need of restoration. A study into the potential restoration opportunities in the federal interest that are not recommended for near-term construction at this time could be included in new phase future spin-off studies.

1.3 Study and Construction Non-Federal Sponsors

The USACE and non-federal sponsors executed Feasibility Cost Share Agreements for each of the six (6) "source" feasibility studies. Many of the study sponsors have agreed to be local sponsors for construction of the recommended projects. In addition, other agencies have agreed to participate as a local sponsor for construction and were added to the restoration planning within the specific waterbody. The non-federal sponsors for each "source" study and potential construction sponsors are shown in Table 1-2. The sponsors have agreed that consolidation of planning efforts into the current study is the best, most efficient course of action for study completion. Letters of support are found in Appendix A.

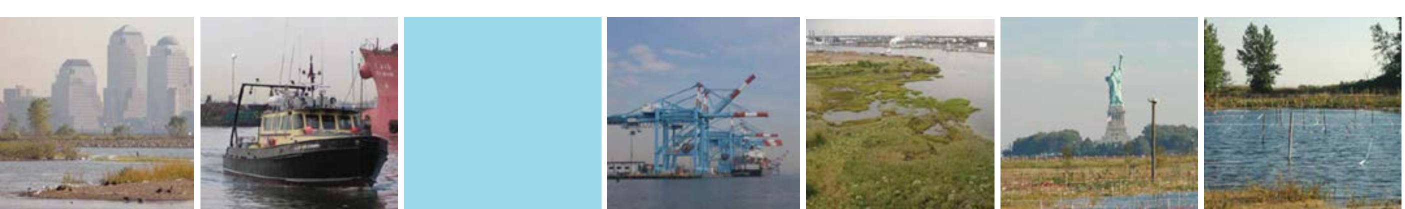


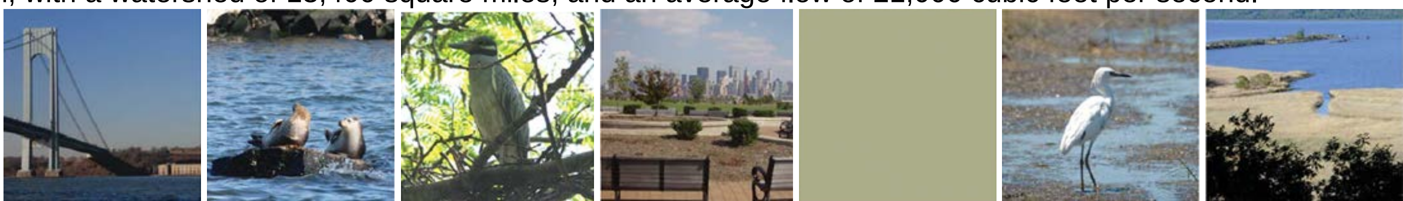
Table 1-2: Non-Federal Study and Potential Construction Sponsors.

"Source" Feasibility Study	FCSA[1] Execution Date	Study Sponsor(s)	Potential Construction Sponsor(s)
Jamaica Bay, Marine Park, and Plumb Beach Ecosystem Restoration Feasibility Study	February 22, 1996	New York City Department of Environmental Protection (NYCDEP)	NYCDEP, New York State Department of Environmental Conservation (NYSDEC), New York City Department of Parks and Recreation (NYC Parks), and New York State Parks
Flushing Bay and Creek Ecosystem Restoration Feasibility Study	September 2, 1999	NYCDEP and Port Authority of New York and New Jersey (PANYNJ)	NYCDEP
HRE Ecosystem Restoration Feasibility Study	July 12, 2001	PANYNJ	All others and NY Harbor Foundation and NY/NJ Baykeeper for oyster restoration
Bronx River Basin Ecosystem Restoration Feasibility Study	November 3, 2003	NYCDEP and Westchester County	NYCDEP, NYC Parks, and Westchester County
Hackensack Meadowlands Ecosystem Restoration Feasibility Study	April 23, 2003	New Jersey Sports and Exposition Authority (Former Hackensack Meadowlands Commission)	New Jersey Sports and Exposition Authority and New Jersey Department of Environmental Protection (NJDEP)
Lower Passaic River Ecosystem Restoration Feasibility Study	June 30, 2003	New Jersey Department of Transportation (NJDOT)	NJDEP

[1] FCSA: Feasibility Cost Share Agreement

1.4 Study Area

The study area is located within one of the largest estuaries on the east coast of the United States, encompassing over 1,600 square miles and almost 1,600 linear miles of shoreline (USACE, 2006a, HEP 2016a). Watershed boundaries and physical landmarks were used to delineate the study area into eight (8) ecologically and historically distinct areas called planning regions (Figure 1-1). The study area includes all tidally influenced portions of rivers flowing into New York and New Jersey Harbor, including the Hudson, Raritan, Hackensack, Passaic, Shrewsbury, and Navesink Rivers, and the East River from the Battery to Hell Gate (USFWS, 1997). The 320-mile Hudson River dominates the hydrology of the system, with a watershed of 13,400 square miles, and an average flow of 21,000 cubic feet per second.



The Hackensack, Passaic, Raritan, Shrewsbury, and Navesink rivers collectively account for about 13 percent of the flow into the harbor (USFWS, 1997).

The study area was delineated into the following eight (8) planning regions, which were developed using a watershed-ecosystem-scale approach to facilitate stakeholders' identification of restoration needs and opportunities specific to each region (Figure 1-1).

- **Jamaica Bay** – The Jamaica Bay Planning Region, located on the southwestern shore of Long Island, is enclosed by the Rockaway peninsula. This region includes portions of Brooklyn, Queens, and Nassau Counties, New York, as well as the John F. Kennedy International Airport. On the bay's western edge, Rockaway Inlet connects Jamaica Bay to Lower New York Bay.
- **Harlem River, East River, and Western Long Island Sound** – The Harlem River, East River, and Western Long Island Sound Planning Region contains sections of Manhattan and the Bronx to the north, and Brooklyn and Queens to the south. It extends east to include part of Long Island Sound, and portions of Westchester and Nassau Counties, New York.
- **Newark Bay, Hackensack River, and Passaic River** – The Newark Bay, Hackensack River, and Passaic River Planning Region encompasses portions of Bergen, Passaic, Hudson, Essex, and Union Counties, New Jersey. A small portion of Rockland County, New York is also included in this planning region.
- **Upper Bay** – The Upper Bay Planning Region begins at the mouth of the Hudson River, is connected to Newark Bay and the Arthur Kill via the Kill Van Kull, and exchanges water with the East River and Long Island Sound.
- **Lower Bay** – The Lower Bay Planning Region includes Lower New York Bay, Raritan Bay, and Sandy Hook Bay. The planning region is bounded on the north by Staten Island and Brooklyn, New York, and on the south by Monmouth County, New Jersey, and on the ocean side by a transect between Sandy Hook, New Jersey and Rockaway Point, New York.
- **Lower Raritan River** – The Lower Raritan River Planning Region is the western-most planning region of the study area. This region contains the lower six (6) miles of the Raritan River before its confluence with Raritan Bay. Portions of the region extend into Union, Somerset, and Monmouth Counties, New Jersey.
- **Arthur Kill/Kill Van Kull** – The Arthur Kill/Kill Van Kull Planning Region lies between Newark Bay and the Lower Raritan River. The planning region connects to the Upper Bay via the Kill Van Kull and mixes those waters with Newark Bay. Important tributaries to the Arthur Kill include the Rahway and Elizabeth Rivers, Old Place Creek, Woodbridge Creek, and Fresh Kills Creek.
- **Lower Hudson River** – The Lower Hudson River Planning Region extends from the Upper New York Bay to the Tappan Zee Bridge, and includes portions of Bergen and Hudson Counties, New Jersey and New York City, Rockland, and Westchester Counties, New York.

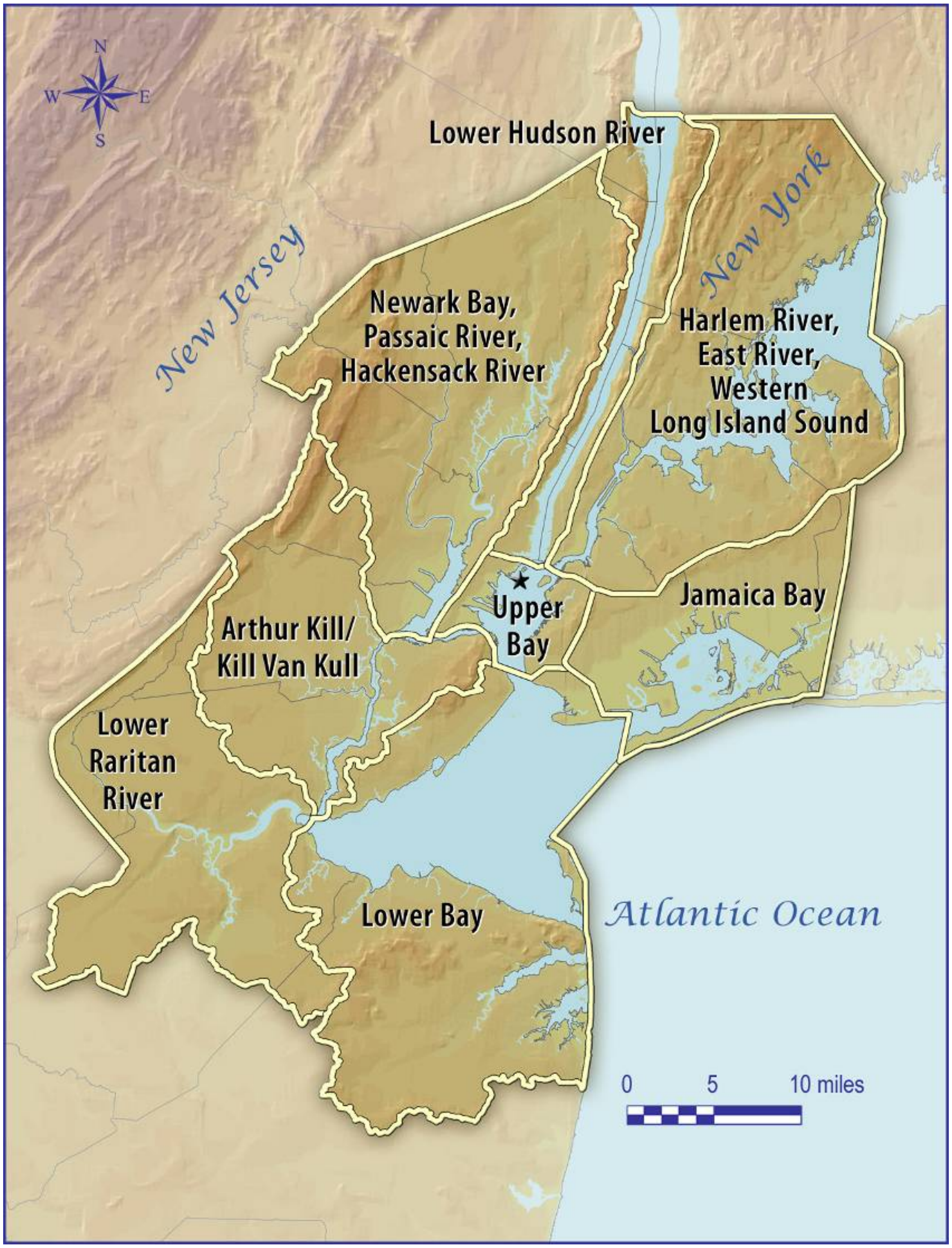
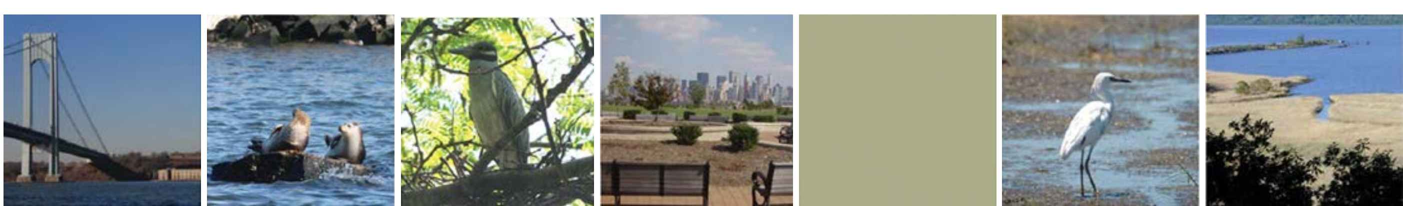


Figure 1-1: HRE Study Area with Planning Regions.
The Statue of Liberty is denoted by a star.




Source: U.S. Fish and Wildlife Service

Figure 1-2: Atlantic Flyway

The HRE study area is located where the east-west oriented shoreline of the New England and Long Island coasts meets the north-south oriented shorelines of the Mid-Atlantic coast. This concentrates those species of birds, insects, and fish that seasonally migrate along the coastline and funnels them into the region, leading to exceptional diversity and numbers (USFWS, 1997). The USFWS lists approximately 400 plant, animal, and fish species of special emphasis as occurring within the HRE study area (USFWS, 1997). Additionally, the Atlantic Flyway (Figure 1-2), one (1) of four (4) major avian migratory routes in North America, passes directly through the HRE study area.

This estuary supports residents and migrants of almost 300 species of birds, over 100 species of fishes, over 2,000 vascular plant species, and many important terrestrial and aquatic invertebrates (Glenn, 2013; Steinberg et al., 2004; USFWS, 1997). In all, dozens of species of animals and plants currently on the federal threatened or endangered species lists depend on this estuary for one or more of their critical life stages, as do many others that are on state lists. In addition, the HRE contains approximately 400 plant and animal species of special emphasis and 25 percent of the nesting herons between Cape May, New Jersey and Rhode Island make their home in the harbor (USFWS, 1997).

The HRE is located within one of the most urbanized regions in the United States. Over 20 million people live within 25 miles of the Statue of Liberty, the approximate center of the estuary, including the highly urbanized cities of New York, and Jersey City, Newark, and Elizabeth, New Jersey. Urbanization and industrialization over the past 400 years has put stress on the estuary, resulting in significant loss of habitat. The estuary has a long history of industrial and residential development that began in the 1600s with the first European settlers and intensified as navigation and infrastructure improved. These alterations resulted in significant ecosystem-level changes due to residual, persistent impacts to numerous habitats, especially those linked to aquatic environments. Regional development of the watershed and massive physical changes to the estuary, including dredging and channeling, damming, and bank stabilization, led to marked hydrologic alterations, acute sediment contamination, pervasive reductions in water quality, and habitat fragmentation. The ecological integrity, health, and resiliency of the estuary have been severely compromised.

The extensive loss of shallow habitats and wetlands together with reductions in water quality has affected almost every aspect of the estuarine ecosystem. The abundance and diversity of fish, shellfish, and estuarine-dependent wildlife species have been severely reduced through the combined impacts of habitat loss and degradation, competition from invasive species, and resource exploitation. The HRE and its major tributaries have lost much of the natural capacity to buffer flood waters, as well as the capacity to sequester, transform, or degrade nutrients and contaminants. This decreased capacity to naturally maintain water and sediment quality is exacerbated by the region's high-density human population that produces enormous volumes of treated sewage effluent which, along with stormwater passing across impervious watershed surfaces, is discharged into the HRE.

The welfare of the human population surrounding the HRE, including health, economic prosperity, and aesthetics, is closely linked to vitality of the estuary. What began as beneficial use of the existing resources related to habitation and the growth of trade and industry eventually grew into overdevelopment, exploitation, and degradation of the HRE. Not only have these developmental changes directly impacted the estuary, but as part of the environment the regional human population has become a potential secondary receptor of these same impacts.

While a significant amount of the ecological value of the HRE and its watershed has been degraded or changed, it still provides habitat for diverse populations of resident and transient biological communities. Though certain irreversible changes to the estuary have occurred, many of the factors that have contributed to its decline can be better controlled or even eliminated. In addition, the implementation of environmental laws and regulations has led to significant recovery of the ecological resources over the past few decades. This recovery has coincided with an improvement in water quality and increased environmental awareness and stewardship of the ecological treasure that the estuary currently is and can still become.

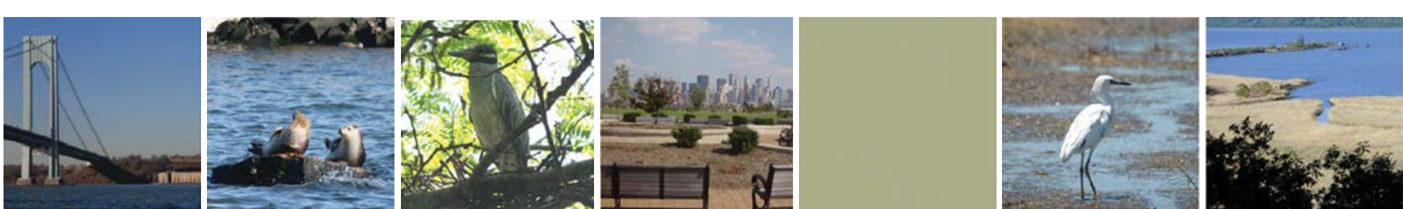
The HRE can be viewed as an example of the resilience of natural systems, in which a mosaic of habitats within a human dominated landscape can actively be restored and created, and where there can be a balance between a healthy vibrant economy and a healthy vibrant estuary. This is the vision of the “World Class Harbor Estuary” that has been embraced by the numerous stakeholders within the region, representing shipping, economic development, and environmental restoration.

1.4.1 Significance of the Hudson-Raritan Estuary and Its Resources

The criteria for determining the significance of resources are provided in the federal Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (United States Water Resources Council, 1983), Resource Significance Protocol for Environmental Project Planning, (IWR Report 97-R-4, July1997) and in USACE planning guidance such as the Planning Guidance Notebook (Engineering Regulation 1105-2-100, April 22, 2000). The consideration of significant resources and significant effects is central to plan formulation and evaluation for any type of water resources development project. Significance of resources and effects are derived from institutional, public, and technical recognition of the ecological, cultural and aesthetic attributes of resources within the study area. As per the USACE Planning Guidance Notebook:

- **Institutional recognition** of a resource or effect means its importance is recognized and acknowledged in the laws, plans, and policies of government and private groups.
- **Technical recognition** of a resource or an effect is based upon scientific or other technical criteria that establish its significance.
- **Public recognition** means some segment of the general public considers the resource or effect to be important. Public recognition may be manifest in controversy, support, or opposition expressed in any number of formal or informal ways.

In ecosystem restoration planning, the concept of significance of outputs plays an especially important role because of the challenge of dealing with non-monetary outputs. The three (3) sources of significance - institutional, public, and technical recognition - and documentation on the relative scarcity of the resources helps determine the significance of the resources to be restored. The significance and the relative scarcity of the resources help to establish a federal interest in the project.



1.4.2 Institutional Significance

Numerous federal laws and executive orders establish National policy for and federal interest in the protection, restoration, conservation, and management of environmental resources. These provisions include compliance requirements with an emphasis on protecting environmental quality. They also endorse federal efforts to advance environmental goals, and a number of these general statements declare it national policy that full consideration is given to the opportunities which projects afford to ecological resources. Water resources development authorizations have enhanced opportunities for USACE involvement in studies and projects to specifically address objectives related to the restoration of ecological resources and ecosystem management. They include the four (4) legislative actions authorizing the studies.

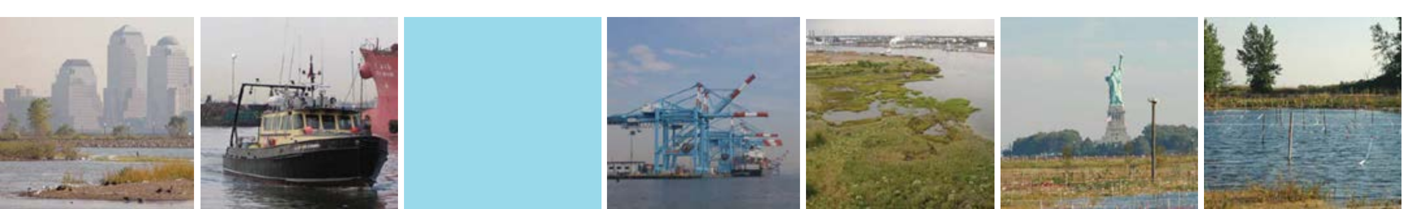
The institutional significance of wildlife resources is demonstrated by the multitude of legislative acts that exist to manage and conserve the resource. Pivotal among these are the following:

- Migratory Bird Treaty Act of 1918 (16 United States Code 703-712)
- Migratory Bird Conservation Act of 1929, as amended (16 United States Code 715-715d, 715e, 715f-715r)
- Fish and Wildlife Coordination Act of 1934, as amended (16 United States Code 661-667e)
- Estuary Protection Act of 1968 (16 United States Code 1221-1226)
- National Environmental Policy Act (NEPA) of 1969, as amended (42 United States Code 4321 et seq.)
- Marine Mammal Protection Act of 1972 (16 United States Code 1361-1421h)
- Coastal Zone Management Act of 1972, as amended (16 United States Code 1451 et seq.)
- Endangered Species Act of 1973 (16 United States Code 1531 et seq.)
- Fish and Wildlife Conservation Act of 1980 (16 United States Code 2901-2911)
- North American Wetlands Conservation Act of 1989 (16 United States Code 4401-4412)
- Executive Order 13186, Responsibilities of Federal Agencies to Protect Migratory Birds, dated January 10, 2001

Wildlife resources are critical elements of the HRE ecosystem and important indicators of the health of aquatic habitats. Wildlife resources are important recreational and commercial resources, as well, and are regarded highly by the public for their aesthetic, recreational, and commercial value.

The HRE is designated as an Ecosystem of National Significance by a number of federal and state agencies, laws, and executive orders. Specific examples of institutional recognition of the significance of the resources in the estuary include the following:

- The National Estuarine Research Reserve System, a partnership of the National Oceanic and Atmospheric Administration (NOAA) and coastal states to study and protect vital coastal and estuarine resources, designated in 1982, four (4) distinct tidal wetland sites within the HRE as the Hudson River National Estuarine Research Reserve.
- In 1987, The New York and New Jersey Harbor Estuary was designated as an Estuary of National Importance and included in the United States Environmental Protection Agency (USEPA) National Estuary Program (Public Law 100-4, Public Law 92-500), one of 28 such Nationally-important estuaries.
- The Hudson River Valley National Heritage Area was designated by Congress in 1996, one of 49 federally-recognized National Heritage Areas.
- New York State established the Hudson River Park Trust within New York City in 1998.



- In 2010, the New York and New Jersey Harbor Estuary was designated by the Assistant Secretary of the Army for Civil Works among the Ecosystems of National Significance, recognizing its importance to our nation's history, the estuary's remarkable recovery over the past 20 years, and the clear vision and strong commitment by the regional stakeholders for continued restoration and conservation of this resource.
- The Bronx River and Harlem River (2011) and Lower Passaic River (2013) Watersheds are two (2) of 19 Urban Waters Federal Partnership locations. Two (2) of the eight (8) Federal Urban River Restoration Initiative pilots (Passaic River and Gowanus Canal) are located in the estuary.
- The Hudson River was designated an American Heritage River by Executive Order 13061 Federal Support of Community Efforts Along American Heritage Rivers, dated September 11, 1997.
- In 2012, the Hudson River Greenway Water Trail is designated as a National Recreation Trail by the National Park Service (NPS).
- The United States Fish and Wildlife Service (USFWS) has identified several regionally significant habitats within the harbor estuary, including Jamaica Bay and Breezy Point, Raritan and Sandy Hook Bays, the Hackensack Meadowlands, the Lower Hudson River, and the Narrows.

1.4.3 Technical Significance

Over 20 million people live within 25 miles of the Statue of Liberty, the approximate center of the estuary, including the highly urbanized cities of New York, and Jersey City, Newark, and Elizabeth, New Jersey. The waters and nearshore habitats of the HRE once supported a diverse mosaic of ecological communities, but centuries of industrialization and urbanization have resulted in severe habitat loss and degradation, poor water quality, pervasive sediment contamination, and lack of public access to the estuary. These actions have significantly affected the ecological integrity, health, and public perception of the estuary and its resources. The HRE has a long history of physical and chemical habitat degradation associated with extensive industrial and residential development, along with vast navigation and infrastructure improvements. These alterations have resulted in ecosystem-level changes to the HRE, causing dramatic shifts in ecological community structure, and in the distribution and resiliency of open-water, nearshore, and coastal habitats.

Chapter 2 discusses further the technical significance and importance of resources within each planning region.

1.4.3.1 Habitat Scarcity

Since the 1600s, over half of the natural wetlands of the contiguous United States have been drained for conversion to other land uses. Within the HRE, over 85 percent of the coastal wetlands and 99 percent of the freshwater wetlands have been lost. Wetlands are threatened by pollution from chemicals, excess nutrients, and sediment. They are also sensitive to many of the effects of climate change, including higher temperatures, changes in rainfall, increased frequency and severity of storms, sea level rise, and higher levels of carbon dioxide in the atmosphere. When wetlands are lost, so are the benefits that they provide, including protection from flooding and drought, aesthetic and recreational services, and critical habitat for birds and other species. Coastal wetlands, like the salt marshes within the HRE, only make up 38 percent of the total wetland area in the lower 48 states; on the east coast, they are being lost at two (2) times the rate that they are being restored (Stedman and Dahl, 2008).

1.4.3.2 Connectivity

Habitat connectivity is the degree to which the landscape facilitates animal movement and other ecological flows. Mobility is the key to survival for many wildlife species. Terrestrial species must navigate a habitat landscape that meets their needs for breeding, feeding, and shelter. Natural and semi-natural components of the landscape must be large enough and connected enough to meet the needs of all species that use them. As habitat conditions change in the face of habitat loss and climate change, some species ranges are already shifting and wildlife must be provided greater opportunities for movement, migration, and changes in distribution. In addition, aquatic connectivity is critical for anadromous and catadromous fish that encounter many potential barriers as they migrate upstream and downstream. Since most of the habitat within the HRE has been severely degraded or destroyed, the habitat that remains is significantly fragmented. It is important to enhance and restore the remaining habitat in order to maintain important spatial areas.

1.4.3.3 Migratory Flyways

The routes followed by migratory birds are numerous, and while some of them are simple and easily traced, others are extremely complicated. The Atlantic Flyway (Figure 1-2) is a major migratory route used by millions of waterfowl. It extends from the offshore waters of the Atlantic Coast west to the Allegheny Mountains, where, curving northwestward across northern West Virginia and northeastern Ohio, it continues in that direction across the prairie provinces of Canada and the Northwest Territories to the Arctic Coast of Alaska. The coastal route of the Atlantic Flyway, which in general follows the shoreline, has its northern origin in the eastern Arctic islands and the coast of Greenland. The flyway embraces several primary migration routes and many more that are important as tributaries, some of the latter being branches from primary routes of other flyways.

The Atlantic Flyway route is of great importance to over 500 avian species, many of which use the HRE as stopover and breeding grounds. They include many species of sparrows, warblers, thrashers, crows, herons, and urban birds. Many of the species are listed as threatened and endangered by the USFWS, including the threatened piping plover (*Charadrius melodus*) and red knot (*Calidris canutus rufa).*

1.4.3.4 Habitat for Special Status Species

Twenty-seven (27) federally-listed species of special status, as well as two (2) additional species listed as candidate species, depend on habitat within and are found in the HRE (Table 1-3). Raritan Bay and Sandy Hook Bay support the greatest variety of federal threatened and endangered species in the study area (USFWS, 1997). Urban areas, such as Manhattan, support the least amount of these species. The HRE also contains 400 plant and animal species of special emphasis, and 25 percent of the nesting herons between Cape May, New Jersey, and Rhode Island make their home in the harbor.

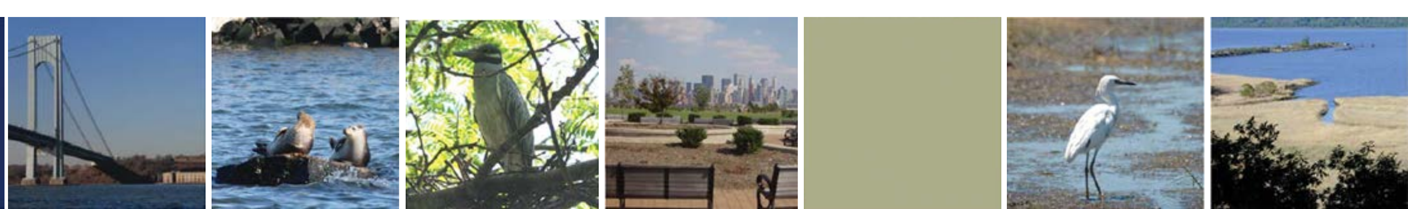
Table 1-3: Federal Threatened, Endangered, and Candidate Species of the Hudson-Raritan Estuary.

Common Name	Scientific Name	Federal Status
Insects		
American Burying Beetle	*Nicrophorus americanus*	Endangered
Northeastern Beach Tiger Beetle	*Cicindela dorsalis dorsalis*	Threatened
Fish		
Alewife	*Alosa pseudoharengus*	Candidate
Atlantic sturgeon	*Acipenser oxyrinchus*	Endangered

Common Name	Scientific Name	Federal Status
Blueback herring	*Alosa aestivalis*	Candidate
Shortnose sturgeon	*Acipenser brevirostrum*	Endangered
Reptiles		
Atlantic Ridley sea turtle	*Lepidochelys kempii*	Endangered
Bog turtle	*Clemmys muhlenbergii*	Threatened
Green sea turtle (non-breeding range)	*Chelonia mydas*	Threatened
Hawksbill sea turtle	*Eretmochelys imbricata*	Endangered
Leatherback sea turtle	*Dermochelys coriacea*	Endangered
Loggerhead sea turtle	*Caretta caretta*	Threatened
Birds		
Piping Plover	*Charadrius melodus*	Threatened
Red Knot	*Calidris canutus*	Threatened
Roseate Tern	*Sterna dougallii dougallii*	Endangered
Mammals		
Indiana bat	*Myotis sodalis*	Endangered
Northern long-eared bat	*Myotis septentrionalis*	Threatened
Plants		
Chaffseed	*Schwalbea americana*	Endangered
Hart's-tongue fern	*Asplenium scolopendrium* var. *americanum*	Threatened
Houghton's goldenrod	*Oligoneuron houghtonii*	Threatened
Knieskern's beaked-rush	*Rhynchospora knieskernii*	Threatened
Leedy's roseroot	*Rhodiola integrifolia* ssp. *leedyi*	Threatened
Monkshood	*Aconitum noveboracense*	Threatened
Northeastern bulrush	*Scirpus ancistrochaetus*	Endangered
Prairie fringed orchid	*Platanthera leucophaea*	Threatened
Sandplain gerardia	*Agalinis acuta*	Endangered
Seabeach amaranth	*Amaranthus pumilus*	Threatened
Small whorled pogonia	*Isotria medeoloides*	Threatened
Swamp pink	*Helonias bullata*	Threatened

1.4.3.5 Human Health

The disruption of the natural hydrology creates conditions favorable to mosquito populations, potentially contributing to the spread of West Nile and Zika virus in the region. The states of New York and New Jersey have issued fishing advisories restricting the consumption of numerous fish and shellfish species taken from the estuary. Local beaches are closed on multiple occasions each summer due to bacterial contamination from sewage or storm runoff, which may lead to gastrointestinal symptoms and ear, nose, eye, and skin infections. In 2015, there were 16 closures at three (3) of the 25 permitted beaches in New York City, and 343 warnings that swimming and wading is not recommended were issued at 19 of the beaches (New York City Department of Health and Mental Hygiene, 2015). Despite such measures to protect the public, individuals may still decide to wade or swim in the nearest waterbody regardless of warnings, or catch and consume shellfish and fish, exposing themselves to mercury and other contaminants.



1.4.3.6 Ecosystem Services

Ecosystem services are the benefits people obtain from ecosystems. Overall, the cumulative impacts of urban coastal development on aquatic and upland habitats have greatly reduced the quantity and quality of coastal habitats, and the environmental benefits and ecosystem services those habitats provide to the nation. Given the overarching potential threats to human health and future sustainability of ecosystem services, the major water resources problems and affected ecosystem services are:

- Loss of quality, quantity, and connectivity of aquatic, wetland, and related coastal habitats (pollination, biological control, food production, raw materials, and genetic resources ecosystem services).
- Imbalance of ecosystem functions and values (gas regulation, climate regulation, disturbance regulation, water regulation, soil formation, and disturbance regulation ecosystem services).
- Degradation of sediment quality (nutrient recycling, erosion control, and sediment retention ecosystem services).
- Degradation of water quality impacting ecosystem function/habitat (water regulation, water supply, and climate regulation ecosystem services).
- Limited recreational opportunities and adversely impacted aesthetic and social issues (cultural and recreation ecosystem services).

Restoration of the HRE to a more natural state would reduce threats to human health and repair the ability of the ecosystem to filter water and provide natural resources.

1.4.4 Public Significance

Public recognition of the significance of a resource may involve memberships in a conservation organization, financial contributions to resource-related efforts, volunteer labor, and correspondence regarding the importance of the resource. Public concerns with the health of the ecosystem have been evident for centuries. A large number of non-profit organizations have formed or organized around improving conditions in the study area. These organizations include:

- American Littoral Society
- Bayonne Oyster Gardeners
- Bergen County Audubon
- Brooklyn Botanic Garden
- Clean Air Campaign Inc
- Clean Ocean Action
- Clifton Environmental Commission
- Concerned Citizens of Bensonhurst
- Crossroads of the American Revolution
- Downtown Boathouse
- East Coast Greenway
- Edison Wetlands
- National Parks Conservation Association
- National Parks of New York Harbor Conservancy
- National Resources Protective Association
- New Jersey Audubon Society
- New York/New Jersey Baykeeper
- New York City Audubon
- New York State Museum
- Outside New York
- Passaic River Boat Club

- American Littoral Society
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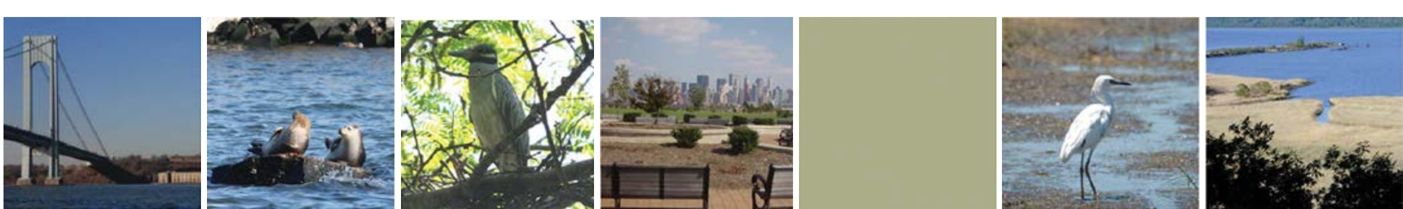
- Clifton Environmental Commission
- Concerned Citizens of Bensonhurst
- Crossroads of the American Revolution
- Downtown Boathouse
- East Coast Greenway
- Edison Wetlands
- Environmental Defense Fund
- Friends of Liberty State Park
- Gateway Bike & Boathouse
- Going Coastal
- Gowanus Canal Conservancy
- Hackensack Riverkeeper
- Hoboken Cove Community
- Hudson River Park Trust
- Interstate Environmental Commission
- Ironbound Community Corporation
- Jamaica Bay Eco Watchers
- Jamaica Bay Task Force
- Jamaica Bay Watershed Protection
- Plan Advisory Committee.
- Lower Passaic River Watershed Alliance
- Lower Passaic River Watershed Alliance.
- National Fish and Wildlife Federation
- National Parks Conservation Association
- National Parks of New York Harbor Conservancy
- National Resources Protective Association
- New Jersey Audubon Society
- New York/New Jersey Baykeeper
- New York City Audubon
- New York State Museum
- Outside New York
- Passaic River Boat Club
- Passaic River Coalition
- Passaic Valley Sewerage Commission
- Raritan Baywatcher
- Raritan River Initiative
- Raritan Riverkeeper
- Red Hook Boaters
- Regional Plan Association
- Rockaway Waterfront Alliance
- Sebago Canoe Club
- Sheepshead Bay/Plumb Beach Civic Association
- The Gaia Institute
- The Natural Areas Conservancy
- The Nature Conservancy
- Trust for Public Land
- Urban Divers Estuary Conservancy
- Washington Park Association
- Waterfront Alliance
- Wildlife Conservation
- Wildlife Trust
- Working Harbor

Over 120 federal and state agencies, academic institutions, and nonprofit and community organizations collaborated to draft the 2009 and 2016 HRE CRP (USACE and PANYNJ, 2009a, 2009b, 2016) to address the need for a comprehensive master plan for restoration of the HRE.

1.5 A History of Collaborative Restoration Planning

Regional, comprehensive restoration planning to restore the HRE began in 1988 following the estuary's recognition by the United States Congress as an estuary of national importance and its subsequent induction into the National Estuary Program. In conjunction with this designation was the formation of the HEP, which established a formal partnership of federal, state, and local governments; scientists; civic and environmental advocates; the fishing community; business and labor leaders; and educators. The HEP provides an open forum for discussion, planning, and action on environmental issues facing the estuary. Technical and advisory committees and work groups made up of government, academic, private, non-profit groups, and citizens inform the Policy and Management Committees. From its



beginning, the USACE has been a federal leader of the HEP, serving on or coordinating with all committees and work groups since 1988.

In 1996, the HEP completed the Comprehensive Conservation and Management Plan, which documents the degraded condition of the estuary's important environmental resources and proposes a series of critical actions to address the significant threats (HEP, 1996). Included among its recommendations is the development of a comprehensive regional plan to restore and protect ecological resources. This recommendation received support from the region's stakeholders, including state and municipal regulators and policy makers, federal agencies, non-governmental organizations, and the general public. In response to this broad support, Congress authorized the USACE to investigate and identify opportunities to restore the estuary that are in the federal interest. A 2000 Reconnaissance Report detailed that there is a federal interest in restoring the HRE (USACE, 2000).

In response to the 2000 HRE Reconnaissance Report (as well as Reconnaissance Reports for Jamaica Bay [USACE, 1994], Flushing Creek and Bay [USACE, 1996], and Bronx River Basin [USACE, 1999]), the USACE and a number of non-federal sponsors began six (6) complimentary feasibility studies in the 1990s and early 2000s that focused on the restoration of priority sites; these are the six (6) "source" studies that were integrated into the HRE Ecosystem Restoration Feasibility Study. Each study was in a different planning phase, as discussed in Section 1.5.3. The studies focused on the needs and opportunities unique to one or more planning regions (Table 1-1).

1.5.1 Needs and Opportunities

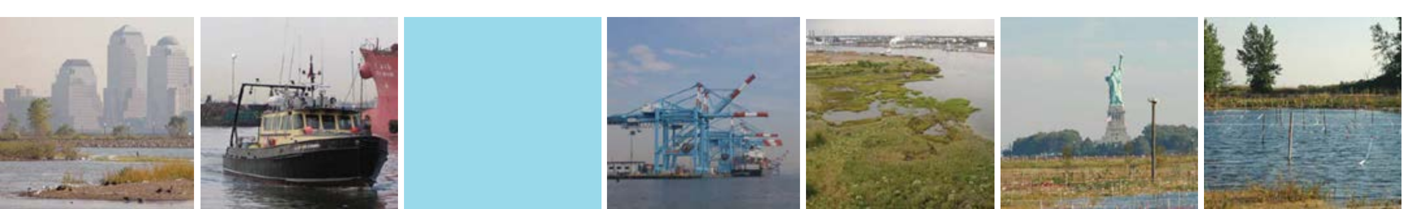
The first step of what was called a "stakeholder based planning process" for the study was initiated in 2001 to develop a "needs and opportunities" report to initiate restoration of the HRE as a whole. The USACE, PANYNJ, and the Regional Plan Association completed the Needs and Opportunities Report (USACE, 2003), which established a collaborative planning process with stakeholders, identified the water resource problems and needs of the estuary, highlighted the need to build upon partner restoration efforts of the past 20 years and stressed the need for a Comprehensive Restoration Plan. The Needs and Opportunities Report also included a list of candidate restoration sites that could address the needs of each waterbody. Subsequently, study area reports that document the history of degradation, restoration needs, existing restoration efforts and potential restoration opportunities within each planning region were prepared (USACE, 2004a-h).

1.5.2 HRE Comprehensive Restoration Plan

The Draft and Version 1.0 of the CRP (USACE and PANYNJ, 2009 and 2016) was the culmination of years of collaborative planning amongst the regions stakeholders and estuarine scientists providing regional consensus on ecosystem goals, objectives, targets, restoration opportunities and implementation strategies for ecosystem restoration in the estuary. The Hudson River Foundation and the Center for the Environment at Cornell University have provided support to the USACE and PANYNJ since 2005 to develop this unifying framework for harbor-wide restoration goals and targets (Target Ecosystem Characteristics), and a shared vision of a restored future state. The HRE CRP presents an overarching program goal:

> *To develop a mosaic of habitats that provides society with renewed and increased benefits from the estuary environment.*

In December 2009 following release of the CRP, the HEP, including all regional partners and stakeholders within the New York-New Jersey Harbor & Estuary, adopted the CRP as their future



restoration plan for the region. Dozens of public outreach meetings occurred in each planning region to obtain comments and input on the draft plan to ensure the consensus vision.

The HEP Restoration Work Group, chaired by the USACE, was formed in 2010 assuming the function of the Habitat Work Group, and charged with steering the coordination and implementation of the HRE CRP. The Restoration Work Group also steers the Program's research and actions relevant to HEP priorities that concern restoration, acquisition, species, or habitat identified in the New York-New Jersey Harbor & Estuary Program Action Plan, Comprehensive Conservation and Management Plan, and Comprehensive Restoration Plan. Members of the group include non-governmental, city, state, and federal representatives with expertise in habitat restoration and preservation. The Restoration Work Group is responsible for developing strategy, providing direction to, and tracking habitat restoration, public access, and acquisition efforts of the program and its participants as they relate to the CRP.

The CRP, prepared for the HRE study, serves as the foundation for all restoration efforts in the study area and highlights ongoing partner ecosystem and coastal restoration efforts in the HRE (see Section 2.6; USACE and PANYNJ, 2016). The CRP presents 296 sites following evaluation of the restoration opportunities identified in the needs and opportunities report, sites nominated by the HEP Habitat Work Group, and sites identified by geographic information system efforts that were deemed as high-value restoration areas that will best help meet the HRE CRP project goal (http://www.harborestuary.org/watersweshare).

1.5.3 Past and Ongoing Restoration Efforts

The HRE feasibility study and "source" studies were built upon the extensive studies undertaken by the USACE and regional federal, state and local partners coordinated within the HEP. In addition, other collaborative frameworks and committees (e.g., New York/New Jersey Federal Leadership Resiliency Collaborative) have been established to coordinate regional efforts to restore, protect and improve the resiliency of the shoreline following Hurricane Sandy. Figure 1-3 illustrates federal efforts to better coordinate and leverage resources and future opportunities. Those shown demonstrate planned federal projects that influence and/or are more effective in combination with the recommendations in this report.

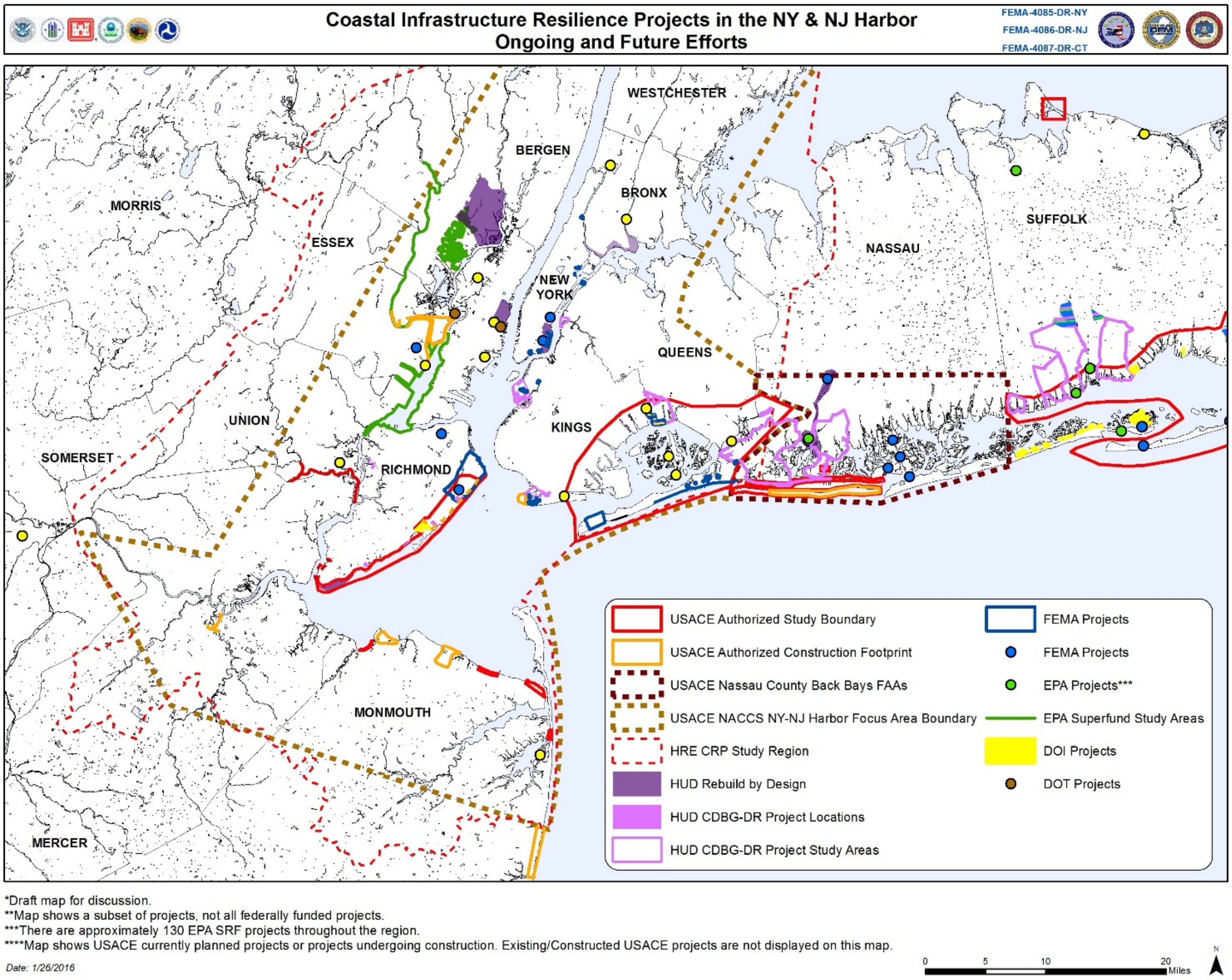


Figure 1-3: Ongoing and Future Coastal Infrastructure Resilience Projects in the HRE Study Area

More detailed coordination within a planning region is ongoing for activities in the Newark Bay, Hackensack River and Lower Passaic River Planning Region (Figure 1-4) and Jamaica Bay Planning Region (Figure 1-5) through leadership committees like the Federal Resilience Collaborative and the Science and Resilience Institute at Jamaica Bay.

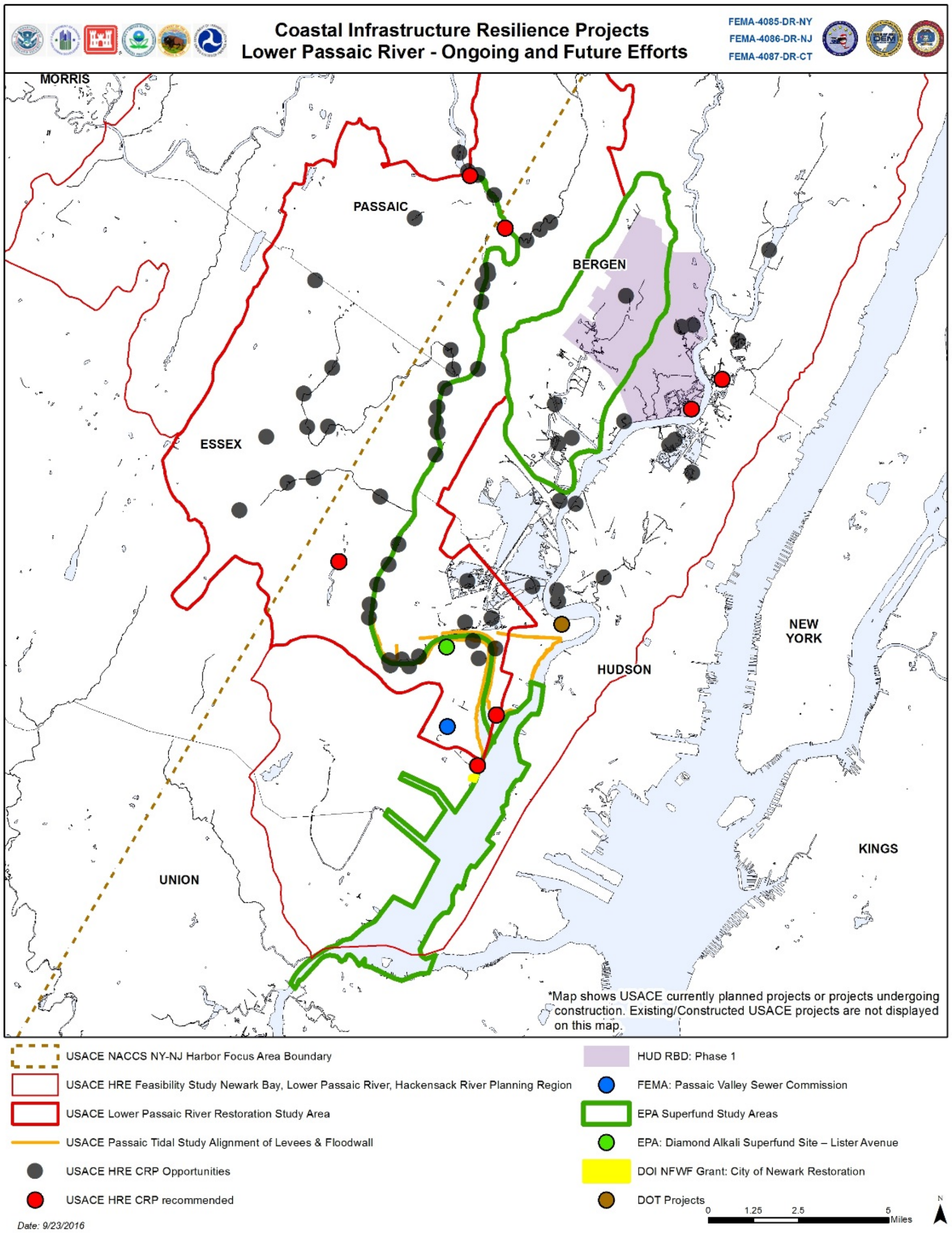
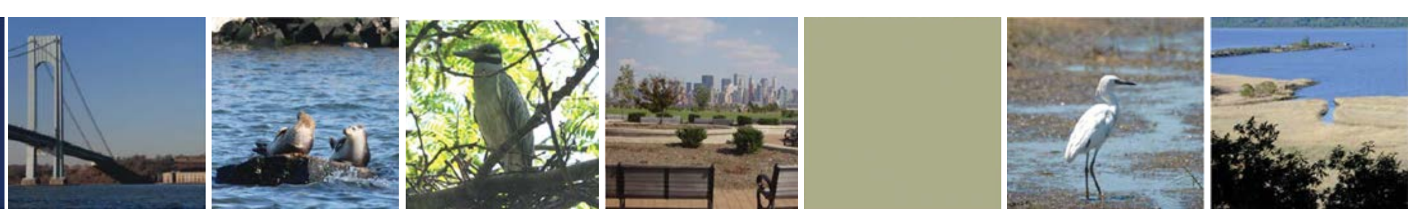


Figure 1-4: Ongoing and Future Coastal Infrastructure Resilience Efforts in the Newark Bay, Hackensack River and Lower Passaic River Planning Region.



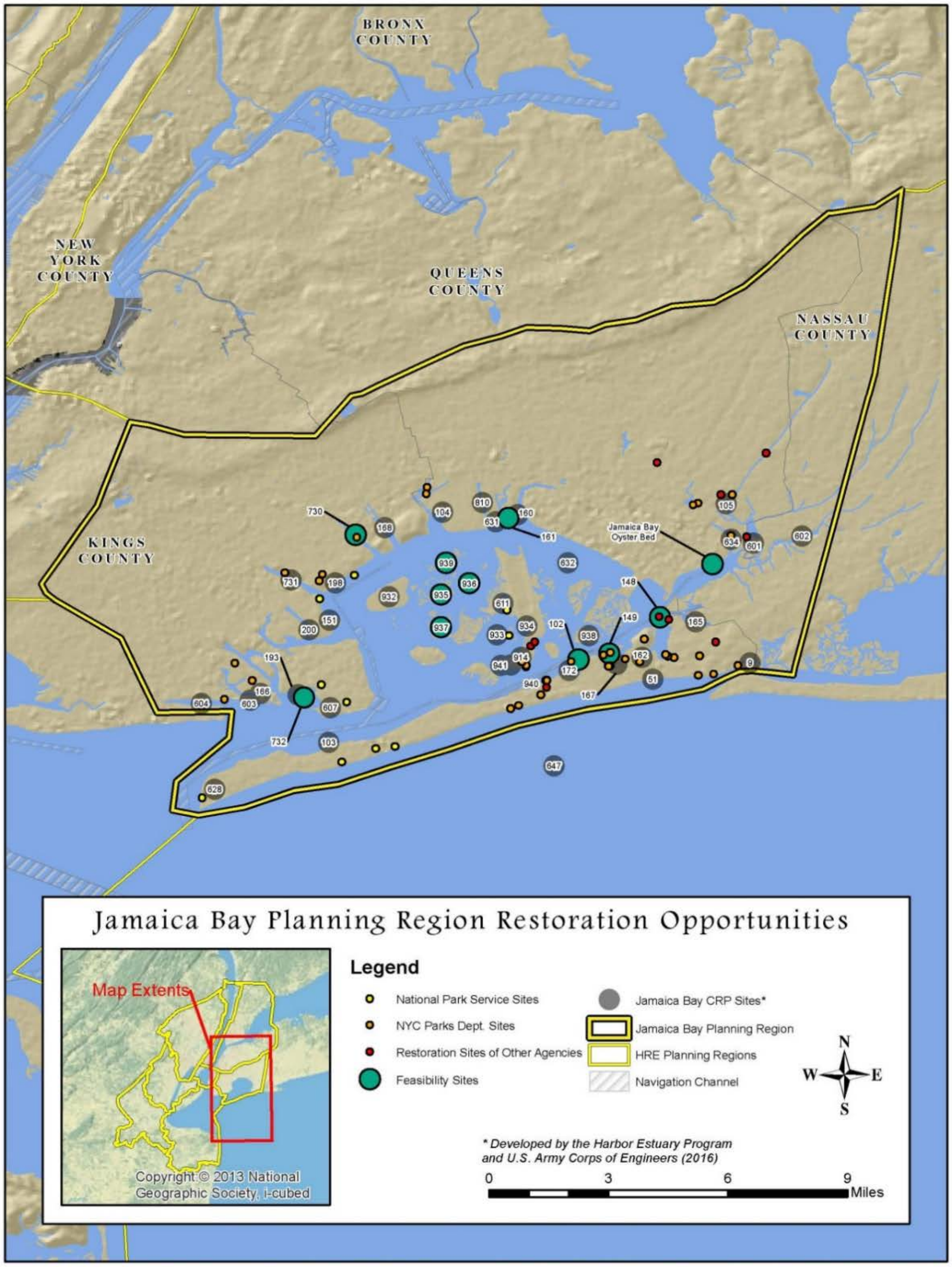


Figure 1-5: Ongoing and Future Coastal Infrastructure Resilience Efforts in Jamaica Bay Planning Region

Prior reports and studies utilized during the restoration planning in the HRE are outlined in Appendix B. In addition, the HEP Restoration Work Group has prepared progress reports highlighting restoration efforts and progress in the harbor estuary through 2014 (HEP, 2014) and progress made between 2014 through 2016 (HEP, 2016).

Significant advancement had been made during the restoration planning efforts for each USACE "source" study. Each feasibility study was at a different stage prior to their consolidation into the HRE Feasibility Study in early 2015:

- **Jamaica Bay, Marine Park, and Plumb Beach Ecosystem Restoration Feasibility Study** was initiated in 1996 with the NYCDEP. During the early stages of the Feasibility Study, significant data collection efforts and planning were conducted in conjunction with NPS including:

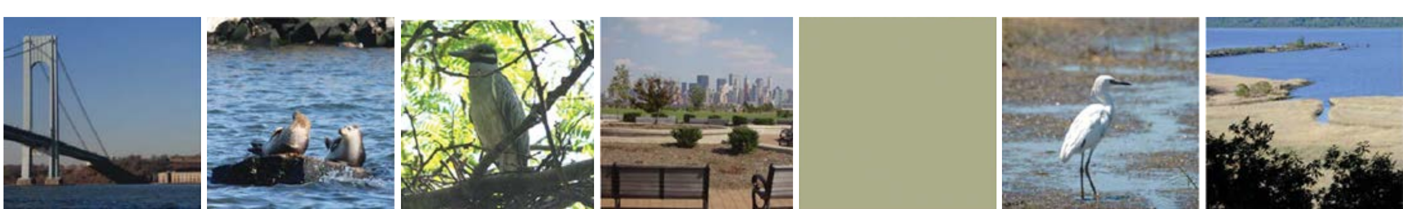
  - ✓ Cultural resource Section 106 National Historic Preservation Act surveys (2000);
  - ✓ Water levels/tide gauges (2001) and Evaluation of Planned Wetlands (EPW) assessment (2001);
  - ✓ Hazardous toxicity radioactive waste (HTRW) contamination (2001);
  - ✓ Biological communities: bird, fish, benthic invertebrates, vegetation, mammals, reptiles and amphibians (2002);
  - ✓ Water quality: Physical (meteorological, tidal, temp, turbidity), chemical (pH, nitrite/nitrates, phosphates, salinity, dissolved oxygen, chlorine), biological (chlorophyll-a, bacteriological) (2002);
  - ✓ Water quality modeling (2003);
  - ✓ Topography/bathymetry (2002) and NPS bathymetry project (pre-Sandy-http://irma.nps.gov/App/Reference/Profile/2204762);
  - ✓ Shoreline change analysis, slope stability, wave analysis, hydrodynamic modeling (2003); and
  - ✓ Bio-benchmarks (2004).

  Based on the above data collection efforts and partner coordination, a total of 39 restoration opportunities were identified and evaluated, resulting in the recommendation of eight (8) perimeter (shoreline) sites, sites along the periphery of Jamaica Bay, as the tentatively selected plan (TSP) in 2010. Meanwhile, steps to address the vanishing marsh islands were advanced using the USACE Continuing Authorities Program and inclusion in the HRE Feasibility Study.

  A preliminary draft integrated feasibility report and environmental assessment was prepared in 2010, but never finalized. Following Hurricane Sandy, which severely impacted portions of New York and New Jersey in October 2012, the perimeter sites were evaluated further in the East Rockaway to Rockaway Inlet and Jamaica Bay Reformulation Study as potential natural/nature based features. Recommendations for ecosystem restoration within the Jamaica Bay Study Area, also the Jamaica Bay Planning Region, were integrated into the HRE Feasibility Study in 2014.

- **Flushing Bay and Creek Ecosystem Restoration Feasibility Study** was initiated in 1999 with the NYCDEP and the PANYNJ. Data collected for the Flushing Bay and Creek Ecosystem Restoration Study included:

  - ✓ Phase 1 environmental site assessment (2001);
  - ✓ Tidal and current measurement program (2001);
  - ✓ Water quality sampling program (2001);
  - ✓ Finfish community surveys (2002);
  - ✓ Benthic community surveys (2002);
  - ✓ NYCDEP Erosion Analysis- Hydrodynamic and Sediment Transport (2011);
  - ✓ NYCDEP Benthic and fisheries surveys (2012-2013);



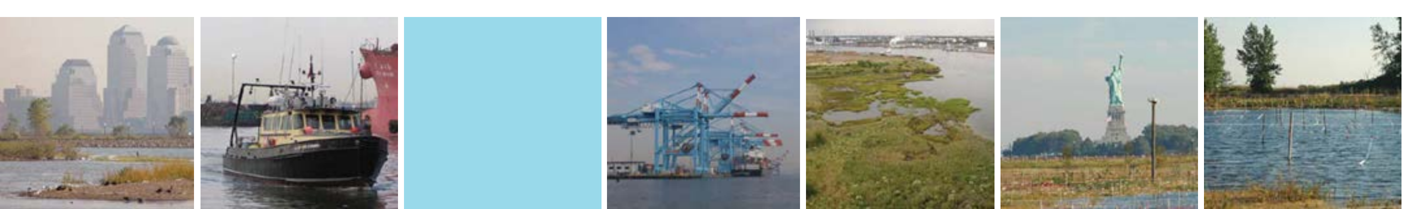
- ✓ NYCDEP Bathymetric (2012) and land surveys (2013);
- ✓ NYCDEP Wetland and Upland Habitat Characterization (2013);
- ✓ NYCDEP Sediment Coring in Flushing Creek (2013);
- ✓ NYCDEP Geotechnical Study (shear stress) (2013); and
- ✓ NYCDEP Sustainability and Hydrodynamic Assessment (2014).

Seventeen alternatives were evaluated and a draft FR/EA was prepared in 2007, but was not released to the public. The recommended restoration alternative was not supported by NYCDEP, and required further coordination with the department's combined sewer outfall (CSO) discharge long term control plans for Flushing Bay and Flushing Creek and with future environmental dredging in the bay and creek. Progress was suspended due to lack of funding and the study was inactivated. Recommendation for ecosystem restoration within Flushing Creek was identified as a priority within the Flushing Creek and Bay Study Area within the Harlem River, East River and Western Long Island Sound Planning Region and was subsequently integrated into the study in 2013.

- **HRE-Lower Passaic River Ecosystem Restoration Feasibility Study** was a unique joint coordinated effort to comprehensively remediate and restore 17 miles of the Lower Passaic River and associated tributaries, Third River, Second River, and Saddle River. The study was initiated in 2003 through a governmental partnership with the USEPA, NOAA, USFWS, NJDOT, and NJDEP. The NJDOT was the official local sponsor for the feasibility study, with subsequent transfer in 2007 to NJDEP for technical oversight of completion of the study.

  Significant amounts of data were collected for the USEPA's Remedial Investigation and Feasibility Study (RI/FS) and USACE restoration planning efforts and are available on www.ourpassaic.org. Much of the data collected for this multi-agency project on baseline conditions has been summarized in the Final Remedial Investigation and Focused Feasibility Study Report for the lower 8.3 miles of the Lower Passaic River (USEPA, April 2014) (see Table 2-1). Project sampling efforts included:

  - ✓ GIS Mapping Overview (2004);
  - ✓ Bathymetry and Geophysical Surveys (2004, 2005, 2007, 2008, 2010, 2011);
  - ✓ Field reconnaissance of restoration opportunities (2004/2005);
  - ✓ Literature review of historic biological community data – in river (2004);
  - ✓ Hydrodynamic Surveys (2004-2005; 2008-2009);
  - ✓ Benthic Invertebrate Survey (2005; 2009-2010);
  - ✓ Low and/or High Resolution Sediment Coring (2005-2010; 2012-2013);
  - ✓ Sediment profile imaging survey of sediment and benthic habitat characteristics – in river (2005);
  - ✓ Side scan sonar (2005);
  - ✓ Municipality Surveys for Regional Visioning (2006-2007);
  - ✓ Restoration opportunities report (2006);
  - ✓ Hydrodynamic surveys (2005-2006 and 2008-2009);
  - ✓ Kingfisher investigation – along shorelines (2007);
  - ✓ Master plan review and municipality surveys regional visioning (2006-2007);
  - ✓ Reconnaissance of potential restoration sites on tributaries to Passaic River (2008);
  - ✓ Identification of Lower Passaic River restoration plant resources (2008);
  - ✓ Vegetation sampling, wetland delineation and bio-benchmarks- subset of restoration sites (2008);
  - ✓ Bioaccumulation testing- fish, crabs and bivalves- in river (2009-2010);



- ✓ Visioning: 3-D flyover for future conditions (2011);
- ✓ Avian community surveys (2010);
- ✓ Combined sewer overflow (CSO) stormwater outfall chemistry (2011);
- ✓ Surface water chemistry – in river (2012-2013);
- ✓ Background sediments- above Dundee Dam (2012-2013);
- ✓ Soil sampling at several upland locations for chemistry (2013); and
- ✓ Bathymetry – in river (1989-2011).

Although significant amounts of data have been collected to characterize baseline conditions in the 17-mile stretch of the Passaic River main stem, limited data is available for the specific restoration opportunities.

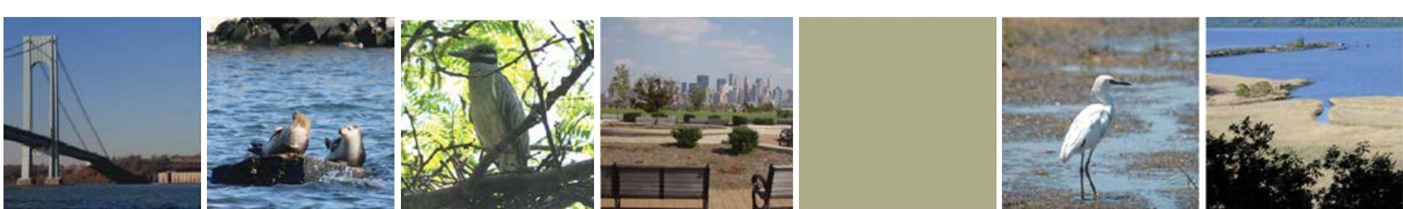
Fifty-two (52) restoration opportunities were identified and are dependent upon the outcome of the USEPA's Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 (42 United States Code 9601 et seq.) Superfund Program. The remedial action decisions have influenced the sequence and type of recommendations for restoration—i.e., near-term construction, near-term construction following remedial actions, or future feasibility study. The study was also a pilot project to coordinate remediation and restoration of degraded urban rivers under the Urban River Restoration Initiative and was selected as a location in the Urban Waters Federal Partnership Initiative Program. The study was re-scoped pursuant Civil Works Transformation in February 2013 and subsequently integrated into the study in 2015.

- **HRE-Hackensack Meadowlands Ecosystem Restoration Feasibility Study** was initiated in 2003 with the New Jersey Meadowlands Commission (NJMC), now the New Jersey Sports and Exposition Authority (NJSEA). While a vast amount of data exists for the Hackensack Meadowlands, the information compilation focused on data that could be useful in accomplishing the ecological restoration of the Meadowlands. Data collection included:

  - ✓ Fisheries Surveys (2001-2003);
  - ✓ Hydro-geomorphic Evaluation (2004);
  - ✓ Geotechnical and HTRW contamination data collection (2004-2005);
  - ✓ Cultural investigations (2006);
  - ✓ Topographic surveys;
  - ✓ Benthic community investigation (2007);
  - ✓ Avian Surveys (2007); and
  - ✓ Geophysical investigation (2008).

  In 2004, the USACE, USFWS, and NJMC conducted the Meadowlands Environmental Site Information Compilation (MESIC) to identify and catalog existing data, assist in creating a strategy for future data collection, and eliminate the potential for duplicating data (USACE, 2004b). The information compilation focused on 50 sites within the Meadowlands and also included data relevant to the Meadowlands as a whole.

  The Meadowlands Comprehensive Restoration Implementation Plan (USACE, 2005) provided a menu of comprehensive, ecosystem-based actions that address the problems affecting the aquatic environs and associated habitats of the Hackensack Meadowlands. A draft programmatic environmental impact statement was prepared and used to support this Environmental Assessment.



A total of 50 restoration opportunities were identified, with 18 of the sites identified as “critical restoration opportunities” for restoration in the future. Progress was suspended in 2012, when funds were no longer available. The study was inactivated and subsequently integrated into the HRE Feasibility Study in 2013. A subset of these “critical restoration opportunities” was then advanced.

- **Bronx River Basin Ecosystem Restoration Feasibility Study** was initiated in 2003 with NYCDEP and the Westchester County Department of Planning. Baseline data collected for the Bronx River Basin Ecosystem Restoration Feasibility Study included:

    - ✓ Water Quality Assessment (2003);
    - ✓ Cultural Investigations (2006);
    - ✓ Water Quality and Baseline Data Collection (2006);
    - ✓ Phase 1 Environmental Assessment (2006);
    - ✓ Existing Conditions Hydrology: HEC-1 Modeling (2006-2007);
    - ✓ Geomorphic Assessment (2006-2007);
    - ✓ Ichthyofaunal Survey (2007);
    - ✓ Wetland Field Assessment (2007); and
    - ✓ Microbial Source Tracking Study (2007).

    A restoration opportunities report was prepared identifying 330 opportunities within the Bronx River Basin (USACE, 2010). Sites were ranked using habitat and water quality parameters and a subset of the sites was to be designed for recommendation for near-term construction. The study was re-scoped in July 2012 and subsequently integrated into the study in 2015.

Given the consistent restoration planning approach for all sites to be recommended for authorization within the HRE planning regions, (in conjunction with the improved efficiency and cost effective strategy) the recommendations from these studies are included likewise in this interim HRE Integrated FR/EA.

1.6 Purpose and Need for Action*

The federal objective of Civil Works ecosystem restoration activities is to restore significant ecosystem function, structure, and dynamic processes that have been degraded. The intent of ecosystem restoration is to partially or fully reestablish the attributes of a naturalistic, functioning, and self-regulating system.

USACE ecosystem restoration projects are required to be responsive to the purpose, intent, and scope of the agency's Civil Works restoration mission. USACE guidance states that, "ecosystem restoration is a primary mission of the [USACE] Civil Works program. ...the purpose of Civil Works ecosystem restoration activities is to restore significant ecosystem function, structure, and dynamic processes that have been degraded. Improving the long-term survival of self-sustaining systems delivers improved conditions for fish and wildlife resources" (Engineer Pamphlet [EP] 1165-2-502). Other pertinent guidance states that, "Restoration projects should be conceived in a systems context...in order to improve the potential for long-term survival as self-regulating, functioning systems. This system view will be applied both in examination of the problems and the development of alternative means for their solution. Consideration should be given to the interconnectedness and dynamics of natural systems..." (ER 1105-2-100). The study approach is consistent with this and other USACE guidance and policies related to ecosystem restoration planning. An investigation into the numerous scientific studies and findings that recognize ecosystem processes as key system drivers that, if degraded, have long-lasting, spatially extensive effects on biological communities were considered during plan comparison and selection. The TSP considers the physical, biological, and anthropogenic dynamics of the ecosystem. The plan compliments work completed or planned by others, which in concert will restore a balanced mosaic of habitats in the estuary.

Ecosystem restoration is to reverse the adverse impacts of human activity and restore ecological resources, including fish and wildlife habitat, to as close to previous levels of productivity as feasible, but not a higher level than would have existed under natural conditions in the absence of human activity.

The purpose of the proposed action is to restore and sustain a mosaic of habitats within the human-dominated landscape important to the people of the region and the nation, in a cost-effective and socially-feasible manner, with minimal risks, and supported by monitoring and adaptive management to ensure meeting the restoration objectives. It uses best available science to advance the goals and objectives of the federally-supported HRE CRP, which is the regional roadmap for interagency restoration. The need for the proposed action comes from recognizing that valuable natural resources have declined to a point that the ecosystem may no longer be self-sustaining without immediate intervention to impede significant ecological degradation. Restoration of ecosystem structure, functions, and processes will benefit nationally significant resources in the study area.

As discussed above in Section 1.4, the HRE region is home to over 20 million people and is the economic hub of the northeastern United States. A healthy estuary is also essential to the regional economy. The prior efforts discussed above and more detailed in the HRE CRP, documents the ecosystem problems that have given rise to the need for a comprehensive restoration effort requiring the assistance of the Federal Government.

The need for the proposed action comes from recognizing that the remaining critical natural resources within the urbanized setting of HRE have declined to a point that without immediate intervention, some resources, like the oysters will not continue to be self-sustaining. Continued anthropogenic stressors associated with development and urbanization have eliminated the mosaic of habitats that are associated with estuarine systems, which are the connection between terrestrial, freshwater, and marine ecosystems.

Aquatic, wetland and associated upland habitats have experienced significant water resources problems. Industrialization and development, including prior wetland filling, hydrologic and benthic changes and deterioration of sediment quality have contributed to creating conditions that do not support a productive ecosystem. Loss of rare, valuable and diverse habitats and increased vulnerability and susceptibility to the encroachment of invasive species are the primary aquatic, wetland and upland habitat problems. The study area is in need of improvements that will reestablish diverse habitat, based on indicator species, and measures that will set forth the conditions to allow the restored ecosystem to be sustainable.

The magnitude of restoring such a huge, highly urbanized area is considerable. As early as 2000, the HRE Reconnaissance Report identified the concept and need for “building blocks,” as an immediate and important ecological benefit to the estuary. The HRE CRP identified the ‘building blocks”, the TSP will be the initial foundation. As an example, Photo 1-1 of the Lincoln Park Restoration, which was facilitated with the beneficial use of dredged material from the USACE’s New York/New Jersey Harbor Deepening Project.

The region’s local, state, and federal agencies, along with nonprofit organizations have recognized the need to identify, evaluate and recommend actions that will maintain, protect and restore the essential and vital HRE. Because of the inherent complexities associated with the nearshore zone, such as

varied ownership and mixed land use, action at many of the 296 CRP sites is beyond the resources of states, local governments, non-governmental organizations, or private entities; federal agencies such as the USACE are better suited to taking the lead and playing a key role in large-scale restoration projects. As ecosystem restoration is one of the primary missions of the USACE Civil Works program, the USACE has the ability to use expertise in water-related resource problems to seek ecosystem construction authority within the estuary.

Photo 1-1: Lincoln Park Restoration - Hackensack River, New Jersey Before and After

Chapter 2: Affected Environment

This chapter identifies the historic, existing and future without project conditions within the eight (8) Hudson Raritan Estuary (HRE) planning regions. The existing conditions include a discussion of each planning region's physical land and water bodies, flora and fauna, cultural resources, and socioeconomic character. Although all planning regions within the HRE study area are in need of restoration, detailed discussion of existing conditions are only presented for planning regions with proposed restoration projects recommended in this Feasibility Report and Environmental Assessment (FR/EA). Only general background information is included for the Arthur Kill/Kill Van Kull, Lower Raritan River and Lower Hudson River Planning Regions since detailed existing conditions can be found in the HRE Comprehensive Restoration Plan (CRP) (USACE, 2016b) and will be documented in future "spin-off" feasibility studies since restoration is not recommended at this point in time.

2.1 History of Degradation, Historic Losses and Projected Sea Level Rise

The HRE is located within one of the most densely populated estuary and urbanized regions in the United States. Over 20 million people live within 25 miles of the Statue of Liberty, the approximate center of the estuary, including the highly urbanized cities of New York, and Jersey City, Newark, and Elizabeth, New Jersey. Urbanization and industrialization over the past 400 years has put stress on the estuary, resulting in significant loss of habitat. The estuary has a long history of industrial and residential development that began in the 1600s with the first European settlers and intensified as navigation and infrastructure improved. These alterations resulted in significant ecosystem-level changes due to residual, persistent impacts to numerous habitats, especially those linked to aquatic environments. Regional development of the watershed and massive physical changes to the estuary, including dredging and channeling, damming, and bank stabilization, led to marked hydrologic alterations, acute sediment contamination, pervasive reductions in water quality, and habitat fragmentation. The ecological integrity, health, and resiliency of the estuary have been severely compromised.

Some of the aforementioned habitats have been preserved or restored in the HRE; however, many of these remaining environmental assets represent isolated sites that are typically surrounded by industrialized or densely populated urban areas and are vulnerable to degradation from surrounding land uses. Although currently they support some fish and wildlife, many of these open areas are severely degraded and would benefit significantly from habitat improvements.

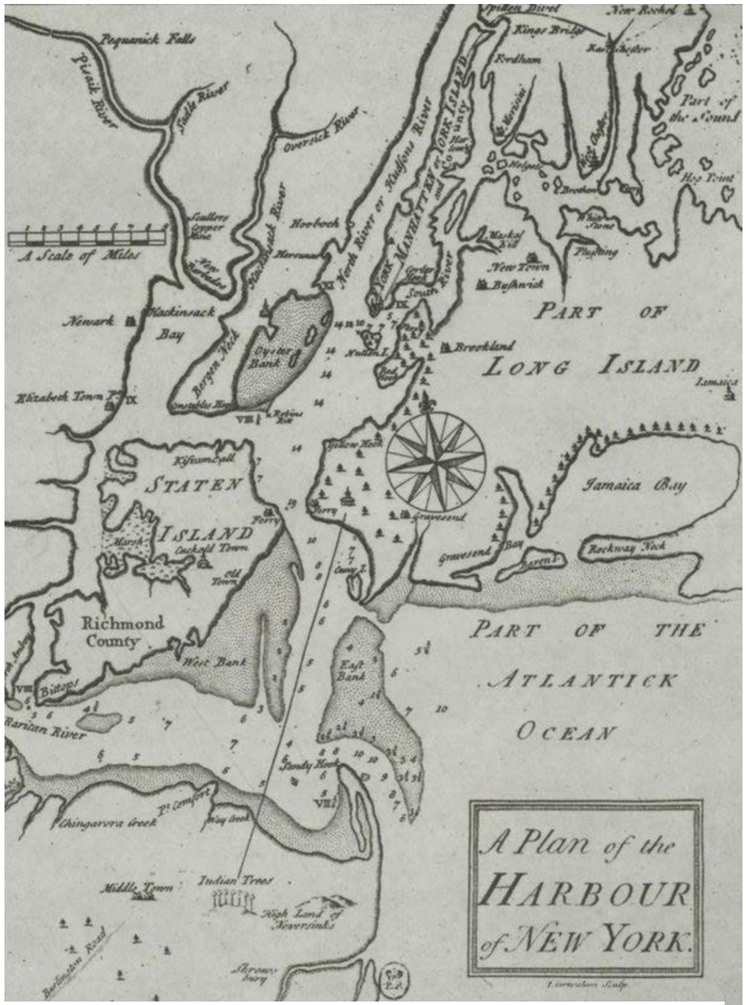
Degradation and destruction of habitats in the HRE study area have been the result of human modifications to natural systems, as well as natural forces. Historically, the types of degradation commonly identified in the HRE study area were classified as bathymetric alterations, shoreline modifications, hydrodynamic and hydraulic changes, and changes to water and sediment quality. In addition to human modifications, natural forces such as Hurricane Sandy have also resulted in habitat loss and degradation.

2.1.1 Bathymetric Alterations

Before colonial settlement, the HRE study area was a relatively shallow system, with most of the waters less than 20 feet in depth at mean low water (Figure 2-1). The completion of the Erie Canal in 1825 along the Mohawk River made passage between the Great Lakes Region and the Atlantic Ocean possible. This eventually required deepening the natural channel of the Hudson River and its estuary. While the lower Hudson River and estuary were naturally deep enough to accommodate most vessels in 1825, as the need for more goods grew and wooden boats were replaced with larger steel ships, a

series of navigation improvement projects was initiated in New York Bay to accommodate these vessels. In 1891, a 30-foot deep passage was dredged through the Lower Bay, followed by an extensive deepening to 40 feet completed in 1914 (Parkman, 1983). During World War II, the network of channels and supporting berthing areas were deepened to almost 45 feet and expanded into the Upper, Raritan, and Newark Bays (Parkman, 1983). Since then, navigation channels have been maintained or deepened throughout the HRE's rivers and bays, resulting in over 250 miles of established channels and associated berthing areas. In 2000, Congress authorized the deepening of the main shipping channels within the HRE to 50 feet to meet shipping needs and ensure New York-New Jersey Harbor's long-term economic viability (§101(a)(2) of Water Resources Development Act 2000, Public Law 106–541), which was recently completed in September 2016.

Approximately 300,000 acres of underwater lands have been filled and dredged for these shipping channels in New Jersey and almost 9,000 acres in New York (Bokuniewicz, 1988; Squires, 1992). Additionally, the Lower Bay of New York Harbor has been a major source of sand and gravel for construction aggregate and fill. For one study period of 1967 to 1978, the rate of removal averaged about 5.5 million cubic yards per year (Kastens, et al., 1978).



Source: Cohen and Augustyn, 2014

Figure 2-1 New York Harbor 1735

Extensive dredging of the Passaic and Hackensack rivers from the late 1800s onward further altered the waters of the Hackensack Meadowlands, the dredging allowed larger amounts of seawater to flow north from Newark Bay into the rivers' deepened channels (Marshall, 2004). Between 1897 and 1936, New York City adopted a plan under which the main basin, tributaries and marshes of Jamaica Bay were to be substantially altered by the creation of two (2) large industrial islands bordered by numerous piers and wharves. This plan was never fully implemented but the substantial portion of the work that was executed significantly changed the northwest portion of Jamaica Bay, filling in large portions of salt marshes and straightening, widening, deepening, truncating and even eliminating tidal creeks that feed the vast marsh complexes along the outer boundaries of the bay.

Flushing Creek was impacted by the land development associated with the New York World's Fair of 1939-1940. Site hydrology was altered with the creation of Willow and Meadow Lakes and also the channelization of Flushing Creek. Bathymetric changes in support of navigation or from aggregate mining can influence estuarine systems and their outer beaches. These impacts include alterations of water circulation (Malhadas et al., 2009; Meyers et al., 2014; Valle-Levinson and Lwiza,

1995) and near shore tidal range (Wong and Wilson, 1979), offshore sediment transport processes (Kelley et al., 2004; Kortkaas et al., 2010), deprivation of littoral replenishment material (Kraus and Galgano, 2001), and alteration of biological communities (Byrnes et al., 2004).

2.1.2 Shoreline Modifications

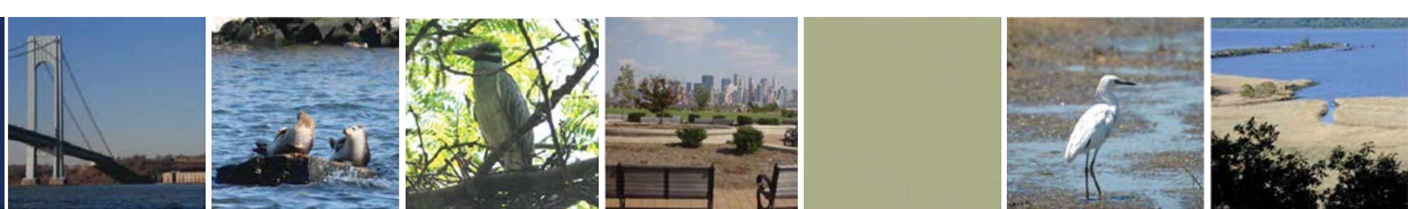
Shortly after European settlement, colonists began developing the shoreline in the HRE study area. By filling and stabilizing nearshore habitat with soil, rocks, and refuse, colonists protected their homes and industries from flooding, erosion, and ice, as well as creating fast lands. Today, approximately 36 percent of shoreline in the HRE study area has been hardened, according to the 2006 NOAA National Geodetic Survey (Bain et al., 2007). Three (3) HRE planning regions with the highest percentage of hardened shorelines are the Harlem River/East River/Western Long Island Sound (46 percent), Lower Hudson River (66 percent), and Upper Bay (87 percent). Most of Manhattan's southern shorelines were hardened and approximately 279 acres of new land was added onto the island in an effort to expand the city. At the expense of the shoreline and shallow waters, riprap revetments and bulkheads stabilized shorelines and allowed for larger vessels to navigate the bays and rivers. By the early 1800s, ship traffic increased and solid-filled pier bases replaced the more basic stone embankment and timber piling designs. By 1853, there were 112 piers in the East and Lower Hudson Rivers, some of them extending 600 feet into the river (Wise et al., 1997).

Continued population growth and technological improvements called for improved transportation infrastructure. Railroad causeways were built, fragmenting many wetlands in the Hackensack Meadowlands and surrounding areas. The present-day LaGuardia, John F. Kennedy, Newark International Airports, and Floyd Bennet Field were constructed on filled wetlands. Major shipping terminals were established in the HRE which occupied a total of 755 miles of shoreline between New York and New Jersey, with 460 miles and 295 miles, respectively (USFWS, 1997).

Urban and industrial uses currently dominate nearshore areas in the HRE study area, and these activities have eliminated natural shoreline habitat from much of the estuary. New York-New Jersey Harbor has close to 1,000 miles of shoreline (576 miles in New York City alone), 75 percent of which consists of man-made structures, such as bulkheads, rip-rap, and piers (HEP, 1996). These hardened and often deepened shorelines have replaced the gently sloping and vegetated natural shorelines. The construction of bulkheads, piers, and placement of shoreline fill have greatly reduced the physically diverse near-shore zone of shallow, soft-bottom habitats, rocky outcroppings, wetlands, and sand beaches.

The littoral zone historically found in the estuary was structurally complex with diverse physical characteristics, supporting resident fish populations as well as attracting large populations of migratory and transient fish for spawning and feeding. These complex and productive waters were ideal nursery areas for young fish, particularly where benthic structure and/or plant communities existed.

The construction of piers slowed near-shore waters and promoted extensive sediment accumulation, which, in concert with other forms of shoreline hardening, contributed to the loss of physically complex habitat, greatly reducing quality of spawning and nursery areas. Remaining stretches of unhardened inner shorelines within the HRE study area are typically littered with debris, such as dilapidated piers or abandoned buildings, which obstruct aquatic and terrestrial growth. While in the New York Harbor segment of the estuary only 20 percent of the original wetland areas were estimated to remain during a 1992 survey (Squires, 1992), the tidal Hudson River had seen a net increase in tidal freshwater wetland area of about the same magnitude resulting principally from shoreline railroad construction. Along the



Lower Passaic River nearly all of the wetland and tidal-creek habitats once present have been destroyed by land-reclamation activities (Iannuzzi and Ludwig, 2004).

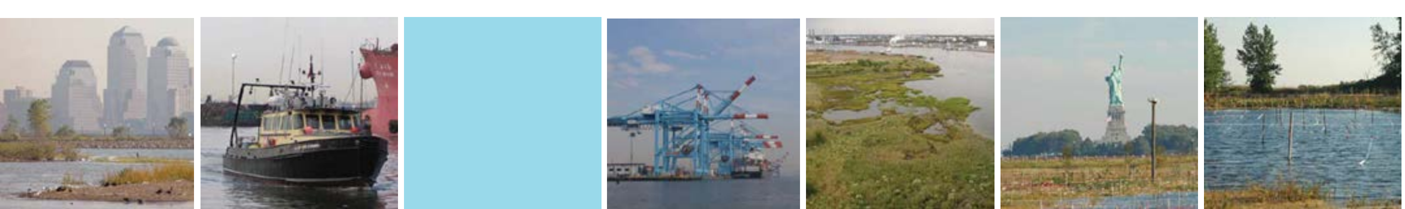
The HRE also includes outer sandy shorelines. While the morphology of outer sandy beaches is chiefly determined by gradual and continuous littoral processes affecting beach mobility (beach accretion or erosion), they can also be altered by punctuated extreme storm events (Bird, 2008; Hapke et al., 2013; Williams, 2013). The main natural controls affecting coastal morphology around tidal estuaries include fetch distance, shoreline orientation, tidal range, slope and width of the low tide terrace, wind and wave orientation and intensity, rates of submergence, vegetation on the foreshore, and sediment supply (Jackson, 1995; Jackson and Nordstrom, 1992). In the HRE, the outer sandy beaches and their nearby waters have also undergone extensive anthropogenic alterations. These activities have included beach nourishment, groin and jetty construction, dredging for navigation, and borrow area excavation. Cumulatively, these actions can alter natural littoral processes and subsequent coastal morphology and ecology (Bulleri and Chapman, 2010; Byrnes et al., 2004; Hall and Pilkey, 1991; Kraus and Galgano, 2001; Valverde et al., 1999; Williams, 2013; Wong and Wilson, 1979).

Long term outer-shoreline changes for the Jamaica Bay Planning Region show low accretion levels with the highest at the East Rockaway Inlet and Breezy Point areas. Recent investigation suggests that Jamaica Bay was historically much more open, without the marsh islands, and there has been an east-to-west progression of the Rockaway Peninsula that in turn led to salt marsh formation in the interior of the bay approximately 200 to 230 years ago (Hapke et al., 2010; Sanderson, 2016). Long term outer-shoreline changes for the Lower Bay Planning Region generally have shown slight erosion in many areas with the exception of Sandy Hook which has migrated considerably northward and quadrupled in size over the past 300 years. The rate of littoral sediment transport along Sandy Hook is the highest within the entire HRE and it has a current accretion rate of almost 19 feet per year (Chrysler, 1930; Gorman and Reed, 1989; Hapke et al., 2010; Nordstrom et al., 1990; USACE, 2015; Yasso and Hartman, 1975).

2.1.3 Hydrodynamic and Hydraulic Changes

Within the estuary, most streams and creeks have either been eliminated by filling, redirected through storm sewers, or have been altered by stormwater runoff or channelization. These modifications have also altered the estuarine salinity gradient in many of the HRE's tidal tributaries. Wastewater treatment plants and CSOs increase freshwater inputs to localized areas. Stormwater runoff into the estuary also brings debris and sediment that can alter nearshore areas by filling or scouring, depending on the magnitude of flow. Bridges, piers, and roadways have constricted or restricted flow in many locations (USACE 2004a). Bathymetric alterations in support of navigation have also influenced water circulation and flow patterns. An increase in ship traffic by larger vessels produces waves and wakes, and large, deep-draft vessels navigating in shallow side channels results in scoured areas.

In addition to factors within the HRE study area that caused hydrodynamic and hydraulic changes, changes occurring outside of the study area have also directly affected the estuary. One of the most substantial has been the decrease in freshwater flow to the estuary. Flow from the Hudson River, the primary source of freshwater to the HRE study area, is significantly diminished relative to historical conditions due to reservoirs, impoundments, and other water diversions. Impoundments alter stream flow patterns and encourage upstream siltation that can alter channel structure, benthic substrate, and bank stability in downstream river reaches. This decrease in freshwater flow to the estuary is exacerbated during low flow periods as flood tides bring a greater volume of saline water up the Hudson River, influencing community composition and habitat use by migratory and transient species.



Changes have been occurring outside of the HRE study area that directly affect the estuary. One substantial change has been the decrease in freshwater flow to the estuary. By physically blocking the river, storing excess runoff, or releasing water according to human needs, dams alter natural flow regimes (Poff et al., 1997). The Hudson River, the primary source of freshwater to the HRE study area, has reduced natural flow to the estuary due to more than 13,000 barriers including culverts, almost 800 dams of significance, and dozens of reservoirs in its watershed. Much fewer dams were found in the East River, Harlem River and Western Long Island Sound Planning Region where only 60 dams were identified in the United States Army Corps of Engineers (USACE) National Inventory of Dams and the New York State Inventory of Dams datasets ranging significantly in age (20 to 201 years), height (four [4] to 40 feet) and width (50 to 7,000 feet) (USACE Engineer Research and Development Center, 2016; Appendix C).

Impoundments alter stream flow patterns and encourage upstream siltation, which can change the channel structure, benthic substrate, and bank stability in downstream river reaches. This decrease in natural freshwater flow to the estuary is exacerbated during low flow periods as flood tides bring a greater volume of saline water up the Hudson River, influencing community composition along the shoreline and habitat use by migratory and transient species preventing the spawning of anadromous fish (American shad [*Alosa sapidissima*], alewife [*Alosa pseudoharengus*], hickory shad [*Alosa mediocris*], striped bass [*Morone saxatilis*], and blueback herring [*Alosa aestivalis*]) and catadromous fish (American eel [*Anguilla rostrata*]).

Likewise, the acceleration of human-engineered alterations of water flow to the Hackensack Meadows rapidly and drastically altered the salinity of its waters (Montalto and Steenhuis, 2004). Construction of dams to create millponds along the Passaic and Hackensack Rivers and their tributaries began diminishing the rivers' flow during the late 1600s and 1700s. In the 1830s, construction of the Morris Canal, the eastern half of which drew water from the tributaries of the Passaic River, further decreased the flow along the Lower Passaic. Newark and Jersey City started pumping water from the Passaic River in the mid-1800s for their municipal water supplies. During the late 1800s, new and larger dams were constructed on the tributaries of the upper Passaic River to create large reservoirs for municipal use (Marshall, 2004).

Within the New York City boroughs, the majority of streams and creeks have either been eliminated by filling, redirected through storm sewers, or have been altered by stormwater runoff or channelization. Reduced freshwater flow regimes can significantly alter downstream ecosystems (Nilsson et al., 1991; Simenstad et al., 1992; Drinkwater and Frank, 1994; Jay and Simenstad, 1994). The decrease in natural freshwater flow can also increase salinity intrusions into an estuary (Liu et al., 2001; Parsa and Etemad-Shahidi, 2009). Salinity intrusions not only affect ecosystems and native species compositions (Marshall, 2004; Xiao et al., 2014) but can also facilitate the introduction of invasive species (Cordell and Morrison, 1996).

The HRE study area has suffered extensive losses in wetland habitat and aquatic vegetation communities, such as eelgrass beds. Approximately 300,000 acres of tidal wetlands and sub-tidal waters have been filled in the study area and only about 20 percent (15,500 acres) of historic tidal wetlands remain. Without aquatic vegetation, which functions as storage areas for flood runoff, most of the current overland runoff and leachate enters directly into open water. The loss of shoreline aquatic vegetation has resulted in increased turbidity, shoreline erosion, and reductions in wildlife breeding and wintering grounds. Moreover, alterations in tidal exchange have transformed much of the remaining shallow water and salt marsh habitat from the originally diverse wetland plant assemblages to

monocultures of invasive species. Almost all of the approximately 224,000 acres of freshwater wetlands that existed in New York City prior to the American Revolution have been filled or otherwise eliminated.

2.1.4 Water Quality and Sediment Degradation

Four (4) centuries of human impacts adversely affected water and sediment quality in the HRE study area (Ayres and Rod, 1986; Bopp et al., 1998; Connell, 1982; Wolfe et al., 1996). Water and sediment quality had been demonstrably degraded in the Hudson River (Rohman, 1988), Lower Passaic River-Hackensack River-Newark Bay system (United States Environmental Protection Agency [USEPA], 2013; 2014a, b, c; 2016; Crawford et al., 1994; Iannuzzi et al., 1997; Iannuzzi and Ludwig, 2004; Shin et al., 2013), the Raritan River-Raritan Bay system (Anderson and Faust, 1974; Bokuniewicz, 1988; Foreman and Johns, 1940; Pearce, 1979) and the Bronx River (USACE, 2010). Unchecked and untreated discharges of human and industrial wastes and debris entered the estuary and its sediments from the time of European settlement to the establishment of environmental regulations in the 1970s.

Although the establishment of water quality regulations such as the Clean Water Act (CWA) has led to gradual improvements to water quality, the surface waters are impaired in areas where bathymetry and/or shoreline alterations have affected the natural flows and flushing. In addition, during large rain events, untreated wastewater enters the estuary through the hundreds of combined sewer overflows (CSOs) that remain in the HRE. The wastewater contains floatable debris, as well as chemical and biological pollutants that include pesticides, fertilizers, nutrients, metals, organochlorines, pharmaceuticals, and pathogens (disease causing microorganisms). Nitrogen inputs to estuaries on the Atlantic Coast of the United States are still two (2) to 20 times greater than during pre-industrialized time. Chronic nitrogen additions to nitrogen-limited estuaries can accelerate primary production and eutrophication, leading to many undesirable responses, such as increased frequency of harmful algal blooms, hypoxic (<4 milligrams 1-1) and anoxic bottom waters, loss of aquatic plants (Latimer and Rego, 2010; Orth et al., 2010; Short and Burdick, 1996), reduced fish stocks, and noxious odors (Castro et al., 2003; Lambert and Davy, 2011; Steinberg et al., 2004; Yozzo et al., 2001). Dissolved oxygen levels can be particularly low in some bays and confined waterways with limited circulation and where sewage treatment plants are the main source of fresh water, such as the tributaries of Jamaica Bay and the Hackensack and Lower Passaic Rivers (HEP, 2012).

Urbanization also causes less conspicuous impairments to water quality. Increased paved and impervious surfaces restrict the amount of water that can be absorbed by the ground surface and increases the amount of stormwater entering surface waters. During extreme rain events, stormwater entering drainage systems may exceed the storage capacity of municipal wastewater treatment plants, and a mixture of predominantly stormwater and diluted sewage is discharged, untreated, into the HRE's waterways. The prevalence of impervious surfaces in the HRE study area generates large volumes of stormwater, and even relatively minor storms may result in CSO discharges. Urban runoff can also decrease clarity and alter circulation patterns in surface waters, affecting sensitive aquatic habitats. Reduced water clarity can also affect foraging by zooplankton or larval fish, and larger, predatory species.

Many point sources and historic discharges of contaminants of concern have also contributed to the legacy contamination within the sediments and soils of the HRE study area. Restoration hinges on removal of Hazardous, Toxic, and Radioactive Waste (HTRW) contamination from within or near ecosystem restoration sites, and is paramount to successful long-term restoration (USACE 2014). An HTRW assessment was conducted by USACE in 2014 to identify, investigate, and assess potential HTRW sites that may influence current and potential restoration opportunities within the HRE. Per the

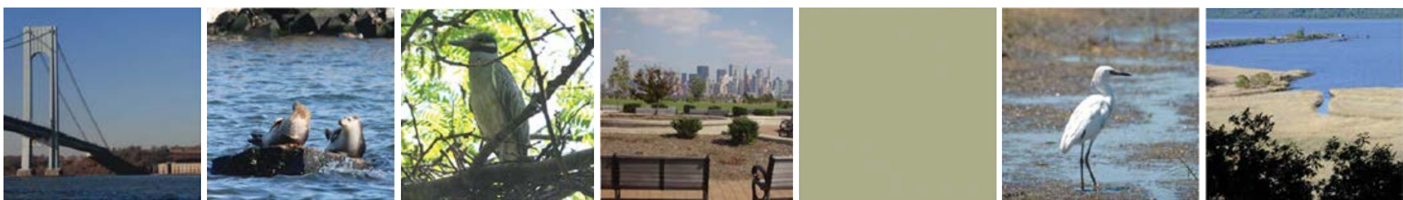
assessment, 1,386 HTRW sites are located within a 0.5 mile buffer of a CRP restoration opportunity sites. There are 50 USEPA Superfund sites, 62 New York State Department of Environmental Conservation (NYSDEC) environmental remediation sites, and 1,274 New Jersey Known Contaminated Sites (KCS) near CRP sites (USACE, 2014). Most notably, the Lower Passaic River and the Hudson River Superfund sites have contributed significant levels of contamination that have been transported throughout the HRE study area. Sediment quality is critical to the estuarine ecosystem, the success of restoration, human health and safety, and the port's economic viability. Any restoration initiative undertaken in or along a water source draining to the harbor and any restoration within the HRE is susceptible to impacts from contaminated sediment (USACE, 2014).

The presence of contaminated sediment from discharges or spills in portions of the HRE study area has decreased the quality of benthic habitat and has led to increased levels of contaminants in many aquatic and terrestrial species. Sediment and mussel samples from the estuary rank the highest overall in heavy metal, polyaromatic hydrocarbon (PAH), polychlorinated biphenyl (PCB), pesticide, and dioxin concentrations among the estuaries sampled by the National Status and Trends Program (NOAA, 1995). Major sources of contaminated sediments include, but are not limited to, industrial discharges, wastewater treatment plant discharges, CSOs, stormwater runoff, non-point source discharges, atmospheric deposition, and chemical and oil spills (USFWS, 1997). Other active sources of contamination to water and sediment quality include leachate (i.e., water percolating through landfills), as well as persistent sediment contaminants that are vestiges from before the CWA (HEP, 1996). The Contaminant Assessment and Reduction Project (CARP), which completed the most comprehensive data sampling and laboratory analysis program of sediments, ambient water, external sources, and biota for the harbor, determined that these legacy contaminants are expected to continue influencing sediments throughout the HRE. In general, CARP model simulations indicate that levels of contaminants will continue to decline even if ongoing loads remain constant. Ultimately, sediment remediation will likely be the most significant future method of source control (Lodge et al., 2015).

Other significant indirect economic impacts of sediment and surface water contamination are associated with fisheries resources. Although the HRE study area has historically supported significant fisheries resources, these benefits are currently unclaimed due to fish consumption advisories relating to high concentrations of mercury, PCBs, dioxin, and dichlorodiphenyl-trichloroethane (DDT) in fish and shellfish (HEP, 2012). Much of the harbor is closed to commercial fishing and recreational fishing is primarily limited to anglers that practice catch-and-release techniques; however, significant subsistence consumption of locally caught fish remains despite health warnings. Contamination issues have limited the economic benefits that could be achieved through a viable fishery that includes both commercial and recreational fishing industries.

Physical and chemical habitat alteration has led to changes in the populations of organisms that use the HRE study area. For example, the historically abundant eastern oyster (*Crassostrea virginica*) has all but disappeared over their once expansive range. Sedimentation likely smothered some oyster beds, killing them directly and buried hard benthic substrates on which oysters colonize, reducing available habitat. These high sedimentation rates were the combined effect of increased overland runoff, dredging, shoreline structure, and poor land management in the HRE study area. Overharvesting and poor water quality also contributed to the population decline of oysters. Other community changes resulted from the disappearance of oyster beds, which provide benthic structure over a range of depths and habitats for many aquatic species.

Contamination of the HRE's surface waters and sediments has also led to significant indirect economic impacts to the region through increased costs of port operation. Maintaining the economic viability of



the region requires navigational access to the Port of New York and New Jersey by container ships and vessels. Navigational channels require periodic maintenance and deepening, and the costs associated with the placement of dredged materials vary with the concentration of contaminants contained therein. Dredged materials with low concentrations of contaminants can be transported by barge for placement at the Historic Area Remediation Site (HARS). However, fine-grained, and often contaminated sediments tend to settle in the navigation channels and when dredged, appropriate placement sites must be identified. Expensive processing of sediments (e.g., solidification and stabilization) is often required to bind the contaminants prior to the overland transport and ultimate upland disposal or beneficial use. These processes can exponentially increase the costs associated with navigation channel maintenance and decrease the overall efficiency of navigation programs (USACE, 2008b; Lodge et al., 2015).

2.1.5 Projected Sea Level Change

Another important consideration for the characterization of future without-project conditions in the HRE is the projected sea level change. Warming global temperatures are considered extremely likely over the coming decades and through the course of the next century. It is anticipated that this warming will be at a faster rate than past trends, which will have the effect of increasing the rate of global sea level rise (SLR). Given the long-term nature of SLR effects and the variables intrinsic to predicting global carbon emissions, global climate conditions, and the resulting effects on sea level, there are ranges in SLR projections that take into account various scenarios (New York City Panel on Climate Change, 2009).

A 2015 report prepared by the New York City Panel on Climate Change (2015) presents SLR projections that take into account the predicted ranges of both global climate change and local land subsidence. The central range of these projections are sea level increases in New York City of 4-8 inches by the 2020s, 11-21 inches by the 2050s, and 18-39 inches by the 2080s (New York City Panel on Climate Change, 2015). Extreme ranges presented in the report that assume rapid ice melt yielded projections of sea level increases of 5-10 inches by the 2020s, 19-29 inches by the 2050s, and 41-55 inches by the 2080s.

Current USACE guidance (ER 1100-2-8162) states that proposed alternatives should be formulated and evaluated for a range of possible future local relative sea level change rates. The relative sea level change rates should consider as a minimum a low rate based on an extrapolation of the historic rate, and intermediate (Curve 1) and high (Curve III) rates which include future acceleration of the eustatic (global) sea level change rate caused by alterations in the volume of ocean water due to climatological processes, including changes in water density from salinity and warming of the oceans. These rates of change for the HRE study area correspond to an increase in sea levels of 0.7 feet (8.4 inches), 1.1 feet (13.2 inches), and 2.6 feet (31.2 inches) over 50 years for the low, medium and high rates, respectively. The historic rate, 0.7 feet (8.4 inches) over 50 years, is being used as the basis of design for the flood protection structures (USACE, 2015). These rates are consistent with the New York City Panel Climate Change report referenced above.

It is anticipated that changes in SLR will affect salt marsh restoration, which depends on the correct planting elevations to survive. Under this predicted scenario, again simplistically assuming no change in marsh plain elevation, approximately 50 percent of the existing vegetated low marsh would be lost and 80 percent of the existing vegetated high marsh would be converted to low marsh habitat. Plans to slow, or even reverse, marsh loss is part of the proposed restoration of the HRE and will be discussed in subsequent chapters.

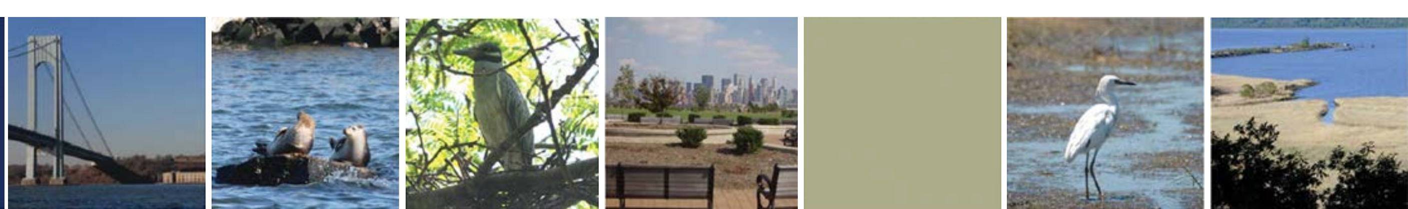
2.2 Hudson-Raritan Estuary Planning Regions Existing and Future Without-Project Conditions

The ecological integrity, health and resiliency of the estuary have been severely compromised as a result of development and industrialization in the HRE. It is estimated that approximately 80 percent of wetlands no longer exist and over 2,000 acres of tidal salt marshes in Jamaica Bay alone have been lost since 1924 (USACE, 2016b). The extensive loss of shallow habitats and wetlands, coupled with competition from invasive species and resource exploitation, has severely reduced the abundance and diversity of fish, shellfish, and estuarine-dependent wildlife species within the HRE. Major tributaries within the HRE have also lost much of the natural capacity to buffer floodwaters, as well as the capacity to sequester, transform, or degrade nutrients and contaminants. This decreased capacity to naturally maintain water and sediment quality is exacerbated by the region's high-density human population that produces enormous volumes of treated sewage effluent that, along with stormwater passing across impervious watershed surfaces, are discharged into the HRE.

In the absence of federal action, it is anticipated that invasive species will expand in many of the sites. Since 1974, regulations preventing the dredging and filling of coastal wetlands in New York State helped curtail the rampant acreage losses observed in the early and middle part of the century. Despite this, since the 1990s severe losses of interior wetlands have alarmed stakeholders. Detailed research studies have investigated the potential causes for the losses and these efforts continue today. Potential causes and contributing factors range from climate change, SLR, and erosive losses to invasive species, increased nutrients, and an unbalanced sediment budget.

Changes in the Clean Water Act (CWA) have led to substantial water quality improvements to date, but there remains significant room for improvement. Legacy chemicals in the sediments, including mercury, PCBs, DDT, and dioxin, still exceed acceptable levels (Steinberg et al., 2004). Many of these chemicals, which are readily absorbed in the fat cells of animals, can accumulate to dangerous levels. Currently, all regions of the HRE study area have consumption advisories in some fish and shellfish species (New York State Department of Health, 2015; New Jersey Department of Health, 2016). Moreover, the recent rates of decline in contaminants will be difficult to match in the future since current non-point sources of these chemicals and metals (e.g., overland runoff, atmospheric deposition) will not be as easy to control as point sources (Steinberg et al., 2004).

Within the HRE study area, each of the eight (8) planning regions consists of different habitats that contribute to the overall health of the ecosystem. The following sections describe the existing and future without project conditions of the HRE planning regions, identifying the primary resource problems within each region. Additional information is presented in the Engineering (D), Alternatives Formulation (E), Essential Fish Habitat Assessment (F), Regulatory Agency Coordination - Protected Species and Rare Habitats (G), Hazardous, Toxic, Radioactive Waste (H), and Cultural Resources Documentation (I) Appendices.



2.2.1 Jamaica Bay Planning Region

The Jamaica Bay Planning Region, located on the southwestern shore of Long Island, is enclosed by the Rockaway Peninsula (Figure 2-2). This region includes portions of Brooklyn, Queens, and Nassau Counties, New York, as well as the John F. Kennedy (JFK) International Airport. On its western edge, Rockaway Inlet connects Jamaica Bay to Lower Bay. Most of the watershed is urbanized and the shorelines are flanked by heavily developed lands, including the Belt Parkway, JFK Airport, and several landfills.

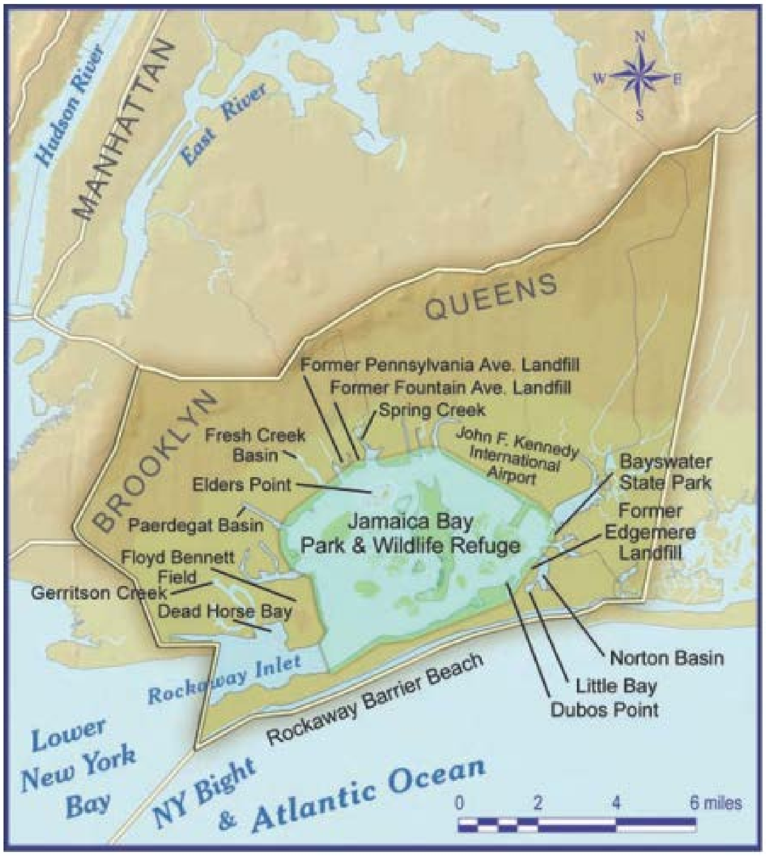


Figure 2-2 Jamaica Bay Planning Region

This planning region contains one of the last large contiguous blocks of habitat in the HRE study area. The Jamaica Bay Wildlife Refuge, established as part of the Gateway National Recreation Area, was the country's first national park and remains a dominant feature of this planning region (NPS, 2014a) (Photo 2-1). The refuge includes over 12,600 acres of aquatic habitat, salt marshes, freshwater and brackish water ponds, upland fields and woods, and open bay and islands (NPS, 2014). The wildlife refuge is centered around an artificial impoundment created to replicate the historically abundant freshwater habitats of the region. The Jamaica Bay Wildlife Refuge and surrounding parkland is dominated by an open water/tidal wetland complex that serves as an island of habitat within the urbanized estuary. These wetlands are visited by over 300 bird species annually, and are home to shellfish, invertebrates, and nearly 100 fish species (NPS, 2014a).

Jamaica Bay is threatened by poor water and sediment quality, and habitat losses. CSOs, landfill leaching, municipal waste discharge, and runoff from the roads and developed areas diminish water quality (USFWS, 1997). Chronic erosion in the bay has sloughed off shorelines and deteriorated the interior islands. Substantial marsh losses were first identified by the Jamaica Bay Ecowatchers and brought to the attention of federal and state agencies in 1999. An estimated 2,000 acres of tidal salt marsh have been lost from the marsh islands since 1924, with the system-wide loss rate rapidly increasing in recent years. From 1994 to 1999, an estimated 220 acres of salt marsh were lost at a rate of 47 acres per year (Figure 2-3). Left alone, the marshes were projected to vanish by 2025, destroying wildlife habitat and threatening the bay's shorelines (NYSDEC, 2001).

Source NPS

Photo 2-1 Photo of the Jamaica Bay. Marshes and osprey nest in foreground. Housing in background.

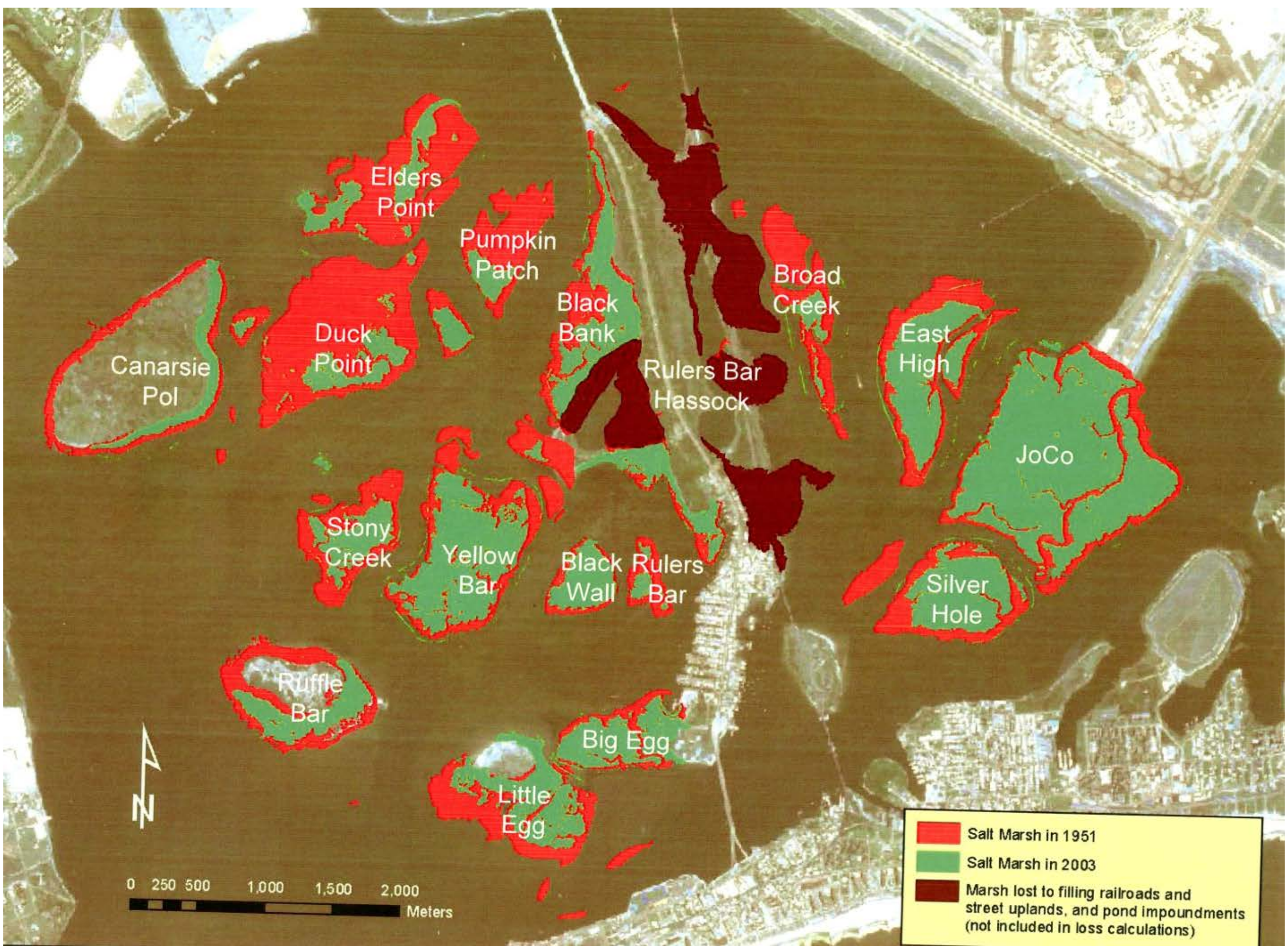
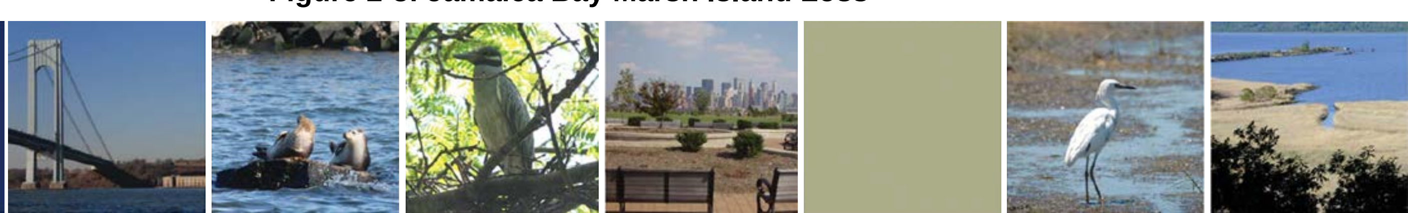


Figure 2-3: Jamaica Bay Marsh Island Loss



The Jamaica Bay Planning Region experienced extensive damages resulting from the storm surge associated with Hurricane Sandy. Hardest hit areas in the planning region were the Atlantic shoreline of the Rockaway Peninsula and Breezy Point and the Howard Beach community (GOSR, 2014) within Jamaica Bay. The Atlantic shorefront suffered severe beach erosion resulting in shoreline retreat of up to 100 feet and lowering dune and berm elevations up to five (5) feet (USACE, 2012). Storm surge induced inundation of up to five (5) feet over the entire inland area. In addition, storm waves induced runup, overtopping, overwash, and damaged waterfront structures including boardwalks, concrete walls, residential buildings, roads, and other infrastructure.

Within the interior of Jamaica Bay, coastal wetlands were littered with debris following the storm and wrack deposits were visible in many marsh areas. Initial reports and damage assessments may have underestimated the amount of wrack deposited, especially where obscured by dense reed stands or maritime woody vegetation (ALS, 2012). The Jamaica Bay marsh islands, restored prior to Hurricane Sandy by the USACE in partnership with NYSDEC, New York City Department of Environmental Protection (NYCDEP), Port Authority of New York and New Jersey (PANYNJ), and National Park Service (NPS), accumulated significant amounts of debris, but experienced relatively little damage to existing plantings; repairs to vegetation originally planted at Yellow Bar Hassock island in the summer of 2012 were required in the spring of 2014. The sand placed on Rulers Bar and Black Wall islands did not experience any damage as a result of the storm. Black Wall and Rulers Bar were subsequently vegetated through a community based planting effort led by American Littoral Society (ALS), Jamaica Bay Ecowatchers, and the Jamaica Bay Guardian funded by NYCDEP in July 2013.

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

Wastewater treatment plants within the Jamaica Bay Planning Region were flooded during Hurricane Sandy, resulting in the release of partially treated or untreated sewage into the surrounding waterbodies. The Coney Island Wastewater Treatment Plant on Sheepshead Bay was inundated and released 213 million gallons of raw sewage, and an additional 284 million gallons of partially treated sewage. The 26th Ward Wastewater Treatment Plant also bypassed 89 million gallons of partially treated sewage into Jamaica Bay via Hendrix Creek (Kenward et al., 2013). Significant investments by the partner agencies to identify solutions to future coastal flooding and restoration of the ecosystem have transpired since Hurricane Sandy devastated the Jamaica Bay Planning Region. Major studies and resiliency efforts include the Atlantic Coast of New York City, East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Coastal Storm Risk Management Reformulation Study (USACE, 2015a), Howard Beach – New York Rising Reconstruction Plan (GOSR, 2014), National Park Service (NPS) Sandy Resilience Projects, and the formation of the Science and Resiliency Institute at Jamaica Bay, coordinated through a General Management Agreement with the City University of New York (CUNY) and the NPS as part of the NPS Sandy Resilience Projects. Many of the efforts are collecting significant amounts of baseline information, advancing the state of the science, and enhancing coordination among partners and stakeholders in order to develop comprehensive strategies for coastal restoration in the planning region.

2.2.1.1 Geomorphology and Sediment Transport

Jamaica Bay is in the Atlantic Coastal Plain physiographic province. The center of the bay is dominated by subtidal open water and extensive low-lying islands with areas of salt marsh, intertidal flats, and uplands. The bay and barrier beach sediments are composed predominantly of sand and gravel derived from glacial outwash and marine sources. Surficial deposits on Long Island are glacial in origin with morainal deposits to the north and outwash deposits to the south. Extensive dredging, filling, and development have altered the landscape. Losses of upland and wetland buffers continue to threaten the estuary. Salt marsh islands that were once prevalent have subsided/eroded and are disappearing.

The sediment in Jamaica Bay is composed of a relatively even ratio of mud and sand. Jamaica Bay is threatened by poor sediment quality derived from a combination of sewage inputs, landfill leaching, industrial activity, and runoff from roads and developed areas (USFWS, 1997). Erosion results in slumping, undercutting, and inward retreat of peat from bank ledges along island peripheries and tidal creeks, and widens tidal channels. Remnant borrow pits and channels in the Bay, some as deep as 60 feet, are sometimes oxygen-deficient (hypoxic), affecting habitat suitability for fish and wildlife. These depressions may act as sediment sinks, trapping fine, organic sediment that otherwise may have been deposited on the surrounding wetlands, and may alter the hydrodynamics of Jamaica Bay by increasing the residence time of water as much as three-fold (Hartig et al., 2002; USFWS, 1997).

Additional details on Jamaica Bay's geology, bathymetry, topography, shoreline stability and geotechnical characteristics of Jamaica Bay are found in more detail in the Engineering Appendix (Appendix D).

2.2.1.2 Water Resources

Jamaica Bay lies within the Southern Long Island watershed (United States Geological Survey Hydrologic Unit 2030202), which has a drainage area of approximately 1,960 square miles and includes Kings, Queens, Nassau, and Suffolk counties of New York State. Within Kings and Queens counties, the aquifer is not utilized as the sole or principal source of drinking water; however, these areas do contribute to the recharge zone for aquifers underlying the southeastern portion of Queens County. The watershed has 625 miles of waterways, consisting mainly of small rivers and streams, including the Peconic River (USACE, 2003). There are no documented freshwater springs in the area (USACE, 2003).

Jamaica Bay itself drains an area of approximately 132 square miles (USFWS, 1997) within the larger Southern Long Island watershed. The bay is a saline to brackish, nutrient-rich estuary covering almost 40 square miles. The bay has a mean depth of 13 feet, a tidal range averaging five (5) feet, and a residence time of about 33 days (USFWS, 1997). The bay opens into Lower New York Bay and the Atlantic Ocean via the Rockaway Inlet. Rockaway Inlet is a high current area that is 0.63 miles wide at its narrowest point, with an average depth of 23 feet (USFWS, 1997).

Jamaica Bay was once a shallow, sandy system with channels networking through extensive salt marsh islands and surrounded by fringing wetlands. Fresh waters entered the bay through an array of tributary creeks that broadened and became more saline as they flowed downstream. Made of glacial till left behind during the last ice age and shaped by erosion and wave action (National Park Service

[NPS], 2004), the open water and wetlands portion of Jamaica Bay is approximately eight (8) miles long, four (4) miles wide and covers 26,645 acres (Swanson et al., 1992). Three-fourths of Jamaica Bay is water, marsh, and meadowland; the remaining upland areas include beaches, dunes, and forests (Swanson et al., 1992). Coastal portions of Jamaica Bay lie within the 100-year floodplain.

Because of landfilling and sewer diversions, the freshwater wetlands of Jamaica Bay comprise less than one (1) percent of their historic coverage (NYCDEP, 2007). The bay's original network of freshwater and brackish creeks have been shortened, straightened, bulkheaded, and channelized, with two-thirds of the freshwater runoff diverted through four (4) water pollution control plants. The waters within Jamaica Bay are classified by the NYSDEC as Class SB (suitable for primary and secondary contract recreation such as swimming, kayaking and fishing), but may be deferred pending development, implementation, or evaluation of other restoration measures. Jamaica Bay was approved for delisting in 2012 by the USEPA as Category 4b waters, where required control measures other than a total maximum daily load are expected to result in attainment of water quality standards within a reasonable period of time (NYSDEC, 2016).

2.2.1.3 Vegetation

The Jamaica Bay Planning Region contains one of the last large contiguous blocks of habitat in the HRE study area. The center of the bay is dominated by subtidal open water and extensive low-lying islands with areas of salt marsh, and intertidal flats. The average mean low tide exposes mudflats and low salt marshes dominated by smooth cordgrass (*Spartina alterniflora*), and high marsh dominated by saltmeadow cordgrass (*S. patens*). Macroalgae growth in the extensive intertidal areas is dominated by sea lettuce (*Ulva latuca*) (Hartig et al., 2002; Holmes and Milligan, 2013; Mack and Feller, 1990).

Aquatic vegetation and habitat of the Jamaica Bay Planning Region has been disturbed by extensive dredging and dredged material placement, and infrastructure development. About two-thirds of wetlands in the bay have been filled in, mostly around the perimeter of the bay. Despite this, Jamaica Bay is an estuary with diverse habitats, including open water (littoral zone), coastal shoals, bars, mudflats, intertidal zones (low and high marshes), and upland areas (Hartig et al., 2002). Upland communities are predominantly grasslands, scrub-shrub, developing woodland, and beachgrass dune. Despite the predominance of urban habitats in the region, the overall vascular plant variety is fairly rich with 456 species in 270 genera recorded in one study (Stalter and Lamont, 2002).

2.2.1.4 Finfish

Jamaica Bay continues to be a significant nursery ground for commercially and recreationally important fish, such as the winter flounder (*Pseudopleuronectes americanus*) and striped bass. In 2002, of all the finfish species, the majority caught in the bay during a Jamaica Bay Ecosystem Research and Restoration Team (2002) study were juveniles. Overall, the most abundant finfish caught during seining in the study was the juvenile Atlantic silverside (*Menidia menidia*), comprising 61 percent of all species. This fish consistently remains one of the most abundant juvenile fish in the bay and also throughout the Middle Atlantic Bight. *Fundulus* species, including the striped killifish (*Menidia beryllina*) and spotfin killifish (*Fundulus luciae*), were the second most prevalent taxa. The third most prevalent taxa caught seining was the Atlantic menhaden (*Brevoortia tyrannus*), followed by the striped mullet (*Mugil cephalus*) and the winter flounder (Jamaica Bay Ecosystem Research and Restoration Team, 2002). Under the Magnuson-Stevens Fishery Conservation and Management Act (16 United States Code 1801 et seq.), Jamaica Bay has been designated by the National Marine Fisheries Service (NMFS) as essential fish habitat (EFH) for numerous species and life stages of commercially or ecologically important fish.

Other common fish species that inhabit this area include Atlantic silverside (*Menidia menidia*), bay anchovy (*Anchoa mitchilli*), mummichog (*Fundulus heteroclitus*), Atlantic menhaden (*Brevoortia tyrannus*), striped killifish (*Menidia beryllina*), scup (*Stenotomus chrysops*), bluefish (*Pomatomus saltatrix*), windowpane (*Scophthalmus aquosus*), tautog (*Tautoga onitis*), weakfish (*Cynoscoin regalis*), black sea bass (*Centropristis striata*), summer flounder (*Paralichthys dentatus*), and American eel. Anadromous species that use the area include blueback herring, Atlantic sturgeon (*Acipenser oxyrhynchus*), alewife, American shad, and striped bass (USFWS, 1997).

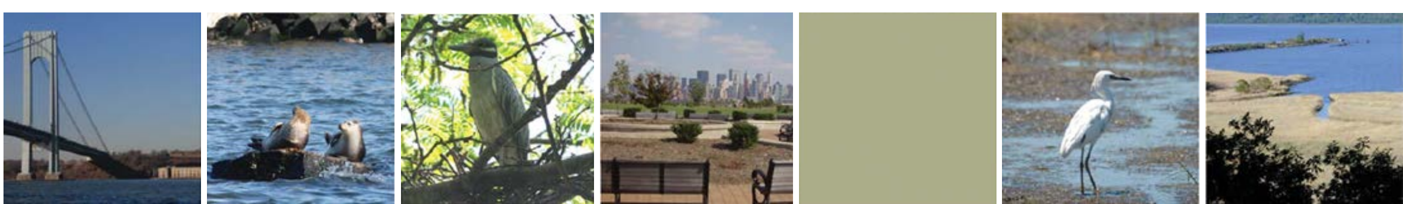
2.2.1.5 Essential Fish Habitat

The regional fisheries management councils, with assistance from the National Oceanic and Atmospheric Administration (NOAA) NMFS, are required under the 1996 amendments to Magnuson-Stevens Fishery Management and Conservation Act to delineate EFH for all managed species, to minimize to the extent practicable adverse effects on EFH, and to identify other actions to encourage the conservation and enhancement of EFH. EFH is defined as “those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity” (NOAA, 2004). In addition, the presence of adequate prey species is one of the biological properties that can define EFH. The regulations further clarify EFH by defining “waters” to include aquatic areas that are used by fish (either currently or historically) and their associated physical, chemical, and biological properties: “substrate” to include sediment, hard bottom, and structures underlying the water; areas used for “spawning, breeding, feeding, and growth to maturity” to cover a species’ full life cycle; and “prey species” as being a food source for one or more designated fish species (NOAA, 2004).

NOAA’s Guide to EFH Designations in the Northeastern United States provides the species and life stages that have EFH. Table 2-1 lists the EFH designations in the Jamaica Bay Planning Region. The planning region falls within two (2) 10-minute grids; however, because these grids extend beyond the bay to also cover a large portion of oceanic area, some of the designated species are oceanic pelagic species that would not occur in the planning region habitat (NOAA, 2016). EFH is discussed further in Appendix F.

Table 2-1 Summary of EFH Designation for Jamaica Bay Planning Region

Managed Species	Eggs	Larvae	Juveniles	Adults
Atlantic Salmon (*Salmo salar*)				X
Pollock (*Pollachius virens*)			X	
Silver Hake (*Merluccius bilinearis*)	X	X	X	
Red hake (*Urophycis chuss*)	X	X	X	
Winter flounder (*Pseudopleuronectes americanus*)	X	X	X	X
Windowpane flounder (*Scophthalmus aquosus*)	X	X	X	X
Atlantic sea herring (*Clupea harengus*)			X	X
Monkfish (*Lophius americanus*)	X	X		X
Bluefish (*Pomatomus saltatrix*)			X	X
Atlantic butterfish (*Peprilus triacanthus*)	X	X	X	X
Atlantic mackerel (*Scomber scombrus*)	X	X	X	X
Summer flounder (*Paralichthys dentatus*)		X	X	X



Managed Species	Eggs	Larvae	Juveniles	Adults
Scup (*Stenotomus chrysops*)	X	X	X	X
Black sea bass (*Centropristis striata*)			X	X
King mackerel (*Scomberomorus cavalla*)	X	X	X	X
Spanish mackerel (*Scomberomorus maculatus*)	X	X	X	X
Cobia (*Rachycentron canadum*)	X	X	X	X
Sand tiger shark (*Carcharhinus taurus*)		X		
Blue shark (*Prionace glauca*)				X
Dusky shark (*Carcharhinus obscurus*)		X		
Sandbar shark (*Carcharhinus plumbeus*)		X	X	X
Tiger shark (*Galeocerdo cuvieri*)		X		

Source: NOAA, 2016.

10'x10' square coordinates: 40° 40.0'N, 73° 40.0'W, 40° 30.0'N, 73° 50.0'W
40° 40.0'N, 73° 50.0'W, 40° 30.0'N, 74° 00.0'W

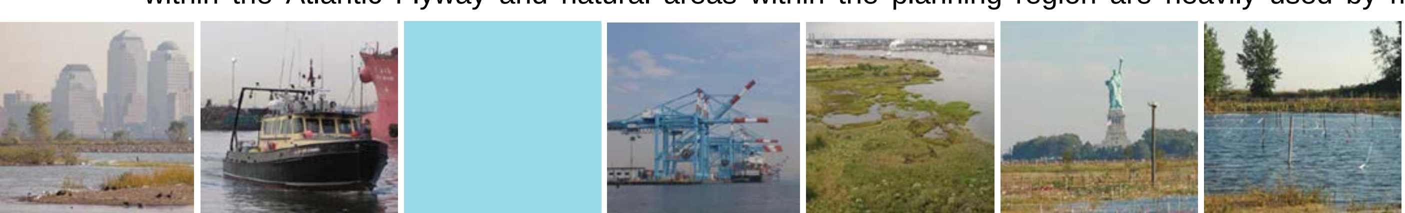
2.2.1.6 Shellfish and Benthic Resources

Areas of existing salt marsh in the Jamaica Bay Planning Region provide reproductive areas for invertebrates, such as mussels and crabs. Mudflats in the planning region are important habitat for horseshoe crabs (*Limulus polyphemus*) and shorebirds. Each spring, horseshoe crabs congregate on these mudflats to breed. Migratory shorebirds that winter in the Geotropic and breed in the Artic stop during their migration to rest and replenish their fat reserves by feeding on the horseshoe crab eggs. Shorebird species such as Ruddy Turnstones (*Arenaria interpres*) and Red Knots (*Calidris canutus*) rely on the horseshoe crabs for their survival. Favorable habitat is generally limited to small, isolated patches on the beaches of Jamaica Bay.

Jamaica Bay once supported significant shellfisheries including eastern oyster, hard clam or northern quahog (*Mercenaria mercenaria*), softshell clam (*Mya arenaria*), and blue crab (*Callinectes sapidus*). However, as a result of pollution, decreased habitat, and overharvesting, the industry collapsed. The New York City Health Department closed harvest of the Bay's shellfish in 1921 due to contamination, a threat which persists today. Current shellfisheries in the Bay are limited to reduced recreational harvest of a few species.

2.2.1.7 Wildlife

Widely recognized as a uniquely valuable habitat complex within the HRE, New York City designated Jamaica Bay as a Special Natural Waterfront Area (SNWA) in response to recommendations in the 1992 Comprehensive Waterfront Plan (NYC, 2011). The habitat of the Jamaica Bay estuary serves important functions for fish, birds, and other wildlife populations. The geographic location of Jamaica Bay at the turning point of the Atlantic coastline creates a convergence point for migratory marine and estuarine species. Shorebirds, raptors, waterfowl, and landbirds are concentrated by the coastlines in both directions. Areas of existing saltmarsh serve as nursery grounds for larval and juvenile fish, as well as reproductive areas for invertebrates such as mussels and crabs. Areas of sandy beach provide critical habitat to breeding horseshoe crabs (*Limulus polyphemus*) and various shorebirds, including several federal and state endangered or threatened species. The Jamaica Bay Planning Region is within the Atlantic Flyway and natural areas within the planning region are heavily used by migrant



birds. The harbor seal (*Phoca vitulina*) has been observed on the islands of Jamaica Bay, as well as the grey seal (*Halichoerus grypus*), although less frequently (USFWS, 1997).

Islands scattered through the marshes and mudflats support important nesting habitat for colonial waterbirds (USACE, 2004a). Upland meadows and shrublands provide habitat for terrestrial species and are important buffer areas that provide protections from noise and human encroachment. The planning region includes the Jamaica Bay and Breezy Point complex, which has been designated by the USFWS as a significant habitat complex of the New York Bight watershed. Although fish and wildlife species use the remaining habitat within the planning region, the wetland habitat within Jamaica Bay is eroding rapidly and the surrounding land use further diminishes the quality of the habitat (NYSDEC, 2001).

2.2.1.8 Rare, Threatened, and Endangered Species

All appropriate federal and state agencies were consulted regarding the documentation of rare, threatened, and endangered species, and species of special concern within the project sites and their vicinities. The USFWS and NMFS were contacted regarding federally listed threatened and endangered species, while the NYSDEC Division of Fish, Wildlife, and Marine Resources gave comments regarding state listed species. Numerous endangered, threatened, or rare plant and animal species exist within the boundaries of the bay.

Some species found in or near several Jamaica Bay restoration sites are the Northern Harrier, Peregrine Falcon, Piping Plover (*Charadrius melodus*), Roseate Tern (*Sterna dougallii*), and seabeach amaranth (*Amaranthus pumilu*). Four (4) different species of protected marine turtles have been found in the bay, as well as a number of marine mammals. Breezy Point, on the western tip of the Rockaway Barrier Beach, sustains large populations of beach-nesting colonies of Piping Plovers (*Charadrius melodus*) in the New York Bight coastal region (USFWS, 1997).

USFWS

The USFWS IPaC website was consulted to determine potential threatened and endangered species or critical habitats that occur in Jamaica Bay (Appendix G). No critical habitats were identified in Jamaica Bay; however, several protected species were identified as being in the habitats of Jamaica Bay. Two (2) endangered species were identified: Roseate Tern and sandplain gerardia (*Agalinis acuta).* Also four (4) threatened species were identified: Piping Plover; Red Knot, seabeach amaranth, and the northern long-eared bat (*Myotis septentrionalis*)

NMFS

Listed by the NOAA NMFS, four (4) species of Endangered Species Act (ESA) sea turtles have been seasonally present in the bay, including:

- Threatened Northwest Atlantic Ocean distinct population segment (DPS) of loggerhead (*Caretta caretta*);
- Threatened North Atlantic DPS of green (*Chelonia mydas*);
- Endangered Kemp's ridley (*Lepidochelys kempii*); and
- Endangered leatherback sea turtle (*Dermochelys coriacea*).

These threatened and endangered sea turtles can be present in the Jamaica Bay area from May to mid-November. Adult and sub-adult Atlantic sturgeon can be found in the Jamaica Bay Planning Area. The New York Bight, Chesapeake Bay, South Atlantic, and Carolina DPSs are endangered, and the Gulf of Maine DPS is threatened in the area. Atlantic sturgeon eggs, larvae, or juvenile life stages will not be found in the waters of the Jamaica Bay Planning Area. Additionally, the shortnose sturgeons (*Acipenser brevirostrum*), of the adult and subadult life stages are also present in these waters.

NYSDEC

Through correspondence with NYSDEC, and their review of the New York Natural Heritage Program database, the following list of endangered, threatened, or species of special concern for any animal species that are listed federally, or are candidates for federal listings in the Jamaica Bay area include:

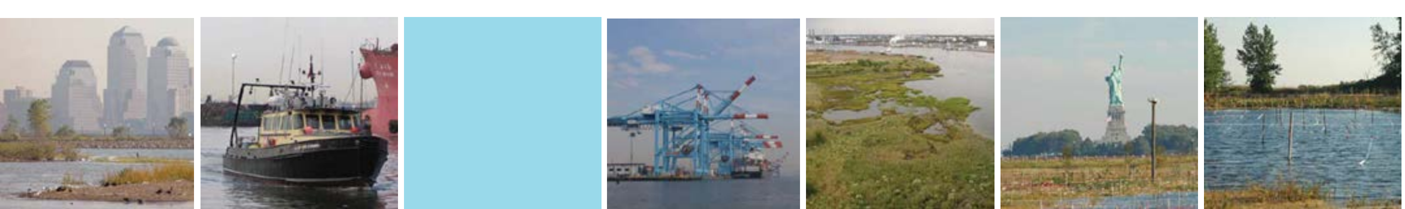
- Short-eared Owl (*Asio flammeus*) – Endangered;
- Peregrine Falcon – Endangered;
- Northern Harrier – Threatened;
- Common Tern (*Sterna hirundo*) – Threatened;
- Black Skimmer (*Rynchops niger*) – Special Concern;
- Upland Sandpiper (*Bartramia longicauda*) – Threatened;
- Laughing Gull (*Leucophaeus atricilla*) – Protected Bird - Critically Imperiled in NYS;
- Barn Owl (*Tyto alba*) – Protected Bird – Critically Imperiled in NYS;
- White-m Hairstreak (*Parrhasium m-album*) – Unlisted – Status Uncertain; and
- Red-banned Hairstreak (*Calycopis cecrops*) – Unlisted – Status Uncertain.

The following list of endangered, threatened, or species of special concern for any plant species that are listed federally, or are candidates for federal listings in the area includes:

- Scirpus-like Rush (*Juncus scirpoides*) – Endangered – Critically Imperiled in NYS;
- Northern Gamma Grass (*Tripsacum dactyloides*) – Threatened – Imperiled in NYS;
- Fringed Boneset (*Eupatorium torreyanum*) – Threatened – Imperiled in NYS;
- Roland's Sea-blite (*Suaeda rolandii*) – Endangered – Critically Imperiled in NYS and Globally Rare;
- Narrow-leaf Sea-blite (*Suaeda linearis*) – Endangered – Critically Imperiled in NYS;
- Cut-leaved Evening Primrose (*Oenothera laciniata*) – Endangered – Critically Imperiled in NYS;
- Willow Oak (*Quercus phellos*) – Endangered - Critically Imperiled in NYS;
- Seaside Bulrush (*Bolboschoenus maritimus ssp. Paludosus*) – Threatened – Imperiled in NYS; and
- Schweinitz's Flatsedge (*Cyperus schweinitzii*) – Rare – Vulnerable in NYS.

In addition, the New York Natural Heritage Program deems the Low Salt Marsh, present throughout Jamaica Bay, to be a significant natural community from a statewide perspective having a high ecological and conservation value.

Threatened and endangered species may be present at any of the Jamaica Bay sites as either residents or transients. It is assumed that prior to construction activities a resource inventory would be conducted to determine if these species are present. Chapter 5 discusses these inventories in greater detail.



2.2.1.9 Land Use

Jamaica Bay is a highly urbanized estuary in southern Brooklyn and Queens that contains the Jamaica Bay Wildlife Refuge, established as part of Gateway National Recreation Area. The recreation area was the country's first national urban park and remains a dominant feature of this planning region (RPA, 2003). Predominant land uses on the northern shore of Jamaica Bay are developed commercial, industrial, and residential. The shorelines of Jamaica Bay are flanked by heavily developed lands, including the Belt Parkway, John F. Kennedy International Airport, and several landfills. Along the waterfront, land and water uses include marinas, marine parks, parkland, vacant disturbed land (wetlands and uplands), tidal wetlands, and residential land. Public parks and open space present in the study area include Floyd Bennett Field, Prospect Park and Spring Creek Park. Rockaway Peninsula, in the southern part of the Jamaica Bay Planning Region, is distinct from the northern shores of the planning region. Developed as a summer resort in the 1830s, Rockaway Peninsula is predominantly a residential area from its border with Nassau County on the east to Rockaway Point on the west.

2.2.1.10 Hazardous, Toxic, and Radioactive Waste

All of eastern Jamaica Bay and its tributaries have been designated by NYSDEC as impaired, due to nitrogen levels, oxygen demand, and presence of pathogens (NYSDEC, 2016). Six (6) sewage treatment plants occur in the planning region; four (4) are owned and operated by the NYCDEP; one (1) is owned and operated by the Village of Cedarhurst, NY; and one (1) is owned and operated by the Nassau County Department of Public Works. Major investments in New York City's sewage treatment plants over the past three (3) decades have dramatically improved the bay's water quality, but significant problems remain. The primary culprits are CSOs and discharges of treated wastewater from the six (6) city sewage treatment plants that encircle the bay. While there is considerable variability in residence time estimates, it is clear that many locations within the bay are prone to retain pollutants for long periods of time, while pollutants can be removed from other locations rather rapidly (NYCDEP, 2007). Jamaica Bay's tributaries and dead-end canals are also prone to reduced water quality due to direct surface runoff and poor flushing (NYCDEP, 2011). Dissolved trace metals, including lead, have also been detected in the water column of Jamaica Bay (Beck et al., 2009).

An HTRW sampling report (USACE, 2002) was completed for potential restoration sites in the Jamaica Bay Planning Region. Soils encountered at the sites under investigation consist primarily of fill materials comprised of disturbed soils and/or placement of dredged material, building demolition debris, domestic refuse, and coal combustion residues (i.e., coal and coal ash). Details of the compounds found in soil samples that exceeded the limits set by the NYSDEC recommended soil cleanup objective and cleanup levels can be found in Appendix H.

2.2.1.11 Air Quality

The HRE encompasses a highly urbanized and industrialized setting, including many major transportation corridors servicing the New York City Metropolitan Area. As required by the Clean Air Act of 1970, National Ambient Air Quality Standards have been established for six (6) major air pollutants identified by USEPA as being of nationwide concern: carbon monoxide, nitrogen oxides, ozone, particulates, sulfur oxides, and lead. In the HRE study area, ambient concentrations of carbon monoxide, ozone, and lead are predominantly influenced by vehicle emissions, nitrogen oxides and particulates are emitted from both motor vehicle and stationary sources (e.g., power generation, industrial), and emissions of sulfur oxides and sulfates are mainly from stationary sources. These standards have also been established as the ambient air quality standards for the state of New York.

Primary standards are intended to protect public health, while secondary standards are intended to protect public welfare (e.g., physical damage to structures, ecological damage).

The NYSDEC operates a network of air monitoring stations to evaluate pollutants and compare them to the National Ambient Air Quality Standards (NYSDEC, 2014). Ambient air in the region is similar to that of other highly urbanized areas. Placing emission controls on automobiles and industrial sources and limiting sulfur content of fuels have helped to improve the regional air quality in the HRE over the last 30 years.

2.2.1.12 Noise

Noise is generally defined as unwanted sound and its loudness is measured by amplitude, which is expressed in decibels. Noise levels can be approximated based on land use and can range from 30 decibels in wilderness areas to 90 decibels in urban areas (USEPA, 1978). Ambient noise levels within the Jamaica Bay Planning Region would be highly variable due to its combination of developed urban land and the less-developed bay and marsh islands. The primary sources of noise in the planning region include air traffic from John F. Kennedy International Airport, automobile traffic on the Belt Parkway or other local roads, and boat traffic in Jamaica Bay. Receptors in the planning region include residential areas and wildlife habitats. Noise criteria and the descriptors used to evaluate project noise will depend on the type of land use in the vicinity of the proposed project areas.

2.2.1.13 Navigation

A federal navigation channel is within Jamaica Bay, along the west and south shores, with an entrance channel connecting two (2) interior channels to the Atlantic Ocean at Rockaway Inlet. North Channel is the interior channel from the Marine Parkway Bridge along the west shore of the bay and is authorized to be 18 feet deep at mean low water (MLW) and 300 feet wide to Mill Basin, with a turning basin 1000 feet wide and 1000 feet long at that point. North of Mill Basin the channel continues with an authorized depth of 12 feet MLW and 200 feet wide to Fresh Creek Basin. Beach Channel, authorized to 15 feet deep MLW and 200 feet wide, is the interior channel from the Marine Parkway Bridge along the south shore and continues to Head of Bay. At the entrance to Head of Bay, the channel branches, going north into the Head of Bay and south, forking into Mott Basin and Inwood Creek. The entrance channel, Rockaway Inlet, is authorized to 18 feet deep MLW and 500 feet wide from the Marine Parkway Bridge to Rockaway Point, where it expands to an authorized 20 feet deep MLW and 1000 feet wide to the ocean. The Rockaway Inlet entrance channel is generally dredged on a two (2) to three (3) year maintenance cycle. The five (5) year average annual commercial tonnage at Jamaica Bay federal navigation channel is 678,400 tons.

2.2.1.14 Recreation

The Jamaica Bay Planning Region has 61 public access points lining the waterfront around the bay. The majority is found at the entrance of the bay around Dead Horse Bay, Gerritsen Creek, and Mill Basin; however, they are not limited to this area and others can be found along the Rockaway Peninsula and the islands of the bay and the Jamaica Bay Wildlife Refuge. Public swimming beaches line Rockaway Peninsula through Fort Tilden and Jacob Riis Parks (New York City Department of Parks and Recreation [NYC Parks], 2012).

In the Jamaica Bay Planning Region, recreational fishing from the shorelines occurs in New York City or state parks and in areas of Gateway National Recreation Area (parts of Floyd Bennett Field, Breezy point, Canarsie Pier, Dead Horse Bay, Fort Tilden, and Jacob Riis Park) (NYCDEP, 2007).

Recreational species that occur in the Jamaica Bay Planning Region include bluefish, tautog, weakfish, black sea bass, winter flounder, summer flounder, and striped bass.

2.2.1.15 Cultural Resources

The Jamaica Bay region has a long history of occupation, first by Native American groups from as early as 12,000 before present until the arrival of European explorers in the fifteenth century. Early colonial settlements appear in the 1600s and evolve slowly from agricultural to industrial in character followed by urbanization in the last century. Potential for prehistoric and historic archaeological sites exists throughout the region. Archaeological sites and above ground historic properties can be found in upland, lowland, marsh, and submerged environments. Architectural and archaeological investigations are required to determine the presence or absence of such resources in most of the study area due to lack of existing data.

In 2014, the USACE completed a cultural resources survey titled *Cultural Resources Overview of the Hudson-Raritan Estuary Comprehensive Restoration Plan* (Harris et al., 2014) that aimed at inventorying all existing cultural resources data relevant to the candidate restoration sites in the HRE study area. The overview survey was not a comprehensive survey but an overview that compiled general cultural resources data for the entire Jamaica Bay region and resource data solely for individual restoration sites. There were 44 restorations sites investigated in the Jamaica Bay Planning Region. More than 120 cultural resources, historic districts, and surveys were recorded within the study area. Of the 120 items, 42 are Automated Wreck and Obstruction Information System (AWOIS) objects, 36 are archaeological sites, and 28 are historic properties.

Three (3) historic districts were recorded within the study area: Floyd Bennett Field, Jacob Riis Park, and Fort Tilden. Eleven (11) cultural resources surveys were documented for these areas within the Jamaica Bay Planning Region. Among the surveys and most relevant to the current study are those that were carried out by the USACE in Jamaica Bay as part of the Jamaica Bay, Marine Park, and Plumb Beach Ecosystem Restoration Feasibility Study (Panamerican Consultants Inc., 2003, 2004, and 2006). All documentation related to Cultural Resources are presented in Appendix I.

2.2.1.16 Social and Economic Resources

The Jamaica Bay Planning Region is predominantly in Kings and Queens Counties with Nassau County covering a small portion to the east. The population in the Jamaica Bay Planning Region is approximately 2.5 million people according to the 2010 Census (United States Census Bureau, 2010). The demographic makeup is 35 percent White, 46 percent Black or African American, 12 percent Asian, and seven (7) percent other races. Seventeen (17) percent of Jamaica Bay is Hispanic. Only 30 percent of housing units are owner-occupied in Jamaica Bay and seven (7) percent of the housing units are vacant.

The median household income in the Jamaica Bay Planning Region is $58,561 (in 2011 inflation-adjusted dollars) based on the American Community Survey 5-year estimates for 2007-2011 (United States Census Bureau, 2011). Seventeen (17) percent of households in the Jamaica Bay Planning Region earned income below the poverty level in 2011.

2.2.1.17 Aesthetics and Scenic Resources

The east portion of Jamaica Bay is bordered by John F. Kennedy International Airport (USACE, 2002). Jamaica Bay is enclosed by Rockaway Peninsula. The bayside of the peninsula is urbanized and

bulkheaded in most areas east of the Breezy Point Cooperative, while the seaside is made up almost entirely of sandy beaches from Breezy Point to Far Rockaway.

Vistas of the remaining marsh islands and other natural areas in Gateway National Recreation Area provide for picturesque views of the bay. The Jamaica Bay Wildlife Refuge also provides a unique landscape containing a variety of native habitats including salt marsh, coastal dunes, upland fields and woods, and both fresh and brackish water ponds.

2.2.1.18 Coastal Zone Management

The Coastal Zone Management Act of 1972 (16 United States Code 1451-1464) was enacted by Congress to balance the demands for growth and development with the competing demands for protection of coastal resources. This act requires that federal activities affecting land or water resources located in the coastal zone be consistent to the maximum extent practicable with the federally approved state coastal zone management plans. This act is regulated in New York by the New York State Department of State, Division of Coastal Resources.

Local governments can participate in the New York State Coastal Management Program through the Waterfront Revitalization of Coastal Areas and Inland Waterways Act, by preparing and adopting local waterfront revitalization programs. The programs provide more detailed implementation of the New York Coastal Management Program through use of existing broad powers such as zoning and site plan review. New York City, Piermont, Dobbs Ferry, Mamaroneck, Port Chester, and Rye have approved local waterfront revitalization programs in the HRE study area. The local program only advises on the New York State Coastal Management Program, and as such, the New York State Department of State makes the final determination on coastal zone consistency.

The Jamaica Bay Planning Region includes portions within the coastal boundary of New York. Restoration activities within the region will be reviewed by the New York State Department of State for consistency with the policies of the New York State Coastal Management Program and the applicable local New York City program, The New Waterfront Revitalization Program. All information related to the USACE coastal consistency review is presented in Appendix J.

2.2.1.19 Future Without-Project Conditions

Under the future without-project condition, ongoing and planned restoration and conservation actions undertaken by agencies, municipalities and nongovernmental entities would continue. Although there are many ongoing programs in the Jamaica Bay Planning Region, they are typically conducted independent of one another. These activities are outlined in Appendix B. While restoration efforts would continue under the without-project condition, these efforts would lead to disjointed projects, missed opportunities and overall inefficiencies in restoring the Jamaica Bay Planning Region.

Jamaica Bay is threatened by poor water and sediment quality, and habitat losses. The future without-project condition of Jamaica Bay will likely be the continuation of non-point source inputs into the Bay, thereby continuing to impact water quality. Ongoing and planned upgrades to wastewater treatment plants, CSO abatement programs, and remediation of landfills will contribute to progressive improvements in water quality. In the absence of federal action, wetlands and marshes along the periphery of the Bay will decrease in acreage due to erosion, subsidence and invasive species interference. Invasive species will expand in many of the sites, resulting in the continuing loss of *Spartina*-based wetlands. Increases in coastal flooding from SLR will exacerbate loss of shoreline and coastal habitat. Sedimentation from non-point source water quality inputs and erosion will continue to contribute to the poor health of the area, and fauna will continue to remain vulnerable. Any jobs from the restoration projects would not occur in the without-project condition.

2.2.2 Harlem River, East River, and Western Long Island Sound Planning Region

The Harlem River, East River, and Western Long Island Sound planning region contains sections of Manhattan and the Bronx to the north, and Brooklyn and Queens to the south (Figure 2-4). It extends east to include part of Long Island Sound and portions of Westchester and Nassau Counties, New York. The East River is an important tidal strait connecting Long Island Sound and Upper Bay. This system connects to the brackish Lower Hudson River via the Harlem River. A portion of this planning region has been designated as the Upper East River-Long Island Sound SNWA by New York City due to the extensive marsh systems in the area, such as those in Alley Pond Park, and islands that support significant populations of nesting shorebirds (NYC, 2011).

These areas are stressed by numerous factors that threaten water quality and habitat integrity (Yozzo et al., 2001), such as shoreline development, persistent contamination, and pollutant discharges (USFWS, 1997). Like all areas in the HRE study area, the shores are heavily urbanized, lessening much of the ecological benefit provided by its beaches, decreasing transitional littoral habitat, and fragmenting important shorebird feeding and waterfowl wintering areas. Water and sediment quality are degraded due to numerous point sources, including landfills and CSOs (USACE, 2000).

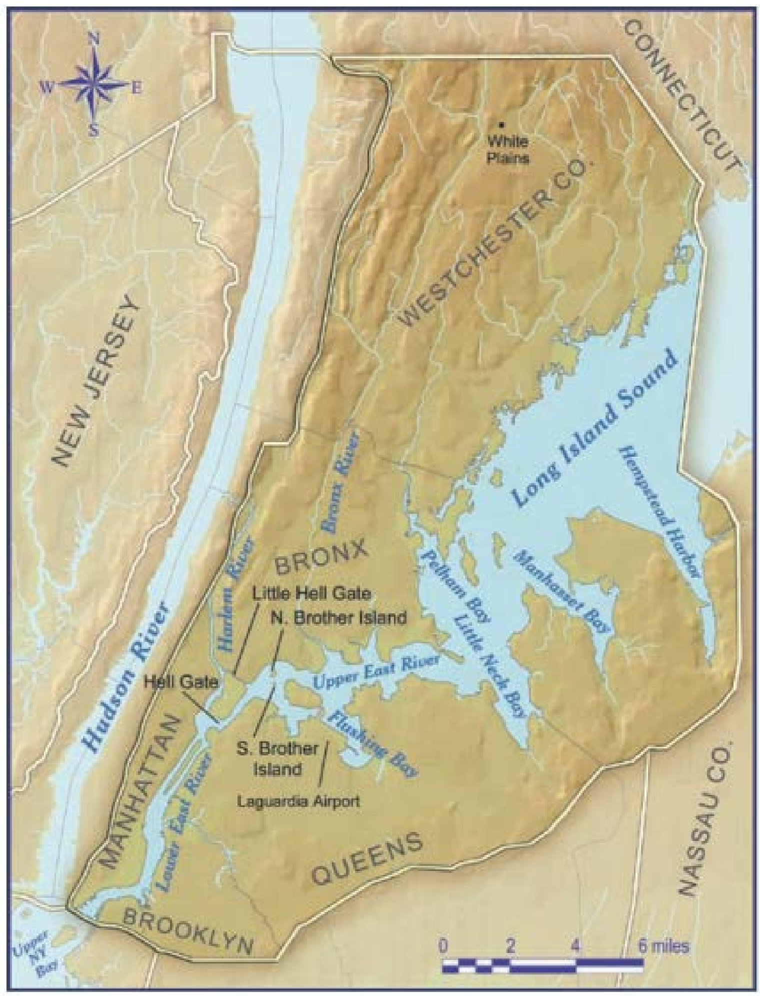
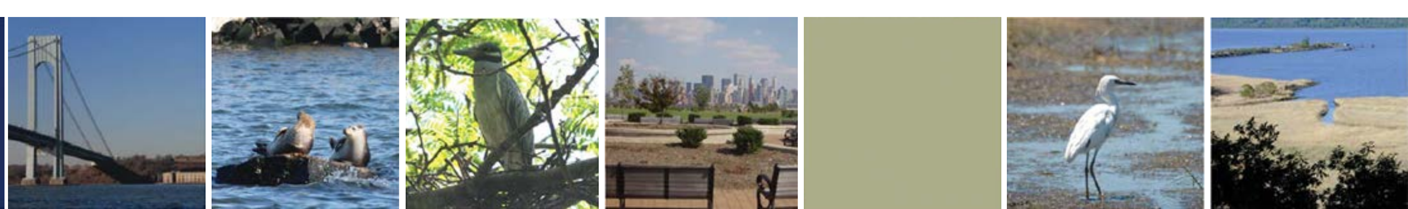


Figure 2-4: Harlem River, East River, and Western Long Island Sound Planning Region

Water quality in the tributaries of this planning region has been severely degraded by industrial discharge and wastewater inputs, limiting the waterways to primarily transportation-related uses. With the exception of Tibbets Brook and Little Hell Gate, the Harlem River's tributaries are completely enclosed in culverts and are often redirected several city blocks from their historic route to allow for building or road construction. In the lower East River, most shorelines have been bulkheaded and filled, creating a deep, narrow passage. Natural river features that created topographic relief, including rock reefs, mudflats and sandbars, were dredged or blasted in the late-19th century to create a continuous, navigable channel through Hell Gate (USACE, 1999).



In 2012, Hurricane Sandy caused extensive flooding, damage from wave action, beach erosion, loss of beach nesting habitat, wind damage, and water advisories in the Harlem River, East River, and Western Long Island Sound Planning Region. Beach erosion and reductions in beach elevations were observed along Long Island's north shore beaches, specifically at Manursing Lake and the Edith G. Read Wildlife Sanctuary in Rye, New York. Beach erosion impacted shorebird nesting areas, leaving these sites vulnerable to repeated flooding, overwash, and high or neap flooding, as well as storm surges and wave action from future storms. Impacted species include piping plover, American oystercatcher (*Haematopus palliatus*), least tern (*Sternula antillarum*), and common tern (*Sterna hirundo*); these species breed and nest on beaches, dunes, and overwash fans. Migratory shorebirds such as sanderling (*Calidris alba*), semipalmated sandpiper (*C. pusilla*), ruddy turnstone (*Arenaria interpres*), black-bellied plover (*Pluvialis squatarola*), and red knot (*C. canutus*) were also impacted as they are all beach foragers.

Manursing Lake in Rye, New York was the subject of a major two-part restoration project completed in 2012. Impacts to this area from Sandy were significant. Sand dunes and vegetation situated between the sound and the lake were destroyed, with only 200 feet of field and road remaining to prevent further inundation to the salt marsh and lake. A large quantity of sand and rock was pushed onto fields and access roads, and sections of the salt marsh were buried by sand and debris. Portions of the lakeshore were eroded, along with cliffs at the north end of the beach.

Wind damage was another impact from Hurricane Sandy reported within this planning region. The New York Botanical Gardens reported more than 200 trees downed. Soundview Park, located in the Bronx, New York, suffered wind damage and loss of trees in the Bronx River Forest canopy, providing an opportunity for an influx of invasive species. However, fallen tree branches created potential habitat in the Bronx River for American eels and other estuarine-dependent fish species (ALS, 2012).

Elevated fecal coliform levels were observed in the waters within the planning region following Sandy, potentially due to the discharge of untreated and partially treated sewage from nearby wastewater treatment plants. The storm surge caused the Newtown Creek Wastewater Treatment Plant to discharge 143 million gallons of untreated sewage into the creek, and the Hunts Point Wastewater Treatment Plant discharged 153.8 million gallons of diluted, untreated sewage into the East River (Kenward et al., 2013).

2.2.2.1 Geomorphology and Sediment Transport

The Harlem River, East River, and Western Long Island Sound Planning Region lies with the Atlantic Coastal Plain physiographic province. Sediments vary depending upon location as a result of the complex flow patterns existing in the Long Island Sound, and overall HRE. Surficial sediments include both glacial and postglacial deposits, with the most recent glaciation period ending about 21,000 years ago. Surficial glacial deposits include till and stratified drift. Postglacial deposits consist of sand, marsh deposits, and estuarine silt.

Appendices D and H include all detailed information regarding the geology, geomorphology, hydrology and sediment transport, including a Sediment Impact Assessment Model, for the Bronx River and Flushing Creek.

2.2.2.2 Water Resources

The Harlem River, East River, and Western Long Island Sound Planning Region is made up of the Bronx River watershed and a portion of the Northern Long Island watershed, which drain into the East

River. The East River is a tidal strait driven by the differences in tide between its two (2) ends, and tidal currents are strong throughout most of the East River with maximum current exceeding five (5) knots in the west channel between Manhattan and Roosevelt Island. Many tributaries of the East and Harlem Rivers have been channelized and redirected through culverts. The upper East River still has bays and creek mouths, but with sparse remnants of tidal wetland and upland habitats (RPA, 2003; USACE, 2004a). With the exception of Tibbets Brook and Little Hell Gate, the Harlem River tributaries are completely enclosed in culverts and are often redirected several city blocks from their historic route to allow for building or road construction. In the lower East River, most of its shorelines have been bulkheaded and filled, creating a deep, narrow passage. River obstructions that created topographic relief, like reefs, shallows, and rocks, were dredged or blasted to create a continuous, navigable channel through Hell Gate (USACE, 1999).

The Bronx River basin is a highly built up urban area within the greater New York City metropolitan area. The drainage area is approximately 56 square miles, through which the Bronx River traverses approximately 23 miles. A series of low head dams along the river form small impoundments or lakes, with the largest pools located near Tuckahoe and Bronxville in Crestwood Lake and Bronxville Lake, respectively. A total of 49 dams were identified within the planning region (Figure 2-5; Appendix C).

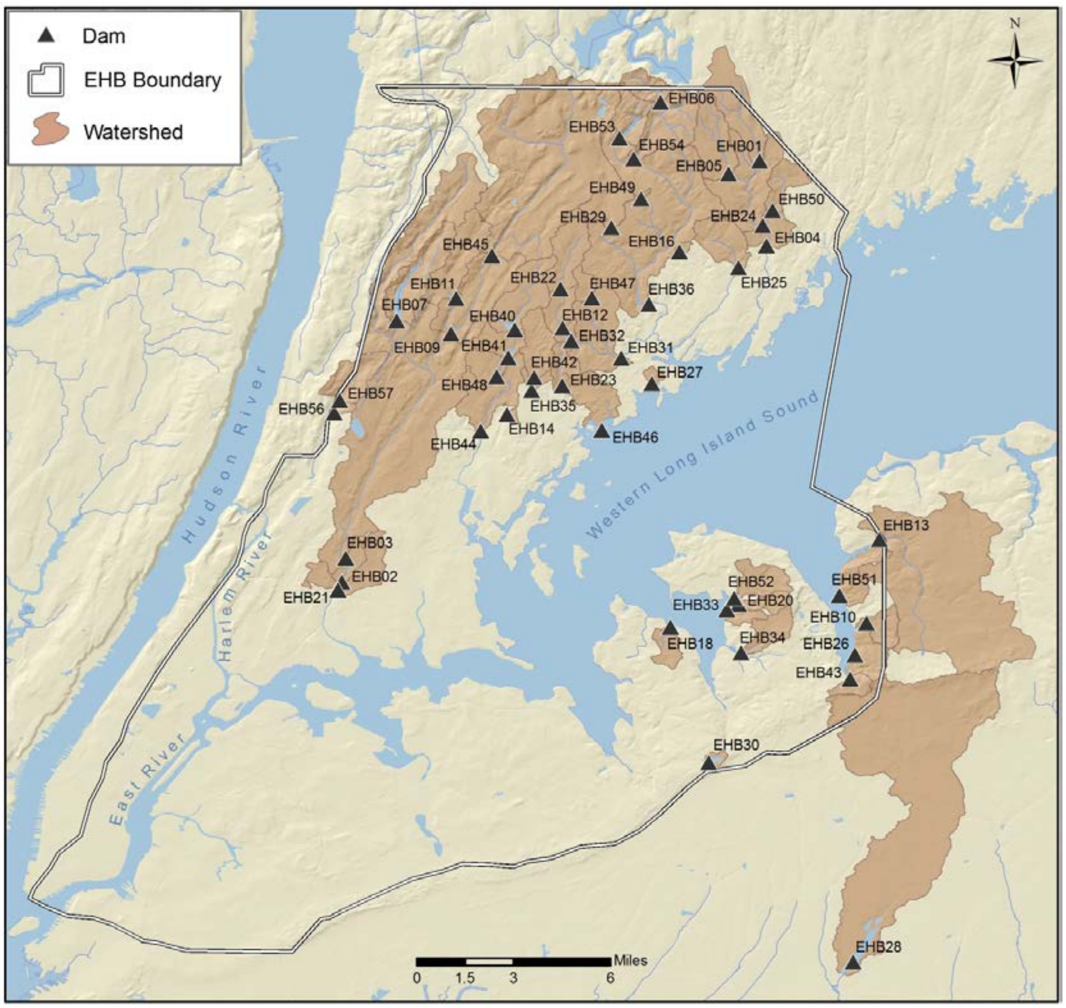


Figure 2-5: Barriers (only dams) Identified in the Harlem River, East River, and Western Long Island Sound Planning Region

Due to a high percentage of impervious surfaces in the watershed, stormwater is collected primarily as runoff and, in many cases, piped directly into the river. Five (5) CSOs also discharge to the Bronx River.

Flushing Bay is an embayment of the East River consisting of approximately 6,200-acres of open water and is a moderately stratified and partially mixed estuary. Flushing Bay exchanges water with the East River which is in contact with both the Atlantic Ocean and Long Island Sound. Flushing Bay is considered a dynamic and well-mixed system. However, the mixing is significantly reduced in the inner bay. The flushing half-life varies from one (1) tidal cycle at mid-bay to six (6) tidal cycles in Flushing Creek. The flushing effectiveness was found to be 99.9 percent. The salinity of the Bay ranges from 22 to 24 parts per thousand.

Tidal range in Flushing Bay is approximately seven (7) feet. Mean tide ranges within Flushing Creek at the Northern Boulevard Bridge are reported to be 6.8 feet at mean tide and 8.0 feet at spring tide. The system receives freshwater (non-saline) flow from CSO discharges, direct rainfall runoff, and discharge through the tide gate from Meadow and Willow lakes. The bay and creek are Class I waters per the NYSDEC. The best intended usages for this classification are secondary contact recreation and fishing. The Flushing Bay and Creek watershed is highly urbanized with a dense mixture of residential, transportation, commercial, industrial and institutional development. Fourteen (14) combined sewer outfalls (CSOs) discharge a combination of raw sewage and storm water during periods of heavy rainfall into the bay and creek.

2.2.2.3 Vegetation

Many of the shorelines, tidal river inlets and embayments within the Harlem River, East River, Western Long Island Sound Planning Region are densely urbanized or disturbed, often with sparse remnants of tidal wetlands, sandy/gravelly beaches, and upland habitats (RPA, 2003; USACE, 2004a). Areas of open space contain maritime salt marsh, mixed hardwood woodland, grassland/meadow, mixed deciduous forests, swamps, marshes, open fields, and fresh water ponds. The numerous islands are mostly covered with grassland, shrub land or deciduous forest, or are highly urbanized.

The Bronx River basin includes estuarine and palustrine wetlands. Estuarine wetlands are located in the southern portion of the watershed. Limited to the tidal portion of the watershed, these wetlands are dominated with native salt grasses such as smooth cordgrass, saltmeadow cordgrass, and spike grass (*Distichlis spicata*), as well as invasive common reed (*Phragmites australis*). Soundview Park located at the delta of the Bronx River, is one of the few remaining estuarine, salt marsh wetlands. Palustrine wetlands are located throughout the Bronx River basin and include emergent, scrub-shrub, and forested wetlands (Appendix E-4).

The estuarine environment of Flushing Bay and Creek include tidal habitats, adjacent tidal marsh wetlands, and mudflats. The low marsh area is dominated by smooth cordgrass. The tidal zone from mean high tide to the spring tide elevation is dominated by salt grass (*Distichlis spicata*) and saltmeadow cordgrass. The invasive common reed is the dominant species in much of these marsh areas. Inter-tidal emergent marshlands persist along the western bank of Flushing Creek and are dominated by invasive species (Appendix E-3).

2.2.2.4 Finfish

Complex tidal flow patterns prevail in this region. The tidal influences in the East River from Upper Bay and Long Island Sound interact with the generally southern movement of water from the Hudson River

through the Harlem River (USACE 1999). The result is a region influenced by the tidal patterns of three (3) estuarine bodies that serve as a significant route for migratory fishes (RPA 2003, USACE 2004a). The bays are also productive nurseries and feeding areas for marine shellfish and finfish, including striped bass, scup, bluefish, Atlantic silverside, Atlantic menhaden, winter flounder, and blackfish, and contain important hard clam beds (USFWS, 1997). However, the size of many of these fish populations, such as American eel, winter flounder, and especially the Atlantic and shortnose sturgeons, are fractions of their historic population levels, likely due to historic harvest, impoundments, and/or habitat degradation within this planning region as well as the entire HRE study area (Mayo et al. 2006).

The fisheries resources of Flushing Bay and creek are limited as confirmed during 2012 and 2013 surveys conducted by NYCDEP (Appendix E-3). The species diversity and abundance of fish species was limited compared to larger and more complex East River and Hudson River estuaries. During the fall and spring 2013 surveys, 477 finfish representing 12 different species and 31 blue crabs were collected including mummichog (62.5 percent), Atlantic silverside (14.9 percent), gizzard shad (10.7 percent) and Atlantic menhaden (8.6 percent).

2.2.2.5 Essential Fish Habitat

The regional fisheries management councils, with assistance from NOAA NMFS, are required under the 1996 amendments to Magnuson-Stevens Fishery Management and Conservation Act to delineate EFH for all managed species, to minimize to the extent practicable adverse effects on EFH, and to identify other actions to encourage the conservation and enhancement of EFH. EFH is defined as “those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity” (NOAA, 2004). In addition, the presence of adequate prey species is one of the biological properties that can define EFH. The regulations further clarify EFH by defining “waters” to include aquatic areas that are used by fish (either currently or historically) and their associated physical, chemical, and biological properties: “substrate” to include sediment, hard bottom, and structures underlying the water; areas used for “spawning, breeding, feeding, and growth to maturity” to cover a species’ full life cycle; “prey species” as being a food source for one or more designated fish species (NOAA, 2004). NOAA’s Guide to EFH Designations in the Northeastern United States provides the species and life stages with EFH. Table 2-2 lists the EFH designations in the Harlem River, East River, and Western Long Island Sound Planning Region. The planning region falls within three (3) 10-minute grids (NOAA, 2016). EFH is discussed further in Appendix F.

Table 2-2 Summary of EFH Designation for Harlem River, East River, and Western Long Island Sound Planning Region

Managed Species	Eggs	Larvae	Juveniles	Adults
Atlantic cod (*Gadus morhua)*			X	X
Pollock (*Pollachius virens*)			X	X
Red hake (*Urophycis chuss*)		X	X	X
Winter flounder (*Pseudopleuronectes americanus*)	X	X	X	X
Windowpane flounder (*Scophthalmus aquosus*)	X	X	X	X
Atlantic sea herring (*Clupea harengus*)		X	X	X
Bluefish (*Pomatomus saltatrix*)			X	X
Atlantic butterfish (*Peprilus triacanthus*)		X	X	X

Managed Species	Eggs	Larvae	Juveniles	Adults
Atlantic mackerel (*Scomber scombrus*)			X	X
Summer flounder (*Paralichthys dentatus*)		X	X	X
Scup (*Stenotomus chrysops*)	X	X	X	X
Black sea bass (*Centropristis striata*)			X	X
King mackerel (*Scomberomorus cavalla*)	X	X	X	X
Spanish mackerel (*Scomberomorus maculatus*)	X	X	X	X
Cobia (*Rachycentron canadum*)	X	X	X	X
Sand tiger shark (*Carcharhinus taurus*)		X		
Dusky shark (*Carcharhinus obscurus*)		X		
Sandbar shark (*Carcharhinus plumbeus*)		X	X	X

Source: NOAA, 2016.

10’x10’ square coordinates: 40° 50.0’N, 73° 50.0’W, 40° 40.0’N, 74° 00.0’W
40° 50.0’N, 73° 40.0’W, 40° 40.0’N, 73° 50.0’W
41° 00.0’N, 73° 40.0’W, 40° 50.0’N, 73° 50.0’W

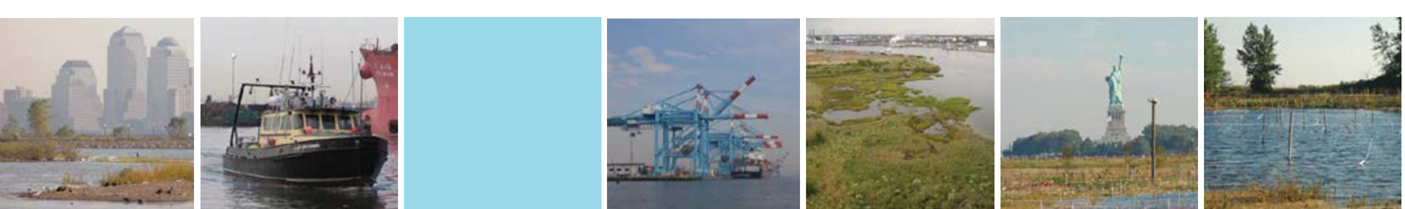
2.2.2.6 Shellfish and Benthic Resources

Within the Harlem River, East River, and Western Long Island Sound Planning Region, Little Neck Bay, Manhasset Bay, and Hempstead Bay are productive nurseries and feeding areas for marine shellfish and finfish. Concentrations of northern quahogs (hard clams) and soft-shelled clams (*Mya arenaria*) are locally important (USFWS, 1997).

Benthic macroinvertebrate community assessment in the Bronx River indicates moderately impacted water quality conditions (Bode et al., 1999, 2003). The benthic biological communities in and around Flushing Bay are subject to significant anthropogenic influences. These influences come in the form of a variety of pollutants with some originating locally while others are transported in from various drainage pipes or from drainage into Flushing Creek. The NYCDEP surveyed benthic communities of the New York-New Jersey Harbor and concluded that the benthic habitat of Flushing Bay was grossly degraded and was not able to support the species typically found in local healthy estuarine bottom sediments (NYCDEP, 2000). NYCDEP further confirmed the benthic communities in fall 2012 and spring 2013 between the intertidal and subtidal habitats and revealed the invertebrate communities were dominated by common, widely-distributed, pollution-tolerant marine annelids (Appendix E-3).

2.2.2.7 Wildlife

Several islands in this region support large populations of wading birds, most notably South Brother Island, which was estimated to support almost 500 breeding pairs of wading birds and over 300 cormorant (*Phalacrocoracidae*) nests (Bernick, 2006; Blanchard et al., 2001). Further east into Long Island Sound, the southern shore contains some of the most significant waterfowl wintering areas in the HRE, Little Neck Bay, Manhasset Bay, and Hempstead Harbor (USACE, 2000; USACE, 2004a). The wetlands along the mainland in this planning region provide important nesting habitat for several species of special emphasis, including Green-backed Heron (*Butorides striata*), Yellow-crowned Night-Heron (*Nyctanassa violacea*), American Bittern (*Botaurus lentiginosus*), Canada Goose (*Branta canadensis*), American Black Duck, and Clapper Rail (*Rallus crepitans*). However, displacement of



herons and destruction of heron nesting habitat by cormorants or human disturbances in the form of intrusions into bird nesting area is a major threat to the heronries in this area (USFWS, 1997).

2.2.2.8 Rare, Threatened, and Endangered Species

The USFWS, NMFS, and NYSDEC agencies were consulted regarding the documentation of rare, threatened, and endangered species and species of special concern within the planning region. Correspondence with these agencies is located in Appendix G.

USFWS

According to the USFWS (USFWS, 1997), listed species in the region include:

- Piping Plover (*Charadrius melodus*) – federally listed threatened;
- Northern Diamondback Terrapin (*Maclemys t. terrapin*) – federal species of concern;
- Least Tern (*Sterna antillarum*) – state-listed endangered;
- Common Loon (*Gavia immer*) – state-listed special concern; and
- Common Barn Owl (*Tyto alba)* – state-listed special concern.

NMFS

Listed by the NOAA NMFS, four (4) species of ESA sea turtles have been seasonally present in the East River and adjacent bays:

- Threatened Northwest Atlantic Ocean DPS of loggerhead (*Caretta caretta*);
- Threatened North Atlantic DPS of green (*Chelonia mydas*);
- Endangered Kemp's ridley (*Lepidochelys kempii*); and
- Endangered leatherback sea turtle (*Dermochelys coriacea*).

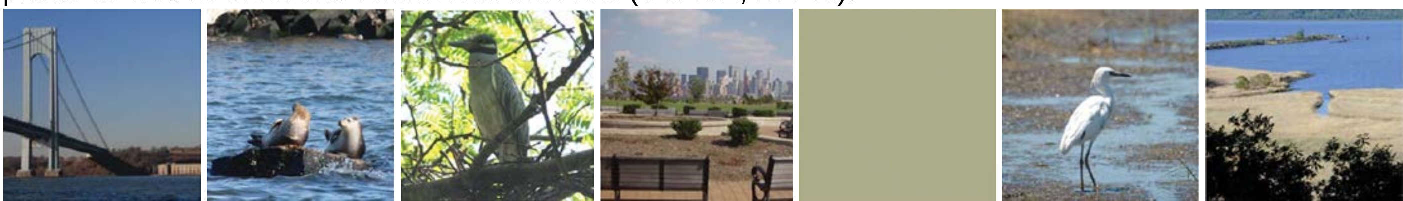
Also two (2) protected fish species, Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) and shortnose sturgeons (*Acipenser brevirostrum*), were identified by NMFS as being potentially present in the East River and adjacent bays.

New York Natural Heritage Program

In correspondence with the New York Natural Heritage Program, the agencies indicated they have no records of threatened species within the planning region where restoration activities would be likely to occur.

2.2.2.9 Land Use

The Harlem River, East River, and Western Long Island Sound Planning Region is the most densely populated of the eight (8) HRE planning regions. Shorelines along the Harlem and East rivers are lined with urban residential, commercial, and industrial development. Commercial ferry terminals, marinas, and parkland are also found along the shorelines of this planning region. The waterways are used for commercial navigation as well as recreational boating, fishing, and water/jet skiing. Public and private beaches, found in the Upper East River and Western Long Island Sound, are open for bathing except when total coliform concentrations exceed water quality criteria. This planning region receives treated effluent from six (6) sewage treatment plants, and water is withdrawn from the East River by four (4) power plants as well as industrial/commercial interests (USACE, 2004a).



2.2.2.10 Hazardous, Toxic, and Radioactive Waste

Water quality in the tributaries of this planning region has been severely degraded by industrial and CSO inputs, limiting the waterways to primarily transportation related uses. This planning region receives treated effluent from six (6) sewage treatment plants, and water is withdrawn from the East River by four (4) power plants as well as industrial/commercial interests (USACE, 2004a).

The majority of the Harlem River, East River, and Western Long Island Sound Planning Region is highly urbanized. Historic inputs of toxic substances have degraded water quality and contaminated bottom sediments of freshwater tributaries. The primary contaminants of concern in the planning region are heavy metals, PCBs, and oil by-products. In addition, sewage and storm water discharges have degraded water quality to the extent that portions of the Western Long Island Sound become hypoxic or anoxic at certain times of the year. Anoxic and hypoxic events in the planning region are believed to occur from sewage effluent that, when discharged into the waters, causes algal blooms and subsequent oxygen depletion due to bacterial decomposition. Leachate, containing toxic substances, particularly ammonia, from the Pelham Bay landfill has also contributed to historic water quality degradation in the planning region (USACE, 2004a).

Water quality problems in the Bronx River are largely caused by infringements in the riparian corridor, loss of wetlands, reduced base flow, sedimentation, channel aggradation, floatable garbage, diffuse waterfowl and pet waste, stream bank erosion, and runoff from impervious surfaces and other point and non-point sources of pollution, including CSOs (USACE, 1999). Throughout the river's 21.5 mile-long freshwater section (including Westchester), storm water from parking lots, sidewalks, roads and roofs flow directly into the Bronx River through more than 100 discharge pipes (USACE, 2010). Water quality in the estuary section of the river is influenced by upstream and tidal waters from the Hudson River estuary, New York Harbor and Long Island Sound. Low dissolved oxygen levels are of special concern in the Bronx River, where four (4) CSOs are located. In the Bronx, most storm water, which is normally directed to water treatment plants, can during heavy rains overload the carrying capacity of the system. When this happens, the combined storm water and sewage flow is directed to the river through CSOs, discharging raw human waste and many other untreated pollutants (USACE, 2010). Additional information on the presence of HTRW within the planning region is presented in Appendix H.

Water quality throughout Flushing Bay and Creek typically exhibit low levels of dissolved oxygen and anoxia, and high levels of bio-chemical oxygen demand. Sediments are organics-rich with a low level of benthic community diversity. Exposed intertidal mudflats generate hydrogen sulfide gas. Elevated concentrations of metals have also been detected in Flushing Bay and Creek, which likely result from the long term presence of industrial activities along streambanks, and other non-point sources of pollution such as CSOs. NYCDEP investments in CSO abatement and Long Term Control Plan since 2007 have improved water quality within this basin (Appendix E-3).

2.2.2.11 Air Quality

The HRE encompasses a highly urbanized and industrialized setting, including many major transportation corridors servicing the New York City Metropolitan Area. As required by the Clean Air Act of 1970, National Ambient Air Quality Standards have been established for six (6) major air pollutants identified by USEPA as being of nationwide concern: carbon monoxide, nitrogen oxides, ozone, particulates, sulfur oxides, and lead. In the HRE study area, ambient concentrations of carbon monoxide, ozone, and lead are predominantly influenced by vehicle emissions, nitrogen oxides and particulates are emitted from both motor vehicle and stationary sources (e.g., power generation,

industrial), and emissions of sulfur oxides and sulfates are mainly from stationary sources. These standards have also been established as the ambient air quality standards for the state of New York. Primary standards are intended to protect public health, while secondary standards are intended to protect public welfare (e.g., physical damage to structures, ecological damage).

The NYSDEC operates a network of air monitoring stations to evaluate pollutants and compare them to the National Ambient Air Quality Standards (NYSDEC, 2014). Ambient air in the region is similar to that of other highly urbanized areas. Placing emission controls on automobiles and industrial sources and limiting sulfur content of fuels have helped to improve the regional air quality in the HRE over the last 30 years.

2.2.2.12 Noise

Noise is generally defined as unwanted sound and its loudness is measured by amplitude, which is expressed in decibels. Noise levels can be approximated based on land use and can range from 30 decibels in wilderness areas to 90 decibels in urban areas (USEPA, 1978). Ambient noise levels within the Harlem River, East River, Long Island Sound Planning Region would likely be in the mid-to high-range in the highly developed southwestern portion, and in the low-to mid-range as the planning region moves north and west away from the city. The primary sources of noise in the planning region include air traffic from LaGuardia Airport, Interstate and local automobile traffic, and boat traffic in Long Island Sound and the East River. Receptors in the planning region include residential areas and wildlife habitats. Noise criteria and the descriptors used to evaluate project noise will depend on the type of land use in the vicinity of the proposed project areas.

2.2.2.13 Navigation

For about 2.5 miles upstream from its confluence with the East River, the Bronx River is a federally designated navigable waterway and is used frequently by commercial barges. This channel is maintained from the East River to East 172nd Street, a distance of approximately 2.6 navigable miles. It is a shallow draft low-usage channel which had commercial tonnage of approximately 269,000 tons in 2006 and a 10-year average of about 133,500 tons per year. It was last dredged in 1991, at which time 64,158 cubic yards of sediment was removed and placed at the Mud Dump Site or Historic Area Remediation Site in the New York Bight. The maintained navigation channel, which was originally authorized by the River and Harbors Act of 1913, is 10 feet deep and 100 feet wide and runs from the East River to East 172nd Street at the downstream end of the River.

A federal navigation channel spans Flushing Bay and Flushing Creek with a designed channel depth of 15 feet mean low water.

2.2.2.14 Recreation

The Harlem River, East River, Long Island Sound Planning Region contains 99 public access points with the many being located along the Lower East River in Manhattan and Queens. Elsewhere in the planning region a significant amount of public access points are spread along the Harlem River, the Upper East River (Flushing and Bowery Bays), and along the Western Long Island Sound (Pelham and Little Neck Bays). Beaches in Nassau County and Westchester County also offer water access to the public for recreation. Rye Playland Beach is a beach that is part of an amusement park. Glen Island Park in New Rochelle is the second most widely used park in the Westchester County Parks system and offers a swimming beach, boat launch, picnic areas, and restaurants. Orchard Beach is a public area for swimming and boating in Pelham Bay Park, New York (Westchester County Department of

Parks and Recreation, 2012; NYC Parks, 2012). In Nassau County, Bay Park offers boating and recreation activities to the public (Nassau County Parks Department, 2012).

Fishing also occurs from vessels and the shorelines of the Harlem River, East River, and Western Long Island Sound Planning Region. In Western Long Island, bays such as Little Neck, Flushing, Manhasset, and Hempstead bays are important recreational fishing areas (USACE, 2000). Species sought include striped bass, bluefish, weakfish, scup, black sea bass, tautog, summer flounder and winter flounder.

2.2.2.15 Cultural Resources

The Harlem River, East River and Western Long Island Sound Planning Region has a long history of occupation, first by Native American groups from as early as 12,000 before present until the arrival of European explorers in the fifteenth century. Early colonial settlements appear in the 1600s which evolved slowly from agricultural to industrial in character followed by urbanization and development of suburbs in the last century. Potential for prehistoric and historic archaeological sites exists throughout the region. Archaeological sites and above-ground historic properties can be found in upland, lowland, marsh, and submerged environments. Architectural and archaeological investigations are required to determine the presence or absence of such resources in most of the study area due to lack of existing data.

In 2014 the USACE completed a cultural resources survey titled *Cultural Resources Overview of the Hudson-Raritan Estuary Comprehensive Restoration Plan* (Harris et al., 2014) that aimed at inventorying all existing cultural resources data relevant to the candidate restoration sites in the HRE study. General background information about the region was collected to provide a historical and cultural context. Cultural resources data was not compiled for the entire region but for each individual restoration site and a one-mile buffer area that was applied to the site for the survey. There were 48 restorations sites investigated in the Harlem River, East River and Western Long Island Sound Planning Region.

The Harlem River, East River, and Western Long Island Sound Planning Region survey area contains more than 1,710 cultural resources, historic districts, or surveys documented, 625 of which are historic properties. The majority of these resources are located in the densely populated portions of Manhattan and Brooklyn. Many additional resources are found in Kings, Queens, and Bronx counties of the city and along the Bronx River Parkway of Westchester County. Similarly distributed are the 46 historic districts in the survey area. The survey found 238 recorded AWOIS objects, mainly in the East River, Western Long Island Sound, and Eastchester Bay near Hart and City islands. A total of 201 recorded archaeological sites are found throughout the survey area, but more densely along the shores and inlets of East River, Western Long Island Sound, and Eastchester Bay; especially around the Pelham Bay area. The 61 cultural resources surveys in the survey area are located mainly in the areas of Manhattan and Brooklyn along the East River and near Pelham Manor in Westchester County.

In the south portion of this planning region, in Flushing, Queens, numerous cultural resources can be found with many still in operation today. Flushing is host to world-class sporting events. Citi Field is home to the New York Mets, and the United States Tennis Association National Tennis Center is home to the United States Open tennis tournament. The Queens Botanical Garden is located on Main Street and has been in operation continuously since its opening as an exhibit at the 1939 World's Fair. Other attractions and remnants from the World's Fairs in Flushing Meadows-Corona Park include the Queens Museum, featuring a scale model of New York City (the largest architectural model ever built), the New York Hall of Science, and the Queens Zoo. In addition to the Unisphere, the park contains a variety of sculptures and markers from the fairs. Appendix I includes additional documentation of cultural resources within this planning region.

2.2.2.16 Social and Economic Resources

The Harlem River, East River, and Western Long Island Sound Planning Region is in Westchester, Bronx, New York, Kings, Queens and Nassau counties. The population in the Harlem River, East River, and Western Long Island Sound Planning Region is approximately 5.2 million people according to the 2010 Census (United States Census Bureau, 2010). The demographic makeup is 49 percent White, 22 percent Black or African American, 14 percent Asian, and 15 percent other races. Thirty-four (34) percent of the Harlem River, East River, and Western Long Island Sound Planning Region is Hispanic. Only 28 percent of housing units are owner-occupied in the Harlem River, East River, and Western Long Island Sound Planning Region and seven (7) percent of the housing units are vacant.

The median household income in the Harlem River, East River, and Western Long Island Sound Planning Region is $62,121 (in 2011 inflation-adjusted dollars) based on the American Community Survey 5-year estimates for 2007-2011 (United States Census Bureau, 2011). Eighteen (18) percent of households in the Harlem River, East River, and Western Long Island Sound Planning Region earned income below the poverty level in 2011.

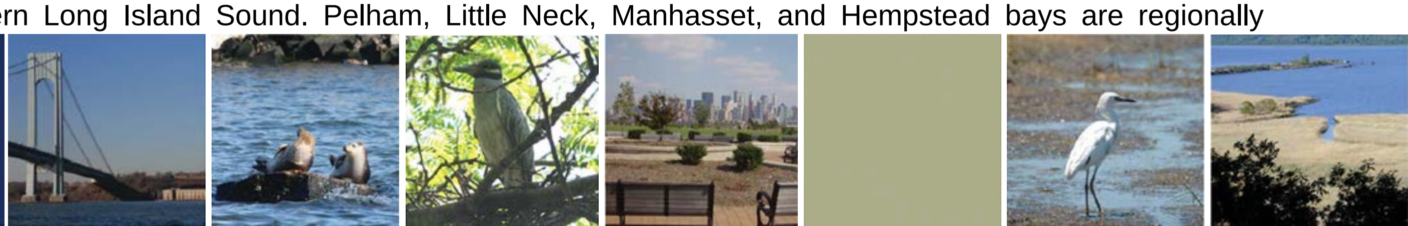
Downtown Flushing is the largest urban center in the borough of Queens, the busiest shopping district in Queens, and a financial center that is corporate home to 47 financial institutions. In 2003, the City of New York designated downtown Flushing as a regional economic center, and has unveiled a $2 billion redevelopment plan that features a revitalized waterfront, high quality mixed-use development projects, street enhancements, open and green spaces, new transportation links and parking strategies. The historic neighborhood core is the largest urban center in the borough, and it is the wealthiest and the largest Chinatown in New York City, surpassing even Manhattan's Chinatown.

Low-income and communities of color along the Bronx River's downstream reaches have received the fewest resources to reclaim, restore and redevelop what is the most polluted and ecologically abused portions of Bronx River and its watershed (Bronx River Alliance, 2006). Based upon the fact that the proposed projects focus on ecological restoration, disproportionately high and adverse human health or environmental effects on minority and low-income populations are not anticipated from the construction of these projects. Rather, the study objective is to enhance the quality of life for communities located in the planning region by: linking disparate communities in the Bronx and Westchester Counties through shared resources; increasing availability of local water resources; improving water quality; protecting and restoring native habitats; strengthening local economies; and expanding recreation opportunities.

As discussed in the Cultural Resources section, Flushing, Queens is host to world-class sporting events such as New York Mets major league baseball at Citi Field and the National Tennis Center United States Open tennis tournament. Other local tourist attractions in the south portion of the planning region include Queens Botanical Garden, remnants from the 1939 and 1964 World's Fairs, the New York Hall of Science, and the Queens Zoo.

2.2.2.17 Aesthetics and Scenic Resources

The shorelines along the Harlem and East rivers are lined with urban residential, commercial, and industrial development. Commercial ferry terminals, marinas, and parkland are also found along the shorelines of this planning region. Public and private beaches can be found in the Upper East River and Western Long Island Sound. Pelham, Little Neck, Manhasset, and Hempstead bays are regionally



distinct, pairing rocky outcroppings characteristic of the New England coast with broad intertidal mudflats.

The planning region contains many access points, parks and esplanades that allow the public to view the water and skylines. The Manhattan Waterfront Greenway is a 32-mile route that circumnavigates Manhattan Island and builds on recent efforts to transform a long-neglected waterfront into a green attraction for recreational and commuting use. Construction on the South Bronx Greenway commenced in November 2006 and encompasses 1.5 miles of waterfront greenway, 8.5 miles of inland green streets, and nearly 12 acres of new waterfront open space throughout Hunts Point and Port Morris. These greenways will link existing parks through a network of waterfront and on-street routes which will provide the community with recreational opportunities such as walking and bike paths contributing to public health (New York City Department of City Planning, 2012; New York City Economic Development Corporation, 2012).

2.2.2.18 Coastal Zone Management

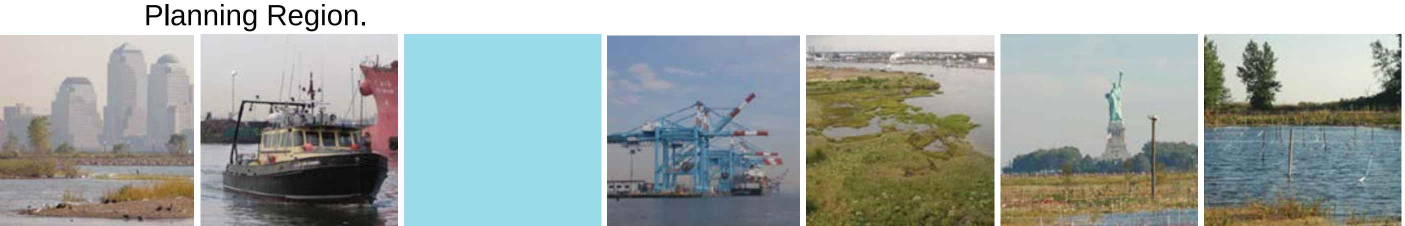
The Coastal Zone Management Act of 1972 (16 United States Code 1451-1464) was enacted by Congress to balance the demands for growth and development with the competing demands for protection of coastal resources. This act requires that federal activities affecting land or water resources located in the coastal zone be consistent to the maximum extent practicable with the federally approved state coastal zone management plans. This act is regulated in New York by the New York State Department of State, Division of Coastal Resources and in New Jersey by the New Jersey Department of Environmental Protection (NJDEP).

Local governments can participate in the New York Coastal Management Program through the Waterfront Revitalization of Coastal Areas and Inland Waterways Act, by preparing and adopting local waterfront revitalization programs. The programs provide more detailed implementation of the New York Coastal Management Program through use of existing broad powers such as zoning and site plan review. New York City, Piermont, Dobbs Ferry, Mamaroneck, Port Chester, and Rye have approved local waterfront revitalization programs in the HRE Study Area. The local program only advises on the New York State Coastal Management Program, and as such, the New York State Department of State makes the final determination on coastal zone consistency.

The Harlem River, East River, and Western Long Island Sound Planning Region includes portions within the coastal boundary of New York. Restoration activities within the region will be reviewed by the New York State Department of State for consistency with the policies of the New York State Coastal Management Program and the applicable local New York City program, The New Waterfront Revitalization Program. All information related to the USACE coastal consistency review is presented in Appendix J.

2.2.2.19 Future Without-Project Conditions

Under the future without-project condition, ongoing and planned restoration and conservation actions undertaken by agencies, municipalities and nongovernmental entities would continue. Although there are many ongoing programs in the Harlem River, East River, and Western Long Island Sound Planning Region, they are typically conducted independent of one another or in isolation from the rest of the region. A list of these activities is included in Appendix B. While restoration efforts would continue under the without-project condition, these efforts would lead to disjointed projects, missed opportunities and overall inefficiencies in restoring the Harlem River, East River, and Western Long Island Sound Planning Region.

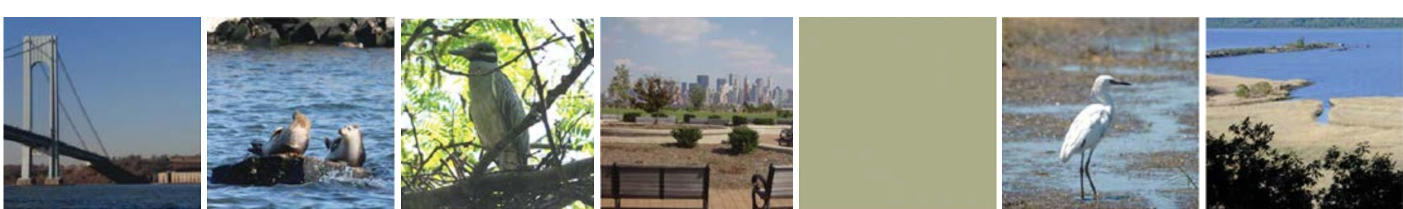


In the absence of federal action, local improvements such as NYCDEP Long Term Control Plan will seek to address the issue of water quality by working to control inputs from sewage and industrial discharge. Both Westchester County and the City of New York have extensive plans for green infrastructure along the Bronx River corridor that will help reduce, but not alleviate, the amount of stormwater run-off and sedimentation entering the river. Local green infrastructure initiatives will also help to reduce the propensity for flash flooding in the Bronx River, but these actions are expected to only partially address the flash flooding issue. The need to modify impoundments to improve water flow and fish passage along the river is recognized but unlikely to occur in the absence of federal action because of budget constraints on the County and State levels. The problem of elevated levels of lead, copper, and nickel in Bronx County soils is expected to stay unchanged in the period of analysis, as no new inputs are anticipated, but there will be no local plans to remove the contaminants without the impetus of a larger restoration project. The current acreage of wetlands is expected to remain at the current level or increase on a modest scale, as local interest in restoring wetlands is high but limited by budgetary constraints.

For Flushing Bay and Creek, it is anticipated that the degraded condition of the study area ecosystem will continue into the future in the absence of federal action. Non-federal improvements include water quality improvements associated with the operation of the CSO retention facility, NYCDEP's Long Term Control Plan, dredging actions in Flushing Bay and the New York City waterfront zoning laws that cover 36 acres of Flushing waterfront and would require waterfront access and waterfront viewing corridors. These planned improvements may have an effect on ecosystem restoration. Without supporting structural measures, including dredging, improved water quality the future degradation of bay and creek sediments will continue. In short, without significant federal involvement a degraded ecosystem will continue throughout the 50 year planning horizon.

2.2.3 Newark Bay, Hackensack River, and Passaic River Planning Region

The Hackensack and Passaic River basins create the upper boundary of this HRE planning region, with the lower boundary encompassing Newark Bay (Figure 2-6). This watershed is indirectly connected to Upper Bay and Lower Bay through Kill Van Kull and Arthur Kill, respectively. The Hackensack and Passaic Rivers drain portions of the densely populated Bergen, Passaic, Hudson, Essex, and Union Counties, New Jersey, including the cities of Newark and Paterson. A small portion of Rockland County, New York is also included in this planning region.



Two (2) large habitat complexes of regional importance and ecological value in this region are the New Jersey Hackensack Meadowlands and a portion of the Central Basin Wetlands. Within the Hackensack Meadowlands District exists the largest remaining brackish wetland complex in the HRE study area, measuring approximately 8,400 acres (USACE, 2004b). Originally a large, 21,000-acre marshland complex, the Meadowlands have diverse habitat types and over 100 species of nesting birds, fish and shellfish, many of which are state- or federally-protected (RPA, 2003). Although degraded, the Meadowlands and surrounding areas in this region represent significant open spaces that continue to provide ecosystem functions, including flood storage and fish/wildlife habitat, and offer a variety of potential restoration opportunities (USFWS, 1997).

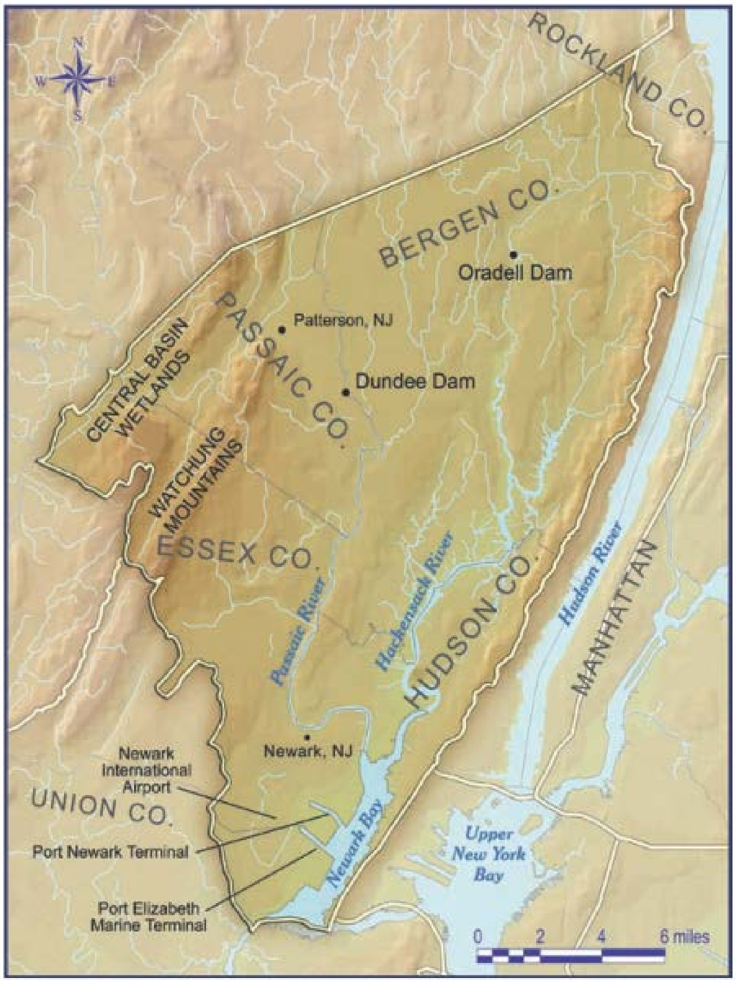


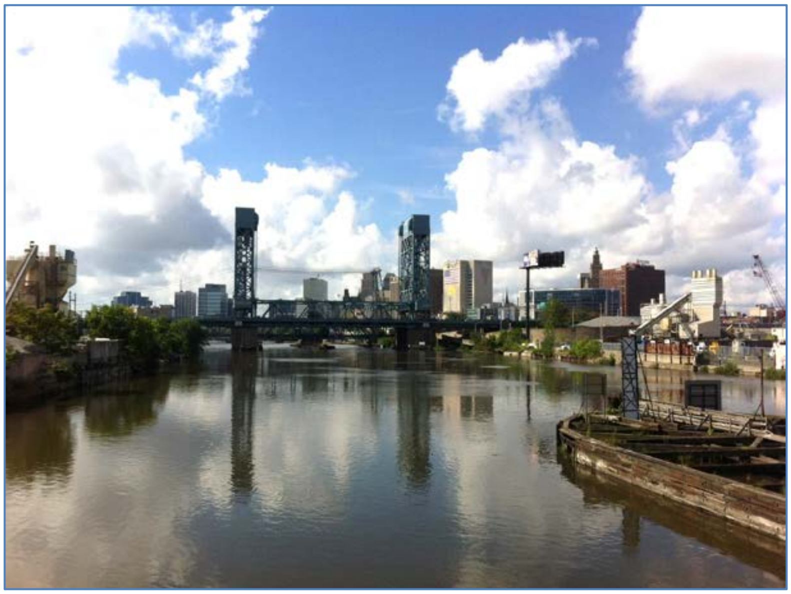
Figure 2-6 Newark Bay, Hackensack River, and Passaic River Planning Region.

Development in this region has contributed to extensive habitat losses. Historic wetland losses and hydrologic modifications have transformed the Hackensack Meadowlands from a rich combination of freshwater and saltwater marshland into a less diverse, brackish tidal marsh with a 60 percent loss in area (RPA, 2003; USACE, 2004b). Even at this reduced size, the Meadowlands still represents, after Jamaica Bay, the largest remaining tracts of habitat in the HRE study area.

In the fall of 2012, the Newark Bay, Hackensack River, and Passaic River Planning Region sustained damage from Hurricane Sandy leading to saltwater intrusion, debris, and water use advisories. In the Hackensack Meadowlands, a series of naturally occurring and man-made earthen berms prevent tidal waters from entering developed areas and freshwater habitats in the surrounding townships. Most of these berms are at an elevation of less than six (6) feet above sea level, and were not able to prevent Sandy's nine-foot storm surge from reaching developed lands and freshwater habitats (MERI, 2013). Some areas along the Hackensack River experienced episodic fish kills potentially due to increases in salinity, with reports of numerous carp washed up along shorelines. Data collected by the Meadowlands Environmental Research Institute (MERI) showed a sharp increase in salinity in various areas of the Meadowlands as the storm hit (MERI, 2013). Kearny Marsh, an important breeding site for least bittern (*Ixobrychus exilis*) was affected by floating islands of common reed stands pushed inland by the storm surge.

Following Hurricane Sandy, sewage releases prompted state officials to issue water use advisories for several surface waters within the planning region, including the Passaic and Hackensack Rivers, and

Newark Bay. Damage to the Passaic Valley Sewerage Commission (PVSC) treatment plant in Newark led to the discharge of 840 million gallons of untreated sewage into Newark Bay in the first few days following Hurricane Sandy, and approximately three (3) billion gallons of partially treated wastewater was released over the next few weeks following the restoration of secondary wastewater treatment (Kenward, et al. 2013). In 2013, PVSC installed a "muscle wall" barricade system around key infrastructure, providing temporary protection against floodwaters. PVSC has several mitigation projects on the horizon including a more permanent floodwall, equipment upgrades, and enhanced emergency response systems (PVSC, 2014). Other natural areas of this planning region sustained little to no impacts during Hurricane Sandy (ALS, 2012).



Source AECOM

Photo 2-2 Photo of the Lower Passaic River (Newark Skyline in Background)

The level of contamination in this region has been of great concern to stakeholders for decades. Many of these contaminants pose risks to human and ecological health. Several USEPA Superfund sites exist within this planning region, including the 17-mile tidal portion of the Lower Passaic River (Photo 2-2), Newark Bay, and portions of the Hackensack River

The Lower Passaic River was designated a location for Urban Waters Federal Partnership (UWFP) in February 2013, a program coordinated by the White House Domestic Policy Council to improve our nation's water systems and promote their economic, environmental, and social benefits (www.urbanwaters.gov). USEPA and USACE serve as co-leads with the intent to reconnect overburdened or economically distressed urban communities with their waterways by improving coordination among Federal agencies and collaborating with community led revitalization efforts. Specifically, the UWFP program will enhance the coordination of USEPA's Superfund program, USACE's Ecosystem Restoration and Flood Risk Management/Coastal Restoration Programs, other Federal and state programs, as well as work with the City of Newark, other interested municipalities, Ironbound Community Corporation (ICC), and other local non-governmental organizations (NGOs).

2.2.3.1 Geomorphology and Sediment Transport

The Newark Bay, Hackensack River, and Passaic River Planning Region lies on the Piedmont Lowlands physiographic province. The Piedmont Lowlands are a moderately low-lying area of wide valleys and small hills. The soils in the Piedmont are very fertile and arable, combined with easily developable terrain, makes the area suitable for agricultural and industrial needs. The region is also characterized by ridges of igneous rock and traprock interrupting the rolling sedimentary sandstones, shales, and deep red soils (USFWS, 1997). Newark Bay sediments tend to be a fine-grained combination of silts, clays, and sands, reflecting the deposition of sediments from river input at the northern end and tidal input at the southern end (USACE, 1999).

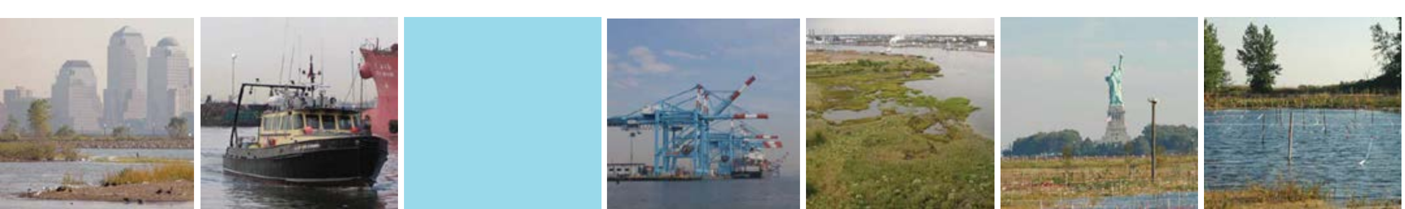
The Passaic River, along with the Hackensack River and Newark Bay, is one of the most complex estuarine systems in the United States. The hydrodynamics of the Passaic-Hackensack-Newark Bay system is predominantly controlled by three (3) forcing mechanisms, freshwater flows (buoyancy sources), tides, and winds. Two (2) major sources of freshwater inflows, the Passaic and Hackensack Rivers, contribute to the salinity gradients in the system. Flow over the Dundee Dam is the primary source of freshwater to the Lower Passaic River, with a long-term average flow of approximately 1,100 cubic feet per second (cfs). The mouth of the river at Newark Bay experiences a semidiurnal (i.e. twice daily) tidal fluctuation in surface elevation, with a range of approximately five (5) feet. This tidal elevation influence may propagate upstream as far as the physical barrier at Dundee Dam under low freshwater (Upper Passaic River) flow conditions.

Salinity in Newark Bay, especially near the bottom of the water column, is high relative to the freshwater inflow to the Lower Passaic River at Dundee Dam, but it varies in response to freshwater flow and wind (Chant and Wilson, 2004; Chant, 2005). During low flow periods, the salinity in Newark Bay is over 20 parts per thousand (ppt), whereas the salinities at the mouth of the Lower Passaic River are typically five (5) ppt lower than Newark Bay. The salinity drops significantly as the freshwater river flow increases, i.e. during periods of higher flow.

Within the Lower Passaic River, the density contrast between the freshwater river flow and more saline water in Newark Bay interacts with the tidal input to form a partially stratified estuary. Denser saline water from Newark Bay extends upstream underneath the less dense freshwater surface layer. The tidally-averaged velocity profile near River Mile (RM) 5 showed a clear residual upstream velocity near the bottom and a strong downstream velocity near the top, which is characteristic of estuarine circulation. Relatively strong tidal currents generate vertical turbulent mixing that partially mixes the water column along the interface between the two (2) layers. The upstream edge of the interface is called the salt front.

The position of the salt front within the Lower Passaic River is controlled by the force balance among riverine discharge, tidal flow, the magnitude of the salinity difference between Upper Passaic River water and Newark Bay water, turbulent mixing of the opposing momentum in the surface and bottom density layers, and frictional effects of the riverbed. For example, under low-flow conditions of approximately 35 cfs, measured salinity and turbidity data place the salt front between RM10 and RM12. Under high-flow conditions of approximately 11,654 cfs, measured data found the salt front pushed well downstream into Newark Bay. Under typical flow conditions, the salt front is usually located between RM2 and RM10, and moves back and forth about four (4) miles each tidal cycle (twice a day).

Since the magnitude of estuarine circulation in the Lower Passaic River is controlled, in part, by the salinity contrast between freshwater inflow at Dundee Dam and salinity at the head of Newark Bay, a complete understanding of the hydrodynamics requires knowledge of the physical processes and morphological features controlling salinity in Newark Bay. Thus, the spatial scale of the hydrodynamic characterization must encompass the Lower Passaic River, the Hackensack River, and Newark Bay. This combination forms one of the most complex estuarine systems in the United States. The confluence of the Passaic River and Hackensack River is located at the northern end of Newark Bay. Newark Bay is connected at its southern end to Upper New York Bay and Raritan Bay through two (2) narrow tidal straits, the Kill van Kull and Arthur Kill, respectively. Relatively deep (35 to 50 feet) shipping channels run along the centerlines of both Kills and extend northward along the western side of Newark Bay, supporting shipping at Port Elizabeth and Port Newark. These shipping channels play an important role in transporting saline water from the coastal ocean into the Passaic River-Hackensack River-Newark Bay system.



The estuarine circulation pattern described above affects the resuspension, deposition and transport of solids in the Lower Passaic River. The stratification and the tidal currents work together to move sediment and associated contaminants both upstream and downstream within the estuary, transporting contaminants multiple miles downstream and upstream of their original discharge points while tending to smooth out contaminant concentration gradients along the Lower Passaic River. While the net transport of sediment at any given time is highly dependent on the balance of fresh water and tidal flows, over the long-term, there is a net transport of sediment from the Lower Passaic River to Newark Bay (Appendix D).

2.2.3.2 Water Resources

The Hackensack and Passaic Rivers receive water from tributaries in Bergen, Passaic, Hudson, Essex, and Union Counties and discharge to Newark Bay. The watershed is indirectly connected to Upper New York Bay and Lower New York Bay through Kill Van Kull and Arthur Kill, respectively.

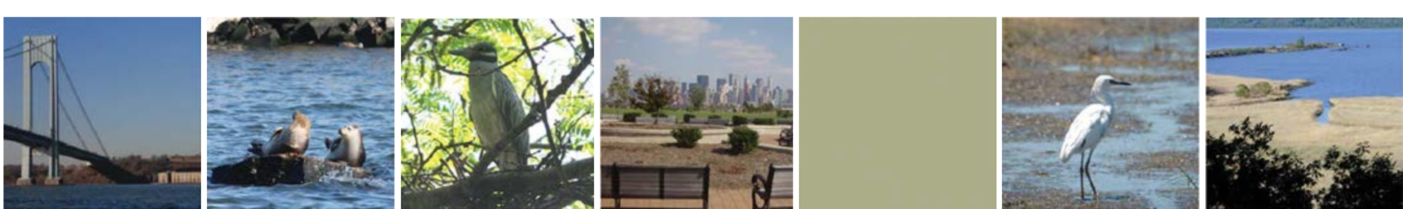
A significant portion of the low-lying areas around Newark Bay and the Hackensack and Passaic Rivers are within the 100-year floodplain. Most of the Hackensack Meadowlands are designated floodplains, where base flood elevation levels range between five (5) and nine (9) feet. Near the Watchung Mountains, the Central Basin Wetlands support large swamp areas and forested wetlands that are fed by several important tributaries. Newark Bay's shorelines and river channels have been greatly modified by bulkheads and riprap. Unfortunately, the hydrology of open river areas was altered by numerous flood risk management structures, dams and debris, which reduce connectivity and freshwater flow to Newark Bay, and block upstream passage by fishes (USFWS, 1997).

Many streams feeding into the Hackensack and Passaic Rivers have been converted to storm sewer drainages. Surrounding wetlands were filled or ditched in order to control mosquito populations. These actions have resulted in water quality degradation and have altered native floral and faunal assemblages (USACE, 2004b, Yozzo et al., 2001). Shorelines and river channels have been greatly modified by bulkheads and riprap. Dams and debris reduce connectivity and freshwater flow to Newark Bay and block upstream and downstream fish passage. The Lower Passaic River and its shorelines have been subject to continued degradation from historical industrial and commercial activities, along with urban development, resulting in significant losses of floodplains and valuable aquatic and terrestrial habitat areas. In the lower seven (7) miles of the Lower Passaic River, the riverbanks consisted of 70 to 80 percent bulkhead and riprap, 10 to 30 percent riprap or bulkhead with overhanging vegetation and five (5) percent aquatic vegetation (Windward, 2011).

2.2.3.3 Vegetation

Habitat complexes of regional importance and ecological value in the Newark Bay, Hackensack River, and Passaic River Planning Region are the Hackensack Meadowlands, a portion of the Central Basin Wetlands, and a portion of Preakness Mountain.

Over 400 vascular plants have been historically reported from the Hackensack Meadowlands including New Jersey rare species: floating marsh-pennywort (*Hydrocotyle ranunculoides*), wild calla (*Calla palustris*), rough cotton-grass (*Eriophorum tenellum*), bunchberry (*Cornus canadensis*), and crested yellow orchid (*Platanthera cristata*). Presently the floral assemblage is much less diverse with the non-native common reed dominate. Uplands within the Hackensack Meadowlands are mostly artificial (including closed landfills) and include grassland, shrubland, and early successional forest. Small



undeveloped, uplands are also scattered around the edge of the Meadowlands (Kiviat and MacDonald, 2004; Sipple, 1971).

The Central Basin Wetlands, also referred to the Passaic Meadows, is a remnant of Lake Passaic, an extinct glacial lake (Salisbury and Kümmel, 1895). This 34-square mile wetland area is one of the largest freshwater wetland complexes in the region (USFWS, 1997). Specific wetlands are the Great Swamp, which includes swamp woodland, hardwood ridges, cattail marsh, and grassland; Troy Meadows, half of which is a large emergent marsh composed of cattails (*Typha*), common reed, and sedges (*Carex* spp.) and the remainder a mix of forested and scrub-shrub swamps, ephemeral ponds, floodplain, and grasslands; and Great Piece Meadows, a mainly forested wetland with some scrub-shrub and emergent marsh areas.

Preakness Mountain is located west of Paterson, New Jersey on the border of the Bergen and Passaic counties. Preakness Mountain is vegetated with open woodland and dense forest. Six (6) upland ecological communities have been identified and mapped, including talus slope community, traprock glade/outcrop community, hickory-ash-red cedar woodland, dry-mesic inland mixed oak forest, mesic hemlock-hardwood forest, and successional old field. The traprock glade/outcrop community is a globally imperiled community type (USFWS, 1997).

Surveys conducted in 2010 as part of the Remedial Investigation for the Lower Passaic River found plant communities were less diverse than other areas and mostly composed of scrub-shrub vegetation, with individual or small stands of trees occasionally present. Sites with emergent vegetation were located primarily below RM3.5 and were associated with intertidal mudflats and occupied by smooth cordgrass or common reed. Areas of mixed forest and urban green spaces and parks became more prevalent upriver of RM4. No extant submerged aquatic vegetation has been documented for the Lower Passaic River (Earth Tech, 2004) and only remnants of the formerly extensive emergent tidal marsh that was contiguous with the Meadowlands complex exist (USEPA, 2014).

Vegetation communities that were identified at the Lower Passaic and Hackensack River restoration sites are found in Appendix E-5.

2.2.3.4 Finfish

Lower reaches of the Passaic and Hackensack Rivers provide habitat for marine and estuarine fish and invertebrates, while farther upstream, the rivers support a mix of estuarine and freshwater species (USACE 2004b). Newark Bay's open water is used by many fish as nursery habitat, although its shorelines and river channels have been greatly modified by bulkheads and riprap. The bay supports some 50 species of finfish including bay anchovy, juvenile red hake, weakfish, alewife, striped bass, and blueback herring (Woodhead *et al.*, 1992; Berg and Levinton, 1985). Urbanization and damming of the rivers upstream stopped the movement of migratory fish beyond certain points in the Hackensack and Passaic Rivers while also threatening resident freshwater fish species. Conditions began improving after the 1972 CWA and there is now a more diverse fish species assemblage than before the act was passed (USEPA, 2011).

The hydrology of open river areas has been altered by numerous flood risk management structures, dams and debris, which reduce connectivity and freshwater flow to Newark Bay, and block upstream passage by fishes (USEPA, 2011). Anadromous fishes make annual spawning runs up the 17-mile tidal stretch of the Passaic River to the Dundee Dam, but are blocked from going further. The Oradell Reservoir Dam, on the Hackensack River, blocks passage of American shad, alewife, and blueback herring from reaching upstream segments of the watershed (USACE, 2004b; USEPA, 2011). Other smaller dams and inoperable tide gates in the planning region degrade habitat and impair passage for anadromous species (Durkas, 1993). Furthermore, catadromous species, like the American eel, may also be negatively affected by these impediments.

Several fish surveys in 2009 and 2010 on the Lower Passaic River indicated the majority of fish occurring throughout the estuarine reaches included white perch (*Morone americana*), inland silverside (*Menidia beryllina*), mummichog (*Fundulus heteroclitus*), alewife (*Alosa pseudoharengus*), striped bass (*Morone saxatilis*), American eel (*Anguilla rostrata*), Atlantic tomcod (*Microgadus tomcod*), and Atlantic menhaden. The freshwater reaches of the Lower Passaic River found freshwater fish habitat for warm water assemblages of carp (*Cyprinus carpio*), largemouth bass (*Micropterus salmoides*), chain pickerel (*Esox niger*), black crappie (*Pomixis nigromaculatus*), and other species (USEPA, 2014).

2.2.3.5 Essential Fish Habitat

The regional fisheries management councils, with assistance from NOAA NMFS, are required under the 1996 amendments to Magnuson-Stevens Fishery Management and Conservation Act to delineate EFH for all managed species, to minimize to the extent practicable adverse effects on EFH, and to identify other actions to encourage the conservation and enhancement of EFH. EFH is defined as “those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity” (NOAA, 2004). In addition, the presence of adequate prey species is one of the biological properties that can define EFH. The regulations further clarify EFH by defining “waters” to include aquatic areas that are used by fish (either currently or historically) and their associated physical, chemical, and biological properties: “substrate” to include sediment, hard bottom, and structures underlying the water; areas used for “spawning, breeding, feeding, and growth to maturity” to cover a species’ full life cycle; “prey species” as being a food source for one or more designated fish species (NOAA, 2004).

NOAA’s Guide to EFH Designations in the Northeastern United States provides the species and life stages with EFH. Table 2-3 lists the EFH designations for the Newark Bay, Hackensack River, and Passaic River Planning Region. Because the planning region is outside the ten-minute squares for marine waters, the designations are based on the Hudson River/Raritan/Sandy Hook Bays, New York/New Jersey estuarine area (NOAA, 2016). EFH is discussed further in Appendix F.

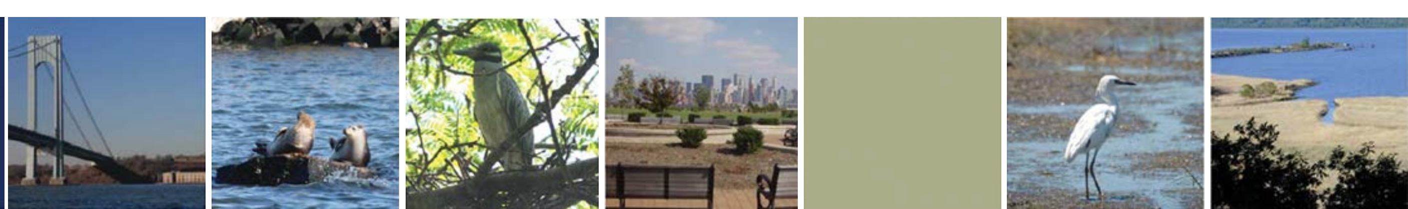


Table 2-3 Summary of EFH Designation for Newark Bay, Hackensack River, and Passaic River Planning Region

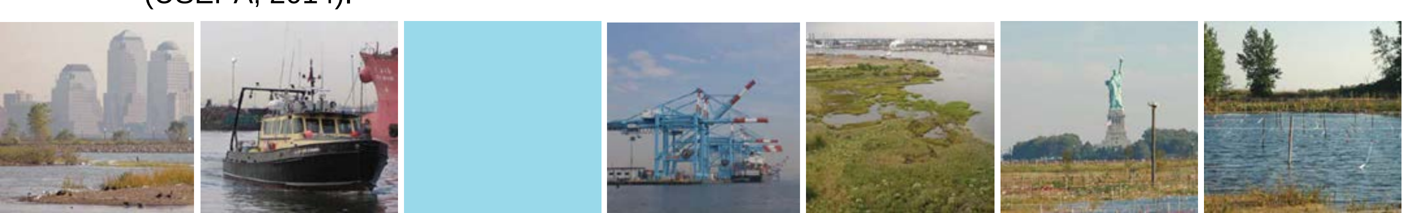
Managed Species	Eggs	Larvae	Juveniles	Adults	Spawning Adults
Red hake (*Urophycis chuss*)		M,S	M,S	M,S	
Winter flounder (*Pseudopleuronectes americanus*)	M,S	M,S	M,S	M,S	M,S
Windowpane flounder (*Scophthalmus aquosus*)	M,S	M,S	M,S	M,S	M,S
Atlantic sea herring (*Clupea harengus*)		M,S	M,S	M,S	
Bluefish (*Pomatomus saltatrix*)			M,S	M,S	
Atlantic butterfish (*Peprilus triacanthus*)		M	M,S	M,S	
Atlantic mackerel (*Scomber scombrus*)			S	S	
Summer flounder (*Paralichthys dentatus*)		F,M,S	M,S	M,S	
Scup (*Stenotomus chrysops*)	S	S	S	S	
Black sea bass (*Centropristis striata*)			M,S	M,S	
King mackerel (*Scomberomorus cavalla*)	X	X	X	X	
Spanish mackerel (*Scomberomorus maculatus*)	X	X	X	X	
Cobia (*Rachycentron canadum*)	X	X	X	X	
Source: NOAA, 2016. S = includes the seawater salinity zone; M = includes the mixing water/brackish salinity zone; F = includes the tidal freshwater salinity zone					

2.2.3.6 Shellfish and Benthic Resources

Within the Newark Bay, Passaic River, and Hackensack River Planning Region, the Hackensack Meadowlands supports an active recreational fishery with target species that include blue crab. However, consumption advisories are in effect throughout the HRE study area.

Shellfish (bivalves and macrocrustaceans) are a critical wildlife resource in the Newark Bay/Lower Passaic River/Hackensack River Planning Area, although the condition of this resource is impaired due to habitat loss and water quality and sediment degradation. No commercial or recreational shellfishing is permitted within the waters of the Newark Bay/Lower Passaic River/Hackensack River Planning Area, due to the legacy of sediment and water quality degradation. This prohibition includes bivalves (clams, mussels, oysters) (NJDEP, 2015) and blue crabs (New Jersey Department of Health, 2016). If the no action alternative is implemented, shellfish habitat in the region would continue to degrade from the effects of water pollution and loss of habitat.

Benthic community surveys conducted in the Lower Passaic River found that dominant species observed were pollution-tolerant organisms, heavily influenced by the urban and industrial surroundings (USEPA, 2014).



2.2.3.7 Wildlife

The Newark Bay, Hackensack, and Passaic River Planning Region supports many species that tolerate a wide range of conditions and disturbances in their physical environment allowing them to utilize urban and developed areas for shelter and forage.

The Hackensack Meadowlands provide important habitat for thousands of shorebirds, both in spring and fall migrations, and for wintering and summering waterfowl (USFWS, 1997). Bats that migrate through the area include the little brown bat (*Myotis lucifugus*), silver-haired bat (*Lasionycteris noctivans*), red bat (*Lasiurus borealis*), and hoary bat (*Lasiurus cinereus*). White-tailed deer (*Odocoileus virginianus*) are abundant in the suburban outskirts of the study area (USFWS, 1997). Additionally, owls and hawks, such as Northern Harrier, Rough-legged Hawk, Red-tailed Hawk (*Buteo jamaicensis)*, American Kestrel, Short-eared Owl, and Long-eared Owl, forage on small mammals that inhabit landfills occurring in this planning region.

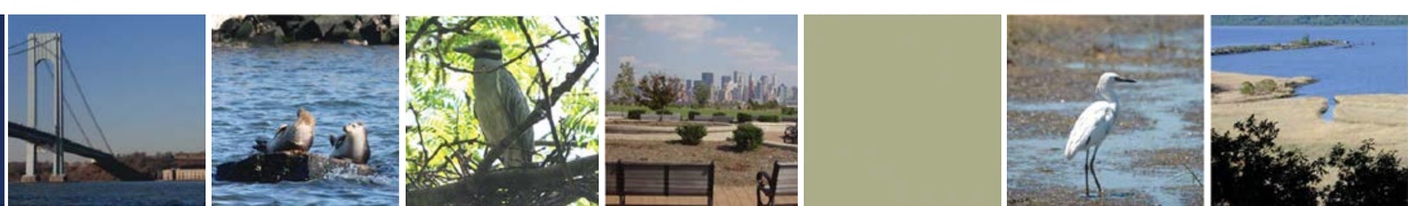
A variety of urban-adapted small mammals are likely to occur in the this planning region including the meadow vole (*Microtus pennsylvanicus*), cottontail rabbit (*Sylvilagus floridanus*), gray squirrel (*Sciurus carolenensis*), raccoon (*Procyon lotor*), muskrat (*Ondatra zibethicus*), opossum (*Didelphis virginiana*), striped skunk (*Mephitis mephitis*), white-footed mouse (*Peromyscus leucopus*), short-tail shrew (*Blarina blevicauda*), and eastern chipmunk (*Tamias striatus*). Small mammals introduced by humans include house mouse (*Mus musculus*), Norway rat (*Rattus norvegicus*), and feral dogs (*Canis familiaris*) and cats (*Felis catus*). Bats that migrate through the area include the little brown bat (*Myotis lucifugus*), silver-haired bat (*Lasionycteris noctivans*), red bat (*Lasiurus borealis*), and hoary bat (*Lasiurus cinereus*). White-tailed deer (*Odocoileus virginianus*) are abundant in the suburban outskirts of the study area (USFWS, 1997).

Avian surveys conducted in 1999, 2000, 2010 and 2011 identified a total of 41 aquatic and semi-aquatic species identified within the Lower Passaic River corridor. Common species included Canada geese, mallard ducks, ring-billed gulls, terns, sandpipers, killdeer, sanderlings, swans, belted kingfishers, double-crested cormorant and red-winged black birds (Windward Environmental, 2011). Mammals including squirrels, chipmunks, groundhogs, and rats were periodically observed along the river banks, and mink tracks were identified along the bank near Dundee Dam (USEPA, 2014).

2.2.3.8 Rare, Threatened, and Endangered Species

Listed sea turtles occur seasonally in the coastal waters of New Jersey and New York, and occasionally occur in the temperate waters of New York-New Jersey Harbor; however, they are not likely to occur in the rivers and estuaries in the planning region. The planning region includes areas mapped as accessible habitat for Atlantic sturgeon. However, Atlantic sturgeons are not likely to be present in the intertidal and shallow water depths where restoration activities would likely occur.

The USFWS and New Jersey Natural Heritage Program were contacted regarding federally and state listed threatened and endangered species for the project sites within this planning region. Correspondence with the referenced agencies can be found in Appendix G.



USFWS

USFWS official species lists (included in Appendix G) indicate that there are no endangered or threatened species or critical habitats under USFWS jurisdiction in the planning region where restoration activities would be likely to occur.

NMFS

NMFS listed species are not likely to occur within the planning region. According to NMFS ESA maps (including in Appendix G) there is no critical habitat for any NMFS ESA species within the waters of the planning region. The planning region is not within the range of Atlantic salmon, shortnose sturgeon, or any of the listed marine mammals in the Greater Atlantic Region.

NJDEP

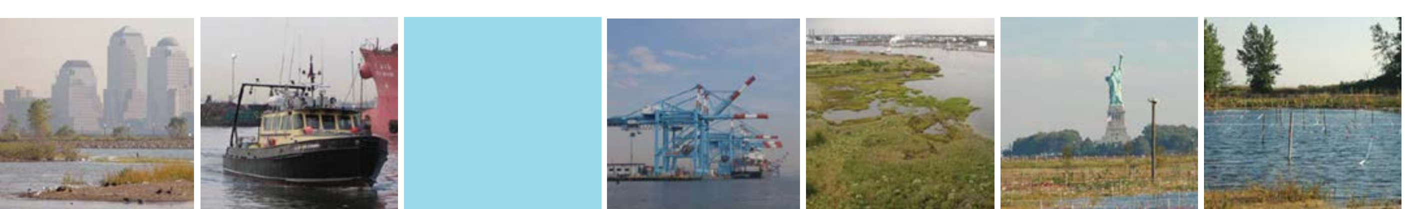
The New Jersey Natural Heritage Program correspondence (included in Appendix G) indicates that there are no records of federally endangered or threatened species in the planning region where restoration activities would be likely to occur. However, there are recent records of state endangered and/or threatened species within the planning region. Through correspondence with NJDEP, and their review of the Natural Heritage Program database, the following list includes endangered, threatened, or species of special concern within the planning region:

- Bald Eagle (*Haliaeetus leucocephalus*) – state endangered.
- Black-crowned Night Heron (*Nycticorax nycticorax*) – state threatened.
- Cattle Egret (*Bubulcus ibis*) – state threatened.
- Glossy Ibis (*Plegadis falcinellus*) – special concern.
- Little Blue Heron (*Egretta caerulea*) – special concern.
- Northern Harrier (*Circus cyaneus*) – state endangered.
- Osprey (*Pandion haliaetus*) – state threatened.
- Peregrine Falcon (*Falco peregrinus*) – state endangered.
- Snowy Egret (*Egretta thula*) – special concern.
- Yellow-crowned Nnight Heron (*Nyctanassa violacea*) – state threatened.
- Red-headed Woodpecker (*Melanerpes erythrocephalus*) – state threatened.
- Tricolored heron (*Egretta tricolor*) – special concern.

It is assumed that prior to construction activities a resource inventory would be conducted to determine if these species are present. Chapter 5 discusses these inventories in greater detail.

2.2.3.9 Land Use

Predominant land uses in the Hackensack River, Passaic River, and Newark Bay Planning Region include commercial, industrial, and residential development. Surface waters are withdrawn from the Hackensack and Passaic Rivers by three (3) power plants. Three (3) sewage treatment plants are also located in this region (USACE, 2004b). The lower 1.7 miles of the Lower Passaic River is dominated by commercial petroleum facilities. The upstream reaches of the lower Passaic River predominantly support recreational uses (USACE, 2008a). Along the western shoreline of Newark Bay are Port Newark and the Elizabeth-Port Authority Marine Terminal. Collectively, these ports are the largest maritime cargo handling facilities on the East Coast of North America, and operate primarily as a container ship facility.



The Hackensack Meadowlands are a dominant feature within this region, measuring approximately 19,730 acres. The New Jersey Meadowlands District contains residential, commercial, industrial, and landfill areas, as well as large expanses of tidal wetlands and open space. Water use in the Hackensack and Passaic Rivers includes municipal drinking water supplies (NYCDEP, 2012). For example, Lake Deforest and the Oradell, Tappan, and Woodcliff Lake Reservoirs supply drinking water to much of Rockland County, New York and northern New Jersey. Similar impoundments at the headwaters of the Passaic River (e.g., Point View Reservoir) also aid in contributing to drinking water in New Jersey (NJDEP, 2012).

2.2.3.10 Hazardous, Toxic, and Radioactive Waste

The lower Hackensack River and Passaic River basins and Newark Bay have been a center of industry since the Industrial Revolution. As a result, hundreds of chemical, herbicide, paint, and pigment manufacturing plants; petroleum refineries; and other large industrial facilities have been located along their banks. Unregulated discharges from these facilities have caused severe contamination of sediments in the rivers. Pathogenic microbial contamination, floatable debris, excessive levels of waterborne nutrients, and non-point source discharges further impair water quality (Appendix H).

Strict consumption advisories are currently in effect for fish and crabs caught from this region. Although several petroleum refineries and chemical manufacturing plants continue to operate, the majority of the industrial facilities in the planning region have been shut down, but their legacy of contaminants still remain in the sediments. Primary contaminants of concern in the study area include dioxins (2,3,7,8-tetrachlordibenzo-p-dioxin), mercury, lead, polychlorinated dibenzofurans, PCBs, PAHs, and DDT. Many of these contaminants pose severe threats to human and ecological health. Several USEPA Superfund sites exist within this planning region, including the 17-mile tidal portion of the Lower Passaic River, Newark Bay, and portions of the Hackensack River.

Contaminants in the Lower Passaic River are largely the result of discharges from the Diamond Alkali Superfund site, which was listed on the National Priorities List in 1984. For approximately 30 years during the mid-20th century, various companies manufactured pesticides and herbicides at facilities in Newark. In addition, there are more than 70 Potential Responsible Parties (PRPs) that have released contaminants of concern into the Lower Passaic River. These PRPs have formed a Cooperating Parties Group (CPG), which is currently completing the remedial investigation and feasibility study (RI/FS) for the 17-miles of the Lower Passaic River, from Newark Bay to the Dundee Dam on behalf of USEPA. As stated in Chapter 1, the USACE's Reconnaissance Study identified the Lower Passaic River as one of the priority restoration areas within the estuary. In recognition of the coincidental study areas and related roles and responsibilities of USEPA and USACE, along with the project sponsor (New Jersey Department of Transportation [NJDOT]), the agencies integrated the USEPA Superfund RI/FS and USACE Feasibility Study into a comprehensive cooperative effort (www.ourpassaic.org). This coordinated effort was also a pilot project to coordinate remediation and restoration of degraded urban rivers in the U.S. under the Urban River Restoration Initiative (URRI). The Governmental Partnership (including USEPA, USACE, NOAA, USFWS, NJDOT, and the NJDEP) was established for the Lower Passaic River Feasibility "Source" Study in order to assist in recommending a comprehensive solution for the Lower Passaic River Basin.

While the RI/FS was advancing, USEPA signed an agreement with Occidental Chemical and Tierra Solutions to remove 200,000 cubic yards (CY) of contaminated sediment from the portion of the Lower Passaic River adjacent to the former Diamond Alkali facility in Newark. The first phase of the removal

(40,000 CY) was completed in 2012. In 2013, USEPA and the CPG implemented a Time-Critical Removal Action (removal of 16,000 CY with cap) to address highly contaminated surface sediments in Lyndhurst, which was completed in 2014. A Focused Feasibility Study and Proposed Plan were released by USEPA in April 2014 (USEPA, 2014a). USEPA issued the Record of Decision on the final cleanup plan for the lower 8.3 miles of the Passaic River in March 2016 that includes bank to bank dredging and removal of 3.5 million CY of sediment and subsequent capping (USEPA, 2016). Additional information is available at www.ourpassaic.org.

The USEPA has also been studying Newark Bay since 2004 to determine the nature and extent of sediment contamination, determine potential risks of contamination, and to determine the significant, on-going sources of pollution (USEPA, 2014b) (www.ournewarkbay.org).

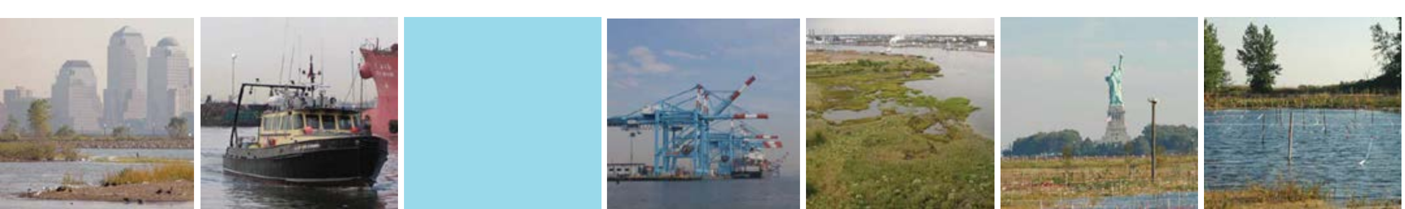
Berry’s Creek is a tidal tributary to the Hackensack River located within the Meadowlands in Bergen County, New Jersey. The creek is located in a highly industrial area, and contaminants and discharges from surrounding properties have led to sediment mercury concentrations greater than what is considered to be protective of wildlife. Berry’s Creek has historically been associated with mercury contamination originating from the Ventron/Velsicol Superfund site. However, two (2) other USEPA Superfund sites, the Universal Oil Products site and the Scientific Chemical Processing site, as well as several hazardous waste sites are located in the Berry’s Creek watershed. The USEPA Berry’s Creek study area includes the 6.5-mile Berry’s Creek, its tributaries, the Berry’s Creek canal, and adjacent wetlands. The Berry’s Creek study area has been the subject of an RI/FS since 2006. The trustees (USFWS and NOAA) completed a pre-assessment screening to determine the extent of impacts to the watershed in 2014 and they are currently planning for a full NRDA.

USEPA is currently conducting sediment sampling after a recently released preliminary assessment report on the Lower Hackensack River in Bergen and Hudson Counties outlined potential threats to public health and/or the environment posed by the site, identified the potential for release of hazardous constituents into the environment, and recommended possible placement of the site on the National Priorities List (USEPA, 2015).

2.2.3.11 Air Quality

The HRE encompasses a highly urbanized and industrialized setting, including many major transportation corridors servicing the New York City Metropolitan Area. As required by the Clean Air Act of 1970, National Ambient Air Quality Standards have been established for six (6) major air pollutants identified by USEPA as being of nationwide concern: carbon monoxide, nitrogen oxides, ozone, particulates, sulfur oxides, and lead. In the HRE study area, ambient concentrations of carbon monoxide, ozone, and lead are predominantly influenced by vehicle emissions, nitrogen oxides and particulates are emitted from both motor vehicle and stationary sources (e.g., power generation, industrial), and emissions of sulfur oxides and sulfates are mainly from stationary sources. These standards have also been established as the ambient air quality standards for New Jersey. Primary standards are intended to protect public health, while secondary standards are intended to protect public welfare (e.g., physical damage to structures, ecological damage).

The NJDEP operates a network of air monitoring stations to evaluate pollutants and compare them to the National Ambient Air Quality Standards (NJDEP, 2014). Additionally, NJDEP has established a pollutant standards index, which is based on concentrations of individual pollutants including carbon monoxide, nitrogen oxides, suspended particulates as "smoke shade," sulfur dioxide, ozone, non-methane organic compounds, and inhalable particulates. Ambient air in the region is similar to that of



other highly urbanized areas. Placing emission controls on automobiles and industrial sources and limiting sulfur content of fuels have helped to improve the regional air quality in the HRE over the last 30 years.

2.2.3.12 Noise

Noise is generally defined as unwanted sound and its loudness is measured by amplitude, which is expressed in decibels. Noise levels can be approximated based on land use and can range from 30 decibels in wilderness areas to 90 decibels in urban areas (USEPA, 1978). As much of the planning region is highly developed, ambient noise levels within the Newark Bay, Hackensack River, and Passaic River Bay Planning Region would likely be in the mid-to high-range. The primary sources of noise in the planning region include air traffic from Newark and Teterboro airports, truck and automobile traffic, and boat traffic in Newark Bay and on the Passaic and Hackensack Rivers. Receptors in the planning region include residential areas and wildlife habitats. Noise criteria and the descriptors used to evaluate project noise will depend on the type of land use in the vicinity of the proposed project areas.

2.2.3.13 Navigation

Although originally a shallow tidal estuary, deep navigational channels are maintained in Newark Bay to provide ocean-going container ship access to the Port Newark-Elizabeth Marine Terminal along the bay's western side. Collectively, these ports are the largest maritime cargo handling facilities on the East Coast of North America, and operate primarily as a container ship facility. The New York and New Jersey Harbor Deepening Project was recently completed in September 2016 dredging the navigation channel to 50-feet in Newark Bay.

These navigational channels originally extended northward from Newark Bay into the Lower Passaic River and the Hackensack River, but the channels in the rivers have not been maintained for decades (USEPA, 2014). The Lower Passaic River is used for commercial navigation, although that navigation is constrained by substantially shallower channel and horizontal and vertical clearances of bridge structures (USACE, 2010). The federal navigation channel is 300 feet at its widest location, which restricts the turning radius of larger vessels (which can be up to 350 feet long). Despite these constraints, the lower two (2) miles of the river are a corridor for transportation of petroleum products to or from major facilities.

2.2.3.14 Recreation

There are 33 public access points that exist in the Newark Bay, Hackensack River, and Passaic River Planning Region. The majority of these public access points are found along the Hackensack and Passaic River and in the Hackensack Meadowlands overlooking the wetlands. A few access points are scattered around the east waterfront of Newark Bay in Bayonne and Jersey City.

The Hackensack Meadowlands supports an active recreational fishery. Target species include blue crab, striped bass, American eel, white catfish (*Ameiurus catus*), white perch, carp (*Cyprinus carpio*), pumpkinseed (*Lepomis gibbosus*), and brown bullhead (*Ictalurus nebulosus*) (Weis, 2004).

2.2.3.15 Cultural Resources

The Newark Bay, Hackensack River, and Passaic River Planning Region has a long history of occupation, first by Native American groups from as early as 12,000 before present until the arrival of European explorers in the fifteenth century. Early colonial settlements appear in the 1600s which evolved slowly from agricultural to industrial in character followed by urbanization and development of suburbs in the last century. Potential for prehistoric and historic archaeological sites exists throughout the region. Archaeological sites and above-ground historic properties can be found in upland, lowland, marsh, and submerged environments. Architectural and archaeological investigations are required to determine the presence or absence of such resources in most of the study area due to lack of existing data.

In 2014 the USACE completed a cultural resources survey titled *Cultural Resources Overview of the Hudson-Raritan Estuary Comprehensive Restoration Plan* (Harris et al., 2014) that aimed at inventorying all existing cultural resources data relevant to the CRP candidate restoration sites in the HRE study. General background information about the region was collected to provide a historical and cultural context. Cultural resources data was not compiled for the entire region but for each individual restoration site and a one-mile buffer area that was applied to the site for the survey. There were 78 restorations sites investigated in the Newark Bay, Hackensack River, and Passaic River Planning Region.

The Newark Bay, Passaic River, and Hackensack River Planning Region has more than 6,300 cultural resources, historic districts, or surveys documented in its boundaries. There are 5,655 historic properties documented within New Jersey and one property that is recorded in New York, but crosses state lines; the Palisades Interstate Parkway. In New Jersey, historic structures are heavily concentrated in Glen Ridge Borough, East Orange, Newark, and the western portion of Union City. The 93 historic districts in the region are all recorded in New Jersey and reflect the distribution of historic resources with the addition of linear transportation related districts throughout. The 466 recorded cultural surveys in the region follow the same pattern as above. The southern two-thirds of the region, from Elizabeth to Patterson, are densely covered with survey areas. However, the northern portion, north of Paramus, there are relatively few surveys. A single cultural resources survey is the document for New York and crosses the region across the mouth of Newark Bay. All of the 87 archaeological sites recorded in this region are recorded in New Jersey. These sites are distributed throughout the region with one notable cluster along the Passaic River just south of Patterson. Finally, there are nine (9) AWOIS objects of the region and all are located in Newark Bay.

2.2.3.16 Social and Economic Resources

The Newark Bay, Passaic River and Hackensack River Planning Region lies within Bergen, Passaic, Hudson, Essex, and Union counties in New Jersey. The population in the planning region is approximately 2.2 million people according to the 2010 Census (United States Census Bureau, 2010). The demographic makeup is 59 percent White, 19 percent Black or African American, 10 percent Asian, and 12 percent other races. Thirty-one (31) percent of the Newark Bay, Passaic River and Hackensack River Planning Region is Hispanic. Forty-five (45) percent of housing units are owner-occupied in the planning region and seven (7) percent of the housing units are vacant.

The median household income in the Newark Bay, Passaic River and Hackensack River Planning Region is $68,917 (in 2011 inflation-adjusted dollars) based on the American Community Survey 5-year estimates for 2007-2011 (United States Census Bureau, 2011). Fourteen (14) percent of households earned income below the poverty level in the planning region in 2011.

2.2.3.17 Aesthetics and Scenic Resources

The Hackensack River winds south from the Oradell Reservoir in northern Bergen County and terminates in Newark Bay. Along the way, multiple bridges and crossings extend across the waterway,

including Portal Bridge (NJ Transit), the New Jersey Turnpike, Route 3, and Route 46. *Phragmites* marshes, industrial and commercial facilities, and major highways can be viewed as the river nears Newark Bay. The Passaic River flows from central New Jersey, growing wider as tributaries flow into it along the way (Ramapo River, Rockaway River, Saddle River), before it terminates in Newark Bay. Extensive *Phragmites* marshes and industrial and commercial facilities can be found surrounding the river and major highways cross the river (e.g., New Jersey Turnpike, Interstate 280).

Commercial and residential structures are the primary feature of the eastern shoreline of Newark Bay, which is protected by structures. The marine terminals at Elizabeth and Port Newark occupy a large portion of the western shoreline of the Bay. The Elizabeth Port Authority Marine Terminal is a large expanse of containers, storage facilities, and cargo/container cranes. Looking east from the pierhead line and marine terminal areas, the Bayonne shoreline is visible across Newark Bay. To the north is a view of the Newark Bay Bridge. The viewshed from the Newark Bay Terminal includes industrial activities, automobile processing, and warehousing facilities. Newark Bay and the surrounding area are visible from the Newark Bay Bridge (USACE, 1999). South of the Newark Bay Bridge, Richard A. Rutkowski Park provides a contrast to the industrial development with preserved wetlands and a bird sanctuary along the eastern shoreline of Newark Bay (City of Bayonne, 2012).

2.2.3.18 Coastal Zone Management

The Coastal Zone Management Act of 1972 (16 United States Code 1451-1464) was enacted by Congress to balance the demands for growth and development with the competing demands for protection of coastal resources. This act requires that federal activities affecting land or water resources located in the coastal zone be consistent to the maximum extent practicable with the federally approved state coastal zone management plans. This act is regulated in New Jersey by the NJDEP.

New Jersey's coastal zone management program primarily derives its authority from three (3) state statutes: The Waterfront and Harbor Facilities Act of 1914 (New Jersey Statutes Annotated 12:5-3), the Wetlands Act of 1970 (New Jersey Statutes Annotated 13:9A), and the Coastal Area Facility Review Act (New Jersey Statutes Annotated 13:19). The Hackensack Meadowlands Reclamation and Development Act (New Jersey Statutes Annotated 13:17), Freshwater Wetlands Protection Act (New Jersey Statutes Annotated 13:9B), the Law concerning the transportation of dredged materials containing PCBs (New Jersey Statutes Annotated 13:19-33) and the Department's dredging technical manual titled, “The Management and Regulation of Dredging Activities and Dredged Material Disposal in New Jersey's Tidal Waters” are additional laws governing New Jersey’s enforceable coastal zone policies.

The Newark Bay, Passaic River and Hackensack River Planning Region includes portions within the inland, seaward, and interstate coastal zone boundaries for New Jersey. Restoration activities within the region will be reviewed by the NJDEP for consistency with the policies of their respective coastal management programs. All information related to the USACE coastal consistency review is presented in Appendix J.

2.2.3.19 Future Without-Project Conditions

Under the future without-project condition, ongoing and planned restoration and conservation actions undertaken by agencies, municipalities and nongovernmental entities would continue. Although there are many ongoing programs in the Newark Bay, Passaic River and Hackensack River Planning Region, they are typically conducted independent of one another or in isolation from the rest of the region. A list of these activities is in Appendix B. While restoration efforts would continue under the without-project

condition, these efforts would lead to disjointed projects, missed opportunities and overall inefficiencies in restoring the planning region.

The USEPA remediation of the Lower Passaic River is a critical action needed to reduce risk to human health and the environment within the planning region and improve the health of the overall HRE study area. With the exception of the cleanup of legacy sediments in the Lower Passaic River proper, the environmental health of the area is still expected to decline with projected non-point source water quality inputs, SLR, and climate change. Sedimentation from non-point source water quality inputs and erosion will continue to contribute to the poor health of the area. Riverbank erosion, expansion of invasive species, degradation of habitat and continued losses of low lying coastal habitats are expected to continue in the without-project condition. In the absence of restoration, the planning region would remain heavily dominated by invasive species and fill and continually be considerably degraded from its past ecological values. The invasive species within the study area could spread into the existing native vegetation, reducing the biodiversity of the habitat. In the without-project condition, future economic opportunities resulting from job creation from the project would not occur.

2.2.4 Upper Bay Planning Region

The Upper Bay Planning Region is centrally located within the HRE study area, connecting five (5) other HRE regions (Figure 2-7). The Upper Bay begins at the mouth of the Hudson River as it empties into Lower New York Bay, is connected to Newark Bay and the Arthur Kill via the Kill Van Kull, and exchanges water with the East River and Long Island Sound. The Upper Bay, surrounding the Statue of Liberty, and Ellis and Governors Islands, is closely tied to portions of Manhattan, Brooklyn, and Staten Island, New York as well as Hudson County, New Jersey.

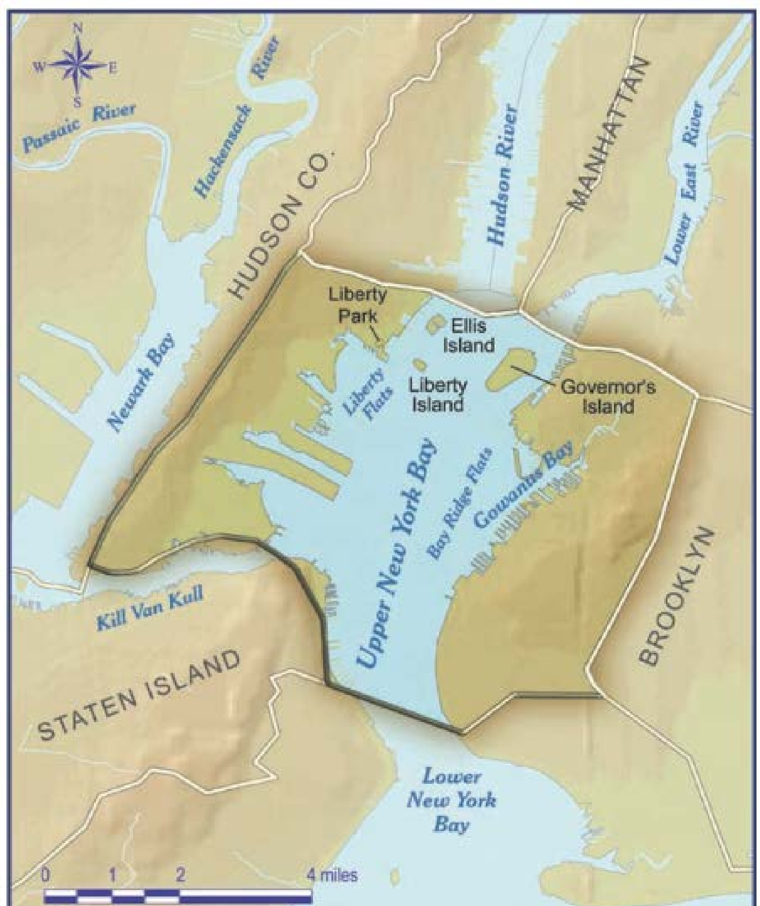


Figure 2-7 Upper Bay Planning Region

Unhardened shoreline habitat and valuable aquatic habitat in the Upper Bay are limited. Shoreline habitat can be found in the form of wetlands on the west side of Liberty Island. Remnant mudflats are located along the New Jersey coastline (USACE, 2000; USACE, 1999). Sandy shallows within the Bay Ridge Flats that have been significantly reduced in size over time by dredging are located along the eastern edge of the bay. These flats provide some habitat to many species of young fishes. The Upper Bay is still a critical component of the HRE study area because it serves as a migratory pathway for many fish species, providing access to important feeding, overwintering, and nursery areas (USACE, 2004a).

In the HRE study area, the Upper Bay is a vital link among the other regions; both influencing them and being influenced by their hydrology, biology, and impairments. Even the open water is crowded with ship traffic and large channels that must be maintained. Sediment contaminants occur in several waterfront areas of the Upper Bay, due in part to historic industrial uses, local runoff, and CSO inputs. Shallow sheltered areas and littoral habitats are almost nonexistent, and heavy commercial boat traffic erodes unprotected shorelines (USACE, 2004a).

Hurricane Sandy impacted the Upper Bay Planning Region with flooding and elevated levels of bacteria in surface waters. Newtown Creek and the Gowanus Canal contained “unacceptable” water levels of Enterococcus bacteria three (3) days after the storm. Enterococcus levels in the Gowanus Canal were 230 times greater than what is considered acceptable for swimming (ALS, 2012).

2.2.4.1 Geomorphology and Sediment Transport

The Upper Bay Planning Region is in the Atlantic Coastal Plain physiographic province. Upper Bay currents vary substantially and, therefore, this area has the most complex distribution of sediments. The Upper Bay sediment varies from coarse sands and gravels in high energy areas to fine-grained silts and clays in low energy areas. This region is heavily urbanized along its perimeter, made possible through shoreline filling and hardening. Additional available information regarding geology, bathymetry, topography and hydrology is found in Appendix D.

2.2.4.2 Water Resources

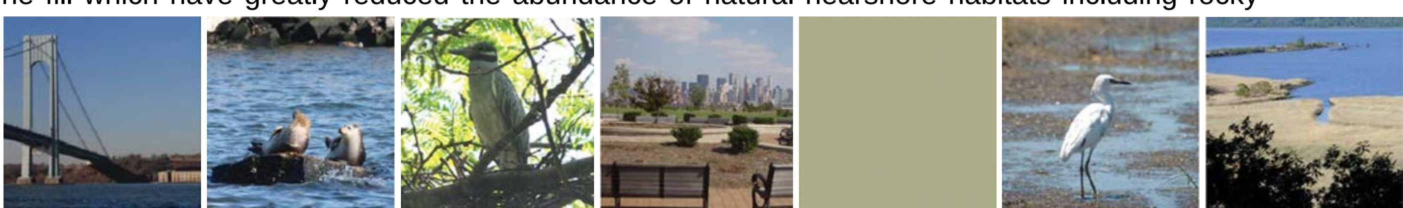
The Upper Bay represents the confluence of oceanic waters and the East River tidal strait, Kill Van Kull, and mouth of the Hudson River. Tidal ranges are approximately five (5) feet. Waters in the planning area are over 55 feet in depth; although, shallow areas (six [6] feet) are common along the New Jersey Coast and near Ellis Island. The shorelines have been significantly altered in the planning area, much of the shallows once present along the Brooklyn coastline have been filled and expanded. The Gowanus Canal is a prominent site within the Upper Bay Planning Region. Its watershed is a highly developed urban area located in the Borough of Brooklyn. There are approximately 60 acres of open water along the canal. Coastal portions of lower Manhattan, Brooklyn, and Staten Island lie within the 100-year floodplain.

Gowanus Canal is impacted by poor water quality. The Gowanus Canal was added to the USEPA Superfund List in 2010, and issued its final cleanup plan for the Gowanus Canal Superfund site on September 27, 2013 (USEPA, 2016). Consumption advisories are in effect for any fish caught in the Harbor, including Upper New York Bay. Two (2) sewage treatment plants discharge effluent into the Upper Bay (USACE, 2004a). Upgrades of existing and construction of new water pollution control infrastructure has led to gradual improvements, as measured by some standards, to surface water quality in the Upper Bay (NYCDEP, 2011).

2.2.4.3 Vegetation

Land in the Upper Bay Planning Region is almost entirely developed. Most of the shorefront land use within the Upper Bay is commercial and industrial, with a few public parks and open spaces. However, parks (e.g., Liberty State Park, etc.) do not constitute “natural” areas but are predominantly recreational grasslands. Liberty State Park is comprised of 1,100 acres including a salt marsh of about 40 acres. The vascular plant assemblage is surprising robust considering the heavily disturbed history.

The Upper Bay perimeter is heavily urbanized dominated by bulkheads, piers, and the placement of shoreline fill which have greatly reduced the abundance of natural nearshore habitats including rocky



outcroppings, wetlands, and sand beaches (Sanderson, 2005). Aquatic habitat and shoreline that is not hardened are limited in the Upper Bay with some persisting wetlands on the west side of Liberty Island, beaches on the eastern edge of Staten Island, and remnant mudflats located along the New Jersey shoreline (USACE, 2000; USACE, 1999). Upland habitat consists of old-field and scrub-shrub/woodland habitats. Many of these upland communities occur on former wetlands that were filled with material that is contaminated. Other upland communities have grown on abandoned or vacant properties that are former developed sites (USACE, 2004).

2.2.4.4 Finfish

The Upper Bay Planning Region is a critical component of the HRE study area because it serves as a migratory pathway for many fish species, providing access to important feeding, overwintering, and nursery areas (USACE, 2004a). Of the 32 species of fish that have been reported in the Upper Bay, characteristic fish species of this area include bay anchovy, winter flounder, American shad, Atlantic tomcod, and alewife (NJDEP, 1984). Consumption advisories are in effect for any fish caught in the Harbor, including Upper New York Bay (NYSDEC, 2011).

2.2.4.5 Essential Fish Habitat

The regional fisheries management councils, with assistance from NOAA NMFS, are required under the 1996 amendments to Magnuson-Stevens Fishery Management and Conservation Act to delineate EFH for all managed species, to minimize to the extent practicable adverse effects on EFH, and to identify other actions to encourage the conservation and enhancement of EFH. EFH is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity" (NOAA, 2004). In addition, the presence of adequate prey species is one of the biological properties that can define EFH. The regulations further clarify EFH by defining "waters" to include aquatic areas that are used by fish (either currently or historically) and their associated physical, chemical, and biological properties: "substrate" to include sediment, hard bottom, and structures underlying the water; areas used for "spawning, breeding, feeding, and growth to maturity" to cover a species' full life cycle; "prey species" as being a food source for one or more designated fish species (NOAA, 2004).

NOAA's Guide to EFH Designations in the Northeastern United States provides the species and life stages with EFH. Table 2-4 lists the EFH designations in the Upper Bay Planning Region. The Upper Bay Planning Region falls within two (2) 10-minute grids, one of which also covers a portion of the Lower Bay Planning Region (NOAA, 2016). EFH is discussed further in Appendix F.

Table 2-4 Summary of EFH Designation for Upper Bay Planning Region

Managed Species	Eggs	Larvae	Juveniles	Adults
Red hake (*Urophycis chuss*)	X	X	X	X
Winter flounder (*Pseudopleuronectes americanus*)	X	X	X	X
Windowpane flounder (*Scophthalmus aquosus*)	X	X	X	X
Atlantic sea herring (*Clupea harengus*)		X	X	X
Bluefish (*Pomatomus saltatrix*)			X	X
Atlantic butterfish (*Peprilus triacanthus*)		X	X	X
Atlantic mackerel (*Scomber scombrus*)			X	X
Summer flounder (*Paralichthys dentatus*)		X	X	X

Managed Species	Eggs	Larvae	Juveniles	Adults
Scup (*Stenotomus chrysops*)	X	X	X	X
Black sea bass (*Centropristis striata*)			X	X
King mackerel (*Scomberomorus cavalla*)	X	X	X	X
Spanish mackerel (*Scomberomorus maculatus*)	X	X	X	X
Cobia (*Rachycentron canadum*)	X	X	X	X
Sand tiger shark (*Carcharhinus taurus*)		X		
Dusky shark (*Carcharhinus obscurus*)		X	X	
Sandbar shark (*Carcharhinus plumbeus*)		X		X
Source: NOAA, 2016. 10’x10’ square coordinates: 40° 50.0’N, 74° 00.0’W, 40° 40.0’N, 74° 10.0’W 40° 40.0’N, 74° 00.0’W, 40° 30.0’N, 74° 10.0’W				

2.2.4.6 Shellfish and Benthic Resources

The Upper Bay is closer to the urban and industrial areas of the harbor, and the benthic habitats consist of shellfish beds and areas of silty sediment. Opportunistic infauna associated with disturbed and polluted habitats dominate the benthos. Northern quahog, softshell clams, American oyster, surf clam (*Spisula solidissima*) and blue mussel (*Mytulis edulis*) beds occur in the Upper Bay Planning Region (USFWS, 1997). Additional information available on existing shellfish/oyster populations is found in Appendix D and E-6.

2.2.4.7 Wildlife

The terrestrial ecosystems of the Upper Bay include a high degree of urban and industrial development that influence the distribution and abundance of terrestrial wildlife. Unhardened shoreline habitat and valuable aquatic habitat in the Upper Bay are limited. Flora and fauna includes many species that tolerate the wide range of conditions and disturbances in their physical environment, allowing them to utilize urban and developed areas for shelter and forage.

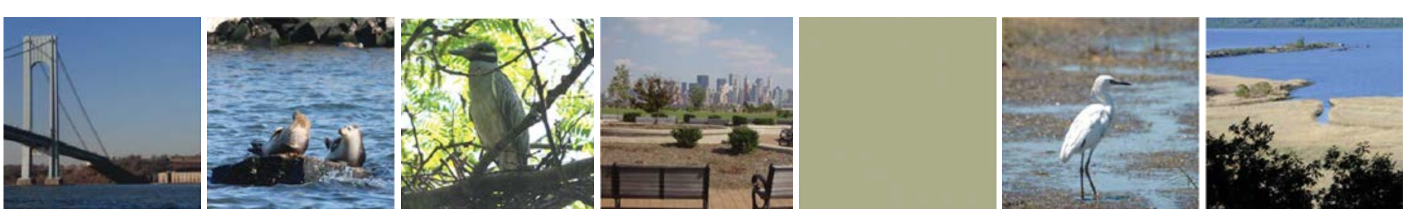
2.2.4.8 Rare, Threatened, and Endangered Species

Atlantic sturgeon (various life stages) and shortnose sturgeons (adults and sub-adults) may be present in the Upper Bay as the species transit through the region to the Hudson River. It is unlikely these species would be present in the intertidal and shallow water depths where proposed restoration activities would occur.

Restoration sites proposed in the Upper Bay Planning Region are limited to marine oyster restoration. As such, federal agency correspondence is limited to NOAA NMFS. The New York Natural Heritage Program was also consulted in regards to state listed species. Agency correspondence is located in AppendixG.

NMFS

Listed by the NOAA NMFS, four (4) species of ESA sea turtles have been seasonally present in the bay, including:



- Threatened Northwest Atlantic Ocean DPS of loggerhead (*Caretta caretta*).
- Threatened North Atlantic DPS of green (*Chelonia mydas*).
- Endangered Kemp's ridley (*Lepidochelys kempii*).
- Endangered leatherback sea turtle (*Dermochelys coriacea*).

These threatened and endangered sea turtles can be present in the Upper Bay area from May to mid-November. Adult and subadult Atlantic sturgeon can be found in the Lower Bay Planning Area. The New York Bight, Chesapeake Bay, South Atlantic, and Carolina DPSs are endangered, and the Gulf of Maine DPS is threatened in the area. Atlantic sturgeon eggs, larvae, or juvenile life stages will not be found in the waters of the Upper Bay Planning Area. Additionally, the shortnose sturgeons (*Acipenser brevirostrum*), of the adult and subadult life stages are also present in these waters.

New York Natural Heritage Program

In correspondence with the New York Natural Heritage Program, the agency indicated that the state threatened Common Tern (*Sterna hirundo*) may be present at one of the project sites. It is assumed that prior to construction activities a resource inventory would be conducted to determine if these species are present. Chapter 5 discusses these inventories in greater detail.

2.2.4.9 Land Use

Land use along the shoreline of the Upper Bay Planning Region is primarily commercial and industrial, with few non-industrial uses. Degraded water quality limits the waterways to primarily transportation-related uses. Scattered among the shipping terminals and marinas are parklands or public promenades, some vacant disturbed land, and small residential areas. Waterfront parks, including Liberty State Park, provide recreational areas and open spaces but are mostly lined by bulkheaded shorelines.

2.2.4.10 Hazardous, Toxic, and Radioactive Waste

Industrial and CSO inputs into tributaries to the Upper Bay, such as the Gowanus Canal and Newtown Creek, have severely degraded water and sediment quality. Historic uses in and around the Gowanus Canal have caused a significant deposition of hazardous materials on the canal bottom. The canal is impacted by poor water quality, contaminated sediments, such as heavy metals, PCBs, and PAHs, deteriorating bulkheads, a poor benthic community structure, extensive filling, little or no buffers, and odors, all resulting from more than a century of heavy industrial use. In 2010, the Gowanus Canal was included on the USEPA Superfund sites National Priorities List, as it has become one of the nation's most extensively contaminated water bodies. In September 2013, the USEPA finalized the cleanup plan for the Gowanus Canal Superfund site. The plan included dredging contaminated sediments, capping the dredged areas, and reducing sewage flows and other land based discharges into the canal. USEPA issued a Unilateral Administrative Order (UAO) to National Grid and 29 other parties in March 2014 to prepare the remedial design and issued an UAO in May 2014 to NYC relating to the CSO portion of the remedy (NYCDEP, 2016). Newtown Creek was also added to the Superfund site National Priorities List in 2010. The Phase I Remedial Investigation for Newtown Creek Superfund site was completed in 2013 (USEPA, 2013).

Commercial shipping terminals throughout Upper Bay Planning Region allow for the constant risk of spill from passing commercial vessels as well as vehicles on land. The dense confluence of both land based and aquatic traffic, as well as existing commercial and industrial uses present the potential for

environmental risk. The Upper Bay Planning Region also includes Governors Island, a 172-acre island in the New York Harbor that served as a U.S Army base and then a Coast Guard Station for over 200 years. It has been listed as a superfund site and is in the process of a remediation and revitalization effort since the announcement of the closure of the coast guard station.

Consumption advisories are in effect for any fish caught in the Harbor, including Upper New York Bay. Two (2) sewage treatment plants discharge effluent into the Upper Bay (USACE, 2004a). Upgrades of existing and construction of new water pollution control infrastructure has led to gradual improvements, as measured by some standards, to surface water quality in the Upper Bay (NYCDEP, 2011).

2.2.4.11 Air Quality

The HRE encompasses a highly urbanized and industrialized setting, including many major transportation corridors servicing the New York City Metropolitan Area. As required by the Clean Air Act of 1970, National Ambient Air Quality Standards have been established for six (6) major air pollutants identified by USEPA as being of nationwide concern: carbon monoxide, nitrogen oxides, ozone, particulates, sulfur oxides, and lead. In the HRE study area, ambient concentrations of carbon monoxide, ozone, and lead are predominantly influenced by vehicle emissions, nitrogen oxides and particulates are emitted from both motor vehicle and stationary sources (e.g., power generation, industrial), and emissions of sulfur oxides and sulfates are mainly from stationary sources. These standards have also been established as the ambient air quality standards for New York and New Jersey. Primary standards are intended to protect public health, while secondary standards are intended to protect public welfare (e.g., physical damage to structures, ecological damage).

The NJDEP and the NYSDEC operate a network of air monitoring stations to evaluate pollutants and compare them to the National Ambient Air Quality Standards (NJDEP, 2014; NYSDEC, 2014). Additionally, NJDEP has established a Pollutant Standards Index, which is based on concentrations of individual pollutants including carbon monoxide, nitrogen oxides, suspended particulates as "smoke shade," sulfur dioxide, ozone, non-methane organic compounds, and inhalable particulates. Ambient air in the region is similar to that of other highly urbanized areas. Placing emission controls on automobiles and industrial sources and limiting sulfur content of fuels have helped to improve the regional air quality in the HRE over the last 30 years.

2.2.4.12 Noise

Noise is generally defined as unwanted sound and its loudness is measured by amplitude, which is expressed in decibels. Noise levels can be approximated based on land use and can range from 30 decibels in wilderness areas to 90 decibels in urban areas (USEPA, 1978). As much of the planning region is highly developed, ambient noise levels within the Upper Bay Planning Region would likely be in the mid-to high-range. The primary sources of noise in the planning region include automobile traffic, truck traffic on the highways and piers, and boat traffic in Upper Bay. Receptors in the planning region include residential areas and wildlife habitats. Noise criteria and the descriptors used to evaluate project noise will depend on the type of land use in the vicinity of the proposed project areas.

2.2.4.13 Navigation

The Upper Bay Planning Region is a major navigational hub in the region, with connections to the Hudson River, East River, Kill van Kull, and the Narrows. In addition to commercial vessels that frequent shipping terminals along most of the shoreline, many public and private ferry systems cross the bay daily. Ellis Island, Liberty Island and Governors Island are also busy destinations for boat traffic

in Upper Bay. Shallow sheltered areas and littoral habitats are almost non-existent, and heavy commercial boat traffic erodes unprotected shorelines (USACE, 2004a).

2.2.4.14 Recreation

The Upper Bay Planning Region contains 20-one public access points mostly found along the waterfront of South Brooklyn and Bayonne and Jersey City. Some are located on the waterfront of northern Staten Island. Recreational fishing in the Upper Bay Planning Region occurs from private vessels, party/charter boats, and from piers. Target species include bluefish, weakfish, black sea bass, winter flounder, summer flounder, and striped bass.

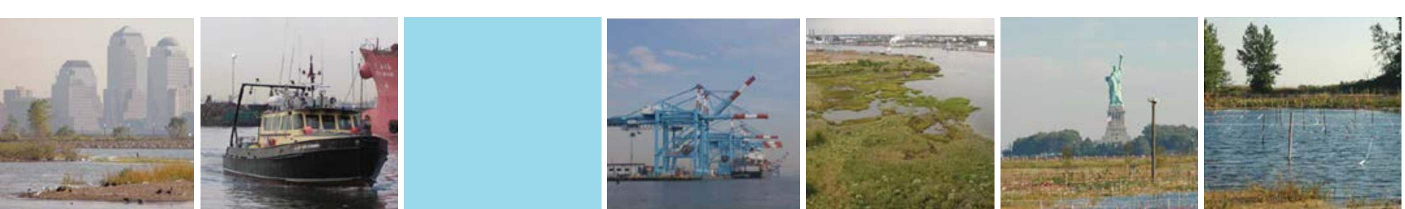
2.2.4.15 Cultural Resources

The Upper Bay Planning Region has a long history of occupation, first by Native American groups from as early as 12,000 before present until the arrival of European explorers in the fifteenth century. Early colonial settlements appear in the 1600s which evolved slowly from agricultural to industrial in character followed by urbanization and development of suburbs in the last century. Potential for prehistoric and historic archaeological sites exists throughout the region. Archaeological sites and above-ground historic properties can be found in upland, lowland, marsh, and submerged environments. Architectural and archaeological investigations are required to determine the presence or absence of such resources in most of the study area due to lack of existing data.

In 2014 the USACE completed a cultural resources survey titled *Cultural Resources Overview of the Hudson-Raritan Estuary Comprehensive Restoration Plan* (Harris et al., 2014) that aimed at inventorying all existing cultural resources data relevant to the CRP candidate restoration sites in the HRE study. General background information about the region was collected to provide a historical and cultural context. Cultural resources data was not compiled for the entire region but for each individual restoration site and a one-mile buffer area that was applied to the site for the survey. This area is referred to below as the study area to differentiate it from the entire region. There were seven (7) restorations sites investigated in the Upper Bay Planning Region.

The Upper Bay Planning Region has more than 270 cultural resources, historic districts, or surveys documented in its study area. The most commonly recorded resource type in this study area are historic properties; including 69 in the New York portion and 43 in the New Jersey portion. Most of these resources are located on Ellis and Liberty Islands, with additional resources recorded on Governors Island, the northernmost point of Staten Island, and throughout Brooklyn. Of the 14 historic districts in this region, five (5) are in New Jersey and nine (9) are in New York. The 51 total AWOIS objects in the study area are spread throughout the Upper Bay Planning Region, increasing in density in the waters around Ellis, Liberty, and Governors islands.

Archaeological sites in the study area are found mainly on the islands of New York, with 20 sites, and to a lesser degree in Bayonne, New Jersey with four (4) sites. Finally, this region is densely covered with a total of 74 cultural resources surveys; 28 in New York and 46 in New Jersey. However, as with many of these resources, Ellis and Liberty Islands are the location of many of these surveys and they are recorded by both state’s repositories. Additional surveys in New Jersey cover a high percentage of the Bayonne area and the mouth of the Kill Van Kull, as well as the New York side of the Upper Bay Planning Region. Documentation related to cultural resources is located in Appendix I.



2.2.4.16 Social and Economic Resources

The Upper Bay Planning Region is predominantly in Hudson County, New Jersey and Kings County, New York with small portions of New York and Richmond counties in the north and south, respectively. The population in the Upper Bay Planning Region is approximately 700,000 people according to the 2010 Census (United States Census Bureau, 2010). The demographic makeup is 59 percent White, 14 percent Black or African American, 18 percent Asian, and nine (9) percent other races. Twenty-three (23) percent of Upper Bay is Hispanic. Only 29 percent of housing units are owner-occupied in Upper Bay and nine (9) percent of the housing units are vacant.

The median household income in the Upper Bay Planning Region is $53,995 in New Jersey and $66,310 in New York (in 2011 inflation-adjusted dollars) based on the American Community Survey 5-year estimates for 2007-2011 (United States Census Bureau, 2011). Sixteen (16) percent of New Jersey households and 16 percent of New York households earned income below the poverty level in the Upper Bay Planning Region in 2011.

2.2.4.17 Aesthetics and Scenic Resources

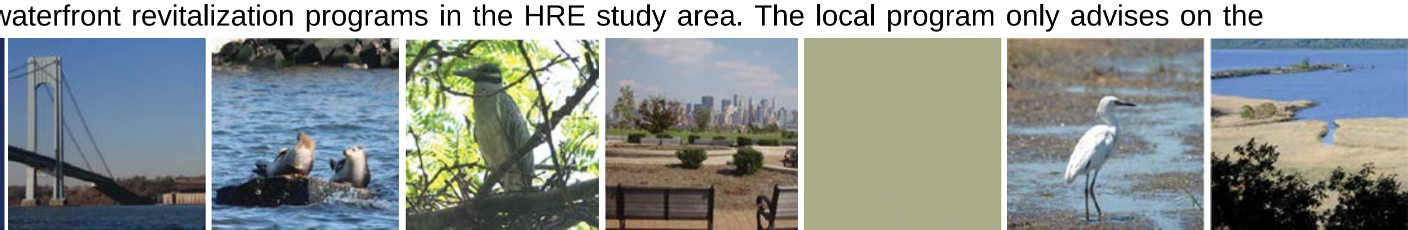
The New Jersey shoreline of Upper New York Bay is dominated by commercial industrial facilities. Riprap and bulkheads predominate along the shore in this area to accommodate these facilities. Very little natural shoreline remains in this area, with the exception of wetlands to the west of Liberty Island, some interpier areas, and a small area north of Caven Point. Mudflats are found along the New Jersey shoreline of Upper New York Bay. A large mudflat is located between the Military Ocean Terminal at Bayonne and Constable Hook (USACE, 1999).

The northern section of the Brooklyn shoreline from the Brooklyn Bridge to Owls Head Park is dominated by the Brooklyn Marine Terminal and the Red Hook Container Terminal. Common shoreline characteristics include a mixture of maintained piers, rock riprap and sheet pile bulkheads, boat launches, residential buildings, and warehouses. The central portion of the Brooklyn shoreline consists of the Shore Parkway about 10 feet above the high-water mark, a landfill, and a small-boat marina. The Upper Bay Planning Region provides many opportunities to view the waters of the area, mostly found along the waterfront of South Brooklyn, Bayonne, Jersey City, and a few on the waterfront of northern Staten Island. The entire shoreline of Governors Island is publicly accessible, providing additional views of the region.

2.2.4.18 Coastal Zone Management

The Coastal Zone Management Act of 1972 (16 United States Code 1451-1464) was enacted by Congress to balance the demands for growth and development with the competing demands for protection of coastal resources. This act requires that federal activities affecting land or water resources located in the coastal zone be consistent to the maximum extent practicable with the federally approved state coastal zone management plans. This act is regulated in New York by the New York State Department of State, Division of Coastal Resources and in New Jersey by the NJDEP.

Local governments can participate in the New York Coastal Management Program through the Waterfront Revitalization of Coastal Areas and Inland Waterways Act, by preparing and adopting local waterfront revitalization programs. The programs provide more detailed implementation of the New York Coastal Management Program through use of existing broad powers such as zoning and site plan review. New York City, Piermont, Dobbs Ferry, Mamaroneck, Port Chester, and Rye have approved local waterfront revitalization programs in the HRE study area. The local program only advises on the



New York State Coastal Management Program, and as such the New York State Department of State makes the final determination on coastal zone consistency.

New Jersey's coastal zone management program primarily derives its authority from three (3) state statutes: The Waterfront and Harbor Facilities Act of 1914 (New Jersey Statutes Annotated 12:5-3), the Wetlands Act of 1970 (New Jersey Statutes Annotated 13:9A), and the Coastal Area Facility Review Act (New Jersey Statutes Annotated 13:19). The Hackensack Meadowlands Reclamation and Development Act (New Jersey Statutes Annotated 13:17), Freshwater Wetlands Protection Act (New Jersey Statutes Annotated 13:9B), the law concerning the transportation of dredged materials containing PCBs (New Jersey Statutes Annotated 13:19-33) and the Department's dredging technical manual titled, “The Management and Regulation of Dredging Activities and Dredged Material Disposal in New Jersey's Tidal Waters” are additional laws governing New Jersey’s enforceable coastal zone policies.

The Upper Bay Planning Region includes portions within the inland, seaward, and interstate coastal zone boundaries for New Jersey as well as within the coastal boundary of New York. Restoration activities within the region will be reviewed by the NJDEP and New York State Department of State for consistency with the policies of their respective coastal management programs. All information related to the USACE coastal consistency review is presented in Appendix J.

2.2.4.19 Future Without-Project Conditions

Under the future without-project condition, ongoing and planned restoration and conservation actions undertaken by agencies, municipalities and nongovernmental entities would continue. Although there are many ongoing programs in the Upper Bay Planning Region, they are typically conducted independent of one another or in isolation from the rest of the region. A list of these activities is in Appendix B. While restoration efforts would continue under the without-project condition, these efforts would lead to disjointed projects, missed opportunities and overall inefficiencies in restoring the Upper Bay Planning Region.

The environmental health of the area is expected to decline with projected non-point source water quality inputs, SLR, and climate change. As such, continued losses of low lying coastal habitats from erosion and sedimentation are expected in the without-project condition. Although oyster populations do exist in isolated areas, much of the reefs in the Upper Bay have been degraded or destroyed by human activities. Experimental programs to restore oyster populations, such as the Oyster Restoration Research Program, are promising, but expansion of restoration efforts is needed to fully benefit from the effects on water quality, nutrient processing, shoreline stabilization, and the provision of nursery habitat for many estuarine-dependent finfish and shellfish species. These benefits from the increase in oyster populations would not occur in the without-project condition.

2.2.5 Lower Bay Planning Region

The Lower Bay Planning Region contains an expanse of both deep and shallow open water habitat, including Lower Bay, Raritan Bay, and Sandy Hook Bay (Figure 2-8). The planning region is bounded on the north by Staten Island and Brooklyn, on the south by Monmouth County, New Jersey. An artificial transect between Sandy Hook, New Jersey and Rockaway Point, New York separates Lower Bay from the New York Bight.

Sandy Hook peninsula, and Hoffman and Swinburne Islands just off Staten Island, are part of the Gateway National Recreation Area. In comparison to other planning regions in the HRE study area, the

Lower Bay's shoreline retains a more natural configuration, with salt marshes, extensive mudflats, and sandy beaches providing valuable fish and shellfish habitat, primarily in Raritan and Sandy Hook Bays (RPA, 2003). The USFWS National Wetlands Inventory depicts over 4,800 acres of intertidal and subtidal sand flats and mudflats off the shorelines of the bays and western Staten Island (USFWS, 1997). Sandy Hook is a nine-mile narrow sand spit that has a fairly extensive vegetated dune system and two (2) distinct maritime forest communities that encompass 285 acres. Soft shoreline habitat, primarily sandy bank, also surrounds Coney Island, with occasional riprap and seawalls (USACE, 1999). Beach habitat provides foraging areas for waterfowl and shorebirds (RPA, 2003). Riparian forests of the Atlantic Highlands occur along the upper reaches of the Navesink and Shrewsbury Rivers (RPA, 2003; USACE, 2004a; USACE, 1999). Raritan Bay and Sandy Hook Bay also support the greatest variety of state and federally listed threatened and endangered species in the HRE study area (USFWS, 1997).

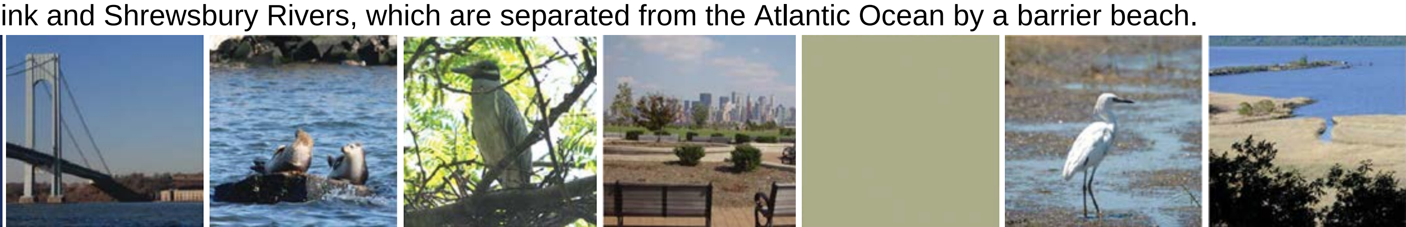
Figure 2-8 Lower Bay Planning Region

2.2.5.1 Geomorphology and Sediment Transport

The Lower Bay Planning Region lies on the Inner Coastal Plain, within the Atlantic Coastal Plain physiographic province. Most of the sediment in this area are marine deposited sedimentary sands, gravels, and clays. The sedimentary deposits of the Inner Coastal Plains were deposited during the Cretaceous Period is separated from the Outer Coastal Plain to its southeast by a belt of hills called Cuestas (USFWS, 1997). The Lower Bay area of the HRE has sediments made up mostly of sand varying in grain size. Lower New York Bay sediments in the area just south of the Narrows are characterized by gravelly sands underlying the main channel, with finer-grained sands, clays, and silts to the east and west of it. Extensive deposits of sand characterize the northern part of the Lower New York Bay (USACE, 1999). Additional available information can be found in the Engineering Appendix D.

2.2.5.2 Water Resources

Major waterbodies in this planning region provide a combination of marine and estuarine habitats that support diverse ecological communities (USACE, 2004a); Lower Bay generally provides deeper, marine habitat, while the Raritan Bay–Sandy Hook Bay complex is generally shallow with much of the bay's 69,188 acre-area at less than 20 feet deep (USFWS, 1997). Lower Bay is influenced by Jamaica Bay, Upper Bay, the Atlantic Ocean, and dozens of freshwater tributaries. Raritan Bay receives inputs from the Raritan River and Newark Bay and its tributaries via the Arthur Kill. Sandy Hook Bay receives inputs from the Navesink and Shrewsbury Rivers, which are separated from the Atlantic Ocean by a barrier beach.



The Lower Bay Planning Region is within the Sandy Hook-Staten Island watershed and contains an expanse of both deep and shallow open water, including Lower New York Bay, Raritan Bay, and Sandy Hook Bay. The watershed includes Kings and Richmond counties in New York, and portions of Essex, Union, Middlesex, and Monmouth counties in New Jersey. The watershed occupies 354,963 acres and ranges in elevation from negative seven (7) to 646 feet above sea level (NRCS, 2011). Lower New York Bay is influenced by Jamaica Bay, Upper New York Bay, the Atlantic Ocean, and dozens of freshwater tributaries. Raritan Bay receives inputs from the Raritan River and Newark Bay and its tributaries via the Arthur Kill. Sandy Hook Bay receives inputs from the Navesink and Shrewsbury Rivers, which are wide tidal rivers with a few dredged material and salt marsh islands at the confluence of the two (2) rivers, surrounded by mostly residential development and separated from the Atlantic Ocean by developed barrier beaches (USFWS, 1997).


Source US Navy

Photo 2-3 Naval Weapon Station Earle

Flooding events associated with only excessive rainfall are rare in the study area due to the system of stormwater conveyances and outfall. Flooding of low-lying areas is more likely to occur from storm surges from tropical storms or “nor’easters” that can surcharge water back into catchment systems combined with heavy precipitation. Coastal flooding in the region is likely to occur less than once every 10 years and is typically restricted to one tidal cycle (a half day).

Hurricane Sandy caused extensive damage along the Atlantic shoreline, within coastal wetlands and freshwater surface waters in the Lower Bay Planning Region. The Atlantic shoreline, including Coney Island in New York, Sandy Hook, and areas south to Manasquan Inlet in New Jersey, experienced changes to the shore profile and loss of beach fill and erosion, with an estimated average drop in beach elevation of five (5) to 10 feet. Locations which previously supported dunes prior to the storm lost up to 100 percent of existing dunes (including dune vegetation), which is critical habitat for nesting seabirds, and feeding and roosting migratory shorebirds (USACE, 2012). Where sand was pushed 60 to 150 feet inland, significant amounts overwashed into the streets of many coastal residential areas including the Borough of Atlantic Highlands, New Jersey (HRF, 2012), the private community of Sea Gate, New York, and Staten Island Borough (USACE, 2012). Sandy Hook was exposed to the full power of the tidal surge and the worst of the storm’s winds. The shore profile was completely changed and sand dunes along the peninsula were pushed up to several hundred feet west. Many dunes were completely flattened, uprooting and dispersing the beach grass normally found on them and likely affecting the bird species that use them for breeding. In addition to the overwash of sand and beach erosion, many coastal areas, such as Coney Island, were inundated and sustained damages to residential buildings and waterfront structures including boardwalks, concrete walls, roads, and other coastal infrastructure. In the private community of Sea Gate, the waterfront bulkhead and the first row of residential buildings were severely damaged by storm waves (USACE, 2012).

Coastal wetlands within Raritan Bay and on Staten Island experienced damage caused by the tidal surge and debris. Reportedly, small mammal populations were eliminated in many areas, creating a food shortage for northern harriers (*Circus cyaneus*), a New York State threatened, and New Jersey

State endangered hawk species. Wrack deposits were visible in many back-bay marsh areas, often at the marsh/upland forest edge. Approximately 100,000 tons of debris was deposited in Cheesequake State Park. This debris layer, composed mostly of reeds and other vegetation, combined with tires, duck blinds, and other manmade structures is expected to inhibit vegetation growth, impacting invertebrate communities (e.g., fiddler and marsh crabs) as well as kingfishers, herons, gulls, and other marsh-dependent birds that feed upon them (ALS, 2012). More information is required to assess the impacts to invertebrates, which could be devastating to marsh-dependent birds. The need for further impact assessment was noted as an important source of concern by resource managers throughout the planning region (ALS, 2012). In addition to coastal wetlands, Hurricane Sandy's tidal surge caused saltwater intrusions in freshwater lakes and wetlands throughout the Lower Bay Planning Region. Several vernal pools in the lowland forest were also destroyed by the storm surge. Affected species include frogs, toads, and salamanders (ALS, 2012). At Hooks Creek Lake in Cheesequake State Park, The saltwater intrusion was exacerbated by a dam/culvert structure damaged by the storm. Potentially impacted species include black bass, catfish, sunfish, carp, and crappie (ALS, 2012). Brown's Pond, located on Staten Island, experienced episodic fish kills as a result of saltwater inundation; impacted species included fish, primarily carp, ducks, and freshwater dependent shorebirds.

Maritime holly (*Illex opaca*) and red cedar *(Juniperus virginiana*) forests in Sandy Hook survived the storm. However, there was extensive damage to Atlantic white cedar (*Chamaecyparis thyoides*) swamp forests in Cheesequake State Park, including saltwater intrusion, blow-down trees, and the creation of canopy gaps. More than 300 trees were lost, including 100-year old oaks and numerous Atlantic white cedars.

Hurricane Sandy caused extensive damage to sewage treatment plants in waters surrounding the Lower Bay Planning Region. State officials issued water use advisories for surface waters within the Lower Bay Planning Region (ALS, 2012).

2.2.5.3 Vegetation

The Lower Bay Planning Region has a diversity of plant communities including numerous marine, estuarine and upland terrestrial habitats scattered throughout. Major waterbodies in the Lower Bay Planning Region provide a combination of marine and estuarine habitats that support diverse ecological communities (USACE, 2004a).

The south shore of Raritan Bay to Sandy Hook Bay is characterized by a narrow strip of high and low salt marsh and creeks with intertidal and shallow subtidal mudflats and sandflats extending from these habitats. The salt marshes along this shoreline consist of high and low marsh cordgrass with some black grass (*Juncus gerardii*), marsh elder (*Iva frutescens*), and groundsel bush (*Baccharis halimifolia*) in the high tide zone, as well as invasive common reed . Riparian forests of the Atlantic Highlands line the freshwater tributaries that feed into Sandy Hook Bay, the Navesink and Shrewsbury Rivers (RPA, 2003; USACE, 2004a; USACE, 1999).

Sandy Hook is a nine-mile narrow sand spit that has a fairly extensive vegetated dune system and two (2) distinct maritime forest communities that encompass 285 acres. Extensive areas of back dune habitat occur toward the northern end, with dry sandy soils supporting shrubby vegetation. The west side of the Sandy Hook spit consists of extensive tidal mud and sandflats and salt marsh dominated by low marsh cordgrass, with a few small inland marsh areas dominated by common reed (USFWS, 1997).

Eastern Staten Island comprises the northwestern boundary of the Lower Bay Planning Region. Beach, maritime shrub and grassland, and forest communities, as well as highly urbanized areas, are located along the eastern Staten Island shoreline from the Verrazano Narrows to Tottenville.

2.2.5.4 Finfish

The waters of the Lower Bay represent the nexus between the nearshore shallow waters of western Brooklyn, eastern Staten Island, the mouth of Jamaica Bay, the greater Raritan Bay and the oceanic waters of the Atlantic Ocean. Fish that migrate into New York Harbor typically will at some point travel through the Lower Bay. Raritan and Sandy Hook Bays are characterized by saltmarshes, extensive mudflats, and sandy beaches with valuable fish and shellfish habitat (RPA, 2003).

Characteristic fish species of the Lower Bay Planning Region include bay anchovy (*Anchoa mitchilli*), winter flounder, American shad (*Alosa sapidissima*), Atlantic tomcod (*Microgadus tomcod*), and alewife (*Alosa pseudoharengus*) (NJDEP, 1984). Thirty-two (32) species of fish have been reported in the upper and lower bays; the most abundant estuarine species include mummichog (*Fundulus heteroclitus*), bay anchovy, Atlantic silverside, white perch (*Monroe americana*), and hogchoker (*Trinectes maculatus*). Weakfish (*Cynoscoin regalis*), bluefish (*Pomatomus saltatrix*), winter flounder, summer flounder (*Paralichthys dentatus*), striped bass, black sea bass (*Centropristis striata*), tautog (*Tautoga onitis*), and scup (*Stenotomus chrysops*) support recreational fisheries (USFWS, 1997).

Benthic habitats within New York Harbor have been studied extensively as part of the USACE New York District Harbor Deepening Project. The findings indicate that extensive shellfish beds and ampeliscid mats are found in the sandy sediments of the Lower Bay, which is the least disturbed by urban and industrial influences. The Lower Bay was least susceptible to pollution and degradation and typically has better water quality than other areas of the harbor. Species identified in the Lower Bay include hard clam, softshell clam, eastern oyster, surf clam (*Spisula solidissima*), and blue mussel (*Mytulis edulis*).

2.2.5.5 Essential Fish Habitat

The regional fisheries management councils, with assistance from NOAA NMFS, are required under the 1996 amendments to Magnuson-Stevens Fishery Management and Conservation Act to delineate EFH for all managed species, to minimize to the extent practicable adverse effects on EFH, and to identify other actions to encourage the conservation and enhancement of EFH. EFH is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity" (NOAA, 2004). In addition, the presence of adequate prey species is one of the biological properties that can define EFH. The regulations further clarify EFH by defining "waters" to include aquatic areas that are used by fish (either currently or historically) and their associated physical, chemical, and biological properties: "substrate" to include sediment, hard bottom, and structures underlying the water; areas used for "spawning, breeding, feeding, and growth to maturity" to cover a species' full life cycle; "prey species" as being a food source for one or more designated fish species (NOAA, 2004).

NOAA's Guide to EFH Designations in the Northeastern United States provides the species and life stages with EFH. Table 2-5 lists the EFH designations in the Lower Bay Planning Region. The Lower Bay Planning Region falls within two (2) 10-minute grids, one of which also covers a portion of the Upper Bay Planning Region (NOAA, 2016b). EFH is discussed further in Appendix F.

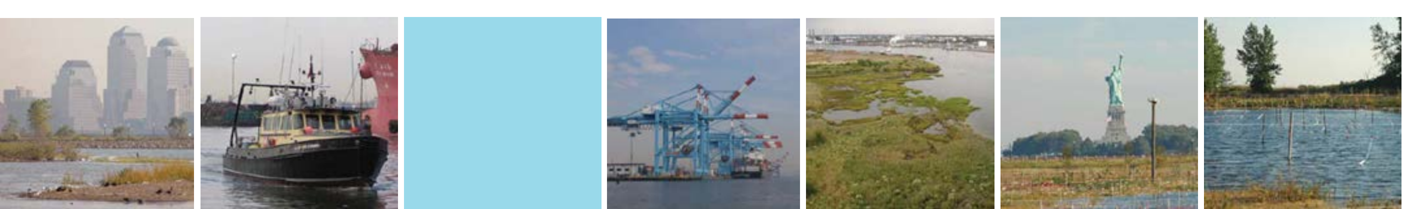


Table 2-5 Summary of EFH Designation for Lower Bay Planning Region

Managed Species	Eggs	Larvae	Juveniles	Adults
Red hake (*Urophycis chuss*)	X	X	X	
Winter flounder (*Pseudopleuronectes americanus*)	X	X	X	X
Windowpane flounder (*Scophthalmus aquosus*)	X	X	X	X
Atlantic sea herring (*Clupea harengus*)		X	X	X
Bluefish (*Pomatomus saltatrix*)			X	X
Atlantic butterfish (*Peprilus triacanthus*)		X	X	X
Atlantic mackerel (*Scomber scombrus*)			X	X
Summer flounder (*Paralichthys dentatus*)		X	X	X
Scup (*Stenotomus chrysops*)			X	X
Black sea bass (*Centropristis striata*)			X	X
King mackerel (*Scomberomorus cavalla*)	X	X	X	X
Spanish mackerel (*Scomberomorus maculatus*)	X	X	X	X
Cobia (*Rachycentron canadum*)	X	X	X	X
Sand tiger shark (*Carcharias taurus)*				
Dusky shark (*Carcharhinus obscurus*)		X	X	
Sandbar shark (*Carcharhinus plumbeus*)		X	X	X
Source: NOAA, 2016. 10'x10' square coordinates: 40° 30.0'N, 74° 00.0'W, 40° 20.0'N, 74° 10.0'W 40° 40.0'N, 74° 00.0'W, 40° 30.0'N, 74° 10.0'W				

2.2.5.6 Shellfish and Benthic Resources

Benthic habitats within New York Harbor have been studied extensively as part of the USACE New York District Harbor Deepening Project. The findings indicate that extensive shellfish beds and ampeliscid mats are found in the sandy sediments of the Lower Bay, which is the least disturbed by urban and industrial influences. The Lower Bay was least susceptible to pollution and degradation and typically has better water quality than other areas of the harbor. Species identified in the Lower Bay include hard and softshell clams, eastern oyster, surf clam (*Spisula solidissima*) and blue mussel (*Mytulis edulis*).

As a result of the poor water quality in the Raritan and Sandy Hook Bays, shellfish that are harvested must undergo a purification process before they can be sold for consumption. Areas are assigned for shellfish areas, and harvesting outside of these areas is illegal (NJDEP, 2008). Additional information regarding shellfish/oyster habitat within the planning region is found in the Engineering and Alternatives Development Appendices (D and E-6, respectively).

2.2.5.7 Wildlife

The Raritan Bay-Sandy Hook Bay complex is one of the USFWS Significant Habitats and Habitat Complexes of the New York Bight Watershed (USFWS, 1997). The combination of geographic location and configuration coupled with productive bay wetlands, flats, and waters in Raritan Bay make it an

important migratory staging area for many species of waterfowl on the Atlantic Flyway. Beach habitat provides foraging areas for waterfowl and shorebirds (RPA, 2003). Additionally, Sandy Hook is an important migratory corridor for raptors, including Northern Harrier (*Circus cyaneus*), Osprey (*Pandion haliaetus*), Common Barn Owl (*Tyto alba*), Red-tail Hawk (*Buteo jamaicensis*), Cooper's Hawk (*Accipiter cooperii*), Sharp-shinned Hawk (*Accipiter striatus*), American Kestrel (*Falco sparverius*), and Peregrine Falcon (*Falco peregrinus*). Overwintering raptors include Northern Harrier, Rough-legged Hawk (*Buteo lagopus*), American Kestrel, Common Barn Owl, Short-eared Owl (*Asio flammeus*), Long-eared Owl (*Asio otus*), and Peregrine Falcon. The small mammal and songbird populations of the urban core provide a rich food resource for resident and migratory raptor populations (USFWS, 1997).

2.2.5.8 Rare, Threatened, and Endangered Species

Raritan Bay and Sandy Hook Bay support the greatest variety of state- and federally-listed threatened and endangered species in the HRE study area (USFWS, 1997). The undeveloped condition of Sandy Hook makes it a favorable nesting habitat for several protected species, including the federally listed threatened piping plover and the state-listed endangered least tern (USFWS, 1997).

Since the only proposed restoration site in Lower Bay is a marine oyster restoration site, federal agency correspondence was limited to NOAA NMFS. NJDEP Landscape Project version 3.1 data was also reviewed. Agency correspondence is located in Appendix G.

NMFS

Four (4) species of ESA sea turtles that have been seasonally present in the Lower Bay Planning Region are listed by the NMFS, including:

- Threatened Northwest Atlantic Ocean DPS of loggerhead (*Caretta caretta*).
- Threatened North Atlantic DPS of green (*Chelonia mydas*).
- Endangered Kemp's ridley (*Lepidochelys kempii*).
- Endangered leatherback sea turtle (*Dermochelys coriacea*).

These threatened and endangered sea turtles can be present in the Lower Bay area from May to mid-November. Adult and sub-adult Atlantic sturgeon can be found in the Lower Bay Planning Area. The New York Bight, Chesapeake Bay, South Atlantic, and Carolina DPS are endangered, and the Gulf of Maine DPS is threatened in the area. Atlantic sturgeon eggs, larvae, or juvenile life stages will not be found in the waters of the Lower Bay Planning Area. Additionally, the shortnose sturgeons (*Acipenser brevirostrum*), of the adult and sub-adult life stages are also present in these waters.

NJDEP

NJDEP Landscape Project 3.1 has also identified foraging habitat within the project area for the special concern species common tern.

It is assumed that prior to construction activities a resource inventory would be conducted to determine if these species are present. Chapter 5 discusses these inventories in greater detail.

2.2.5.9 Land Use

The Lower Bay Planning Region is predominantly developed with industrial, commercial, and residential land uses. Sandy Hook's shoreline is interspersed with public and private marinas, sandy

beaches, and riprap shorelines (USACE, 1999). Private and public beaches are scattered throughout the region, located in Monmouth County, New Jersey, and on Coney Island and Staten Island, New York. The surface waters in this planning region are used for commercial shipping, recreational boating, and fishing/shellfishing (USACE, 2004a).

2.2.5.10 Hazardous, Toxic, and Radioactive Waste

As a result of industrial activities in and near the Lower Bay Planning Region, toxic contaminants such as heavy metals, hydrocarbons, PCBs, and PAHs, are present in the sediments. Shellfisheries in this area have been closed and fish consumption advisories have been issued due to high sediment contamination in the planning region. Sediment contamination in Raritan Bay is generally the result of the outflow from the Arthur Kill and the Raritan River. The highest toxicity levels are found in western Raritan Bay. Previous studies within the Lower Bay have identified areas with slightly elevated levels of arsenic, copper, and mercury and moderate to high levels of nickel, silver, zinc, and chromium. The Lower Bay also has localized “hotspots” of aldrin and hexachlorobenzene (USACE, 2004a).

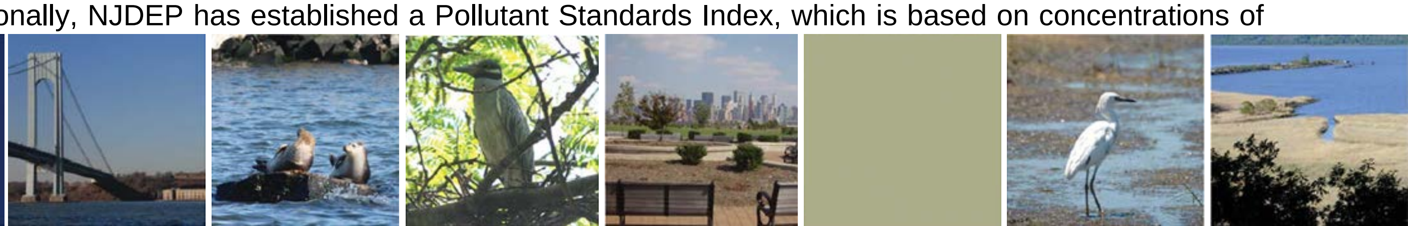
An April 2016 Environmental Data Resources, Inc. database search was conducted within one (1) mile of the Naval Weapons Station Earle, located in Sandy Hook Bay. According to the Environmental Data Resources, Inc. database search, *Naval Weapons Station Earle* has operated since the 1940s as a base for renovation, storage, and maintenance of ammunition, including small arms, missile components, and explosives. Twenty-seven (27) areas of concern have been identified at the station under the Superfund program, and three (3) areas are permitted under the Resource Conservation and Recovery Act. Contamination was first detected in the 1980s, and has since come to include contaminants from paint and ammunition chips, PCBs, lead, volatile organic compounds, and hydrocarbon compounds. In addition a 2-mile long naval service pier that includes fuel lines and transports munitions extends above the proposed restoration site.

Leonardo State Marina is a state run marina located to the east of the NWS Earle site, which features a boat launch and 176 berths. The marina has several records, including the removal and ongoing remediation of a fuel tank, and a sunken vessel, which resulted in release of fuel and other contaminants. Additional details on potential HTRW in the Lower Bay Planning Region can be found in Appendix H.

2.2.5.11 Air Quality

The HRE encompasses a highly urbanized and industrialized setting, including many major transportation corridors servicing the New York City Metropolitan Area. As required by the Clean Air Act of 1970, National Ambient Air Quality Standards have been established for six (6) major air pollutants identified by USEPA as being of nationwide concern: carbon monoxide, nitrogen oxides, ozone, particulates, sulfur oxides, and lead. In the HRE study area, ambient concentrations of carbon monoxide, ozone, and lead are predominantly influenced by vehicle emissions, nitrogen oxides and particulates are emitted from both motor vehicle and stationary sources (e.g., power generation, industrial), and emissions of sulfur oxides and sulfates are mainly from stationary sources. These standards have also been established as the ambient air quality standards for New York and New Jersey. Primary standards are intended to protect public health, while secondary standards are intended to protect public welfare (e.g., physical damage to structures, ecological damage).

The NJDEP and the NYSDEC operate a network of air monitoring stations to evaluate pollutants and compare them to the National Ambient Air Quality Standards (NJDEP, 2014; NYSDEC, 2014). Additionally, NJDEP has established a Pollutant Standards Index, which is based on concentrations of



individual pollutants including carbon monoxide, nitrogen oxides, suspended particulates as "smoke shade," sulfur dioxide, ozone, non-methane organic compounds, and inhalable particulates. Ambient air in the region is similar to that of other highly urbanized areas. Placing emission controls on automobiles and industrial sources and limiting sulfur content of fuels have helped to improve the regional air quality in the HRE over the last 30 years.

2.2.5.12 Noise

Noise is generally defined as unwanted sound and its loudness is measured by amplitude, which is expressed in decibels. Noise levels can be approximated based on land use and can range from 30 decibels in wilderness areas to 90 decibels in urban areas (USEPA, 1978). Ambient noise levels within the Lower Bay Planning Region would likely be in the lower to mid-range, as much of the planning region encompasses residential communities, open water or open space . The primary sources of noise in the planning region include boat traffic in Raritan and Sandy Hook Bays, automobile traffic on local roads, and periodic explosions from demolition training ant Naval Weapons Station Earle. Receptors in the Lower Bay Planning Region include residential areas and wildlife habitats. Noise criteria and the descriptors used to evaluate project noise will depend on the type of land use in the vicinity of the proposed project areas.

2.2.5.13 Navigation

The Ambrose Channel, providing 50-foot water access, is the main shipping channel in and out of the Port of New York and New Jersey. The Ambrose Channel is part of the Lower Bay located several miles off the coasts of Sandy Hook, New Jersey and Breezy Point, Queens, New York. The Ambrose Channel connects to the Anchorage Channel at the Narrows which connects to channels leading to main container terminals within the Port to accommodate the fleet of larger and deeper draft container ships. The Ambrose Channel terminates at Ambrose Anchorage, just south of the Verrazano Narrows Bridge.

Sandy Hook Channel has a project depth 35 feet and provides a secondary route from the sea to deep water in Lower Bay; it connects with Raritan Bay Channel to the westward, Chapel Hill Channel to the north, and Terminal Channel to the south. Chapel Hill Channel has a project depth of 30 feet. Swash Channel, a natural buoyed passage between Ambrose Channel and Sandy Hook Channel, has a controlling depth of 18 feet. Terminal Channel, entered from Sandy Hook Channel about one (1) mile west-southwest of the northern tip of Sandy Hook, leads to a turning basin, and two deepwater ammunition handling piers of the U.S. Naval Ammunition Depot at Earle/Leonardo. Federal project depth is 35 feet in the channel and turning basin. The deepwater piers and barge pier are connected to the shore by a trestle that extends nearly two miles across the mud flats from Earle/Leonardo. This area is restricted to authorized craft or vessels only (NOAA, 2017).

Raritan Bay is full of shoals with depths of seven (7) to 18 feet. Great Kills Harbor, a shallow bight on the south side of Staten Island, is used as an anchorage by small craft. The harbor is entered through a dredged channel that leads from deep water in the Lower Bay along the southwesterly side of Crookes Point, thence along the westerly side of the harbor to the head of bay. Coney Island Channel is a buoyed passage along the south side of Coney Island that leads from deep water in Lower Bay to Rockaway Inlet. In January-April 2000, the controlling depth was 12 feet. It is used principally by vessels going to Jamaica Bay and Coney Island (NOAA, 2017).

2.2.5.14 Recreation

The Lower Bay Planning Region has 120 public access points. These public access points are distributed fairly evenly around the planning region along the beaches of the Sandy Hook Peninsula, up the Navesink and Shrewsbury Rivers, the Raritan Bay shoreline of New Jersey to Perth Amboy, and the waterfront area of Staten Island.

Numerous public and private beaches are located in the Lower Bay region. Point Comfort beach, located in Keansburg, New Jersey, includes an amusement park/waterpark with a walkway along the beach. The south shore of Sandy Hook Bay features maintained beaches. The recently renovated South Beach, located on Staten Island just south of the Verrazano Narrows Bridge, offers views of the bridge and Lower New York Bay. Other beaches on the eastern shore of Staten Island include Midland Beach (part of Franklin D. Roosevelt Beach and Boardwalk), New Dorp Beach, Oakwood Beach, Fox Beach, Cedar Grove Beach (in Great Kills Park), Annandale Beach (Blue Heron Park Preserve), and Huguenot Beach (Bunker Ponds Park) (NYC Parks, 2012). The beach at Coney Island, on the south shore of Long Island in Brooklyn, features an amusement park, a boardwalk, and swimming beaches. Moving west, Manhattan Beach Park contains public swimming beaches, sports recreation areas, and play areas for children.

In the Lower Bay Planning Region many offshore coastal areas have been designated by New Jersey and New York as sport fishing grounds, including the intersection of the Chapel Hill South Channel, Raritan Bay Channel, Sandy Hook Bay, Old Orchard Shoal, Flynn’s Knoll, and Romer Shoal. A number of charter companies provide sport fishing opportunities in the New York and New Jersey Harbor. Many of these “party boats” can accommodate dozens of anglers and are based in Sheepshead Bay Brooklyn, and on City Island in the Bronx. Common recreational species caught by boat in the Lower Bay Planning Region include silver hake (*Merluccius bilinearis*), red hake (*Urophycis chuss*), striped bass, black sea bass, scup, weakfish, bluefish, summer flounder, and tautog (NJDEP, 1982).

Some fishing areas in the Lower Bay Planning Region can be accessed from piers and beaches (USACE, 2000). Recreational fishing areas have been designated in Gateway National Recreation Area, where waters are calm. At the Sandy Hook unit, a fishing beach is found just north of the ranger station, although surf fishing is permitted at any unguarded beach (USACE, 1999). Recreational species caught from shore include, weakfish, bluefish, winter flounder, summer flounder, and striped bass.

2.2.5.15 Cultural Resources

The Lower Bay Planning Region has a long history of occupation, first by Native American groups from as early as 12,000 before present until the arrival of European explorers in the fifteenth century. Early colonial settlements appear in the 1600s which evolve slowly from agricultural to industrial in character followed by urbanization in the last century. Potential for prehistoric and historic archaeological sites exists throughout the region. Archaeological sites and above ground historic properties can be found in upland, lowland, marsh, and submerged environments. Architectural and archaeological investigations are required to determine the presence or absence of such resources in most of the study area due to lack of existing data.

In 2014 the USACE completed a cultural resources survey titled *Cultural Resources Overview of the Hudson-Raritan Estuary Comprehensive Restoration Plan* (Harris et al., 2014) that aimed at inventorying all existing cultural resources data relevant to the 301 candidate restoration sites in the HRE study. General background information about the region was collected to provide a historical and

cultural context. Cultural resources data was not compiled for the entire Lower Bay Planning Region but for each potential restoration site and a one-mile buffer area that was applied to the site for the survey. There were seven (7) restorations sites investigated in the Lower Bay Planning Region.

More than 1,000 historic properties, archaeological sites, historic districts, and surveys were compiled for the Lower Bay Planning Region. There are 597 historic properties; 542 of which are in the New Jersey portion of the region. In New Jersey, the recorded historic properties are concentrated in Keyport, Middletown Township, Red Bank, and Matawan. The 55 New York resources are found throughout eastern Staten Island and Gravesend, Brooklyn. Of the 19 historic districts in this region, 17 are located in New Jersey and two (2) in New York. Notable districts include the Naval Weapons Station Earle Historic District, Fort Hancock and Sandy Hook Proving Ground Historic District, and Garden State Parkway Historic District (Monmouth), all in New Jersey, and Fort Wadsworth Historic District on Staten Island, New York.

A total of 168 archaeological sites are recorded in this planning region; 103 in New York and 65 in New Jersey. These sites are found most densely along the eastern shoreline of Staten Island, but also along the near shore areas of the Raritan Bay in New Jersey. A total of 78 AWOIS objects are documented all around Raritan Bay, but found in concentration in Gravesend Bay, Brooklyn and off of Belford Harbor in Monmouth County, New Jersey. Finally, a total of 166 cultural resources surveys have been carried out in the region; 141 in New Jersey and 25 in New York. Many of the surveys in the New York portion of the region are large marine surveys in the Raritan Bay, while in New Jersey many surveys area found along the southern shore of the Raritan Bay, in the Matawan Creek drainage, and in Sandy Hook.

2.2.5.16 Social and Economic Resources

The Lower Bay Planning Region lies mostly within Monmouth County, New Jersey, with small portions falling within Middlesex County, New Jersey and Kings and Richmond counties in New York. The population in the Lower Bay Planning Region is approximately 1.1 million people according to the 2010 Census (United States Census Bureau, 2010). The demographic makeup is 77 percent White, six (6) percent Black or African American, 13 percent Asian, and four (4) percent other races; 12 percent of Lower Bay is Hispanic. Fifty-four (54) percent of housing units are owner-occupied in Lower Bay and eight (8) percent of the housing units are vacant.

The median household income in the Lower Bay Planning Region is $92,436 in New Jersey and $59,685 in New York (in 2011 inflation-adjusted dollars) based on the American Community Survey 5-year estimates for 2007-2011 (United States Census Bureau, 2011). Six (6) percent of New Jersey households and 14 percent of New York households earned income below the poverty level in the Lower Bay Planning Region in 2011.

2.2.5.17 Aesthetics and Scenic Resources

Salt marshes, beaches, and riprap- and bulkhead-protected shorelines characterize the New Jersey shoreline from Sandy Hook to Perth Amboy. Sandy beaches cover most of the shore on Sandy Hook, while the Perth Amboy shoreline is predominantly bulkheaded (USACE, 1999). The southern section of the Brooklyn shoreline is characterized by private dwellings, the Norton Point Coney Island Light House, a wide sand beach at Coney Island, and the Coney Island Amusement Park (USACE, 1999).

The view of the southeast shoreline of Staten Island from the Verrazano Narrows bridge southwestward to Tottenville is predominantly of sandy beaches, most of which are maintained and groomed (USACE, 1999). Looking east from Fort Wadsworth across the Narrows towards Fort Hamilton in Brooklyn, the

Belt Parkway can be seen running along the bulkheaded shoreline. Coney Island Amusement Park and its associated beaches and boardwalk are also visible providing a scenic view of the Brooklyn shoreline.

2.2.5.18 Coastal Zone Management

The Coastal Zone Management Act of 1972 (16 United States Code 1451-1464) was enacted by Congress to balance the demands for growth and development with the competing demands for protection of coastal resources. This act requires that federal activities affecting land or water resources located in the coastal zone be consistent to the maximum extent practicable with the federally approved state coastal zone management plans. This act is regulated in New York by the New York State Department of State, Division of Coastal Resources and in New Jersey by the NJDEP.

New Jersey's coastal zone management program primarily derives its authority from three (3) state statutes: The Waterfront and Harbor Facilities Act of 1914 (New Jersey Statutes Annotated 12:5-3), the Wetlands Act of 1970 (New Jersey Statutes Annotated 13:9A), and the Coastal Area Facility Review Act (New Jersey Statutes Annotated 13:19). The Hackensack Meadowlands Reclamation and Development Act (New Jersey Statutes Annotated 13:17), Freshwater Wetlands Protection Act (New Jersey Statutes Annotated 13:9B), the law concerning the transportation of dredged materials containing PCBs (New Jersey Statutes Annotated 13:19-33) and the Department's dredging technical manual titled, “The Management and Regulation of Dredging Activities and Dredged Material Disposal in New Jersey's Tidal Waters” are additional laws governing New Jersey’s enforceable coastal zone policies.

The Lower Bay Planning Region includes portions within the inland, seaward, and interstate coastal zone boundaries for New Jersey as well as within the coastal boundary of New York. Restoration activities within the region will be reviewed by the NJDEP and/or New York State Department of State for consistency with the policies of their respective coastal management programs. All information related to the USACE coastal consistency review is presented in Appendix J.

2.2.5.19 Future Without Project Conditions

Under the future without-project condition, ongoing and planned restoration and conservation actions undertaken by agencies, municipalities and nongovernmental entities would continue. Although there are many ongoing programs in the Lower Bay Planning Region, they are typically conducted independent of one another or in isolation from the rest of the region. Shoreline stabilization project in Monmouth County, New Jersey may alter existing conditions and affect restoration efforts. A list of ongoing activities in the Lower Bay Planning Region is in Appendix B. While restoration efforts would continue under the without-project condition, these efforts would lead to disjointed projects, missed opportunities and overall inefficiencies in restoring the Lower Bay Planning Region.

The environmental health of the area is expected to decline with projected non-point source water quality inputs, SLR, and climate change. As such, continued losses of low lying coastal habitats from erosion and sedimentation are expected in the without-project condition. Although oyster populations do exist in isolated areas, much of the reefs in the Lower Bay have been degraded or destroyed by human activities. Recent experimental programs to restore oyster populations, such as the NY/NJ Baykeeper oyster restoration at Naval Weapons Station Earle, are successful, but expansion of restoration efforts is needed to fully benefit from the effects on water quality, nutrient processing, shoreline stabilization, and the provision of nursery habitat for many estuarine-dependent finfish and shellfish species. These benefits from the increase in oyster populations would not occur in the without-project condition.

2.2.6 Lower Raritan River Planning Region

Primarily located in Middlesex County, New Jersey, the Lower Raritan River is the western-most planning region of the HRE study area (Figure 2-9). This region contains the lower six (6) miles of the Raritan River before its confluence with Raritan Bay (USACE, 2004a). Portions of the planning region stretch into Union, Somerset, and Monmouth Counties, New Jersey. The shoreline of the Lower Raritan River is flanked with residential or industrial development. Land use changes from predominantly industrial development with bulk-headed shorelines and piers at the river's mouth to a mix of industrial, commercial, and residential development farther upstream (USACE, 2004a; USACE, 1999). Agricultural lands are located along the upstream boundary of the planning region (USACE, 2004a). Isolated pockets of tidal wetlands occur along the shore (USACE, 2004a; USACE, 1999). An unremediated landfill, the former Raritan Arsenal, and the Sayreville and Werner generating stations are also located along the shoreline. Although there are no public bathing areas in the region, waterbodies are used for recreational navigation and secondary contact recreation including water/jet skiing and fishing (USACE, 2004a).

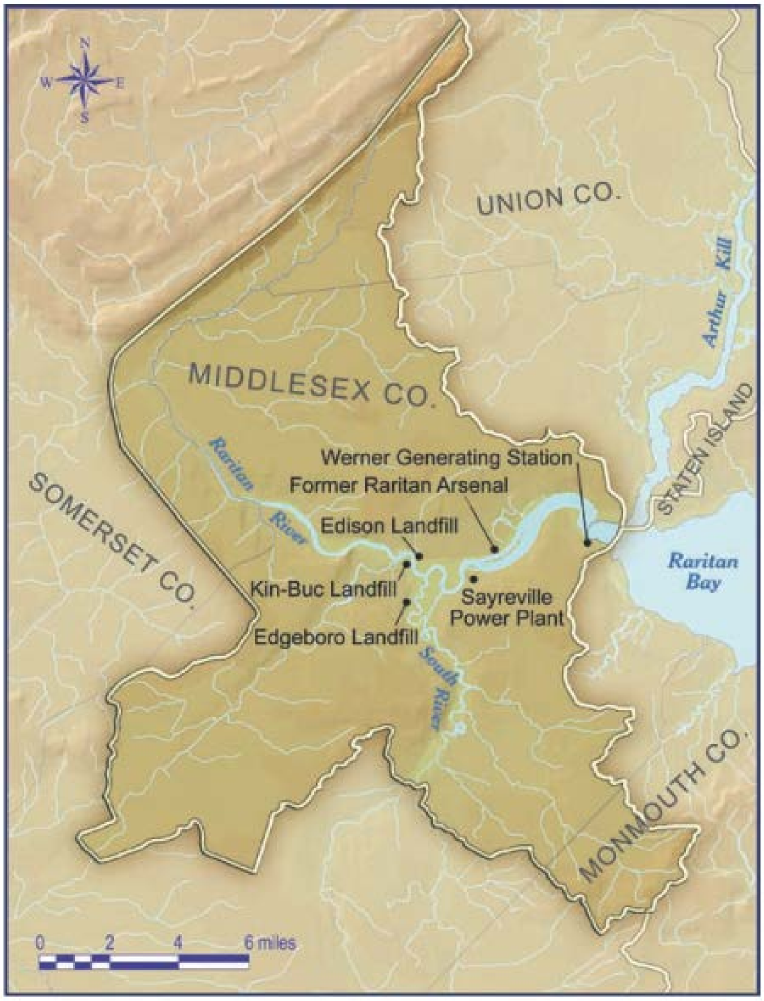


Figure 2-9 Lower Raritan River Planning Region.

This tidally influenced river features some regionally important floral and faunal assemblages (RPA, 2003; USACE, 2004a). A large wetland complex of 1,000 acres, located in Edison Township, provides habitat for waterfowl, wading birds, mammals, and fish (USACE, 2004a). Saltwater intrusion occurs throughout the length of the Lower Raritan River, with sensitive estuarine resources such as tidal wetlands, submerged aquatic vegetation, and intertidal mud flats occurring in shallow, nearshore areas (USACE, 1999). Some fallow or abandoned agricultural lands afford open spaces for upland wildlife (USACE, 2004a). However, these habitats are isolated and somewhat degraded due to the industrial land uses in the region.

The landscape of the Lower Raritan River Planning Region has changed tremendously over the past few centuries. Wetland losses due to filling have been estimated at 93 percent of their former area, and remaining wetlands are generally a degraded mix of non-native or invasive plants (USACE, 2004a).

In addition, 12 dams are located on the Lower Raritan River and its tributaries, impeding the movement of diadromous fish that travel upriver or downriver to spawn.

Hurricane Sandy affected the Lower Raritan River Planning Region with sustained flooding from the storm surge. The flooding rendered several major sewage treatment plants inoperable due to power outages, which resulted in the release of raw or partially treated sewage into local waterways. The Middlesex County Utilities Authority pump stations in Sayreville and Edison, New Jersey were severely damaged during Hurricane Sandy, causing the release of more than 1.1 billion gallons of sewage over a three (3) month period (Kenward et al., 2013). State officials issued water use advisories for several water bodies and described the event as an “ecological catastrophe.” The releases posed several threats, including hypoxic zones caused by waste-fed algal blooms, high concentrations of E. coli bacteria and other pathogens, and a general degradation of water quality. Impacted resources included fish, invertebrates, small mammals, wading birds, and amphibians (ALS, 2012).

2.2.7 Arthur Kill/Kill Van Kull Planning Region

The Arthur Kill/Kill Van Kull Planning Region lies between Newark Bay and the Lower Raritan River (Figure 2-10). The Arthur Kill is a tidal strait that connects to Upper Bay via the Kill Van Kull (another tidal strait) and mixes waters with Newark Bay. The Arthur Kill also connects Newark Bay with Raritan Bay. Important tributaries to the Arthur Kill include the Rahway and Elizabeth Rivers, Old Place Creek, Woodbridge Creek, and Fresh Kills Creek (USACE, 2004a). The Arthur Kill/Kill Van Kull Planning Region has a dynamic hydrology due to the variation in tidal velocity, amount of freshwater flow, and bathymetry among the three (3) connecting bays (i.e., Upper, Newark, and Raritan Bays; USACE, 1999).

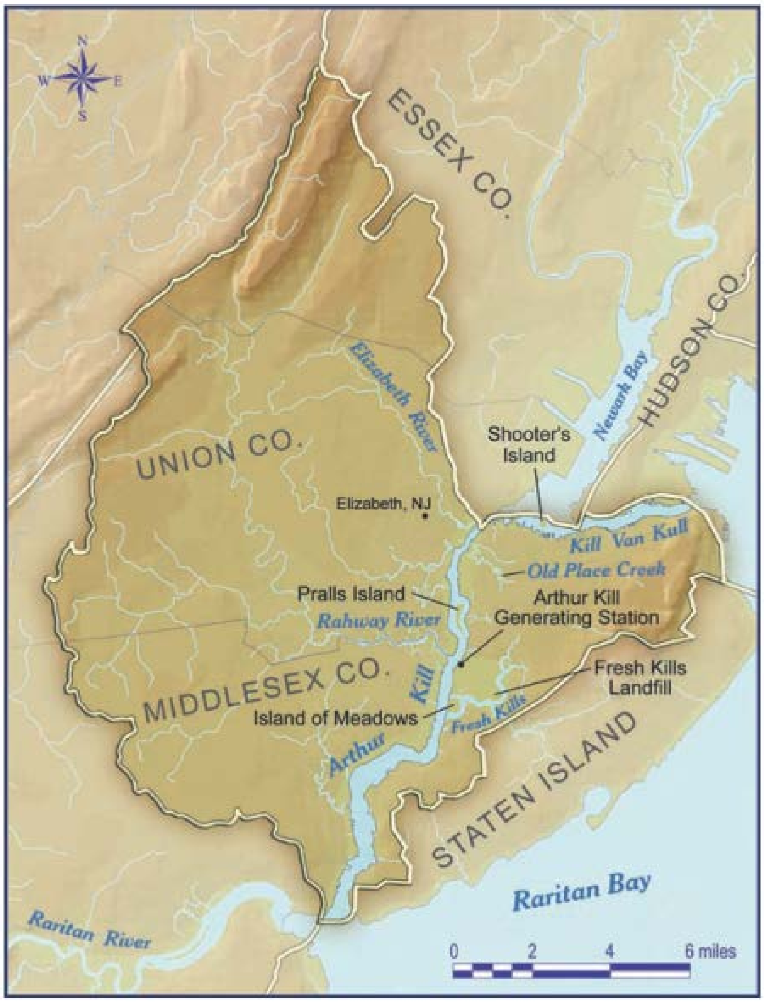


Figure 2-10 Arthur Kill/Kill Van Kull Planning Region.

These waterways exist within a heavily industrialized and developed corridor, with an average population density of almost 5,000 people per square mile. The New Jersey side of the Arthur Kill is industrialized; large areas of wetlands are intermingled with industrial facilities on the New York side. On Staten Island, wetlands are located adjacent to the world’s largest landfill (Fresh Kills) and the Arthur Kill Generating Station. In the southern section, many abandoned industrial facilities exist along the shoreline (USACE, 2004a). The industries of the Arthur Kill and Kill Van Kull waterways process petroleum and non-petrol chemicals along their shorelines, and occasional oil spills occur (Yozzo, et al. 2001, Steinberg et al. 2004). At least 30 closed landfills

and dozens of contaminated brownfields once discharged leachate into the groundwater in this planning region (USACE, 2004a). Although leachate collection systems are now in place on most of the closed landfills, many contaminants persist in estuarine sediments (USACE, 2004a).

The Arthur Kill and Kill Van Kull also have deepwater navigation channels that allow transport of cargo into and out of the Ports of New York and New Jersey. Howland Hook Marine Terminal (HHMT) is located on Staten Island's northwestern waterfront along the Arthur Kill, approximately one mile west of Arlington, New York. The area between Arlington and HHMT is sparsely populated, with large industrial sites and a few local roadways. Much of the area is undeveloped and vacant. Prominent land uses around HHMT include transportation facilities and industrial sites. Industrial properties south of HHMT include the PANYNJ's Gulfport, Visy Paper Plant, R.T. Baker & Sons (defunct salvage operation), and the former GATX Staten Island Terminal Property. The extensive tributary system of the Arthur Kill supports a mosaic of tidal and freshwater wetlands, mudflats, and riparian forest. Deeper, open-water habitats in this planning region support over 60 migratory and resident fish species including species of commercial or recreational importance such as winter flounder (*Pseudoplueronectes americanus*) and black sea bass (*Centropristis striata*; RPA, 2003; USACE, 2004a). Northwest Staten Island and the islands along the Arthur Kill and Kill Van Kull were designated as a SNWA by NYC due to the diverse landscape of habitats (NYC, 2011). Arlington Marsh and Graniteville Swamp are examples of important habitats within this planning region. Three (3) islands are located in the Arthur Kill and Kill Van Kull Planning Region. Pralls Island and the Isle of Meadows are located adjacent to the western shoreline of Staten Island on the Arthur Kill, and Shooters Island is located on the Kill Van Kull.

Large breeding populations of herons, egrets, and ibises have used these uninhabited islands as nesting sites, and the nearby marshlands and mudflats as foraging areas. From the late 1970s through the early 1990s, the islands supported the largest heron rookery in New York State. It was estimated that the entire rookery in the HRE study area accounted for almost 25 percent of the wading birds that nested in coastal waters within New York, New Jersey, and Connecticut (USFWS, 1997). Although none of the islands in the Arthur Kill region currently support active wading bird rookeries, these islands provide habitat for other bird species and may be recolonized by wading birds in the future (Bernick, 2006). Many of the coastal sections in this planning region are fragmented or degraded and monotypic stands of common reed (*Phragmites australis*) dominate wetland parcels (USACE, 2000). Several spillways and cement riverbeds exist on tributaries on both sides of the Arthur Kill, creating ponds for urban parks (Durkas, 1992). Unfortunately, these structures often deter movement of anadromous fish (USACE, 2000; Durkas, 1993; Durkas, 1992; USFWS, 1997). This region has had long-term issues with poor water quality and high contaminant levels (USACE, 1999). However, because this HRE planning region contains More than 30,000 acres of open space, these sites have the potential to be important for future habitat restoration programs (RPA, 2003).

Damage from Hurricane Sandy within the Arthur Kill and Kill Van Kull Planning Region included shoreline erosion, loss of colonial bird nesting habitat, oil spill contamination, and sewage releases. The western shore of Staten Island experienced flooding, but relatively little wind damage. Coastal areas experienced some erosion, with sizable sections of shoreline eroded away by waves in some locations (HRF, 2012). Pralls Island sustained a complete overwash from Hurricane Sandy's storm surge, as well as damage to trees and other plants from both the surge and high winds. Debris previously scattered along Pralls Island's edges was piled in the middle; deer fencing established to protect potential heron nesting areas was knocked own (ALS, 2012).

Oil spill contamination resulting from Hurricane Sandy impacted areas along the Arthur Kill, adjacent marshes and tributaries. As the storm surge flooded the banks of the Arthur Kill, several bulk fuel tanks

were damaged, releasing nearly 378,000 gallons of diesel fuel into the water (ALS, 2012). Oil contamination in the area was far reaching, and oil coated marshes along the Arthur Kill shorelines of Staten Island and New Jersey, including Pralls Island and tidal tributaries such as Woodbridge Creek, Rum Creek, and Smith Creek. Impacted resources included fish, invertebrates, small mammals, wading birds, and a recently discovered species of leopard frog (*Rana kauffeldi*) documented to inhabit freshwater wetlands along the western shoreline of Staten Island (ALS, 2012). In addition to the release of oil, raw and partially treated sewage was spilled into the waters within the planning region. State officials issued water use advisories for several waterways including the Arthur Kill and the Kill Van Kull (ALS and NFWF, 2012).

2.2.8 Lower Hudson River Planning Region

The Lower Hudson River Planning Region extends from the Upper Bay to the Tappan Zee Bridge and includes portions of Bergen and Hudson Counties in New Jersey, NYC, Rockland, and Westchester Counties in New York (Figure 2-11). The western Manhattan, west Bronx, and lower Westchester County shoreline is densely populated. Areas in northeastern New Jersey along the Hudson River coastline are among the most populated in the state (USACE, 2006a). The Palisades Interstate Park runs along the western shoreline of the Lower Hudson River from Bergen County, New Jersey to Rockland County, New York. Recreational and commercial boating is prevalent in the Lower Hudson River.

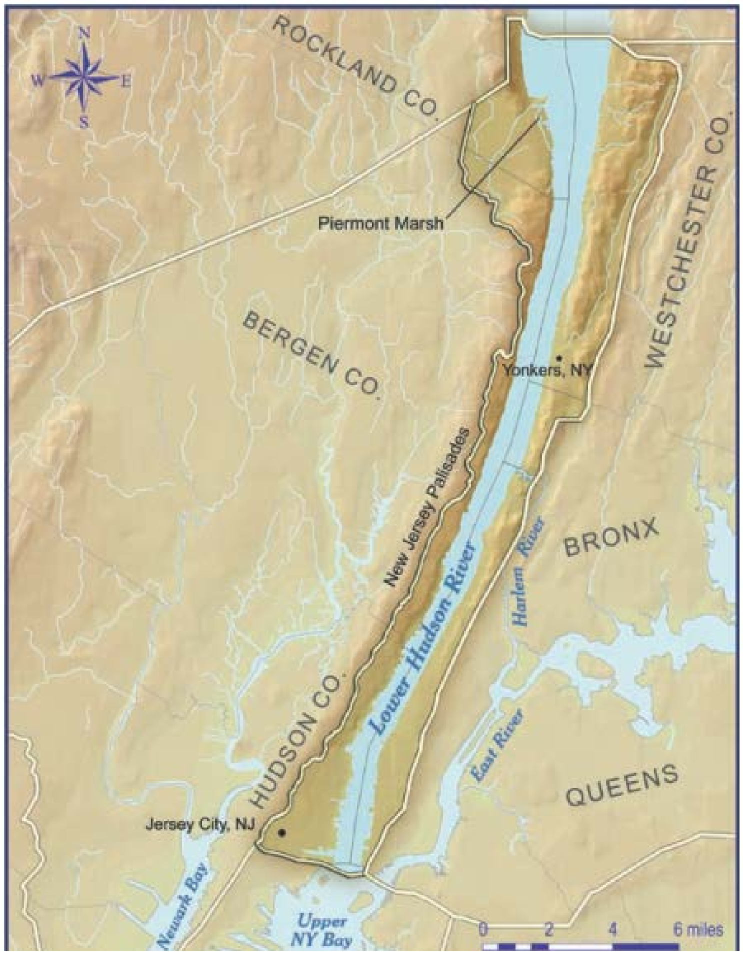
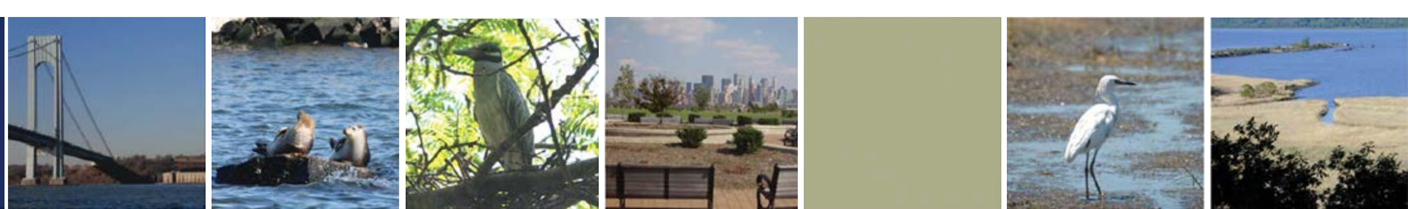


Figure 2-11 Lower Hudson River Planning Region.

Land use along the shoreline consists of residential areas, marinas, marine parks, some vacant disturbed lands, and scattered commercial and industrial facilities, especially in areas below the George Washington Bridge. Several commercial/industrial facilities (including the World Financial Center) draw cooling water from the Lower Hudson River; nine (9) wastewater treatment plants are also located in this region (USACE, 2004a). Power plants and industrial facilities draw cooling water from the Lower Hudson River and discharge heated water back into the river.

Strong semi-diurnal tides make the Lower Hudson River one of the few major tidal rivers of the North Atlantic coast (USFWS, 1997). This stretch of river is naturally turbid, with limited primary productivity and moderate to high salinity levels. The Lower Hudson River includes a wide range of riverine and estuarine habitats that function as overwintering habitat and significant nursery areas for many fish and invertebrate species (USACE, 2004a; USFWS, 1997; USACE, 2000). The Lower Hudson River is the



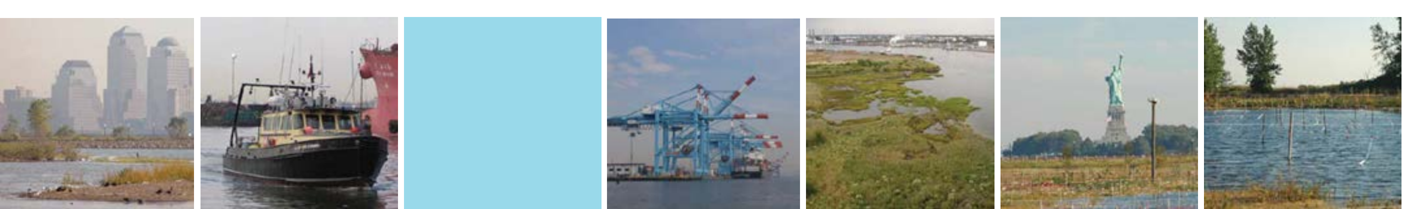
primary nursery and overwintering area for striped bass (*Morone saxatilis*) in the Hudson River estuary. Two (2) federally listed endangered species, shortnose sturgeon (*Acipenser brevirostrum*) and Atlantic sturgeon (*A. oxyrhynchus*), also spawn in the Lower Hudson. At the northern reach of the region, Piermont Marsh, a brackish intertidal wetland supports a variety of aquatic and terrestrial species. Shallowwater habitat of the Lower Hudson River, including shoals and inter-pier areas, may be important foraging sites for young fish before they move into deeper harbor waters (USACE, 2004a).

Like most major rivers in the U.S., the Lower Hudson River is maintained for navigation and has been affected by centuries of human use. Shorelines and wetlands were extensively altered, relocated, and eliminated between 1800 and 1972. Hundreds of dams have been built in tributaries leading to the Hudson, fragmenting habitats, degrading water quality, and preventing migratory fish movement, while simultaneously welcoming invasive plant and animal species in the estuary (Miller, 2013). Consumptive water use has altered the natural salinity range, resulting in secondary effects on species diversity and habitat function, particularly of wetlands such as Piermont Marsh, which are currently dominated by monotypic common reed stands (USFWS, 1997). Maintenance of the shipping channel and bulkhead construction have progressively narrowed and deepened the river. The western shore runs along the Palisades (a geologic feature dominated by steep, rocky shorelines); therefore, littoral (e.g., shallow water) habitat is naturally sparse. Bulkhead and pier construction on the eastern shore eliminated any remaining natural shoreline and littoral habitats (USACE, 2000).

The Lower Hudson River is also contaminated with persistent chemicals. Between 1946 and 1977, about 1.3 million pounds of PCBs were released from two (2) General Electric Company plants located in the Upper Hudson River, upstream from the HRE study area (NYSDEC, 2015). The USEPA designated a 200-mile stretch of the Hudson River, from Hudson Falls to the Battery in NYC, as a Superfund site due to this contamination. PCBs from the discharge points were transported to the Lower Hudson River, causing bioaccumulation and contamination of fishery resources throughout the river. A cleanup called for targeted environmental dredging of approximately 2.65 million cubic yards from a 40-mile section of the Upper Hudson. In 2009, the USEPA and General Electric initiated the first phase of dredging a 14-mile stretch of the Upper Hudson River in an effort to remove PCBs that were discharged north of the Federal Troy Lock and Dam (USEPA, 2014c). The second phase of dredging began in 2011 dredging to remove PCBs from a 40-mile stretch of the upper Hudson River between Fort Edward and Troy, New York was completed in the fall 2015. The Operation, Maintenance & Monitoring phase of the project is underway and will continue. During this phase, monitoring is conducted to track the ongoing recovery of the river and the effectiveness of the cleanup over time. The five-year review period will be completed by April 23, 2017 (USEPA, 2016; http://www.epa.gov/hudson).

In 1976, the contamination of benthic habitat and fish tissue in the Hudson River led New York State to close the commercial striped bass fishery throughout the river and to issue consumption warnings for many other important species of the Hudson River (USEPA, 2008; NYSDOH, 2014). The New York State Department of Health (NYSDOH) recommends that children and women under 50 should not eat any fish from the Lower Hudson River, and men over 15 and women over 50 should consume no more than one meal per month of striped bass collected from the Lower Hudson (NYSDOH, 2014).

During Hurricane Sandy, the Yonkers Joint Wastewater Treatment Plant released 1.2 billion gallons of partially treated sewage into the Lower Hudson River; the North River Wastewater Treatment Plant on the west side of Manhattan released 83 million gallons of raw sewage into the river in the first few days following the storm (Kenward, et al. 2013). The impact of Hurricane Sandy in the Lower Hudson River region was felt by all counties along the New Jersey shoreline of the Hudson, and in New York, north of the HRE study area, as far as Albany and Rensselaer Counties (USACE, 2015a).



In order to minimize similar impacts in the face of future storm events along the Upper Hudson River, the NYSDEC Hudson River Estuary Program released a restoration plan in 2013 and the Action Agenda 2015-2020 (Miller, 2013; NYSDEC, 2014). These reports, in conjunction with the future Hudson River Comprehensive Restoration Plan and Hudson River Habitat Restoration Feasibility Study, will complement the HRE CRP for the Hudson River north of the Tappan Zee Bridge.

Chapter 3: Plan Formulation

Plan formulation is the process of building plans that meet planning objectives and avoid planning constraints. U. S. Army Corps of Engineers (USACE) guidance for planning studies requires the systematic formulation of alternative plans that contribute to the federal objective. To ensure that sound decisions are made with respect to development of alternatives and ultimately with respect to plan selection, the plan formulation process requires a systematic approach to the formulation, comparison, and selection of plans. This chapter presents the results of the plan formulation process.

This study was conducted in accordance with the requirements of the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (1983); Planning Guidance Notebook (Engineer Regulation [ER] 1105-2-100; USACE 2000a); Project Modification for Improvement of the Environment and Aquatic Ecosystem Restoration (Engineer Circular [EC] 1105-2-214); Civil Works Ecosystem Restoration Policy (ER 1165-2-501); and Ecosystem Restoration Supporting Policy Information (Engineer Pamphlet 1165-2-502). The plan formulation framework incorporated an analytical screening process to develop alternative plans, based on existing information from prior plan formulation efforts and more recent data collection conducted for each site. The strategy involves the formulation of interdependent management measures and components that serve to meet the planning objectives while avoiding planning constraints.

3.1 Problems and Opportunities

This section documents the identification of problems and opportunities within the Hudson-Raritan Estuary (HRE), which is the first step in the USACE six (6)-step planning process (USACE 2000a). From the planning perspective, a problem can be thought of as an undesirable condition, while an opportunity offers a chance for progress or improvement. The identification of problems and opportunities gives focus to the planning effort and aids in the development of planning objectives.

Plan Formulation General Terms

Plan formulation is the process of building alternative plans that meet planning objectives and avoid planning constraints.

Alternative plans are sets of one or more management measures functioning together to address one or more planning objectives.

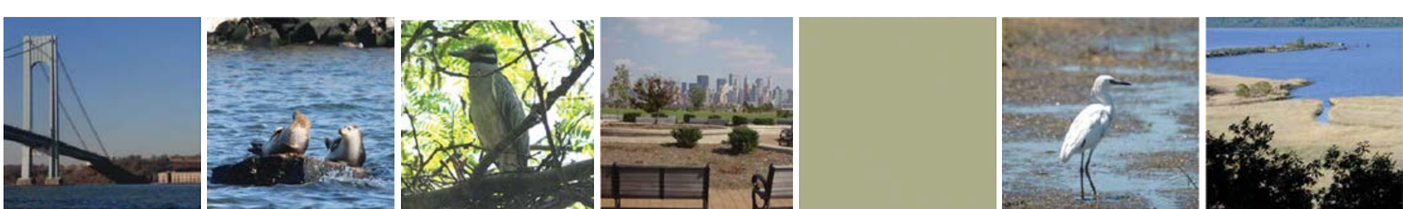
Management measures are features or activities that can be implemented at a specific geographic site to address one or more planning objectives.

Features are structural elements that require construction or assembly on site. **Activities** are nonstructural actions.

3.1.1 Problems

As described in Chapter 2, the major environmental problems in the HRE are extensive habitat loss and degradation, which have reduced the quantity and diversity of habitats, and the functional and structural integrity of the overall HRE ecosystem and its ability to provide valuable and sustainable services. These acute environmental problems are due to the direct and indirect impacts of urban coastal development in New York and New Jersey. Development-induced impacts on the environment include the following degradation factors:

- Modifications to the natural hydrologic regime;
- Creation of fast land (upland) in former aquatic/wetland habitats;
- Shoreline hardening;
- Contaminant inputs to water and sediment; and
- Overall increase in impervious area throughout the watershed.



Adverse impacts on aquatic habitats have been exacerbated by the degradation of water and sediment quality, resulting from extensive pollution loading, and from reduced flow and flushing rates in many areas. Populations of fish, shellfish, and fish-eating birds have been severely reduced through the combined impacts of habitat loss and system-wide degradation.

3.1.2 Opportunities: Target Ecosystem Characteristics

Target ecosystem characteristics (TECs) were developed to focus restoration goals on distinct actions. Each TEC is an important ecosystem property or feature that is of ecological and/or societal value. The TECs are key components essential for successful restoration of healthy estuary. The TECs defined for the HRE Comprehensive Restoration Plan (HRE CRP) address the problems affecting the HRE and describe critical habitats and habitat complexes that have become diminished within the HRE over the past several centuries. Some TECs focus on specific habitats, others on the interconnectedness of the habitats, while still others address support structures for the estuary, contamination issues, and societal values.

The process of establishing the TECs began with a two (2) -day workshop in October 2005, led by the Hudson River Foundation and Cornell University to review existing restoration plans and solicit candidate restoration goals and actions (Bain et al., 2006). The process of selecting the TECs successfully demonstrated an effective framework for building consensus and defining broad restoration objectives. The multidisciplinary group was comprised of approximately 45 people from various federal, state, and local agencies, non-governmental organizations, and national and regional estuarine scientists. Eleven (11) TECs were developed at the 2005 workshop, with a twelfth TEC added in 2012 in response to public comment (Table 3-1). Of the 12 TECs, the following eight (8) are within the purview of the USACE's aquatic ecosystem restoration mission:

- Wetlands
- Habitat for Waterbirds
- Coastal and Maritime Forests
- Oyster Reefs
- Eelgrass Beds
- Shorelines and Shallows
- Habitat for Fish, Crab, and Lobsters
- Tributary Connections

Sub-objectives were developed for each TEC and incorporated into the planning process (Table 3-1).

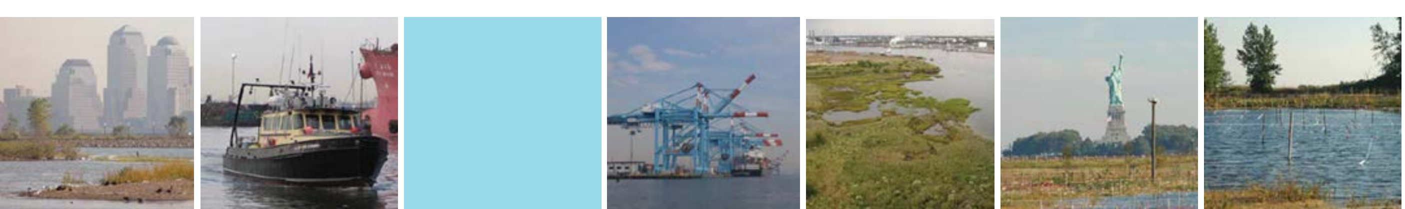


Table 3-1: Target Ecosystem Characteristics and Sub-Objectives in the Hudson-Raritan Estuary Study Area.

TEC	Target Statement/Sub-Objectives/Secondary Benefits
Wetlands 	**Target Statement** • Create and restore coastal and freshwater wetlands, at a rate exceeding the annual loss or degradation, to produce a net gain in acreage. **Sub-Objectives** • Improve the quantity, quality, and complexity of wetland habitat. • Increase overall diversity and abundance of wetland habitat. • Increase connectivity of wetland habitats to reduce fragmentation. • Improve the hydrologic connectivity of the floodplain and the river/estuary. • Reduce shoreline erosion. • Reduce invasive species monocultures and replace with diverse native vegetation. • Restore tidal marsh systems to offset both historical and future losses. **Secondary Benefits** • Provide secondary coastal storm risk management benefits (e.g., wave attenuation, shoreline stability, and shoreline resiliency), serving as potential natural and nature-based features. • Improve water quality and storage of floodwaters.
Habitat for Waterbirds 	**Target Statement** • Restore and protect roosting, nesting, and foraging habitat (i.e., inland trees, wetlands, shallow shorelines) for long-legged wading birds. **Sub-Objectives** • Improve roosting, nesting, and foraging habitat for long-legged wading birds. • Increase the number of nests and improve feeding habitat for target species.
Coastal and Maritime Forests 	**Target Statement** • Create a linkage of forests accessible to avian migrants and dependent plant communities. **Sub-Objectives** • Restore maritime forest and grassland habitat to ensure the sustainability of adjacent wetlands/aquatic habitat. • Restore maritime forest and grassland habitat to the system to provide vegetated buffer and transitional zone between aquatic habitat and urban environment. • Provide habitat and food sources for bird and wildlife species, stabilize shorelines, and provide soil retention. **Secondary Benefits** • Provide secondary coastal storm risk management benefits (e.g., wave attenuation, shoreline stability, and shoreline resiliency), serving as potential natural and nature-based features.

TEC	Target Statement/Sub-Objectives/Secondary Benefits
Oyster Reefs	**Target Statement** • Establish sustainable oyster reefs at several locations. **Sub-Objectives** • Incorporate diverse habitat structure to improve feeding, breeding, and nursery grounds for fish and benthic communities. **Secondary Benefits** • Incorporate habitat structure to provide secondary coastal storm risk management benefits (e.g., wave attenuation, shoreline stability, and shoreline resiliency), serving as potential natural and nature-based features. • Improve water quality through filtration.
Eelgrass Beds	**Target Statement** • Establish eelgrass beds at several locations in the HRE study area. **Sub-Objectives** • Provide habitat that is vertically and horizontally complex to improve diversity and density of macroinvertebrates, shellfish, and fish. • Reduce erosion, stabilize sediment, and dissipate wave and current energy. **Secondary Benefits** • Improve water quality through nutrient cycling, oxygen production.
Shorelines and Shallows	**Target Statement** • Create or restore shoreline and shallow sites with a vegetated riparian zone, an intertidal zone with a stable slope, and illuminated shallow water. **Sub-Objectives** • Soften hardened shorelines to restore transitional zones. • Restore buffer riparian zones, including littoral zones and intertidal areas, to support increased diversity and abundance of biological communities.
Habitat for Fish, Crab, and Lobsters	**Target Statement** • Create functionally related habitats in each of the eight (8) regions of the HRE. **Sub-Objectives** • Develop mosaic of diverse quality habitats to sustain fish and invertebrate populations. • Restore natural stream geomorphology. • Reduce sediment loads to improve fish, shellfish, and benthic organism habitats. • Objectives for wetland, eelgrass beds, and oyster reef habitat included.

TEC	Target Statement/Sub-Objectives/Secondary Benefits
Tributary Connections	**Target Statement** • Reconnect and restore freshwater streams to the estuary to provide a range of quality habitats to aquatic organisms. **Sub-Objectives** • Increase connectivity of riparian habitats to reduce fragmentation in migratory corridors. • Improve the hydrologic connectivity of the floodplain and the river/estuary to improve the function of riparian habitat, reduce velocities, increase infiltration, and improve natural sediment processes. • Enhance basin and tributary bathymetry configuration to promote optimal circulation. • Reduce shoreline erosion. • Remove invasive species and replace with diverse native vegetation. • Increase habitat available for migratory fish through removal of fish passage impediment.
TECs (Limited within the USACE Mission) and Target Statements	
Enclosed and Confined Waters	**Target Statements** • Improve water quality in all enclosed waterways and tidal creeks within the estuary to match or surpass the quality of their receiving waters.
Sediment Contamination	• Isolate or remove one or more sediment zone(s) that is contaminated until such time as all HRE sediments are considered uncontaminated based on the all related
Public Access	• Improve direct access to the water and create linkages to other recreational areas, as well as provide increased opportunities for fishing, boating, swimming, hiking, education, or passive recreation.
Acquisition	• Protect ecologically valuable coastal lands throughout the HRE from future development through land acquisition.

Each TEC represents a unique habitat type or complex, ecological service, or value, as described below. Together, the TECs cumulatively define habitat and societal needs that will promote increased biotic diversity, sustainable ecosystem functions, and public enjoyment.

3.1.2.1 Wetlands

Wetlands are established in the estuary's brackish to saline waters of the intertidal zone where there is sufficient substrate stability and nutrient supply. Coastal wetlands, defined as tidally influenced wetlands connected to the open waters of the HRE, historically represented a significant regional habitat complex. Non-tidal freshwater wetlands, including riparian forested and emergent wetlands along watercourses, fringing wetlands along lakes and ponds, and isolated wetlands maintained by groundwater or precipitation, were also historically abundant. Today, almost 99% of freshwater wetlands have been lost in the HRE.

Coastal and freshwater wetlands perform a variety of functions including shoreline stabilization, storage of floodwaters, maintenance of surface water quality, groundwater recharge, and sediment retention, which is important for chemical detoxification, nutrient retention and recycling, and decomposition processes (Seneca and Broome, 1992). The ability of coastal and freshwater wetlands to retain high levels of nitrogen has important implications for eutrophication and nitrogen-loading to the HRE study area; they also have a role in denitrification, by converting stored mineralized nitrogen and returning it to the atmosphere as gas. Coastal and freshwater wetlands also provide valuable habitat for a variety of organisms. Juvenile fish and crustaceans gain refuge from predators and benefit from abundant prey resources in tidal marshes. Deep pools and channels in non-tidal freshwater wetlands also support a characteristic fish community, typically comprised of warm-water species. Wetlands are critical habitat for Waterbirds. Wading birds prey upon resident fishes and invertebrates in wetlands. Migratory waterfowl use wetlands as stopovers during their winter and summer migrations. A variety of mammals use wetlands for foraging, breeding, and refuge. Coastal and freshwater wetlands can also be important areas for recreational boating and fishing, and offer numerous public access and educational opportunities.

3.1.2.2 Habitat for Waterbirds

Although waterbirds include a variety of species that are adapted to life in coastal habitats, including seabirds, shorebirds, waterfowl, and long-legged wading birds, the long-legged waders are the primary focus of this TEC. Nine (9) species of egrets, ibises and herons collectively known as the “Harbor Herons” are known to have inhabited coastal islands for over three (3) decades (Winston, 2015, 2007).

Waterbirds function as important species in estuarine systems, are indicators of ecosystem integrity, and are intrinsically valuable to the public (Bain et al., 2007). Waterbirds consume fish and crustaceans within coastal wetlands and other littoral areas, and, in their natural setting, are sought after by members of the birding community, members of which are often active supporters of ecological restoration initiatives, especially in urban locales. In addition to the important ecological role and the recreational opportunities waterbirds offer, they also function as indicators of ecological health. Through bioaccumulation of contaminants in the food web, bird reproduction can be impaired, leading to diminished or extirpated populations. Species bioaccumulate and biotransform chemicals differently; therefore, contaminants may have different effects on species as they pass throughout the food web (Rand, 1995). In some cases, high concentrations of single contaminants can be as lethal as low concentrations of a mixture of contaminants. Most effects are sub-lethal, in that the effects may manifest themselves singly or as a combination of behavioral (e.g., swimming, feeding, predator-prey interactions), physiological (e.g., growth, reproduction, development), biochemical (e.g., enzymatic, ion levels), or histological (e.g., immune system, genetic, carcinogenic) modifications (Bain et al., 2007).

Long-legged wading birds have experienced a dramatic comeback since the 1960s, when populations were nearly extirpated by centuries of hunting, pollution, and habitat loss. With improved water and habitat quality, herons began populating the uninhabited islands of the Arthur Kill, Kill Van Kull, East River, and Jamaica Bay during the late 1970s (Steinberg et al., 2004). Eight (8) islands and one (1) mainland roost in the study area currently function as nesting rookeries for resident and transient waterbirds (Craig, 2013).

3.1.2.3 Coastal and Maritime Forests

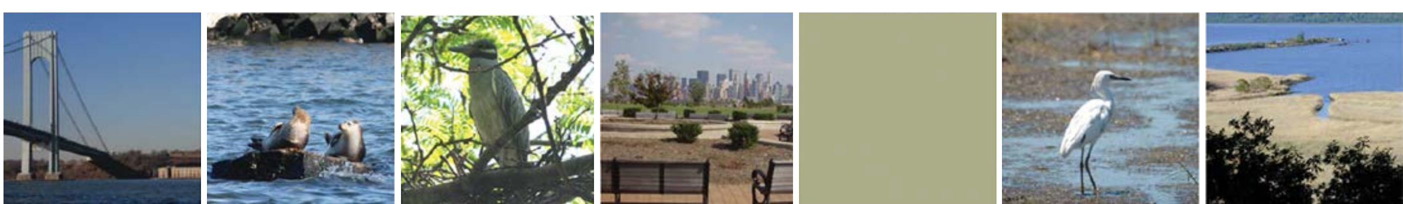
Coastal and maritime forests are regionally rare, ecologically significant plant communities that provide habitat and food resources to support many bird and wildlife species, as well as attenuate waves, stabilize shorelines, and provide soil retention. These systems have become vulnerable to extirpation within the HRE study area and globally.

Maritime plant communities are dynamic systems that occur across a range of fringe seacoast habitats in narrow, discontinuous bands (National Biological Service, 1995). These forests, often described as “strand forests”, are influenced by strong salt spray, high winds, unstable substrates (e.g., dune deposition/shifting), and have characteristically stunted and contorted trees (National Biological Service, 1995, Yozzo et al., 2003, Edinger et al., 2014). Maritime communities are perpetually shifting complexes that interchange in response to the dynamics of the substrate. Beach and dune habitats are the most dynamic of the maritime vegetative communities, being modified by winds and waves, and stabilized by vegetation. When the dunes are altered, this changes the inland shrub and forested lands, bringing them closer to shore, pushing them further inland or even periodically eliminating them. Herbaceous and shrub layers thrive on the outskirts of the forest and in bog areas, behind the dune and swale communities (Bain et al., 2007). Both evergreen and deciduous trees, such as American holly (*Ilex opaca*), oaks (*Quercus spp*.), sassafras (*Sassafras albidum*), shadbush (*Amelanchier canadensis*), black tupelo (*Nyssa sylvatica*), American beech (*Fagus grandifolia*), Eastern red cedar (*Juniperus virginiana*), northern bayberry (*Myrica pensylvanica*), and beach plum (*Prunus maritima*), commonly dominate the forest community (Bain et al., 2007). The species composition can depend upon how connected these communities are to nearby forests on the coastal plain (Bain et al., 2007).

Coastal forests are non-maritime communities found within the coastal plain, but are not exposed to the same intensity of salt spray, wind, and substrate shifting as maritime communities. This results in trees that are of normal stature and not contorted or “salt-pruned”, despite the minor salt spray from severe storms like hurricanes (Edinger et al., 2014). Coastal forests occur on dry, well-drained, low-nutrient soils, do not have dense, vine undergrowth, and have low species diversity typically dominated by few tree species. These communities include oak, hickory (*Carya* spp.), beech, holly, red maple, and pitch pine (*Pinus rigida*) forests (Edinger et al., 2014).

Barrens (i.e., pine barrens) occur on shallow, low-nutrient soils, comprised of stunted or dwarfed trees that are generally adapted to a high frequency of fire (Olsvig et al., 1998). These communities occur on stabilized dunes, glacial till, outwash plains, and rocky soils, and include species such as pitch pine, scrub oak (*Quercus ilicifolia*), post oak (*Quercus stellata*), and blueberry (*Vaccinium corymbo*sum), and huckleberry (*Gaylussacia baccata*) shrubs. Pine-dominated forests blend with pine-oak forests as soil composition changes, but species composition generally stays the same, with only abundance changing. Representative examples outside of the HRE study area include the southern New Jersey Pine Barrens, and the Long Island Pine Barrens, which occur along the glacial outwash plain of the Ronkonkoma Moraine and along the Peconic River. Some pitch pine communities do not require fire regimes to persist and would be viable for restoration in the HRE.

Coastal and maritime forest communities provide a variety of valuable functions to human and natural communities. When overlying coastal aquifers, they typically function as groundwater recharge areas. By providing a vegetated buffer between human development and the water, these forests attenuate runoff from developed areas and provide protection from storm surges and coastal flooding. Coastal areas within the HRE study area are especially vulnerable to threats posed by coastal surges associated with sea level change and coastal storms. In the aftermath of Hurricane Sandy, federal, state, and municipal assessment and planning documents emphasized the need for Natural and Nature-Based Features (NNBFs) that would protect the coastline of the HRE from future storms. The NNBFs (wetlands and dunes) such as those found in coastal and maritime forest communities could reduce coastal risk (USACE, 2013). Coastal and maritime forest restoration opportunities would contribute to coastal storm protection through wave attenuation, sediment stabilization, and dense vegetation that could slow the advance of storm surge, enhancing shoreline resiliency and



sustainability, and providing coastal risk management benefits for surrounding communities (USACE, 2015).

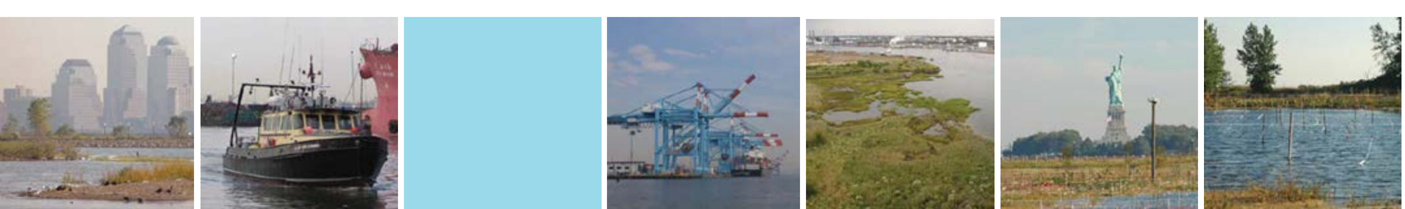
These forests provide a self-perpetuating and increasingly effective permanent erosion control (Brennan and Culverwell, 2004). Many wildlife species depend on these forests for at least a portion of their life history, with requirements for feeding, breeding, refuge, and movement/migration. The diamondback terrapin (*Malaclemys terrapin*) and many shorebirds (e.g., plovers, sandpipers, skimmers, terns and gull species) use sandy soils at the margins of forested habitats inland from dunes for nesting. Some waterbird species (herons and egrets) do not nest in these habitats, but will stage in them during post-breeding dispersal periods. Many maritime/coastal forest tree species are also fruit-bearing and provide an important food source to avian migrants. Most coastal and maritime forests in the HRE study area have been degraded or eliminated by timber harvest and development. Recent encroaching development has increasingly affected and fragmented these communities. Although there have been few attempts to restore these forests, many species in these habitat types are opportunistic and can rapidly colonize protected areas, making restoration of these forest communities in the HRE study area potentially feasible (Yozzo et al., 2003).

3.1.2.4 Oyster Reefs

Oysters were once prevalent throughout the study area. At the time of European settlement, approximately 350 square miles of oyster beds were present in the estuary (Mackenzie, 1996). By the early 19th century, overharvesting of natural oyster populations was so prevalent that the fishery was primarily based on stock brought in from other estuaries to the north and south of New York City (Kirby and Miller, 2005). Today, although the vast majority of oyster reefs in the HRE have been degraded or destroyed by human activities, isolated populations do exist in a few areas, where water quality, hydrodynamics, and substrate conditions combine to promote opportunities for limited reproduction, settlement of spat, and growth.

American oyster (*Crassostrea virginica*) reefs, or beds, provide spatially complex substrate and benthic structure that is important for many estuarine organisms. A well-developed oyster reef will typically consist of intricately layered formations of live oysters on the exterior and layers of old oyster shell forming the base and reef interior. Deep crevices created by the oyster shell provide refuge for numerous species of small aquatic organisms. Oyster reefs are also feeding, breeding, and nursery grounds for finfish and large crustaceans, where multi-species congregations occur (Harding and Mann, 1999). Oyster reefs provide attachment sites for the eggs of many small fishes, such as gobies and blennies, as well as the oyster toadfish (*Opsanus tau*). Juvenile and adult oysters are important prey for gastropods, whelks, sea stars, crabs, and boring sponges. Intertidal oyster reefs provide rich feeding grounds for many shorebird species.

Oysters are valuable organisms that can actually promote the growth and viability of other habitats. By filtering particulate material from the water column, oysters form an important link between the pelagic (i.e., open water) and benthic food webs (Yozzo et al., 2001). Through water clarity improvements, oysters can enhance other subtidal habitats like eelgrass by increasing the amount of light that can penetrate the water (Cerco and Noel, 2007). Investigators have documented measureable water quality effects of reefs soon after construction, including removal of nitrogen, particulate phosphorus, and seston (Dame et al., 1989, Grizzle et al., 2006). In some geographic areas, oyster reefs may develop substantial vertical relief off the sea floor, altering patterns of current flow and possibly creating or expanding shallow water habitat by trapping sediments. Oyster reefs can encourage the growth and



expansion of salt marshes located inshore of the reefs by functioning as natural breakwaters (Coen and Luckenbach, 2000).

Historical accounts from colonial times document flourishing oyster populations in the estuary. Large expanses of oysters in upper Raritan Bay stretched a mile in diameter and were referred to as the “Great Beds.” Populations also existed in the Hudson River and tributaries of Staten Island, although the upstream extent to which they occurred is uncertain (MacKenzie, 1992). Historically, oysters were a keystone species in the HRE study area, providing both ecological functions and an economic role in the region. The oyster fishing industry in the estuary thrived in the mid-late 19th century and was estimated to cover approximately 200,000 acres (Kennish, 2002, Bain et al. 2007). By the early 20th century, poor water quality conditions and incidence of human-transferable diseases resulted in declining harvest and, by 1925, the oyster industry in the estuary was abandoned (MacKenzie 1992). The loss of historic oyster beds permanently altered the structure and functions of the estuary’s benthic ecosystem, and eliminated a significant habitat resource for estuarine fish and invertebrate species that rely on spatially complex submerged structures.

3.1.2.5 Eelgrass Beds

Eelgrass beds are believed to have historically represented a significant habitat complex in the region, but were eliminated as a result of disease, shoreline modification, dredge and fill activities, and water quality degradation by the mid-20th century. During the 1930s, wasting disease, a widespread infection by the slime mold (*Labryinthula zosterae*), decimated Atlantic coast eelgrass populations, including those in the HRE and adjacent waters (Short et al., 1986, 1988).

Eelgrass (*Zostera marina)* is a seagrass, not a seaweed, and is one of the few plants that occur almost exclusively in subtidal waters with marine salinities, utilizing the water column for vertical support (Fonseca, 1992). The Eelgrass Beds TEC represents a habitat that is vertically and horizontally complex, attracting dense and diverse communities of macroinvertebrates, shellfish, and fishes, as well as providing critical nursery habitat for important fishery species. Eelgrass beds support all trophic levels and provide many ecosystem services to the estuary.

Eelgrass can grow rapidly, producing large quantities of organic matter. This primary production supports a complex food web that cycles nutrients between sediments and surface waters (Fonseca 1992). Eelgrass plants produce oxygen and can filter nutrients and contaminants, improving the surrounding water quality (Bain et al. 2007). Eelgrass beds also provide physical benefits to the ecosystem. Wave and current energy is dissipated through the beds, reducing erosion and sediment resuspension, and preserving sediment-dwelling bacteria and fungi (Bain et al., 2007; Fonseca, 1992). Enhanced sediment stability increases the accumulation of organic and inorganic materials (Fonseca, 1992). The improved conditions surrounding eelgrass beds enhance their self-sustainability by providing stable sediment and optimal water quality for eelgrass bed expansion.

3.1.2.6 Shorelines and Shallows

Many natural shorelines have been replaced with bulkheads, revetments, riprap, and dock/pier infrastructure. These structures have eliminated transitional intertidal and littoral areas. Hardened shorelines dissipate but also redirect wave energy, which can increase erosion and deepen nearshore waters, affecting water quality and clarity, and habitat availability. Pier construction has reduced channel width, reduce current velocities, and increase sedimentation. Increased sedimentation reduces available water column habitat and buries existing, natural hard substrates. Shading impacts of

shoreline structures on aquatic flora and fauna are increasingly being recognized in aquatic resource assessments, and recent research conducted within the HRE study area has documented fewer species, lower abundances, and fewer feeding opportunities underneath large over-water structures in comparison to open water, pile fields, or edge habitat (Able and Duffy-Anderson, 2006).

3.1.2.7 Habitat for Fish, Crab, and Lobsters

Physical and chemical habitat alteration has led to changes in the populations of organisms that use the HRE study area. The construction of bulkheads, piers, and placement of shoreline fill have greatly diminished the extent and function of shallow, soft-bottom habitats, rocky outcroppings, wetlands, and sand beaches (Sanderson, 2005). Historically, the littoral zone in the estuary was structurally complex with diverse physical characteristics, supporting resident fish populations as well as attracting large populations of migratory and transient fish for spawning and feeding (Levinton and Waldman, 2006). These complex and productive waters were ideal nursery areas for young fish, particularly where benthic structure and/or plant communities existed. The construction of piers slowed near-shore waters and promoted extensive sediment accumulation, which in concert with other forms of shoreline hardening, contributed to the loss of physically complex habitat, greatly reducing the quality of spawning and nursery areas.

This TEC focuses on the spatial arrangement of aquatic and intertidal habitats like oyster reefs, eelgrass beds, and tidal marshes, which are components of other TECs, as well as non-TEC habitats like soft-bottom, unvegetated mudflats or hard-bottom substrates. Each fish and crustacean species has specific habitat needs, especially during spawning or early development, for specific substrates or structural elements. For instance, vegetated or structurally complex habitats provide refuge from predators, whereas broad, sandy flats may be ideal foraging areas (Bain et al., 2007). The most effective way to sustain or increase fish and macroinvertebrate populations in the HRE may be to restore and/or create mosaics of critical habitats, to provide what habitat was historically lost, as well as expand upon existing habitats (e.g., subtidal shallows, rocky intertidal).

3.1.2.8 Tributary Connections

Streams and rivers are important parts of the landscape providing water, sediment, and nutrients from higher elevations to the estuary influencing water quality and functioning downstream habitats. Land use changes in the watershed, channel straightening, culverts, removal of streambank vegetation, impoundments, and other activities lead to stream instability and adjustments in channel form (Harman et al., 2012). Stream degradation (scour) has resulted from increased streamflow volume and frequency and stream aggradation has resulted from land use practices that have caused increased sediment loads. Restoration of stream functions increases the likelihood of stream stability, thus allowing the watershed and its tributaries to function to transport water, sediment, and nutrients to the ensure and maintain connections between various habitats.

Tidally influenced streams and creeks provide thruways for fish to access habitats across a gradient of abiotic factors (i.e., salinity, depth, temperature, dissolved oxygen, and sediment type). The estuary historically has provided passage for migratory fish populations that would move up the tributaries to spawn. Many migratory or highly mobile fish species require access to upstream areas to spawn because eggs or larvae have specific life history requirements that are very different from juvenile or adult life stages. In addition to benefiting native migratory species, such as American shad, alewife, blueback herring, striped bass, and American eel, re-establishing tributary connections may also benefit resident fish and invertebrate populations by providing greater access to feeding, spawning, and refuge habitats. Several freshwater mussel species (i.e., Family Unionidae) may also benefit from improved fish passage, as they are dependent upon fish movement for dispersal (Peckarsky et al., 1990).

3.1.2.9 Enclosed and Confined Waters

Modified tidal creeks, enclosed basins, and manmade bathymetric depressions with poor circulation are typical of the estuary's waters. These waterbodies are often characterized by a host of degraded conditions, including contaminated sediments, hypoxic/anoxic water masses, noxious odors, hardened shorelines, and accumulation of fine sediments, creating low quality habitat that is of limited use for foraging, nursery, or refuge by estuarine organisms. Numerous enclosed dead-end basins, and deep borrow pits where water quality is impaired due to a lack of circulation and stormwater discharge are found throughout the estuary.

3.1.2.10 Sediment Contamination

Being an urban environment with a long history of anthropogenic influences, the region exhibits sediment contamination to varying degrees brought about by historical industrial discharges, municipal point and nonpoint source pollution, and inputs from upstream of the study area. There are many areas within the estuary that have bottom sediments that exceed the NOAA ecotoxicological guidance thresholds for one or more contaminants.

3.1.2.11 Public Access

Public access to the estuary means providing residents of the HRE study area with accessible routes to natural areas, enabling them to enjoy local scenic, natural, cultural, historic, and recreational resources. Contact with nature can afford numerous public benefits in the form of educational experiences, relaxation, and improved quality of life (Bain et al., 2007). Throughout the HRE's history, there has been a conflict of interest concerning the use of the waterfront. Differing views among government, local communities, and private industries were rarely able to reach a consensus when deciding between urban or natural uses, or some combination thereof, for the waterfront. Often, attempts to create parkland during the 19th century were rejected as being inconsistent with the economic goals and commercial opportunities for the city. By the mid-20th century, views had changed and the focus became renewal and revitalization of urban waterfronts (Wise et al., 1997).

Since then, water quality improvements and a reanimation of recreational activities along the waterfront and within water bodies of the estuary have occurred (Wise et al., 1997). Since the Draft CRP was released in 2009, many collaborative public access planning initiatives have been developed, spurring the design and construction of innovative new publically accessible areas, new parks and public spaces (Boicourt, et. al., 2015; HEP 2005, 2016). A reconnection with the estuary has accompanied these activities, resulting in increased popularity and momentum of community-led environmental programs and restoration efforts. Through environmental improvements and increased community participation in the HRE study area, there has been an increased demand for recreational and outdoor educational opportunities at parks and natural areas.

3.1.2.12 Acquisition

The HRE study area is the most densely populated estuary in the United States, with more than 20 million residents (USACE, 2006a). In addition to residential land use, a large amount of the HRE study area is used for industry and commerce. Approximately 300,000 acres of tidal wetlands and subtidal waters have been filled in the study area and only about 20% (15,500 acres) of historic tidal wetlands remain (USFWS, 1997). Almost all of the approximately 224,000 acres of freshwater wetlands that existed in New York City prior to the American Revolution have been filled or otherwise eliminated (USFWS, 1997). In addition to eliminating much of the HRE study area's aquatic habitat, the construction of bulkheads, piers, and placement of shoreline fill have greatly reduced the physically diverse near-shore habitats (Sanderson 2005). Land acquisition of wetlands and other valuable open spaces has been and continues to be an important means of habitat protection coordinated by state and local organizations. Given the intensity of development in the HRE study area, even low quality undeveloped lands have become a priority for protection.

Implementation and the increase in extent of the TECs contribute to the overall program goal of restoring the HRE through the establishment of a mosaic of habitats that provide society with new and increased benefits from the estuary environment (Bain et al., 2007). The TECs provide the basis for a decisive environmental agenda for the estuary as well as a long-term strategy capable of changing with environmental conditions and human needs (Bain et al., 2007).

3.2 Planning Objectives

Planning objectives were identified based on problems, needs, and opportunities, as well as on existing physical and environmental constraints, present in the study area. Four (4) broad planning objectives with associated sub-objectives were used to guide the formulation and screening of alternatives. All objectives are for a 50-year period of analysis ending in 2070.

3.2.1 Objective #1: Restore the structure, function, and connectivity, and increase the extent of estuarine habitat in the HRE.

This objective includes restoring the quantity, quality, and complexity of wetland, waterbird, and coastal and maritime forest habitat; improving the quantity of eelgrass beds, shorelines and shallows, and habitat for fish, crab, and lobsters; and enhancing tributary connections in estuarine systems.

3.2.2 Objective #2: Restore the structure and function, and increase the extent of freshwater riverine habitat in the HRE.

This objective includes restoring riparian wetlands; improving the quality of waterbird habitat, shorelines and shallows, and habitat for fish, crab, and lobsters; and enhancing tributary connections in freshwater riverine systems.

3.2.3 Objective #3: Restore the structure and function, and increase the extent of marsh island habitat in Jamaica Bay.

This objective includes restoring critical marsh island wetland and waterbird habitat, shorelines and shallows, and habitat for fish, crab, and lobsters; and enhancing wetland habitat connectivity in the Jamaica Bay Planning Region.

3.2.4 Objective #4: Increase the extent of oyster reefs in the HRE.

This objective includes increasing the acreage of oyster reefs in shallow water areas, and improving the quality of shorelines and shallows, and habitat for fish, crab, and lobsters throughout the HRE.

Each objective relates to *specific habitats and geographic regions* – habitats and regions being simply the place where organisms live (Odum, 1971). The structure and function of a habitat greatly influences what types of organisms will live there, how they will live, and if a community will thrive. Table 3-3 illustrates the TECs within the USACE's aquatic ecosystem restoration mission that apply to each planning objective.

Table 3-2: Target Ecosystem Characteristics Applicable to Each Planning Objective.

TECs	Planning Objectives			
	Restore Estuarine Habitat	Restore Freshwater Riverine Habitat	Restore Jamaica Bay Marsh Islands	Increase Oyster Reefs
Wetlands	●	●	●	
Habitat for Waterbirds	●	●	●	
Coastal and Maritime Forests	●	●		
Oyster Reefs				●
Eelgrass Beds				
Shorelines and Shallows	●	●	●	●
Habitat for Fish, Crab, and Lobsters	●	●	●	●
Tributary Connections	●	●	●	

3.3 Planning Constraints and Considerations

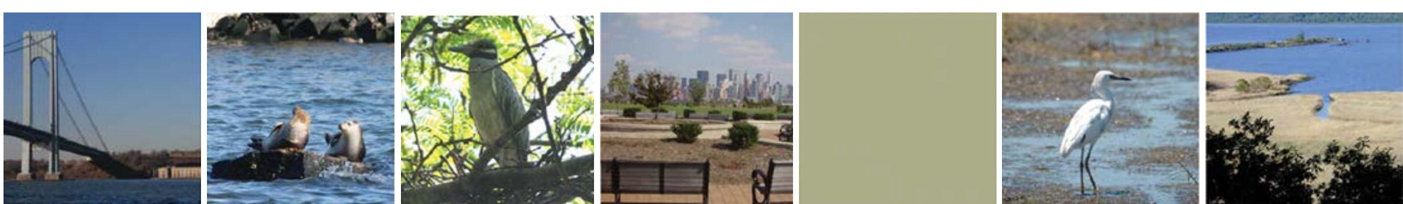
Planning constraints and considerations guide the plan formulation and selection process. The planning team identified a number of constraints and considerations that are unique to the study and study area.

3.3.1 Constraints

Constraints are significant barriers or restrictions that limit the extent of the planning process. Constraints are designed to avoid undesirable changes between without- and with-plan conditions. A number of constraints unique to the study were considered during plan formulation.

3.3.1.1 Physical Constraints

The most obvious constraint on restoration within the HRE is physical. The study area contains many locations where permitted land uses and infrastructure, such as combined sewer outfalls (CSOs), landfills, port terminals, and hardened shorelines, are necessary to society and the economy and cannot be removed without significant secondary costs, which would have to be borne by the federal government in this case. For instance, New York-New Jersey Harbor was once famous for its oysters (Kurlansky, 2006). Many of the oyster beds have been filled for industrial or residential development. While it is technically possible to remove the fill to restore historic conditions, the relocation of the current, associated businesses or homes may be economically and socially infeasible. Conversely, it may be possible to restore some oysters to the estuary by placing them in locations where they did not historically exist, but where physical and chemical properties indicate that the water quality and hydrodynamic parameters would meet their survivability requirements.



In some cases, projects may be sited in areas where stakeholders can directly influence major causes of ecological disturbance, to minimize or eliminate the disturbance (National Research Council, 1992). Sensitive habitats were not proposed for areas prone to disturbance. Populous areas may also not be appropriate for restoring sensitive habitats, because the costs associated with restricting access and safeguarding against vandalism and disturbance from feral or domesticated animals can be prohibitive (National Research Council, 1992). Additionally, restricting access to popular recreational locations can cause community resentment toward future restoration activities. Instead, restoration projects sited in populous areas should be designed to incorporate recreational uses, provide natural settings, and enable residents to gain a greater appreciation for the services habitats provide.

3.3.1.2 Induced Flooding

Restoration should not contribute to or induce flooding. For example, in some cases, restoration of the hydrologic regime of a degraded wetland may not be feasible through removal of existing barriers such as dams or floodwalls that functions to protect the public from potential storm surges.

3.3.1.3 Limitations by Policy and Law

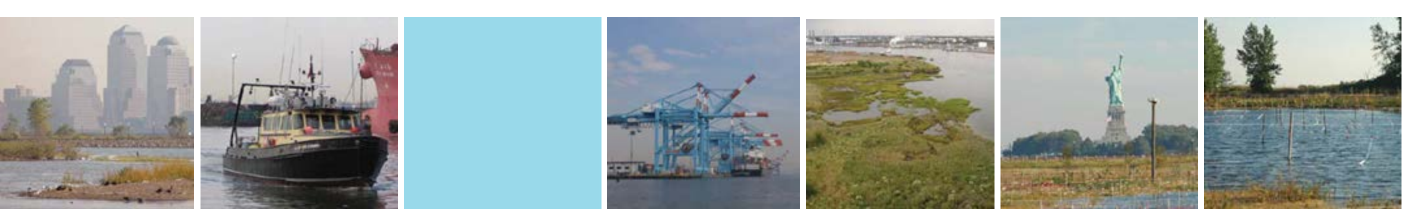
Because the TEC sub-objectives reflect the collective interest of the regional restoration community, some restoration actions are limited within the authority of USACE to implement as a cost-sharing partner under current law. For example, coastal and maritime forest communities are located within many tidally-influenced areas, but also far inland of the shore and beyond lakes and rivers. The USACE is limited in its authority to participate only in the restoration of aquatic habitat. In addition, the inclusion of recreation features may be added to a project if the cost of such measures does not increase the federal share of the total project costs by more than 10 percent.

3.3.1.4 Remediation Actions

Due to the urban nature of the estuary, some sites may contain contaminated material. To the extent practicable during the study, contamination has been considered during plan formulation; there are some areas with known contaminated sites and/or sediment that would require clean-up action by the non-federal sponsor, USEPA, or responsible state prior to construction (e.g., Kearny Point and Oak Island Yard in the Lower Passaic River). Sites that require remediation under a selected restoration alternative will not be restored until a restoration partner remediates the site. Conversely, sites with contaminated sediments that nonetheless do not require remediation may experience benefits to sediment contamination indirectly. This could occur under restoration alternatives that include capping through placement of excavation fill or other measures. The study sponsors recognize that if additional activities are required due to the presence of contamination, the sponsor is required to pay for such activity at 100 percent non-federal expense.

3.3.2 Considerations

Considerations are those issues or matters that should be taken into account during the planning process, but do not necessarily limit the extent of the process as do constraints. A number of considerations unique to the study were considered during plan formulation.



3.3.2.1 Attractive Nuisances

Coastal wetland restoration can become an attractive nuisance in areas where tidal waters have a legacy of contamination. These waters carry suspended sediments and contaminants downstream that eventually settle out of the water column. Any uplands or areas newly opened to tidal exchange would be exposed to these contaminants, which would then accumulate in the restored tidal wetland. The accumulation of contaminated sediments opens exposure pathways for vegetation and wildlife initially through direct exposure and eventually through consumption. Human exposure pathways are unlikely, as entry into restoration areas and harvesting food sources is prohibited.

In the states of New York and New Jersey, creation of both oyster reefs and artificial reefs for lobsters (i.e., fish, crab, and lobster habitat) has regulatory implications, as oyster restoration in prohibited or specially restricted waters creates an attractive nuisance that can lead to human exposure pathways. While New York has regulatory policies that reflect an understanding that the ecological benefits of having sustainable populations in these waters outweighs the potential health risks of consuming poached oysters, oyster restoration in New Jersey is currently permitted only in closed waters with continuous security to prevent poaching (e.g., Naval Weapons Station Earle). Concerns about the potential for economic repercussions may affect the rest of the shellfish industry if tainted oysters were to be consumed. With regard to oysters and lobsters, there is concern that fishing could lead to consumption of shellfish that are unsafe to eat. This would result in the need to restrict harvesting or fishing in these areas and lead to greater enforcement needs and increased costs to the regulatory agencies. However, the ban may be lifted in the near future, as bill S2617 was signed in early 2016. The bill requires the New Jersey Department of Environmental Protection (NJDEP) to adopt new Shellfish Rules to provide improved and expanded research and restoration opportunities.

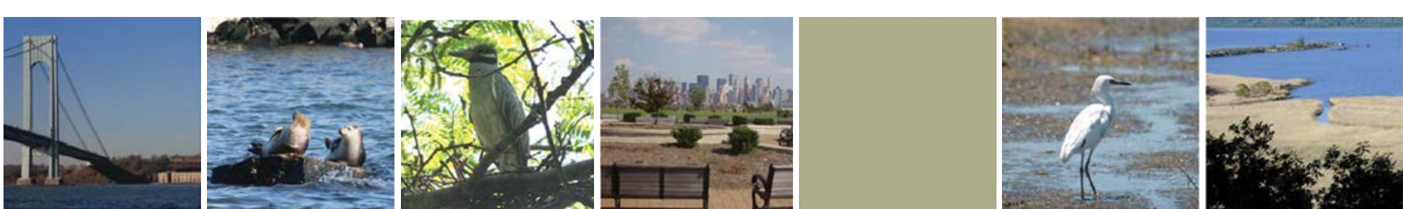
Attracting wildlife to areas where it may create hazards for public safety is another serious concern. For example, migratory and nesting birds in the region are a concern to airport operators, particularly within a five-mile radius of airports (FAA, 2007). Increasing the amount of habitat near airports could attract birds and other animals that are particularly hazardous to aircraft, resulting in an increased number of strikes by planes. Bird and animal strikes are a serious economic and public safety issue in the aviation industry. These concerns are often addressed through cooperative interagency policies, such as Wildlife Hazard Management Plans, that detail preventive measures to reduce wildlife attractants, minimize hazards, and identify responsible parties. This guidance should be an integral component of community land use planning within a five-mile radius of airports and any restoration actions should be planned with full realization and compliance with these plans to maximize the safety of the flying public.

3.3.2.2 Consistency with Current Master Plans

Restoration planning should consider and be complimentary to the many municipal, site, and park master plans. Potential for conflicting objectives exists with respect to zoning and land use. Restoration projects should be sited and designed in coordination with stakeholders to also meet local planning objectives.

3.3.2.3 Synergy with Other USACE Studies and Projects

Recommended actions have been planned in coordination with other USACE studies and projects. Additionally, the purpose of the HRE CRP is to identify potential conflicts and to bring meaningful dialogue to the table with all regulatory agencies and stakeholders, in an effort to make the process run more smoothly and be more transparent from the onset of the process.



3.4 Restoration Opportunities (Initial Array of Sites)

During the development of the HRE CRP, restoration opportunities were identified through a nomination process established by the NY/NJ Harbor Estuary Program Habitat and Restoration Work Groups. For this effort, each potential restoration site was considered an opportunity. Geolgoical Information System (GIS) data related to each TEC were identified and applied in a map overlay procedure to identify broad zones of opportunities that meet the characteristics of each TEC. The data layers included physical parameters such as bathymetry, fetch, and total suspended solids. Water quality and sediment quality were used for some of the TECs, and land use constraints were also incorporated into the spatial analysis. Figure 3-1 illustrates the GIS mapping effort for the oyster TEC to aid in the identification of potential restoration sites (USACE and PANYNJ, 2016).

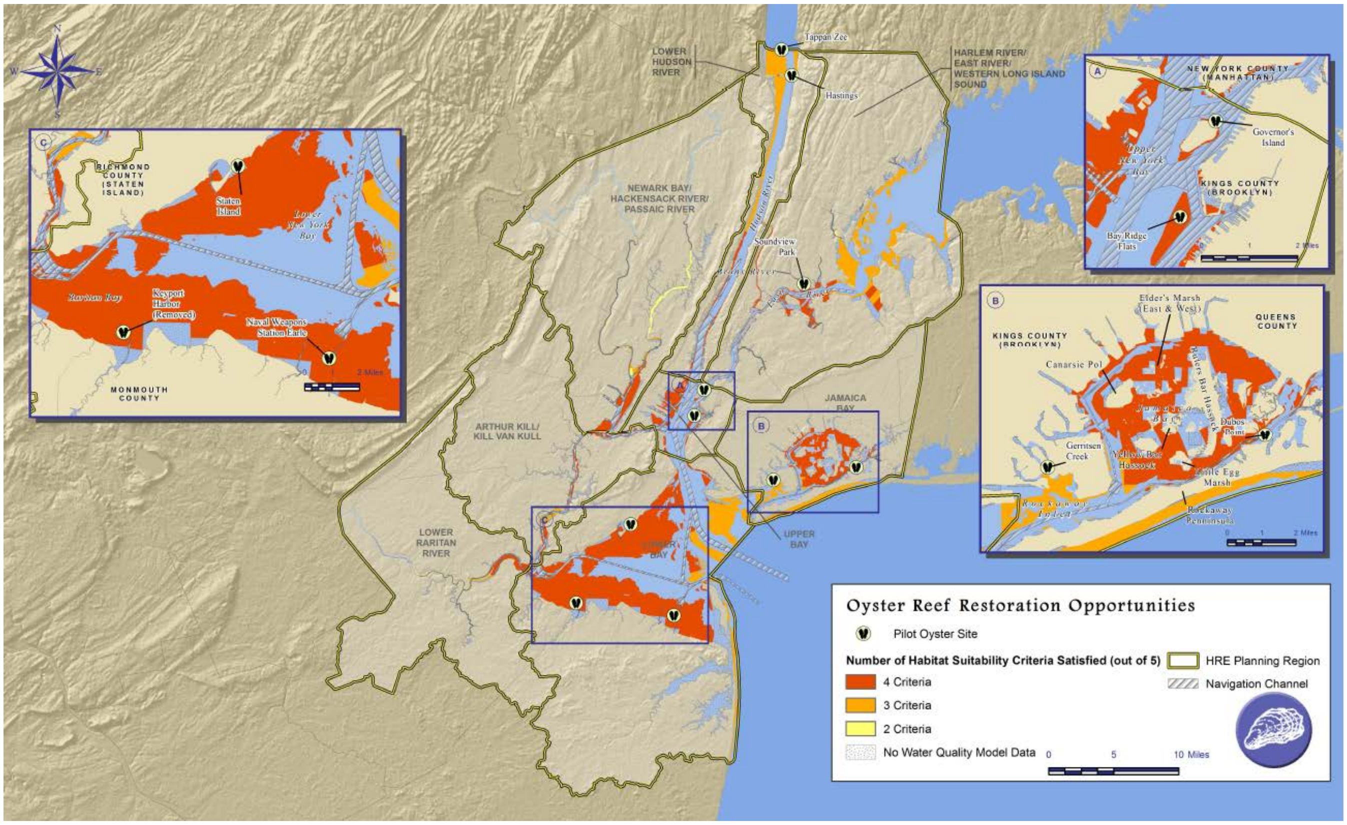


Figure 3-1: Oyster Reef Target Ecosystem Characteristic (TEC) Restoration Opportunities

More than 400 restoration opportunities have been catalogued and reviewed since the Draft CRP was released in 2009. As of March 2016, a total of 296 CRP sites throughout the eight (8) HRE planning regions have been identified as having opportunities for habitat creation and restoration that would address the many water resource problems within the HRE study area and planning regions (Table 3-3). Of those sites, 275 sites are within the purview of the USACE's aquatic ecosystem restoration mission. While hundreds of restoration sites have been identified, additional sites must be identified, nominated, and restored to ensure the ambitious goal of the HRE CRP is achieved. Some of the sites have been or are currently being restored, but most actions are waiting funding, collaboration, design, or permits.

Each planning region was evaluated for potential restoration opportunities that are within the USACE aquatic ecosystem restoration mission. Generally, discrete habitat types are found in differing ranges and densities within each planning region. Most sites within each planning region have similar attributes, problems, needs, opportunities, constraints, considerations, and trade-offs. Thus, whereas most restoration opportunities are similar within a planning region, the types and quantity of restoration opportunities vary greatly between the planning regions, as do the TECs they support.

Table 3-3: CRP Restoration Sites and TECs Identified within each Planning Region.

Planning Region	CRP Sites	Target Ecosystem Characteristics												
		Wetlands*	Habitat for Waterbirds*	Coastal and Maritime Forests*	Oyster Reefs*	Eelgrass Beds*	Shorelines and Shallows*	Habitat for Fish, Crab, and Lobsters*	Tributary Connections*	Enclosed and Confined Waters	Sediment Contamination	Public Access	Acquisition	To Be Determined
Jamaica Bay	46	35	0	28	1	0	23	21	6	16	42	12	8	4
Harlem River, East River, and Western Long Island Sound	48	21	3	20	2	0	19	21	19	9	21	17	12	25
Newark Bay, Hackensack River, and Passaic River	76	46	0	6	0	0	22	31	41	5	62	36	21	9
Upper Bay	7	3	0	0	1	0	3	5	0	1	5	4	1	1
Lower Bay	52	33	1	38	1	1	6	4	15	0	38	23	21	7
Lower Raritan Bay	26	6	0	7	0	0	1	3	5	0	9	6	22	16
Arthur Kill/Kill Van Kull	31	19	2	15	0	0	5	7	15	0	23	9	15	5
Lower Hudson River	10	3	0	6	0	0	4	3	1	0	5	7	2	2
Total	**296**	**166**	**6**	**120**	**5**	**1**	**83**	**95**	**102**	**31**	**205**	**114**	**102**	**69**

***** TEC is within the purview of the USACE's aquatic ecosystem restoration mission.

3.4.1 Jamaica Bay Planning Region

The Jamaica Bay Planning Region has substantial potential for the creation and restoration of a variety of habitats, including wetlands, oyster reefs, eelgrass beds, islands for waterbirds, and coastal and maritime forests. Centered by Jamaica Bay Wildlife Refuge and the Jamaica Bay unit of the Gateway National Recreation Area, Jamaica Bay includes a complex of shallow littoral and intertidal areas, as well as marine habitats that offer the potential for aquatic and wetland habitat improvements. Upland restoration opportunities include improvements to island habitats and coastal and maritime forests. In this region, there is potential to reduce the effects of human disturbance by improving water and

sediment quality in former tidal creeks that are now enclosed basins, and in the bathymetric depressions that experience seasonal hypoxic conditions. A total of 46 restoration opportunities were identified.

3.4.2 Harlem River, East River, and Western Long Island Sound Planning Region

The Harlem River, East River, and Western Long Island Sound Planning Region offers a variety of opportunities to create and restore each of the TEC habitats with extensive shallow littoral and subtidal waters that provide the opportunity to create a variety of aquatic habitat types. Many islands exist within this planning region, representing the potential to improve habitat for waterbirds. There are also many opportunities to reverse human-induced habitat degradation. A total of 48 restoration opportunities were identified.

3.4.3 Newark Bay, Hackensack River, and Passaic River Planning Region

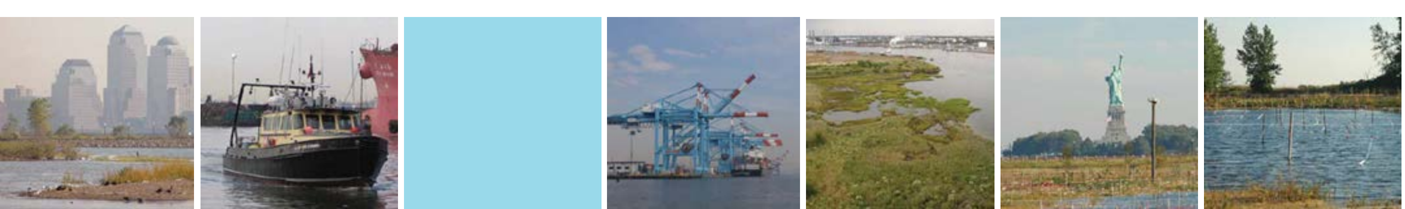
The Newark Bay, Hackensack River, and Passaic River Planning Region offers substantial opportunities to restore coastal and freshwater wetlands, create and restore coastal upland habitats, repair human-induced habitat degradation, and provide increased public access to the waterfront. The restoration opportunities within the Lower Passaic River have specific implementation challenges since the river is part of the Diamond Alkali Superfund Site. A total of 76 restoration opportunities were identified.

3.4.4 Upper Bay Planning Region

The Upper Bay Planning Region is the smallest and among the most urbanized of the HRE planning regions. This planning region is dominated by transportation related uses, with bulkheaded shorelines scattered among shipping terminals, marinas, parklands, public promenades, and vacant disturbed land. A total of seven (7) restoration opportunities were identified including restoration of wetlands, oyster reefs, and fish crab and lobster habitat. Most notably, Liberty State Park was the first HRE site to be recommended in a spin-off Feasibility Study in 2005 and 2006 Chief's Report which was subsequently authorized for construction in Water Resource Development Act (WRDA) 2007, Section 1001(31). The Liberty State Park project provides restoration of the 234 acre including creation of 46 acres of salt marsh, 26 acres of freshwater wetlands, 50 acres of grasslands, and the enhancement of 100 acres of urban hardwood and maritime forest buffer habitat. This restoration will significantly enhance the ecological value of the wetlands and create habitat for fish and water birds. The wetlands will restore bio-diversity to park, provide for treatment of runoff and enhance the habitat for listed species.

3.4.5 Lower Bay Planning Region

Similar to Jamaica Bay, the Lower Bay Planning Region substantial potential for the restoration of a variety of habitats, including oyster reefs, wetlands, eelgrass beds, and maritime forests. The extensive shallow littoral, marine, and intertidal habitats have the potential to offer numerous opportunities for aquatic habitat restoration along southeastern Staten Island and southwestern Brooklyn in New York, and Monmouth County in New Jersey. This region also contains coastal forest restoration opportunities and the potential to reverse some effects of human disturbance. A total of 52 restoration opportunities were identified.



3.4.6 Lower Raritan Bay Planning Region

The Lower Raritan Bay Planning Region includes opportunities to restore wetlands, coastal and maritime forest and to improve tributary connections. Opportunities to improve fish passage and connect habitats along tributaries are throughout the Lower Raritan River Planning Region. This planning region may also represent a substantial opportunity to bring public access to the lower Raritan River and its tributaries. A total of 26 restoration opportunities were identified.

3.4.7 Arthur Kill/Kill Van Kull Planning Region

The Arthur Kill/Kill Van Kull Planning Region offers substantial opportunity to restore coastal wetlands, shorelines and shallows, tributary connections, and waterbird habitat, and to increase existing public access. Coastal wetland creation and restoration opportunities are abundant in the northwestern portion of Staten Island. Islands and the surrounding wetlands throughout the region that had previously established colonies of hundreds of waterbirds represent an opportunity to restore suitable habitat to attract nesting populations again. A total of 31 restoration opportunities were identified.

3.4.8 Lower Hudson River Planning Region

Coastal wetland, shorelines and shallows (living shorelines) and oyster restoration opportunities exist along the Lower Hudson River Planning Region. The high density urban development along the shorelines in this planning region may offer opportunities to enhance shoreline structures and adjacent waters by incorporating habitat features and structures into their designs. A total of 10 restoration opportunities were identified.

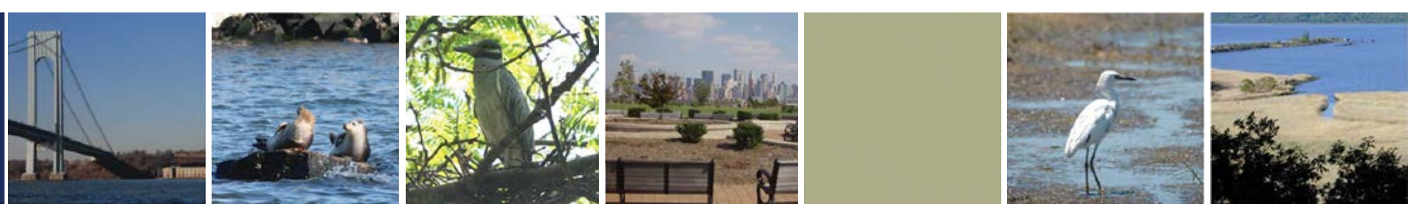
Each planning region is distinct in its combination and distribution of TECs, and contributes in a unique way to the character of the HRE ecosystem. Therefore, the restoration of one (1) site, or all sites within one (1) planning region, cannot meet all objectives, but a plan that includes the restoration of a variety of sites throughout the study area can contribute to developing a mosaic of habitats.

This report is considered an interim response to the HRE Study authorization by this TSP recommending the construction of a subset (33) of sponsor-supported restoration opportunities and allowing for restoration opportunities via “spin-off” studies within each planning region under the same study authority to contribute further to the region’s restoration goals. These studies may start the feasibility phase without competing as a new start, where each spin-off study is considered a new investment decision and would be categorized as a “New Phase” (EC 11-2-214).

3.5 Plan Formulation Strategy

The study formulation strategy is to choose the most cost effective alternative at each restoration site that meets planning objectives, avoids, constraints, and supports the HRE program goal to create to a mosaic of habitats. Most sites within each planning region have similar attributes, problems, needs, opportunities, constraints, considerations, and trade-offs. The formulation strategy revolves around the fact that, generally, discrete habitat types are found in differing ranges and density within each planning region, and thus, most restoration opportunities and management measures are similar within a planning region.

3.5.1 Plan Formulation Strategy for Estuarine Habitat and Freshwater Riverine Habitat (Planning Objectives #1 and #2)



Measures that could address objectives and avoid constraints were combined into alternative plans. Typically, three (3) alternatives were developed for each restoration site. The alternatives represent a range of levels of effort and varying degrees of achieving the desired future condition for each objective over the 50-year period of analysis. The various measures were evaluated, comparing their costs and benefits. Existing conditions and forecasted future with- and without-project conditions were quantified using field data and the Evaluation of Planned Wetland (EPW) ecological model. The alternatives were compared using a cost effectiveness/incremental cost analysis (CE/ICA). The best buy plan that maximized net benefits was ultimately selected for each site.

Best Buy Plans

Best buy plans produce the greatest increase in value at the lowest cost. These plans are typically considered candidates for recommendation in a feasibility study.

3.5.2 Plan Formulation Strategy for Jamaica Bay Marsh Islands (Planning Objective #3)

The USACE successfully constructed five (5) marsh islands in Jamaica Bay (Elders Point East and West, Yellow Bar Hassock, Black Wall, and Rulers Bar) from 2007 through 2012. Lessons learned and cost effectiveness evaluations were used to develop optimal marsh island size and design, and were the foundation of plan formulation for the marsh islands. Using the extensive body of knowledge related to the restoration of marsh islands in Jamaica Bay, one plan for each Jamaica Bay marsh island restoration site was developed. Each plan includes features in its design that best achieves the maximum benefits possible (e.g., optimal water depth and maximum supportable acreage). The plans provide specific frames of reference relating to the restoration of habitat (acres of habitat) and ecological integrity (structural and functional elements that support and maintain a community).

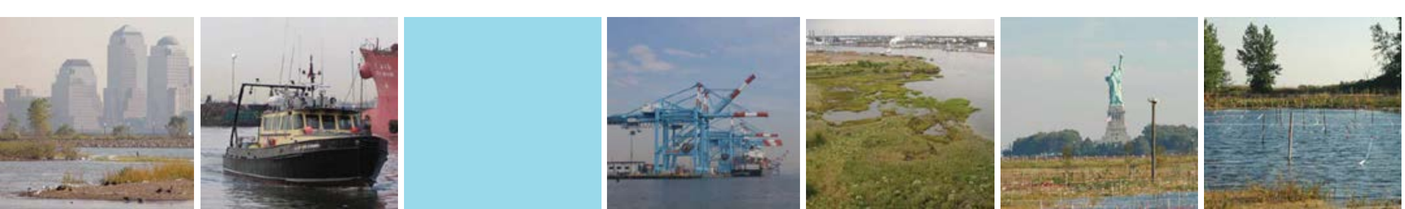
3.5.3 Plan Formulation Strategy for Oyster Reefs (Planning Objective #4)

A number of non-governmental and academic organizations have constructed successful oyster reefs in the study area. The design and extent of proposed restoration sites built upon lessons learned from these projects to design and recommend one (1) plan each at a number of restoration. The site locations were selected to maximize oyster productivity, based on best available science. Using the extensive body of knowledge related to oyster reef restoration, one (1) plan for each site was developed. Each plan includes features in its design that achieves the maximum benefits possible (e.g., acreage that maintains existing hydrology). The plans provide for specific frames of reference relating to the restoration of habitat (acres of habitat) and ecological integrity (structural and functional elements that support and maintain a community).

3.6 Plan Formulation Process: Building on the Past (Identifying the Focused Array of Sites)

The initial array of sites identified in the HRE CRP (Section 3.4), were evaluated and screened as part of the “source” studies using the formulation strategies described in Section 3.5. In addition, sites were also identified as a critical need to meet a planning objective (e.g., marsh islands and oyster restoration). The study builds upon and is informed by the initial plan formulation for, technical work in support of, and decisions made for the six (6) “source” studies.

At the time of integration of the studies, a focused array of sites had been developed for all of the studies except the HRE feasibility study. The formulation logic and results for the “source” studies were incorporated into this FR/EA, as described in the following sections. Figure 3-2 illustrates the overall approach to identify the focused array of sites.



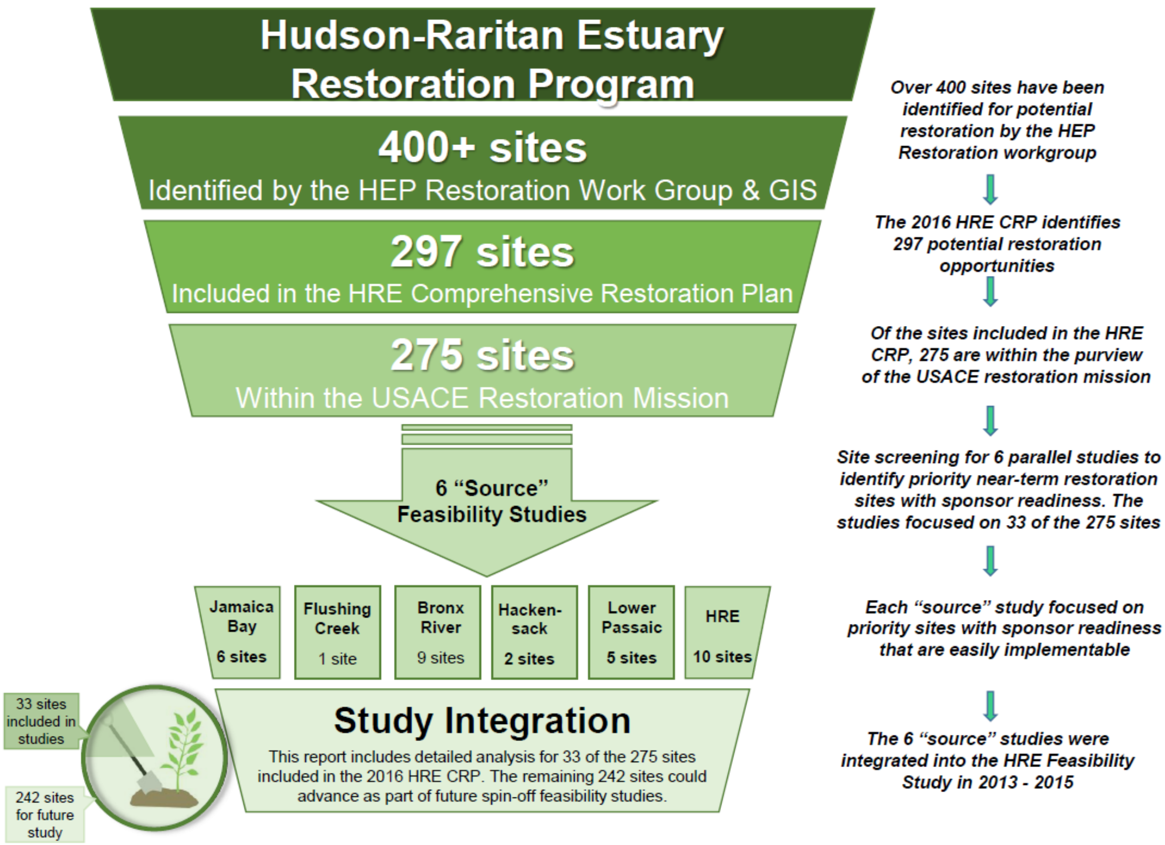


Figure 3- 2: Summary Process for Selecting a Focused Array of Sites for Restoring the HRE Study Area.

The site selection process outlined in the following sections identified a total of 33 sites which would be evaluated further as part of the overall HRE Feasibility Study to characterize water resource problems, select measures (Section 3.7), develop restoration alternatives (Section 3.8) and evaluate alternatives (Section 3.9) at each site. The remaining 242 restoration opportunities could be advanced as part of future "spin-off" feasibility studies that could result in subsequent requests for construction authorization in the future.

3.6.1 Jamaica Bay Planning Region

3.6.1.1 Jamaica Bay Perimeter Sites Screening & Selection Process

A total of 39 restoration opportunities were identified as potential restoration sites. Of these, eight (8) were chosen for more detailed study, design, and implementation. Selection of the eight (8) sites along the periphery of the bay resulted from the following screening process (Appendix E-1):

Initial Screening: The first phase of screening eliminated nine (9) sites with the following characteristics that were expected to greatly increase the monetary costs and reduce the ecological benefits of any restoration proposal, such that the costs would outweigh the benefits. These site characteristics included:

- Real estate held exclusively by private property owners.
- Constraints such as buildings, public roadways, and utilities that did not allow adequate space for the development of viable wetland restoration projects.
- Former industrial uses in which soils had been contaminated.
- Complex, unresolved stormwater management issues.

The initial screening left 30 potential sites for further study.

Second Screening: Since conducting detailed investigations on all 30 sites would have been cost prohibitive, the sites were further screened on the basis of their potential contribution to habitat restoration as determined by a panel of technical experts from various agencies and interested local groups. Based on ecological priority, 12 sites were identified for initial consideration: Gerritsen Creek, Spring Creek, Fresh Creek, Broad Channel, Jo Co Marsh, Ruffle Bar, Dead Horse Bay, Hawtree Point, Brant Point, Dubos Point, Paedergat Basin and Bayswater State Park.

Third Screening: Of the 12 sites, four (4) were screened out as follows:

- Jo Co Marsh and Broad Channel were removed from further consideration by NYCDEP based on water quality modeling.
- Gerritsen Creek was studied and implemented with USACE Continuing Authorities Program (CAP) authorization.
- Ruffle Bar was eliminated as restoration of submerged aquatic vegetation (eelgrass) beds was no longer considered at the time.

Two (2) (including Paerdegat Basin and Spring Creek South) of the eight (8) sites that were originally selected as part of the Jamaica Bay, Marine Park, and Plumb Beach Ecosystem Restoration Feasibility Study for more detailed study, design, and implementation were advanced through other programs and, therefore, were not included as part of this FR/EA. Between 2007 and 2010, the NYCDEP implemented restoration at Paerdegat Basin, and NYSDEC advanced the Spring Creek south perimeter site pursuant a Federal Emergency Management Agency Hazard Mitigation Grant, awarded in 2013. The northern portion of Spring Creek was advanced by the Continuing Authorities Program (CAP) under Section 1135, Project Modifications to Improve the Environment (USACE, 2016).

The six (6) Jamaica Bay perimeter restoration sites included in the TSP represent a set of actions that would work collectively to restore the Jamaica Bay ecosystem.

Jamaica Bay was severely impacted as a result of Hurricane Sandy in October 2012. The Jamaica Bay "Source" Study was then included in the Second Interim Report to Congress per the Disaster Relief Appropriations Act. The ecosystem restoration recommendations were to be reevaluated to provide coastal storm risk management (CSRM) benefits as Natural and Nature Based Features (NNBFs). An initial Assessment was conducted in November 2013 (Attachment 1 of Appendix E-1) and the Feasibility Cost Share Agreement with NYCDEP was amended in December 2013. It was subsequently decided to be evaluated as part of the perimeter plan alternative for the East Rockaway to Rockaway Inlet and Jamaica Bay Reformulation Study. However, as the storm surge barrier was tentatively selected as the Reformulation Study's flood risk management measure, the six (6) remaining perimeter restoration sites are included in the recommendation for the Jamaica Bay Planning Region (USACE, 2016).

Figure 3-3 shows the selected restoration sites in the Jamaica Bay Planning Region. Appendix E-1 includes details of the site screening and selection process and the alternatives development of the perimeter sites in Jamaica Bay.

Figure 3-3: Selected Jamaica Bay Planning Region Perimeter Sites.

3.6.1.2 Jamaica Bay Marsh Islands Screening & Selection Process

The Jamaica Bay marsh islands are at the heart of the complex urban ecosystem of Jamaica Bay that is a part of Gateway National Recreation Area (GNRA), the first urban national park, which was established in 1972. The marsh islands complex is an integral part of the Jamaica Bay ecosystem and has been targeted for restoration by numerous stakeholders.

Approximately 2036 acres of tidal salt marsh were lost from the marsh islands between 1924 and 1999, with the system-wide rate of loss rapidly increasing over time (NYSDEC, 2001). From 1994 to 1999, an estimated 220 acres of salt marsh were lost at an average rate of 44 acres per year. Left alone, the marshes were projected to vanish by 2025, destroying wildlife habitat and threatening the bay's shorelines. In response to these losses, under the USACE’s CAP, NYSDEC and NYCDEP requested assistance in implementing one or more marsh island restoration projects. The lessons learned from the successful construction of marsh island restoration projects are the foundation of the plan formulation strategy:


Elders East- 2007

- A 2006 report titled Jamaica Bay Marsh Islands, Jamaica Bay, NY, Integrated Ecosystem Restoration Report included recommendations for restoration of three (3) marsh islands: Elders Point East, Elders Point West, and Yellow Bar Hassock.

- Activities at Elders Point East marsh island in 2006-2007 involved restoring 43 acres of marsh constructed for mitigation purposes to offset environmental impacts of the New York & New Jersey Harbor Deepening Project (HDP).

- In 2010, the USACE, in partnership with the PANYNJ, NYSDEC, NYCDEP, and NPS restored approximately 40 additional acres at Elders Point West as a result of the beneficial use of dredged material from the HDP.

- The restoration plan for Elders Point East and Elders Point West included restoring the existing vegetated areas and the sheltered and exposed mudflats by placing dredged sand up to an elevation suitable for low marsh growth. This included hand planting more than 700,000 plants grown from local seed stock by the United States Department of Agriculture (USDA) National Resources Conservation Service (NRCS) on Elders Point East and replanting more than 200,000 plants on Elders Point West.


Elders East- 2011

Yellow Bar Hassock, Black Wall and Rulers Bar- 2012

- As part of the New York/New Jersey Harbor-Jamaica Bay Multi-Project Initiative, sand from the Ambrose Channel was beneficially reused from the harbor deepening project to create an additional 87 acres of marsh island habitat within Jamaica Bay. In 2012, 375,000 cubic yards of sand was placed at Yellow Bar Hassock marsh island resulting in 67 acres of new marsh island and approximately 47 acres of wetlands, including approximately 13.3 acres of hummock relocation, 28 acres of low marsh seeding, 17,175 high marsh plants, and 21,859 high marsh transition plants.

- In 2012, Ambrose Channel sand was also beneficially used to restore an additional 30 acres of marsh islands at Black Wall (155,000 cubic yards of sand, 20.5 acres) and Rulers Bar (95,000 cubic yards of sand, 9.8 acres) as part of the USACE's Beneficial Use Program with local partners NYCDEP, NYSDEC, and PANYNJ. NYCDEP and the NYSDEC with local non-profit organizations (EcoWatchers, Jamaica Bay Guardian and the American Littoral Society) completed a community based planting effort to vegetate the 30 new acres created at Black Wall and Rulers Bar with the above referenced plants in June 2013. The successful construction of these five (5) marsh islands is the foundation for the plan formulation of the five (5) additional marsh islands recommended for near-term construction and included in the TSP.

The selection of the location for the next marsh islands for restoration is primarily based on:

- Constructability and existing bathymetry and hydrodynamics in Jamaica Bay.
- Minimum sand volumes for maximum wetland acreage and sustainability.

Figure 3-4: The selected Jamaica Bay marsh island restoration sites.
Appendix E-2 includes details of the site screening and selection process and the alternatives development of the five (5) Jamaica Bay Marsh Islands.

3.6.2 Harlem River, East River, and Western Long Island Sound Planning Region

3.6.2.1 Flushing Bay and Creek Screening & Selection Process

The Flushing Bay and Creek Ecosystem Restoration Feasibility "Source" Study initially proposed six (6) measures for ecosystem restoration and water quality improvements in Flushing Bay and Creek (USACE, 1996):

- Measure 1 - Tidal wetland restoration
- Measure 2 - Freshwater wetland restoration

- Measure 3 - Dredging in Flushing Bay and Creek
- Measure 4 - Partial or total removal of breakwater at LaGuardia Airport
- Measure 5 - Reorientation of the federal navigation channel
- Measure 6 - Bank stabilization, site cleanup and debris removal

Preliminary plan alternatives were developed from the measures and screened or refined as part of the planning process. Twelve (12) alternatives/sites were screened out and not advanced due to a variety of reasons such as real estate requirements, lack of non-federal spronsor support, heavy recreational use of land, water quality modeling results, or small size.

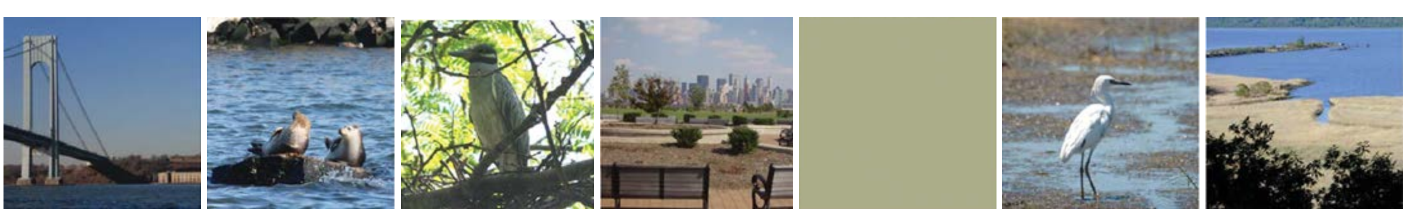
Two (2) restoration alternatives were recommended and evaluated further for full feasibility analysis:

- Tidal wetland restoration in lower Flushing Creek between the Van Wyck Expressway (Route 678) crossing at the mouth, to the tidal gates at Porpoise Bridge beyond the New York City Transit Authority yard and rail crossing. An opportunity exists to restore about 6.5-acres of low tidal marsh where scattered areas currently total about one (1) acre, and to create forest along 2,000 linear feet of the creek.
- Dredging in selected areas of the inner bay and Flushing Creek, which includes the removal of the top two (2) to eight (8) feet of sediments, coupled with replacement of clean sediments for possible beneficial use of dredged material, would reduce concentrations of total organic carbon in the sediments and improve substrate quality, while also reducing the oppressive hydrogen sulfide odor. The dredging alternative could also include re-contouring the bay bottom in the vicinity of high velocity CSO discharges to reduce localized scouring, turbidity, and the conveyance of sediments downstream. Coarse substrate materials could be used to attract fish into the inner bay and creek.

A total of 17 alternatives were developed that focused on variations of Flushing Creek dredging, capping and adjacent habitat restoration within the riparian, tidal wetland, and benthic zones of the project area. The specific project area was located between the Long Island Railroad and the Interborough Rapid Transit Railroad. Alternatives were evaluated using the study specific three-part model which assessed benefits in three (3) distinct restoration zones, a benthic zone, a tidal wetland zone, and a riparian zone using concepts from Benthic Index of Biotic Integrity; terrestrial coefficient of conservatism assessment approaches; wetland variables from the EPW assessment (Bartoldus et al, 1994) and standard forestry metrics. Costs for each alternative were estimated using rough order of magnitude costs which were sufficient to scale and select a restoration alternative.

CE/ICA (IWR-PLAN Beta Version 3.33 software) was used to evaluate 490 alternative plans derived from the 17 alternatives. Screening identified 22 cost effective plans and eight (8) best buy plans. Incremental cost analysis (ICA) was conducted on the best buy plans resulting in the selection of the TSP focused on Flushing Creek dredging and adjacent marsh restoration, including 4.4 acres of riparian restoration, 1.8 acres of wetland restoration on the left descending bank of Flushing Creek, and 4.2 acres of wetland restoration on the right descending bank.

The TSP was not supported by NYCDEP at the time, as the agency wanted the USACE to include additional environmental dredging activities in coordination with NYCDEP's own environmental dredging activities and Long Term Control Plan. Progress was then suspended due to lack of funding, and the study was inactivated and subsequently rolled into the HRE Feasibility Study in 2013. The USACE evaluated subsequent opportunities to integrate additional dredging into the restoration plans; however the dredging measures were not advanced due to cost. NYCDEP decided to consider



advancing the environmental dredging activities in Flushing Creek in parallel with 100% of the costs borne by NYCDEP if implemented.

The site and 2007 selected plan were then optimized further with NYCDEP (Figure 3-5). Appendix E-3 includes details of the site screening and selection process and the alternatives development of the Flushing Creek site.

3.6.2.2 Bronx River Screening & Selection Process

A restoration opportunities report was prepared identifying 330 opportunities within the Bronx River Basin (USACE, 2010). An existing conditions and GIS analysis was developed to integrate data collected from multiple sources in a spatial form to enable prioritization of restoration sites and activities.

The identification of 330 restoration opportunities was guided by relevant TECs developed as part of the HRE CRP, data on habitat impairments, existing catalogues of restoration opportunities as identified by Westchester County or the Bronx River Alliance, and available open spaces. Of these 330 sites, 23 sites were deemed to have federal interest because of their potential for high value habitat restoration and water quality improvements and were selected for further investigation in this study.

Of the 23 sites selected for further investigation, 10 sites were selected for feasibility level analysis based on their potential to contribute to restoration of the watershed and non-federal sponsor acceptability. Two (2) physically contiguous sites, Harney Road and Garth Woods, were combined resulting in a total of nine (9) sites.

Figure 3-5: Selected Flushing Creek and Bronx River Restoration Sites.

Figure 3-5 shows the selected Bronx River restoration sites. Appendix E-4 includes details of the site screening and selection process and the alternatives development of the Bronx River sites.

3.6.3 Newark Bay, Hackensack River, and Passaic River Planning Region

3.6.3.1 Hackensack Meadowlands Screening & Selection Process

In 2004, the USACE, USFWS, and New Jersey Meadowlands Commission - now the New Jersey Sports and Exposition Authority (NJSEA) - conducted the Meadowlands Environmental Site Information Compilation (MESIC) to identify and catalog existing data, assist in creating a strategy for future data collection, and eliminate the potential for duplicating data (USACE, 2004b). The information compilation focused on 50 sites within the Meadowlands and also included data relevant to the Meadowlands as a whole. As part of the HRE-Hackensack Meadowlands Ecosystem Restoration Feasibility Study, the USACE, with the NJSEA, prepared the Meadowlands Comprehensive Restoration Implementation Plan (USACE, 2005). The plan provided a menu of comprehensive, ecosystem-based actions that address the problems affecting the aquatic environs and associated habitats of the Hackensack Meadowlands. The plan is a precursor to the design and construction phases of restoration implementation.

Of the 50 sites identified in the MESIC report, 18 of the sites were identified as critical restoration opportunities by using measures such as:

- Restoring hydrology or wetlands;
- Land ownership, with priority placed on sites owned only by the NJSEA; and
- Presence of contamination.

The 18 critical restoration sites were screened further, with input from USFWS that grouped the potential restoration sites into the following three (3) categories based on presence of contamination:

- Preferred sites;
- Potential sites; and
- Currently unsuitable sites.

- Of these critical restoration sites, the USACE and NJSEA selected two (2) restoration sites (Figure 3-6). Appendix E-5 includes details of the site screening and selection process and the alternatives development of the Hackensack River sites.

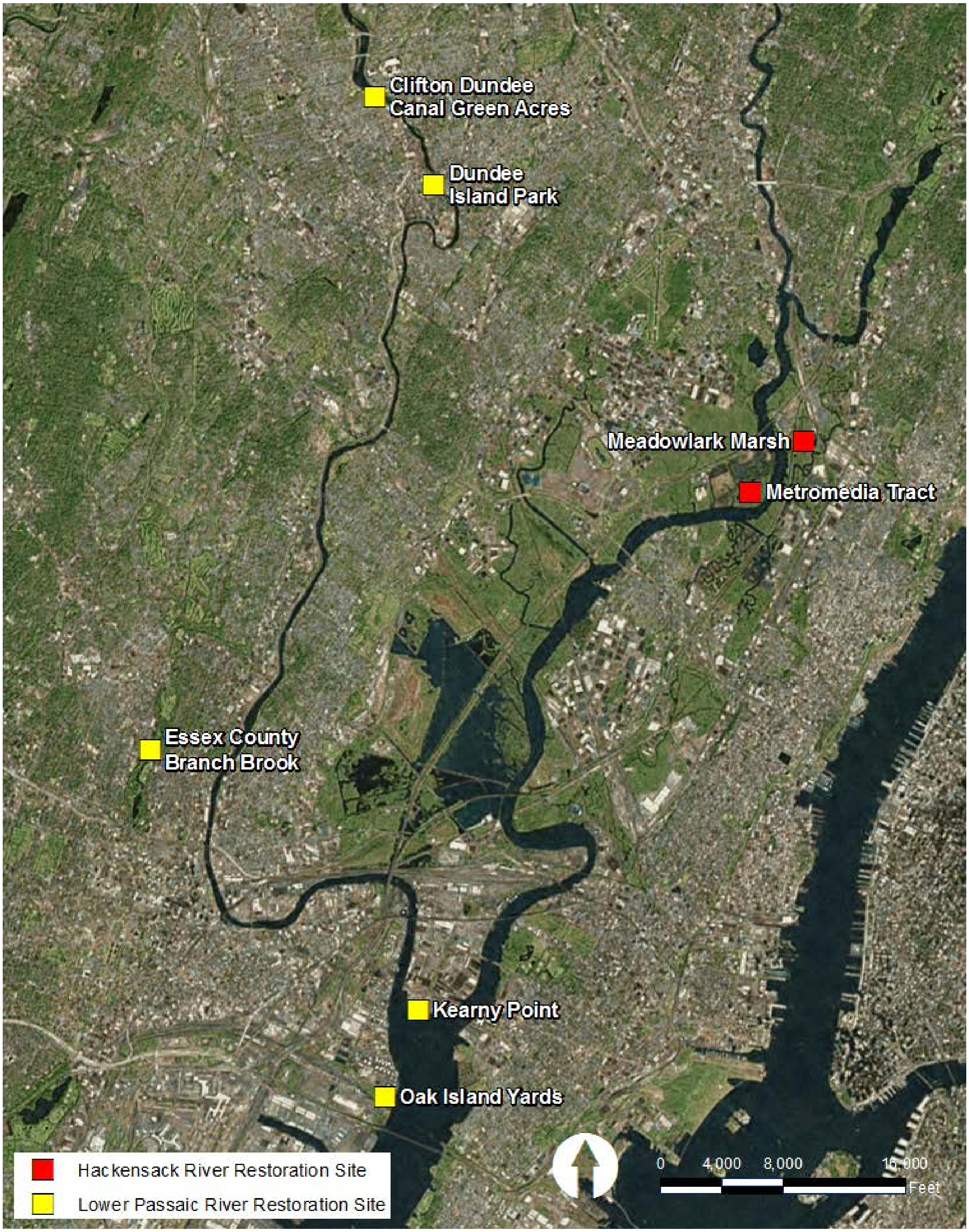


Figure 3-6: Selected Hackensack River and Lower Passaic River Restoration Sites.

3.6.3.2 Lower Passaic River Screening & Selection Process

The project goal of the HRE-Lower Passaic River Ecosystem Restoration Feasibility Study was to coordinate with the USEPA, USFWS, NOAA, and the State of New Jersey, to remediate and restore 17 miles of the Lower Passaic River and its tributaries (i.e., Third River, Second River, and Saddle River). The study was a unique joint program with the USEPA Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Superfund program in order to develop a comprehensive solution for remediation and restoration in the watershed. Proposed CERCLA remedial action decisions and the timing of those actions heavily influenced the sequence and types of restoration actions that could be recommended in the Lower Passaic River study area.

Since 2004, restoration opportunities were identified through public outreach, baseline surveys conducted as part of the coordinated USEPA and USACE Remedial Investigation/Feasibility Study, three (3) Restoration Opportunities Reports (USACE, 2006), and visioning efforts with municipalities within the tributaries and the 17-mile lower river. A total of 52 sites were identified and were grouped into the following two (2) categories:

- Tier 1 sites: Opportunities that can advance without remediation, comprising 29 sites.
- Tier 2 sites: Opportunities that require remediation, comprising 23 sites within the mainstem of the river.

Based on the direction at a re-scoping charrette, the focus was on Tier 1 sites that could be recommended in the near term without requiring remediation from the Superfund program. To advance sites designed at a feasibility study level, a subset of the restoration sites was evaluated further to determine which sites would be advanced in the feasibility study. The following factors were employed in the screening to select up to 16 sites, as outlined in the scope for field investigation:

- Restoration potential, based on TEC type and habitat acreage;
- Land ownership; and
- Known upland on-site contamination.

Of the 16 selected sites, five (5) were eliminated during scope negotiations, based on site access, land ownership, and contamination issues raised. The USACE and NJDEP, the non-federal sponsor, investigated 11 sites in the field, including the collection of EPW data. Included among the 11 sites were two (2) Tier 2 sites for construction following USEPA remedial actions, at Kearny Point and Oak Island Yards.

The USACE held design charrettes with the NJDEP to discuss the sites and the baseline EPW results, and determine which sites NJDEP would support as the local sponsor for construction. NJDEP evaluated the data and conducted two (2) site visits, and selected three (3) sites based on the department's assessment of ecological lift and the state's intent to compensate for natural resource damages on the Lower Passaic River. The three (3) Tier 1 near-term construction sites, which were screened in the Lower Passaic River Feasibility Study, were then evaluated similar to other shoreline sites. Figure 3-6 shows the Lower Passaic River restoration sites that were selected.

The Kearny Point and Oak Island Yards Tier 2 sites were also evaluated further as a result of the original goal and intent of the coordinated CERCLA/Water Resource Development Act feasibility study illustrating the intended coordination with the CERCLA Superfund program, as well as to meet the goals of the project and the restoration of Lower Passaic River. Kearny Point and Oak Island Yards are two (2) mainstem sites providing the most potential for restoration while meeting the project objectives. The evaluation and recommendation of Kearny Point and Oak Island Yard sites are valuable restoration sites that illustrate the coordination of a cooperative comprehensive solution for remediation and restoration indicative of the USEPA/USACE Urban Waters Federal Partnership Program.). Appendix E-5 includes details of the site screening and selection process and the alternatives development of the Lower Passaic River sites.

3.6.4 Small-Scale Oyster Restoration

A number of agencies and nonprofit and academic organizations have constructed successful oyster reefs within the regions. The HRE Feasibility Study builds upon lessons learned from these projects to design and recommend individual plans at a number of restoration sites identified in coordination with potential construction sponsors. The site locations were selected to maximize oyster productivity, based on best available science. In addition, seasonally- and spatially-variable water quality parameters were mapped to identify restoration opportunities and to ensure that the locations of restoration would yield greatest success (USACE and PANY/NJ, 2009a, 2016). The analysis was based on physical-chemical properties (salinity range, dissolved oxygen, and total suspended solids) and bathymetry of the waterbody in comparison with oyster life-cycle needs and habitat characteristics.

Due to overharvesting, pollution, and habitat disturbances, oysters became practically non-existent by the mid-20th century. Oyster reefs and their restoration were identified as a TEC with a target statement to “establish sustainable oyster reefs at several locations.” The Oyster Reefs TEC was assigned a short-term objective of establishing 20 acres of reef habitat across several sites by 2020, and a long-term objective of establishing 2,000 acres of oyster reef habitat by 2050. To accomplish these objectives, the USACE and the construction sponsors—NYCDEP, New York Harbor Foundation, and NY/NJ Baykeeper—proposed small-scale oyster restoration for near-term construction at five (5) locations in four (4)planning regions (Figure 3-7), as follows:

- Head of Bay – Jamaica Bay Planning Region;
- Soundview Park – Harlem River, East River, and Western Long Island Sound Planning Region;
- Bush Terminal – Upper Bay Planning Region;
- Governors Island – Upper Bay Planning Region; and
- Naval Weapons Station Earle – Lower Bay Planning Region.

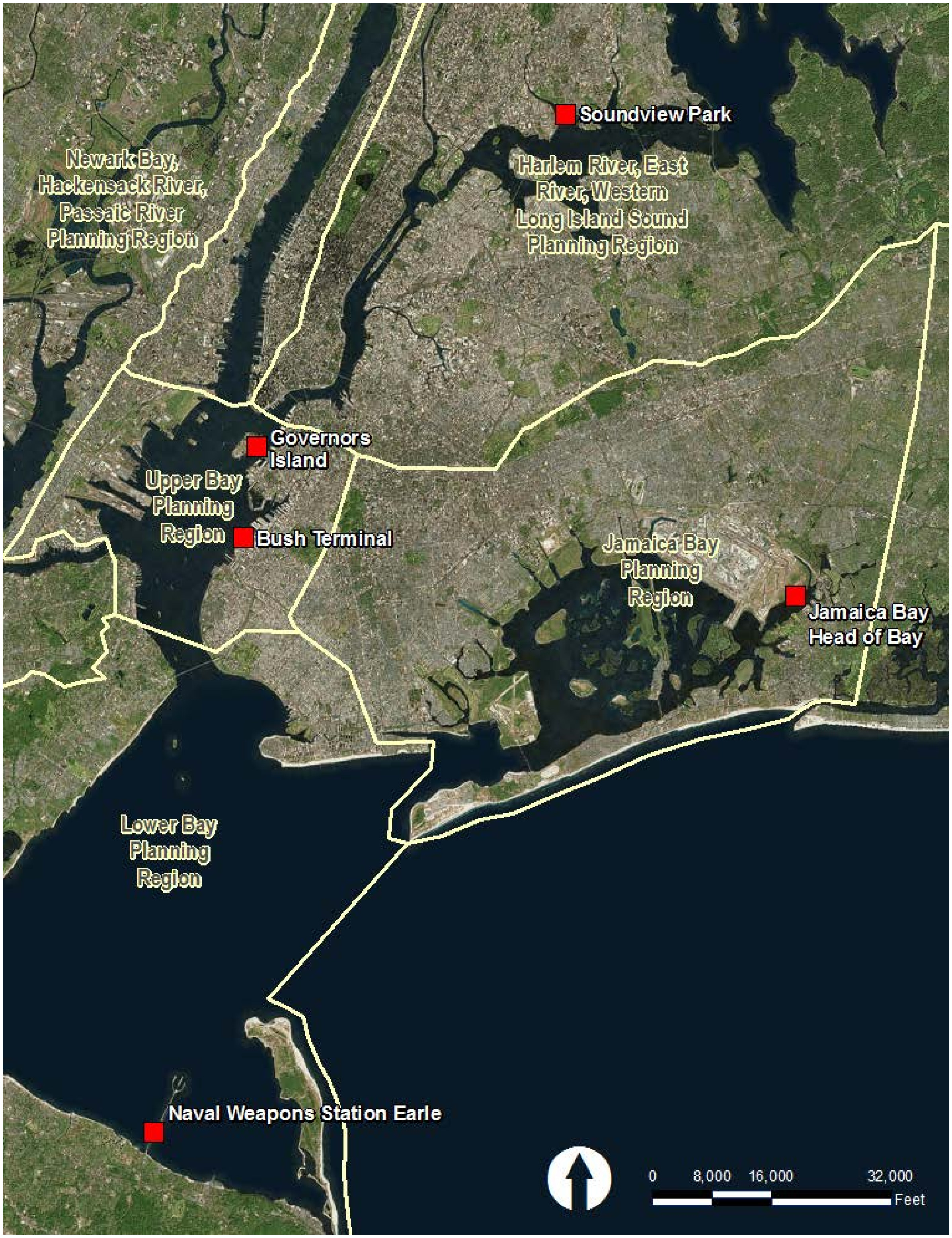


Figure 3-7: Selected Small-scale Oyster Restoration Sites.

3.7 Management Measures

Management measures are features or activities that can be implemented at a specific geographic site to address one or more planning objectives. Structural measures (e.g., wetland creation, construction of fish ladders) and nonstructural measures (e.g., invasive species control) were identified and evaluated. Measures revolved around the planning objectives and TECs. Generally, discrete habitat types are found in differing ranges and densities within each planning region. Thus, most restoration opportunities, and therefore most management measures are similar within a planning region. The study team identified and evaluated cost-effective and site-appropriate measures, scales, and combinations of feature and activity types at each restoration site to improve the native habitats within the site. This supports an intent to develop a mosaic of habitats within each site proper, given the limited opportunities and available habitat within the highly urbanized environment.

Table 3-10 identifies the measures that could enhance TECs. The team combined these measures to generate conceptual plans at each of the sites within the study area, and bundled the conceptual plans for each site to form planning alternatives for the feasibility study. It should be noted that some of the TECs are not within the USACE's ecosystem restoration authority. They are included in the table to capture a complete list of possible measures but were not carried forward for future consideration (these measures are denoted as such). Measures considered include:

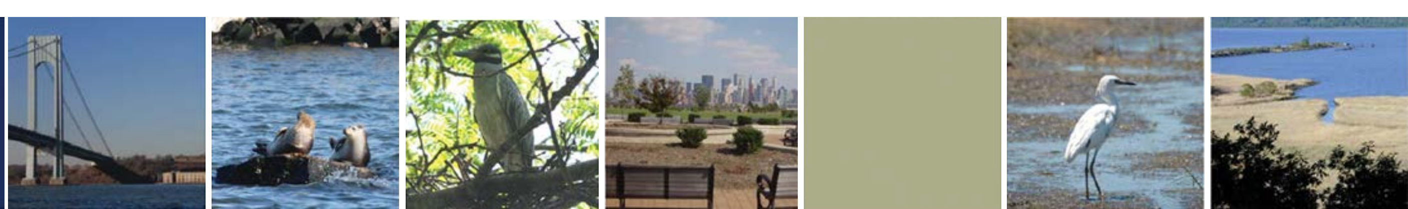
- Habitat restoration and creation (improve biodiversity, biomass, functional habitat);
- Wetlands, forest, riparian, oyster reefs, submerged aquatic vegetation;
- Invasive species removal and replanting;
- Tributary connections improvements;
- Allow upstream and downstream migration of anadromous and catadromous fish through fish ladders, dam removal, weir modifications;
- Restore functional habitat along shorelines;
- Shoreline softening;
- Bank stabilization;
- Hydrologic/hydrodynamic improvements; and
- Channel modification, instream structures, dredging.

Details about each measure for each TEC are included in Appendix E (Alternatives Development).

Table 3-4: Target Ecosystem Characteristics and Proposed Measures.

TEC	Measures	
Wetlands*	• Fill removal • Grading • Hydrologic restoration • Invasive species removal • Native vegetation planting	• Open marsh water management • Sediment/material placement • Wetland creation/restoration • Wetland protection

TEC	Measures	
Habitat for Waterbirds*	• Contaminated sediment removal • Grading • Invasive species removal • Marsh island restoration	• Native vegetation planting • Predatory species management • Sediment/material placement
Coastal and Maritime Forests*	• Associated habitat creation/restoration • Fill removal • Forest creation/restoration • Forest preservation	• Grading • Invasive species removal • Native vegetation planting • Sediment/material placement
Oyster Reefs*	• Deploying live shellfish • Sediment/material placement	• Submarine structure placement
Eelgrass Beds*	• Eelgrass planting • Eelgrass seeding	• Sediment/material placement
Shorelines and Shallows*	• Associated habitat creation/restoration • Bank Stabilization • Fill removal • Grading • Invasive species removal • Native vegetation planting	• Riparian forest and scrub/shrub habitat creation/restoration • Riparian vegetation protection • Shallow water creation/restoration • Shoreline softening
Habitat for Fish, Crab, and Lobsters*	• The Habitat for Fish, Crab, and Lobsters TEC is subject to measures listed above in support of the Wetlands, Oyster Reefs, Eelgrass Beds, and Shorelines and Shallows TECs.	
Tributary Connections*	• Barrier removal • Bed restoration • Channel modification/realignment • Channel modification/realignment with instream structures	• Fish attractor installation • Fish passage system installation • Hydrologic restoration • Sediment control BMP installation • Sediment removal
Enclosed and Confined Waters	• Contaminated sediment removal or capping • Debris removal • Landfill removal or stabilization	• Sediment control BMP installation • Sediment/material placement • Shoreline softening • Water quality BMP installation
Sediment Contamination	• Contaminated sediment removal or capping • Grading	• Hazardous material disposal • Native vegetation planting



TEC	Measures
Public Access	• Fill removal • Public access improvement • Public education • Sediment/material placement

***** TEC is within the purview of the USACE's aquatic ecosystem restoration mission.

3.8 Screening of Management Measures

Several evaluation criteria were used to screen measures for consideration at each restoration site identified in Section 3.6. A measure was considered for use at a site providing it met the following qualitative criteria:

- Meets the planning objectives;
- Avoids planning constraints;
- Observes planning considerations;
- Contributes to achieving TEC objectives within the watershed, as well as in the overall HRE. Measures that address TECs that have not seen much progress may receive priority consideration, as the primary goal is to develop a mosaic of habitats;
- Accounts for technical and institutional significance of resources as components of an estuary of importance under the National Estuary Program in a highly urbanized context;
- Size or scale is conducive to implementation;
- Operations and maintenance would be relatively minor, making restoration as self-sustaining as possible; and
- Performs well with respect to climate change (i.e., sea level change), as some sites are spatially constrained to a narrow strip along a water interface and may lose acreage as the sea level rises.

Screening

Screening is the ongoing process of eliminating from further consideration, based on planning criteria, what is no longer important. Criteria are derived for the specific planning study, based on the planning objectives, constraints, and the opportunities and problems of the study or project area.

A measure was considered only if it met the following criteria:

- Conclusively enhances one or more of the TECs;
- Can be sustained with limited future maintenance;
- Complements adjacent measures and/or future actions proposed by the project sponsors;
- Can be implemented without requiring impractical engineering controls or causing a burden or intolerable hardship on the local community (e.g., without requiring extensive grading or relocation of structures such as highway bridge piers); and
- Increases ecological uplift either alone or in concert with other measures.

3.9 Development of Site-Specific Alternatives

Alternatives were developed for each of the 33 sites to be recommended for near-term construction authorization (Section 3.6.5). Site appropriate measures (Section 3.7) were chosen based on existing conditions, and site-specific problems, opportunities, objectives, constraints, and considerations. Topographic surveys, hydraulic and hydrology analyses, and ecological functional assessments—EPW rapid assessment procedure for wetlands and Stream Visual Assessment Protocol (SVAP) for upstream freshwater sites—were performed to establish, quantify, and evaluate existing baseline conditions.

Measures met the following criteria:

- Help to achieve the objectives;
- Scaled for each site;
- Proven to have been effective on other, similar projects;
- Covered the range of life stages that would occur in the study area; and
- Implementable given site-specific constraints.

Conceptual plans were developed for each potential restoration site (Appendix E). In most cases, measures have been designed to build upon each other, meaning that increased functionality is a product of the interactions of all measures proposed at a given site. At each of the sites in the final array of site plans, each of the recommended measures is needed to fully meet the objective or objectives that will be addressed at that site. Anything less than implementing all of the recommended measures at each site will not be sufficient to meet the objectives.

Appendix K includes a summary of each alternative, environmental outputs and benefits, total project cost for each alternative, and CE/ICA results for each site evaluated.

3.9.1 Estuarine and Freshwater Riparian Restoration Sites

Alternatives were developed through the following multi-step, iterative process in which the sponsors and stakeholders were closely involved. As a benchmark, all restoration alternatives addressed, at a minimum, the most serious environmental stressors at the specific site. The alternatives prepared for each restoration site were developed by varying and combining site-appropriate measures (e.g., wetland restoration, sediment load reduction) aimed at meeting region- and site-specific objectives. In selecting measures, the feasibility study team considered the following:

- The capacity of the measures to address site-specific water resource problems was assessed through comparison with applicable screening criteria.
- Rigorous scrutiny occurred to avoid any measures that were impractical or too costly relative to the ecological uplift provided.
- The various measures for each alternative were selected to work in concert with each other, to provide the greatest ecological uplift for each site.
- The measures for all sites were selected to act synergistically to address key stressors in a particular watershed.

Typically, three (3) restoration alternatives or concept plans were developed, varying the type and magnitude of TECs achievable within the site. The three (3) alternatives comprised the following:

- Alternative A maximizes the restoration potential for each site through the placement of a mosaic of habitats, or TECs, and solutions for stressors of water resources. Typically, this alternative has the highest anticipated restoration benefits and the greatest ecological lift through a range of benefits.

- Alternative B focuses largely on correcting the most significant environmental stressors and restoring targeted habitats and ecological functions for a particular site. The alternative removes key stressors and has moderate to high ecological lift.
- Alternative C focuses on correcting the most significant environmental stressors for a particular site. The alternative has moderate ecological lift, achieved only through removing key stressors.

For the sites included in the Jamaica Bay “source” study (including Dead Horse Bay, Fresh Creek, Hawtree Point, Bayswater Point State Park, Dubox Point, Brant Point), a range of one (1) to six (6) alternatives were developed for each site.

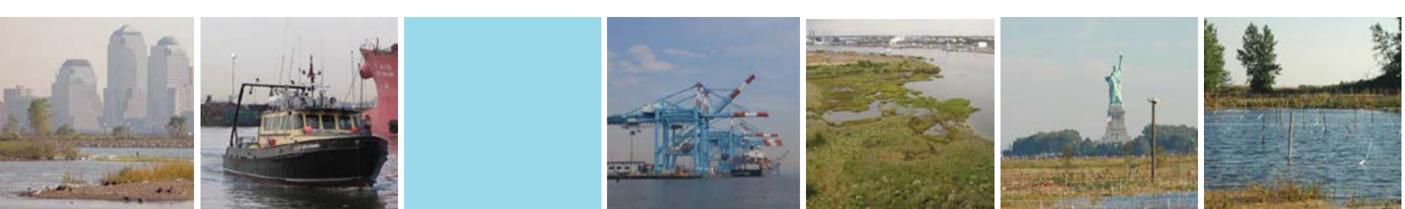
For the site included in the Flushing Creek and Bay “source” study, 12 restoration plans/sites were screened and two (2) restoration alternatives (restoration is Lower Flushing Creek and dredging selected areas of the Inner Bay and Creek) were evaluated in greater detail. A recommended alternative was identified in 2007 following the development and evaluation of 17 alternatives that focused on variations of Flushing Creek dredging, capping and adjacent habitat restoration within the riparian, tidal wetland and benthic zones of the project area. The three (3) additional alternatives presented in this FR/EA resulted from optimizing the previously selected preferred alternative.

Restoration concept designs were discussed with non-federal study sponsors and potential construction sponsors at design charrettes or coordination meetings. Preliminary engineering designs, quantity takeoffs, and preliminary cost estimates were prepared for concept designs.

3.9.2 Jamaica Bay Marsh Islands

Alternatives developed at the five (5) marsh island locations were based on lessons learned and cost-effectiveness evaluations to develop the optimal marsh island size and design. Past construction provided valuable data on how to restore the marsh islands in the most effective and efficient manner. Basic lessons learned that influenced alternative development included the following:

- Ecological output for a given acre of marsh island is constant based on the prior EPW assessments for Elders Point East, Elders Point West and Yellow Bar Hassock and monitoring results of the islands by the National Park Service (NPS) and USACE.
- The cost of marsh island construction is dependent upon existing condition depth and the cost of the sand material and material transport.
- Coordination with New York State Department of Environmental Conservation (NYSDEC) and the NPS recommended that the maximum perimeter of each of the restored islands should not exceed their 1974 footprints, estimated to be the inflection point at which the existing marsh vegetation began to rapidly deteriorate.
- The size of the marsh island is influenced by the amount of contiguous and sustainable acreage within the 1974 regulatory footprint within a given range of elevations.
- The range of acreage at each marsh island has a minimum area driven by cost constraints of mobilization and demobilization of dredging and placement of sand.
- The maximum area/acreage of the marsh island may be described by the existing depth, or contour, at which sand placement becomes more expensive and less cost-effective.
- Approximately 50 percent subsidence of sand following placement of dredged material was assumed.
- The marsh islands selected for future restoration were based on constructability, existing bathymetry and hydrodynamics within Jamaica Bay.



- Past construction and monitoring indicated success of hummock replanting and use of tri-plugs (*Spartina alterniflora*, *Spartina pattens*, and *Distichlis spicata*) with optimal spacing (18-inches on center).
- Plans were developed based on minimum sand volumes for maximum wetland acreage and sustainability.
- Marsh islands also have potential to serve as NNBFs providing secondary coastal storm risk management benefits as suggested by the Structures of Coastal Resilience; http://structuresofcoastalresilience.org/locations/jamaica-bay-ny/.

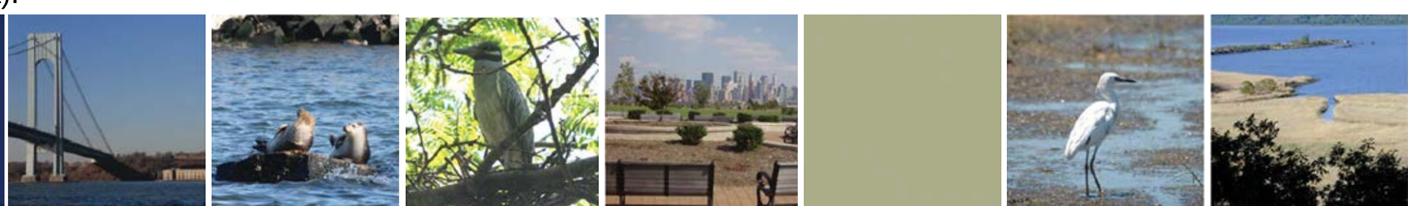
Given the fact that ecological output for an acre of marsh island is constant, cost effectiveness analysis of prior marsh restoration efforts clearly indicated that the primary driver of cost and cost efficiency is the depth of the placement site and the resulting volume of material needed for restoration. Furthermore, prior screenings acknowledged the scalability of the TSP: the final size of the plan could be scaled up or down within limits dictated by the existing condition bathymetry as well as the imposed constraint of the 1974 marsh island footprint without significantly impacting the cost efficiency of the selected plan. It was therefore decided that the best plan development approach for the marsh island restoration efforts recommended here would be to identify and delineate the site specific constraints at each location and to formulate a recommended plan informed by the constraints. The governing constraints used in the design development for each recommended plan are provided below and relate to the lessons learned articulated above:

- Minimum restoration area/volume: a minimum area for each site was defined based on the cost constraints of mobilization and demobilization and the ratio of mobilization and demobilization to the overall project cost such that the cost of mobilization and demobilization is estimated to be less than 30 percent. Of the project costs, placement of this minimum area, and to a lesser extent the size of this minimum area, was informed by the location of the highest existing condition elevations and vegetation, the 1974 footprint and the historic configuration of the marsh island footprint as indicted by historic aerial photography.
- Maximum restoration area: a maximum area for each site was delineated based on existing condition contours. Restoration beyond this contour represents a break point where the per acre cost of restoration increases considerably. This constraint was well defined at some sites and less defined at others and is discussed in detail in the site summaries provided below.
- Sustainability: this constraint consists of a number of related factors including the configuration of the selected plan which is constrained by minimum widths, contiguity, proximity to relatively high velocity currents, and existing channels.

A single alternative was therefore developed for each marsh island based upon these fundamental and governing constraints and the lessons learned from prior efforts. Initial quantity take-offs and costs where then developed and the plans were then further refined based on the guidelines established above.

3.9.3 Oyster Restoration

The oyster restoration recommendations build upon pilot programs that were conducted by regional partners. Initial pilot programs to restore oysters - such as the Oyster Restoration Research Project, a partnership of over 30 not-for-profit organizations, federal agencies, including USACE, state and city agencies, scientists, and citizens - began in the early 2000s. Among the objectives of the Oyster Restoration Research Project is determining the best sites and methods to use in scaling up to large-scale oyster reef restoration in the New York/New Jersey Harbor Estuary (USACE and PANY/NJ, 2009a).



The partnership's initial pilot programs, along with those undertaken by NYCDEP, NY/NJ Baykeeper, The Urban Assembly New York Harbor School, and others, have determined that restored oysters and created oyster beds can survive in the HRE. However, oysters are sessile organisms and offspring are often dispersed into the current with little chance of resettlement. Thus, a more targeted oyster restoration effort in the HRE, as proposed, would advance oyster recovery in key areas of the HRE.

Based in part on its experience restoring oysters in the HRE and on its research findings, the Oyster Restoration Research Project has provided recommendations for future oyster restoration within the HRE. The HRE Feasibility Study builds upon the research provided by these pilot programs, serving as the foundation of recommendations for specific restoration techniques, site considerations, and management of existing reefs. Feasibility-level conceptual plans were developed for small-scale restoration at the five (5) sites in the HRE, incorporating restoration techniques that have been tested during pilot programs implemented between 2010 and 2015. Based on a literature review, information gathered from pilots, and sponsors' recommendations, the designs include combinations of restoration techniques most suitable for the conditions, such as bathymetry, tidal currents, and substrate, at each site.

The proposed oyster restoration sites would create in total over 50 acres of reef structure, which, allowing for natural mortality associated with restoration. It is envisioned that, between the HRE Feasibility Study oyster restoration projects and continuing restoration efforts by the sponsors and other entities in the HRE study area, there will be considerably more functioning oyster reef habitat in the future.

3.10 Evaluation of Restoration Alternatives

Alternative restoration plans were evaluated by conducting the following tasks:

- Assess the benefits by calculating and comparing the differences between the with- and without- project conditions for each alternative;
- Characterize the beneficial and adverse effects by magnitude, location, timing and duration;
- Determine the contribution to the planning objectives;
- Evaluate the contributions to the principals and guidelines accounts;
- Evaluate the contributions to the four (4) principals and guidelines criteria including completeness, effectiveness, efficiency, and acceptability; and
- Estimate first level costs.

3.10.1 Methods for Measuring Ecosystem Benefits

Restoration alternatives were developed and evaluated at each site as described in the plan formulation process (Section 3.6). Restoration alternatives were evaluated through a variety of methods demonstrating ecosystem benefits at each site (i.e., EPW, SVAP, oyster pilot research). To evaluate potential restoration alternatives for this study, it was necessary to measure the benefits expected from the restoration projects.

Metrics for each planning objective revolve around TECs, each of which defines a specific habitat type, habitat complex, support structure, relationship, or societal value. Together, the TECs contribute to the overall program goal of restoring the estuary through the establishment of a mosaic of habitats that provide society with new and increased benefits from the estuary environment. Table 3-11 shows the metrics used to estimate ecosystem benefits for each TEC.

3.10.2 Estuarine and Freshwater Habitat

The EPW functional assessment model was used to estimate ecosystem benefits in terms of ecological uplift at shoreline sites in estuarine and freshwater habitats. The EPW model was certified by USACE for regional use within the entire study area in July 2016. For freshwater riverine sites, the SVAP was used to qualitatively rank stream segments and provide input on benefits from specific restoration alternatives.

Table 3-5: Metrics for Estimating Ecosystem Benefits.

TEC	Metric	Output/Unit
Wetlands	EPW-estimated ecological uplift	AAFCUs[1]
Habitat for Waterbirds	EPW-estimated ecological uplift	AAFCUs
Coastal and Maritime Forests	EPW-estimated ecological uplift	AAFCUs
Oyster Reefs[2]	Kilograms (kg) fish and shellfish. Area gained. Gallons of water filtered	Per one (1) acre of functional oyster reef: 141,570,000 gallons of water filtered daily[3] ~1,050 kg of fish and larger mobile crusteaceans
Eelgrass Beds	EPW-estimated ecological uplift	AAFCUs
Shorelines and Shallows	EPW estimated ecological uplift SVAP estimated stream rank	AAFCUs SVAP score[4]
Habitat for Fish, Crab, and Lobsters	EPW estimated ecological uplift SVAP estimated stream rank	AAFCUs SVAP score
Triutary Connections	EPW estimated ecological uplift SVAP estimated stream rank	AAFCUs SVAP score

[1]AAFCUs: Average Annual Functional Capacity Units from Evaluation of Planned Wetlands (EPW)
[2] Oyster reef restoration benefits are measured by the gain in the extent of oyster habitat providing improved fish and benthic habitat and water quality. Monitoring data collected from regional pilots were used to demonstrate benefits. Metrics for oyster restoration will be further developed between draft and final report.
[3] Assumes 65 adult oyster per square foot.
[4] SVAP: Stream Visual Assessment Protocol

3.10.2.1 Evaluation of Planned Wetlands

The EPW handbook describes EPW as, "*a rapid-assessment procedure for use in determining whether a planned wetland has been adequately designed to achieve defined wetland function goals"* (Bartoldus et al., 1994). The EPW allows the designer and decision maker to identify characteristics that are important to each function and determine how and if the planning goals are attainable.

In the EPW process, the wetland assessment area (WAA) represents a designated wetland area to which the planned wetland will be compared. The WAAs are the restoration sites and the planned wetlands are the design alternatives for the sites. The EPW evaluates a site on six (6) major wetland functions (Table 3-12). The non-tidal stream/river function was the only EPW function used from the fish function category.

Table 3-6: Evaluation of Planned Wetlands Functions.

Function	Definition
Shoreline Bank Erosion Control (SB)	Capacity to provide erosion control and to dissipate erosive forces at the shoreline bank
Sediment Stabilization (SS)	Capacity to stabilize and retain previously deposited sediments
Water Quality (WQ)	Capacity to retain and process dissolved or particulate materials to the benefit of downstream surface water quality
Wildlife (WL)	Degree to which a wetland functions as habitat for wildlife as described by habitat complexity
Fish (FL) Tidal Fish Non-tidal Stream/River Non-tidal Pond/Lake	Degree to which a wetland habitat meets the food/cover, reproductive, and water quality requirements of fish
Uniqueness/Heritage	Presences of characteristics that distinguish a wetland as unique, rare, or valuable

The EPW uses a unitless element score to represent the functional capacity of the physical, chemical, or biological characteristics of the wetland or landscape. The element score range from 0.0 to 1.0, where 0.0 represents unsuitable conditions and 1.0 represents the optimal condition. A low score indicates low potential for functional capacity of that wetland or landscape characteristic and a high score implies a greater potential to increase the wetland or landscape's functional capacity. The element score for each EPW function is used to calculate a functional capacity index (FCI).

The FCI is a dimensionless number ranging from 0.0 to 1.0 that describes a wetland's relative capacity to perform a function, where 0.0 indicates no functional capacity and 1.0 indicates optimal function capacity. The FCI and WAAs are then used to derive the functional capacity units (FCU). The FCIs represent the quality of functional capacity per unit area, whereas the FCUs represent the quantity of functional capacity. FCUs are calculated by multiplying the FCIs times the area of the existing habitat, or the area of the planned or anticipated impact.

The evaluation of each site occurred generally in the summer, during the height of the growing season. The field teams typically consisted of a trained ecologist and engineer who identified biological, hydrological, and soil conditions in the field. Following the completion of the data sheets for all the sites, the data sheets and the resulting FCIs were reviewed and compared to ensure that the various elements were scored consistently across the sites.

The average annual functional capacity unit (AAFCU) is an FCU, which is the area of a habitat multiplied by its FCI for the functions of Shoreline Bank Erosion Control (SB), Sediment Stabilization (SS), Water Quality (WQ), Wildlife (WL), and Fish (FL). The AAFCU are the FCUs realized per year in a given timeframe. AAFCUs provide a measure of the ecological uplift provided by a given alternative plan generated over the 50 year period of analysis. Assumptions made for each year of analysis include:

- Year 2: Assumption that all benefits from water quality, fish and sediment stabilization functions would be fully realized in Year 1. The two remaining functions (wildlife and shoreline bank

erosion control) the benefits would be fully realized by the end of Year 3 for estuarine marsh sites only. This is based on the proposed creation of a predominantly herbaceous intertidal wetland and an anticipated increase in wildlife (bird) usage as the marsh establishes itself and the regraded banks would be further stabilized by the root mat created by the plantings. Riparian sites (Bronx River and Lower Passaic River) would realize all five (5) functions by end of Year 1.

- Year 20: Assumed that stabilized banks would contain 10 percent more wetlands than Year 1.
- Year 50: Assumed that all wetlands would be realized and a 5 percent loss would occur due to erosion.

3.10.2.2 Stream Visual Assessment Protocol

To assess hydrologic and morphologic stream conditions that were not addressed by the EPW, the field team utilized the SVAP, developed by the USDA NRCS in 1998. The protocol is a qualitative field reconnaissance technique that assesses channel and floodplain conditions, riparian areas, water quality, and aquatic habitat. It was developed to assess existing physical conditions within a project site, but may not detect factors originating from the watershed or stream reaches outside of the project limits that affect conditions on the site.

During a site assessment, the SVAP inputs are recorded on a standard two (2)-page worksheet. Up to 15 of the following assessment elements were scored in a range from 1 to 10:

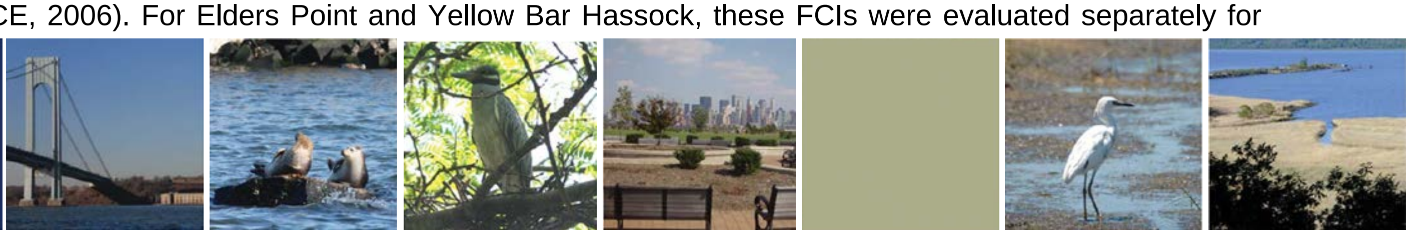
- Channel condition
- Hydrologic alteration
- Riparian zone
- Bank stability
- Water appearance
- Nutrient enrichment
- Barriers to fish movement
- Instream fish cover
- Pools
- Insect/invertebrate habitat
- Canopy cover (if applicable)
- Manure presence (if applicable)
- Salinity (if applicable)
- Riffle embeddedness (if applicable)
- Macroinvertebrates observed

Depending on the existing site conditions, not all elements were recorded. The overall assessment score is created by adding up the scored value for each element and dividing that by the number of the elements assessed. This numerical score is used as a general determination of the overall quality of the stream condition. Any overall assessment score under six (6) is considered poor and any score over nine (9) is considered excellent.

The SVAP evaluations of the restoration sites typically occurred in the summer, during the height of the growing season. The field teams usually consisted of a trained ecologist and an engineer who identified biological, hydrological, and soil conditions in the field.

3.10.3 Jamaica Bay Marsh Islands

Ecological output for a given acre of marsh island is expected to be similar within Jamaica Bay, based on the prior EPW assessments for Elders Point East, Elders Point West, and Yellow Bar Hassock and the results of monitoring of the islands by the National Parks Service and USACE. The EPW process was also applied to the Jamaica Bay marsh islands. Existing acreages for the five (5) proposed marsh islands were estimated from Google Earth aerial imagery. The baseline EPW FCI were derived from an average of the pre-restoration FCI from the Elders Point and Yellow Bar Hassock marsh islands (USACE, 2006). For Elders Point and Yellow Bar Hassock, these FCIs were evaluated separately for



high and low marsh. For each proposed island, the FCIs were weighted by the island's high to low marsh ratios to capture each FCI accurately. These baseline acreages and FCIs were used to calculate EPW in the same manner as the estuarine and riverine sites as discussed above. Proportional changes in each FCI over time were derived from the EPW assessments for Meadowlark Marsh and Metromedia Tract. For Elders Point Center, which has no existing above-water acreage, an average of the other islands' existing FCI were used as a baseline in the AAFCU calculation.

3.10.4 Oyster Restoration

No model exists to adequately document the diverse benefits and value of oyster restoration to meet USACE cost-benefit analysis requirements. Other USACE districts have been seeking methods to address this. For example, USACE Norfolk District and USACE's Engineer Research and Development Center in coordination with Virginia Marine Resource Commission are working to develop a model to estimate ecosystem benefits and services from oyster restoration as part of their common ground activities. This effort will include hydrodynamic and ecological modeling to better define the benefits of oyster restoration. However, based on existing literature, in terms of ecological and functional uplift, any successful oyster restoration effort should be expected to:

- Stabilize the shoreline to prevent erosion;
- Improve habitat quality for vegetation, invertebrates, and fish;
- Improve water quality through filtration of nutrients, water turbidity, nitrogen, phosphorous, and organic carbon; and
- Sequester carbon.

3.10.4.1 Oyster Production

Healthy oyster reefs are self-sustaining and self-renewing. Shells of established oysters act as anchor points for establishment of larvae, leading to further recruitment. The mineral base of oyster reefs is a scaffold of dead shells containing void spaces filled with seawater and organic rich biodeposits (Waldbusser et al., 2013). An installed oyster bed can grow larger through recruitment of wild larvae to become a three-dimensional reef if not destroyed by direct impact, disease, or smothering by sediments. By expanding beds and reefs, oyster species are classified as ecosystem engineers, species that modify and define the surrounding environment (Grabowski and Peterson, 2007). As a reef matures, the extended topography increases rugosity of the benthic habitat, increasing benthic surface area (Hargis and Haven, 1999). Under the ideal tidal zone at 20 to 40 percent exposure, Ridge et al. (2015) found accretion rates of approximately 20 millimeters per year in constructed eastern oyster reefs in North Carolina.

3.10.4.2 Habitat Creation

Oysters are described as a keystone species on the Atlantic coast of the United States (Stanley and Sellers, 1986, Rothschild et al., 1994, USFWS, 2010), as a species whose presence is vital to the structure of the rest of the associated estuarine community. Oyster establishment and growth creates three-dimensional reefs providing habitat for large numbers of species, including vegetation, invertebrates, crustaceans, and fish (Kellogg et al., 2013). Oysters provide hard-bottom habitats that are found to support more productive and higher density invertebrate communities compared to soft-sediment habitats (Grizzle et al., 2013). Oyster reefs also provide complex structures that provide increased attachment points and shelter for marine species (Grabowski and Peterson, 2007). Loss of oyster habitat has been linked to reduced biological production and altered water chemistry (Rothschild et al., 1994), and shifts in estuarine communities from benthic consumer species to phytoplankton and pelagic consumers (Grabowski and Peterson, 2007).

Water filtration by bivalves can reduce phytoplankton, but can also remove diatoms, dinoflagellates, and larva and juvenile stages of other species, shifting the pelagic community (Prins and Escarvage, 2003). Larval, juvenile, and adult oysters also provide a prey resource for invertebrates and fish species, including blue and mud crabs (Stanley and Sellers, 1986).

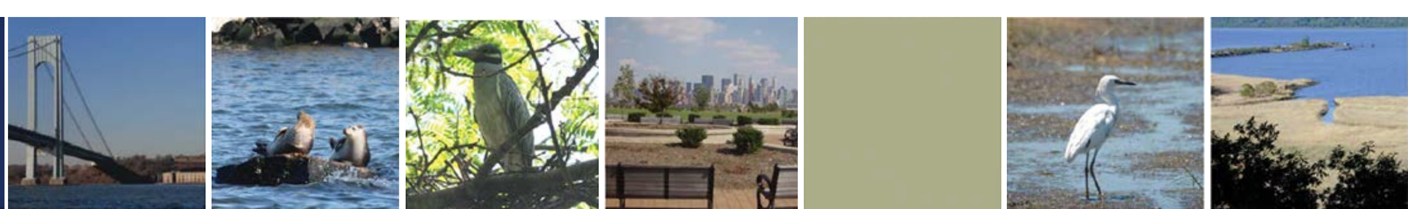
Increased acreage of oyster reefs would also increase habitat complexity in the HRE (Lodge et al., 2015), as the habitat is rare compared to the more dominant mud flat habitat. Increased habitat complexity is associated with increased landscape diversity and production by supporting an increased number of species. Studies examining the marine community associated with oyster beds have found oysters support a distinct invertebrate and fish community versus mud flat habitat (Zimmerman et al., 1989; Lodge et al., 2015). In studies in the HRE, several epibenthic (e.g., *Balanus, Crepidula*) and infaunal taxa (e.g. *Gemma, Mulinia*) were common to both mud flat and oyster bed habitats, but infauna dominated the mud flat communities while epifauna dominated the constructed oyster bed communities (Grizzle et al., 2013).

The increase in benthic community productivity associated with established oyster bed habitat is believed to improve productivity of economically important fish populations. Striped bass (*Morone saxatilis*) and Atlantic sturgeon (*Acipenser oxyrhynchus*), both high-value fish species of the HRE, utilize oyster reefs as habitat (USFWS, 2010). Zimmerman et al. (1989) found a 20-fold increase in fish density in oyster reef habitats versus mud bottom habitats in the Gulf of Mexico. Analysis of marine habitats of the southeastern United States has shown increases in commercial species due to oyster reefs. Peterson et al. (2003) estimated that 10 square meters of functional restored oyster reef can yield an additional 2.6 kilograms of fish and large mobile crustaceans per year, and Grabowski and Peterson (2007) calculated that an acre of oyster reef could result in an increase of $40,000 of value for finfish fisheries. Scyphers et al. (2011) found constructed reefs enhanced blue crab populations by 297 percent, and approximately doubled populations of other sport fish.

3.10.4.3 Sediment and Shoreline Stabilization

The hard structure of oyster reefs, in both intertidal areas and further offshore in deeper subtidal waters, may function to moderate wave climate and potentially reduce shoreline erosion from storm events and vessel wakes (USACE, 2016 and PANYNJ, 2009). With increased reef elevation, up thrusting reefs can divert and modify surrounding currents (Hargis and Haven, 1999). Diverted/slowed currents can lead to increased particle settlement. Large reefs (or series of smaller reefs) can act as natural wave attenuators, protecting nearby shorelines and other aquatic, tidal, and terrestrial habitats. Oyster beds/reefs seaward of salt marshes may enhance/supplement the ability of marshes to stabilize shorelines and moderate wave energy (USACE, 2016 and PANYNJ, 2009).

Experiments by Meyer et al. (1997) showed that installing oyster beds at the base of mid-Atlantic tidal wetland sites reversed soil erosion, which preserved the tidal wetland habitat. Sediment loss of 1.3 to 3.2 centimeters/year was reported in sites without oyster beds, compared to sediment gain of 2.9 to 6.3 centimeters/year. The resulting accretion of sediment consistently slowed or reversed loss of marsh vegetation. While sites without oysters showed slow declines in marsh vegetation limits, the addition of oyster clutches (groups of oysters clustered together) was shown to cause a mean net marsh advance of 0.26 meters/year (Meyers et al., 1997). Shoreline retreat has been reduced by as much as 40 percent by constructed oyster reefs (Scypher et al., 2011).



3.10.4.4 Water Filtration and Nutrient Sequestration

Filtration of water by oysters can improve water quality. Oysters filter water while feeding, thereby removing sediment and other particles from the water and depositing it on the bottom in pellets called pseudo-feces. Adult oyster can filter up to 50 gallons of water a day (Luckenbach, 2009). A two (2) year old oyster filters 4.09 liters/hour while an eight (8) year old oyster is capable of filtering 13.29 liters/hour (Paynter et al., 2010). This removal and deposition of organic material can act as a buffer against eutrophication by removing nitrogen, carbon, and phosphorous from the water column, and depositing it in the sediment, where it becomes buried.

Filtration by large numbers of oysters can reduce the time that sediment remains suspended in the water column and increase the clarity of the filtered water. Recent modeling evaluated an increase of up to fifty times the 1994 oyster biomass and estimated such increases would increase summer bottom DO, summer average surface chlorophyll, and summer average light attenuation (Cerco and Noel, 2005). Oysters' pseudo-feces are rich in nutrients and, therefore, help to support primary production among bottom-dwelling organisms in areas immediately surrounding oyster bars. Local nutrient enrichment also stimulates the exchange of various forms of nitrogen and nitrogen compounds from one part of the system to another (Newell et al., 2002).

Oyster populations remove substantial amounts of planktonic N and P from the water column and enrich bottom sediments (Newell et al., 2004). Oysters produce feces (digested particles) as well as pseudofeces (ingested particles that are not digested). Oysters (and mussels) maintain high clearance rates even when seston concentrations are high and therefore, have the unique ability to greatly influence benthic-pelagic coupling (Newell et al., 2004). The natural processing of the oyster's pseudofeces in shallow water can result in denitrification (the direct removal of nitrogen from the water) under aerobic conditions (Newell et al., 2002). Under aerobic conditions, P release to the water column from bivalve deposits is negligible (Newell et al., 2004).

Each of these factors is often elevated in waters adjacent to urban areas, such as the HRE. Removal of seston and nutrients from the water column eases the oxygen debt of the water. The organic molecules are digested and deposited, rather than settling to decay, which can cause an oxygen debt, and anoxia in extreme conditions.

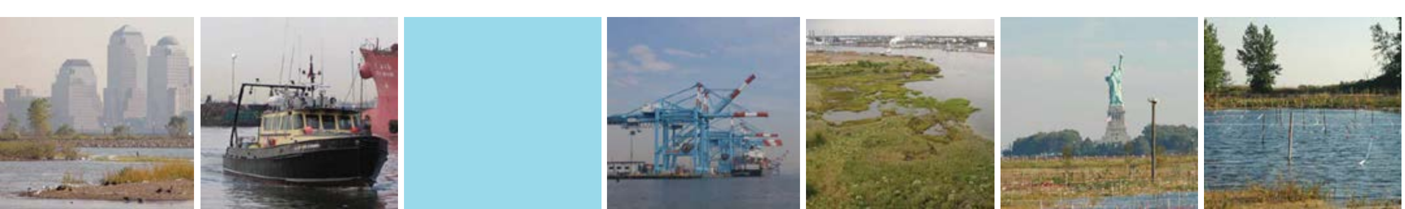
3.10.4.5 Carbon Sequestration

Fully functioning, biogenic oyster reefs engage in a form of biosequestration, acting to store carbon dioxide by fixing carbon into their CaCO3 shells. The fixed carbon is effectively removed from the carbon cycle and eventually fixed into limestone. Estimates project that oysters are capable of sequestering carbon at a rate comparable to other high-performing carbon sequestration restoration efforts such as reforestation (Appendix E-6: Oysters). High salinity oyster bars with dense oysters have the greatest potential to play a serious role in carbon sequestration and efforts to abate climate change.

3.11 Development of Cost Estimates

3.11.1 Estuarine and Freshwater Habitat

Preliminary cost estimates were developed for each Lower Passaic River, Hackensack River, Bronx River and Flushing Creek alternative as follows:

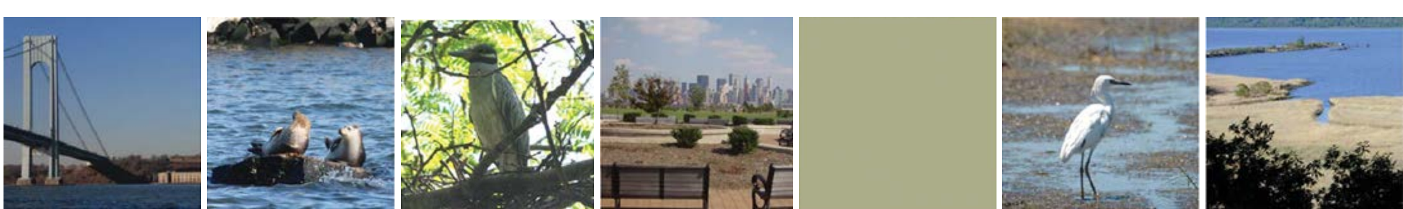


- A comprehensive "Materials List" was prepared that tabulated all potential measures proposed for each alternative.
- Quantity take-offs were prepared for each restoration alternative using the conceptual design drawings. The quantity take-offs provided quantities for each of the applicable measures that were tabulated on the "Materials List."
- A single preliminary Micro-Computer Aided Cost Estimating System (MCACES), Second Generation (MII) estimate was then prepared. This MII estimate served as a "library" estimate in which a reasonable current unit price was calculated and documented for each of the measures shown on the "Materials List."
- A preliminary estimate was then prepared for each alternative applying the current unit prices calculated within the MII 'library' estimate against the quantities generated by the take-offs.
- Account 01 – Lands and Damages: Costs of $6,800 per site were used as a placeholder to acquire fee title or easements until additional detailed real estate is evaluated at each site.
- Account 30 – Planning, Engineering and Design: Costs ranged from 20.5 to 30.5 percent of construction costs.
- Account 31 – Construction Management: Costs ranged from 9.0 to 14.5 percent of construction costs.
- Monitoring costs were assumed to be one (1) percent of construction costs.
- Adaptive management was assumed to be three (3) percent of construction costs.
- Contingency ranged from 29 to 40 percent per results of Abbreviated Risk Analysis.
- Operations, Maintenance, Repair, Rehabilitation, and Replacement (OMRR&R) costs were included in the Adaptive Management Costs.
- Costs are first costs only, where fully funded costs (escalated per the mid-point of construction) will be calculated between the draft and final FR/EA.
- Costs were presented as current year (i.e., fiscal year 2016) values without escalation.

For the Jamaica Bay perimeter sites, conceptual first and implementation costs were prepared for each alternative in 2003 (USACE, 2003) (Table 3-7). These cost estimates were used for the CE/ICA evaluation to select the TSP which was approved at the Alternative Formulation Briefing in 2010. The fully funded cost estimates were certified by the USACE Walla Walla Cost Engineering Mandatory Center of Expertise. The fully-funded MCACES estimate prepared in 2008 for the TSP for each of the six sites were updated to present costs at the 2016 price level. The estimate update entailed a MCACES "translate and reprice" function to the latest available MII cost book. The estimate update also entailed revisions to the labor, equipment, material, and subcontractor unit costs to an effective pricing date of April 2016. Select quantities were also updated to conform to the most recent conceptual design information.

3.11.2 Jamaica Bay Marsh Islands

The construction cost estimates for Jamaica Bay Marsh Islands were developed in MCACES, Second Generation (MII) using the appropriate Work Breakdown Structure (WBS) and based on current estimated quantities provided by the Hydraulics & Hydrology Engineers. The cost estimate was developed from these quantities using cost resources such as RSMeans, historical data from similar construction features, and MII Cost Libraries. The contingencies were developed based on input to the Abbreviated Risk Analysis (ARA) (template provided by the Cost Mandatory Center of Expertise, MCX, Walla Walla District). These contingencies were applied to the construction cost estimates to develop the Total Project First Cost.



Costs are presented for the Jamaica Bay Marsh Islands as one alternative and separately for the five (5) selected sites: (1) Stony Creek, (2) Duck Point, (3) Pumpkin Patch East, (4) Pumpkin Patch West and (5) Elders Center.

3.11.3 Oyster Restoration

Cost estimates for oyster restoration were prepared in the same method as the estuarine and freshwater habitat.

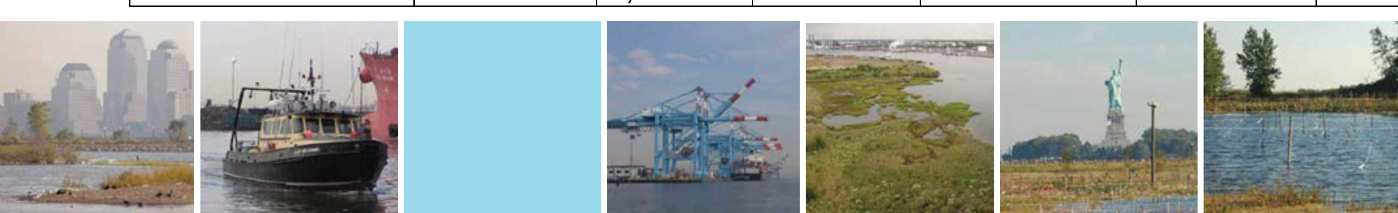
3.12 Summary of Site Benefits and Costs

3.12.1 Estuarine and Freshwater Riparian Sites

Table 3-7 provides an overview of the benefits (Appendix E) and costs (Appendix L) for the restoration alternatives that were evaluated through a variety of methods demonstrating ecosystem benefits at each site. For estuarine and freshwater riparian restoration sites, EPW ecological functional assessment model was conducted in 2015 to document baseline conditions at the site and compare among restoration alternatives demonstrating the ecological lift of each. SVAP scores are also presented for freshwater riparian sites illustrating water quality benefits from each alternative.

Table 3-7: Ecological Benefits and Costs of Each Alternative for Estuarine and Freshwater Riparian Habitat Site.

Site	Alternative	Costs		Benefits		
		Total First Cost ($1000)	Avg. Annual Cost ($1000)	Total Area (acres)	AAFCU[2]	SVAP[4] (baseline)
Jamaica Bay Planning Region						
Dead Horse Bay[1]	1	*23,615*	*1,269*	131	116	-
	2	*26,197*	*1,407*	131	166	-
	3	*31,864*	*1,712*	130	334	-
	4	**82,769** *34,885*	**3,274** 1,874	131	413	-
Fresh Creek[1]	1	*5,057*	*272*	22.2	88	-
	2	*5,231*	*281*	22.2	119	-
	3	*8,388*	*451*	40.6	126	-
	4	*8,259*	*444*	22.2	208	-
	5	**45,473** *10850*	**1,933** *583*	48.5	246	-
Hawtree Point[1]	1	**1,463** *327*	**57** *18*	1.77	6.5	-
Bayswater Point State Park[1]	1	*1,007*	*54*	3.31	41	-
	2	**5,815** *2,507*	**230** *135*	4.41	76	-
	3	*3,751*	*202*	5.41	69	-
Dubos Point[1]	1	*1,464*	*79*	6.8	24	-
	2	*2,192*	*118*	6.8	27	-
	3	**9,560** *2,919*	**378** *157*	6.8	58	-



Site	Alternative	Costs		Benefits		
		Total First Cost ($1000)	Avg. Annual Cost ($1000)	Total Area (acres)	AAFCU[2]	SVAP[4] (baseline)
Brant Point[1]	1	*2,091*	*112*	8.7	12	-
	2	**7,480** *3,641*	**296** *195*	8.7	27	-
Marsh Islands[3]						
Stony Creek	1	30,520	1,209.53	51	122.2	-
Duck Point	1	27,780	1,100.94	27.9	65.2	-
Pumpkin Patch East	1	37,950	1,503.98	35.3	63.3	-
Pumpkin Patch West	1	20,040	794.19	16.3	29.9	-
Elders Point Center	1	20,730	821.54	16	17.9	-
Harlem River/East River/Western Long Island Sound						
Flushing Creek[5]	A	5,900	233.0	2.42	12.48	-
	B	17,500	691.0	12.04	16.93	-
	C	20,000	789.0	12.52	17.74	-
River Park/West Farm Rapids Park	A	4,050	154.78	0.33	0.380	6.1 (4.3)
	B	4,000	152.87	0.33	0.379	6.0 (4.3)
	C	2,510	95.93	0.06	0.069	5.9 (4.3)
Bronx Zoo and Dam	A	6,340	242.59	1.38	2.038	5.3 (3.9)
	B	4,950	189.41	1.11	1.692	5.3 (3.9)
	C	3,850	147.14	0.92	1.369	4.9 (3.9)
Stone Mill Dam	A	720	27.7	0.03	NA (Fish Ladder)	7.1 (6.2)
	B	650	25.0	0.03		7.0 (6.2)
	C	490	18.8	0.09		6.3 (6.2)
Shoelace Park	A	25,010	959.25	2.84	3.304	7.1 (4.8)
	B	18,610	713.78	0.41	0.462	6.3 (4.8)
	C	8,850	338.23	0.39	0.364	5.5 (4.8)
Muskrat Cove	A	7,840	300.70	0.64	0.757	6.9 (5.9)
	B	8.050	308.75	0.64	0.766	7.0 (5.9)
	C	4,090	156.50	0.07	0.095	6.5 (5.9)
Bronxville Lake	A	21,210	813.50	4.68	7.469	5.8 (2.9)
	B	14,530	555.97	3.39	5.342	4.9 (2.9)
	C	13,150	503.17	0.96	1.613	4.6 (2.9)
Crestwood Lake	A	27,610	1,058.97	5.97	13.267	5.9(3.8)
	B	14,000	536.33	2.32	6.154	4.8 (3.8)
	C	12,610	482.51	1.70	5.185	5.4 (3.8)
Garth Woods/Harney Park	A	7,200	275.83	1.78	3.227	6.6 (6.5)/ 5.8 (4.0)
	B	6,490	248.63	1.22	2.442	6.6 (6.5)/ 5.0 (4.0)
	C	3,750	143.49	1.22	2.263	6.6 (6.5)/ 4.7 (4.0)

Site	Alternative	Costs		Benefits		
		Total First Cost ($1000)	Avg. Annual Cost ($1000)	Total Area (acres)	AAFCU[2]	SVAP[4] (baseline)
Westchester County Center	A	24,560	515.5	5.09	9.642	7.7 (5.9)
	B	14,520	555.0	3.70	7.259	7.2 (5.9)
	C	13,490	940.8	3.68	6.112	6.4 (5.9)
Newark Bay/Hackensack River/Lower Passaic River						
Metromedia Tract	A	32,510	1,285.27	68	187.1	-
	B	49,800	1,968.82	59.4	202.72	-
	C	36,600	1,446.97	59.3	198.37	-
Meadowlark Marsh[6]	A	63,700	2,475.32	77.33	306.02	6.63 (5.55)
	B	56,400	2,191.65	84.35	307.25	6.63 (5.55)
	C	41,660	1,618.87	82.64	292.22	5.55 (5.55)
Oak Island Yards	A	29,640	1,134.14	11.44	30.77	-
	B	29,960	1,146.38	11.40	29.03	-
	C	28,160	1,077.51	11.39	29.54	-
Kearny Point	A	81,650	3,172.84	57.89	145.00	-
	B	75,520	2,934.64	54.04	135.01	-
	C	57,790	2,245.67	51.77	125.27	-
Essex County Branch Brook Park	A	74,690	2,898.93	53.33	142.82	8.73 (4.45)
	B	74,390	2,887.29	42.88	103.30	6.55 (4.45)
	C	21,890	849.61	35.90	99.70	6.18 (4.45)
Dundee Island Park	A	2,720	103.71	0.47	1.29	-
Clifton Dundee Canal Green Acres Site	A	11,950	457.25	5.99	14.43	-
	B	10,750	411.33	2.88	8.36	-
	C	9.530	364.65	2.81	6.74	-

[1]*Cost estimates for Jamaica Bay perimeter site alternatives in italics represent 2008 implementation costs (Appendix L)* used in the CE/ICA conducted to select the TSP approved at the 2010 Alternative Formulation Briefing. **Bolded costs are updated 2016 price level for TSP alternative.**
[2]Average Annual Functional Capacity Units (AAFCUs)
[3] AAFCUs projected from EPW evaluation from Elders Point East, West and Yellow Bar Hassock field efforts.
[4] Stream Visual Assessment Protocol (SVAP) scores represent year 20 after construction
[5] Flushing Creek Alternative A and Alternative C are reversed in the appendices.
[6] SVAP scores for Meadowlark Marsh were only assessed for a small portion of the site that was freshwater.

3.12.1.1 Oyster Restoration

Table 3-8 provides an overview of the benefits (Appendix E) and costs (Appendix L) for the oyster restoration alternatives that were evaluated through a variety of methods demonstrating ecosystem benefits at each site.

As discussed previously in Section 3.1.2.4, oysters and oyster reefs can provide a variety of benefits to a local ecosystem from carbon sequestration, to habitat diversity, wave attenuation to water filtration. Due to the irregular nature of a mature oyster reef, many of these benefits can only be quantified on a

site specific basis. However, with respect to water quality, an adult oyster can filter 50 gallons of water a day. USACE research in the Chesapeake indicates that on a mature reef, 700 adult oysters per square meter (approximately 2.8 million oysters per acre) can be found on a mature reef with varying numbers of spat (USACE, 2010). Assuming just the benefits of adult oysters only, one (1) acre of oyster reefs can theoretically filter in excess of 141,570,000 gallons of water filtered daily.

For this particular project, most of the oyster reefs are sited on rather featureless, muddy bottom habitats. The placement of the reefs would add structural diversity to the marine bottom and significantly increase biomass. Based on data presented in 3.1.2.4, it can be extrapolated that the reefs, once mature, can result in over 1,000 kg of fish and benthic invertebrates per acre.

Table 3-8: Ecological Benefits and Costs of Small-Scale Oyster Restoration.

Planning Region	Site	Costs		Benefits	
		Total First Cost (1000)	Average Annual Cost (1000)	Area (acres)	Description
Jamaica Bay	Head of Jamaica Bay	820	31.19	2.0	• Improve habitat quality for invertebrates, fish and vegetation • Improve ecosystem function • Improve water quality through filtration of nutrients, water turbidity, nitrogen, phosphorous, organic carbon • Carbon sequestration • Stabilize shoreline to prevent erosion • Wave attenuation. • 141,570,000 gallons of water filtered daily per acre of functional oyster reef • Approximately1,050 kg of fish and larger mobile crustaceans
Harlem River, East River, and Western Long Island Sound	Soundview Park	760	28.94	0.97	
Upper Bay	Bush Terminal	32,950	1,274.63	43.72	
	Governors Island	4,880	188.13	4.13	
Lower Bay	Naval Weapons Station Earle	7,420	285.65	7.6	

3.13 Cost Effectiveness/Incremental Cost Analysis (CE/ICA)

CE/ICA was performed using the Institute for Water Resources (IWR) Planning Suite certified version 2.0.6.1 to evaluate and compare plan alternatives at each site in order to select the TSP (Appendix M). The suite is a water resources investment decision support tool, built by the USACE IWR for the formulation and evaluation of ecosystem restoration alternative plans. The CE/ICA approach is consistent with the Principles and Guidelines planning paradigm.

3.13.1 Estuarine and Freshwater Riparian Restoration Sites

CE/ICA was conducted on alternatives at 16 sites in the Lower Passaic River (with exception of Dundee Island Park), Hackensack River, Bronx River and Flushing Creek. CE/ICA was conducted on individual sites to determine which alternative was considered the best buy plan and the most cost effective for each site.

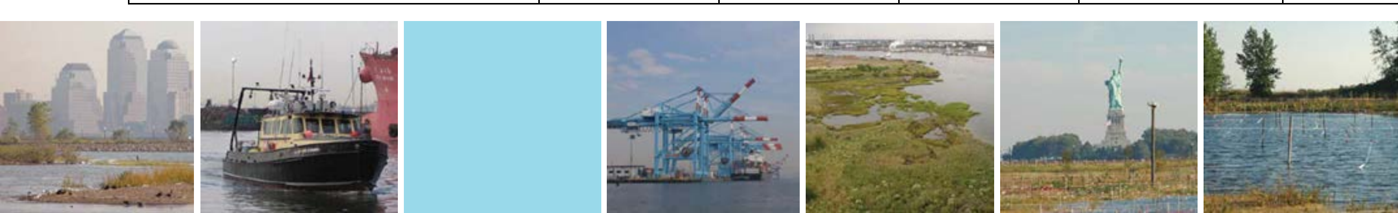
Costs were amortized at the FY2017 discount rate of 2.875% over a 50 year period of analysis. The 50 year total wetland AAFCU scores were the benefit metric that was assessed in CE/ICA. Site locations were assessed for plan efficiency and effectiveness by comparing the AAFCU output performance and the cost of management measures of various scales, including a no-action plan. The alternative scales used for each site were A, B, and C; with A typically being expected to provide the greatest ecological uplift, followed by B, and then C which is expected to provide the least ecological uplift.

The cost effectiveness analysis ensures that the least cost plan is identified for each possible level of environmental output; and that for any level of investment, the maximum level of AAFCU output is identified. The best buy and cost-effective plans are identified by an algorithm that measures plans along a frontier of higher output with lower costs. ICA calculates the cost per additional AAFCU of the best buy plans only, which allows for comparison of best buy plans across the site study area. All outputs for the CE/ICA are presented in Appendix M.

In most cases, the TSP was identified as the best buy plan which had the least cost per AAFCU. If two alternatives were identified as the best buy plans, SVAP results were considered to select the TSP alternative. Table 3-9 presents the results of the CE/ICA outputs for each alternative at each of the 16 sites.

Table 3-9: CE/ICA Results (Cost/Average Annual Functional Capacity Unit) for Each Alternative (Best Buy Plan bolded).

Site	Avg. Cost ($1000)/Average Annual Functional Capacity Units (AAFCU)			Best Buy Plans	Most Cost Effective
	A	B	C		
Flushing Creek	**18.64**	40.88	44.57	A, B, C	A
River Park/West Farm Rapids Park	407.33	**403.36**	1,390.26	A and B	B
Bronx Zoo and Dam	119.03	111.94	**107.48**	A, B and C	C
Stone Mill Dam	NA				
Shoelace Park	**290.33**	1,544.97	929.21	A	A
Muskrat Cove	**397.22**	403.07	1,747.35	A and B	A
Bronxville Lake	108.92	**104.08**	311.94	A and B	B
Crestwood Lake	**79.82**	87.15	93.06	A	A
Garth Woods/Harney Park	**85.47**	101.81	63.41	A and C	C (TSP A)
Westchester County Center	97.58	**76.54**	84.35	A and B	B
Metromedia Tract	**6.87**	9.71	7.30	A, B and C	A
Meadowlark Marsh	8.08	7.13	**5.50**	B and C	C
Oak Island Yards	**36.86**	39.49	36.48	A and C	C (TSP A)
Kearny Point	21.88	21.74	**17.93**	A and C	C
Essex County Branch Brook Park	20.30	27.95	**8.52**	A and C	C
Dundee Island Park	80.39	-	-	A	
Clifton Dundee Canal Green Acres Site	**31.69**	49.14	54.18	A	A



***Selected Alternative Cost/AAFCU is Bolded**

3.13.2 Estuarine Restoration- Jamaica Bay Perimeter Sites

In 2010, 32 restoration alternatives, including the no–action alternative, for the original eight (8) Jamaica Bay sites were analyzed through the IWR PLAN Decision Support Software. Each of these eight (8) sites contributes to the overall degradation of the Jamaica Bay area and their restoration would work towards solving the water resources problems.

Elements that affected the performance of measures over the course of the 50 target years included tidal energy, shore protection measures, maturity periods of habitat types, and proposed habitat proportions for each of the 32 measures. Since ecosystem restoration outputs are not monetary, they were not discounted. Restoration costs were calculated in terms of present worth using the 2010 rate of 4 7/8% and annualized. Annualized costs and average annual restoration outputs were input into IWR-PLAN.

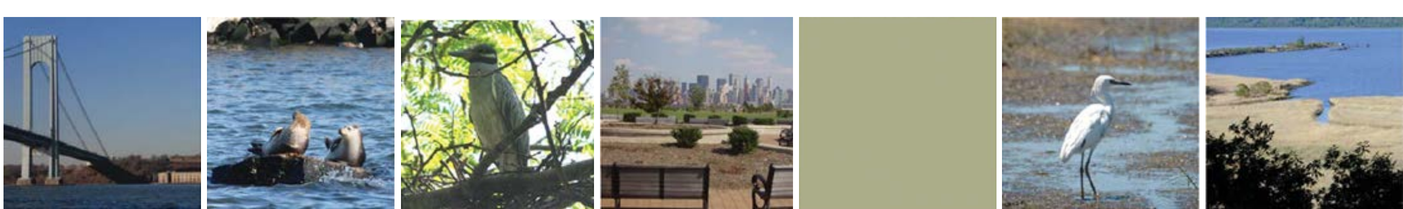
No two alternatives from one site were included in a plan (i.e., Dubos Point no action and Dubos Point tidal channel could not logically both be included within one plan). Consequently, from 32 restoration alternatives among eight (8) sites, IWR-PLAN identified 46,080 possible combinations. Best buy plans and cost effective plans were identified and provided in Appendix M. Of the 46,080 possible combinations, 187 were identified as cost effective. For each plan identified as cost effective, no other plan provides the same output for less cost. Of the 187 cost effective plans, IWR-PLAN identified 11 best buy plans through an ICA. Each of the best buy plans indicate additional sites added to each plan. An ICA reveals changes in costs as output levels increase, and allows an assessment of whether the increase in output is worth the additional cost.

The 11 best buy plans are presented in Table 3-10 below, along with their respective average costs and incremental costs per additional output. Jamaica Bay best buy plans range from $0 to $136,000,000 in construction costs, from $0 to $7,309,000 in annual costs, and from 0 to 1,631.5 AAFCUs. The primary difference between most of the plans was the inclusion of more restoration sites. For instance, Best Buy Plan 2 recommends a tidal channel with coastal dunes at Bayswater Point State Park. The next plan, Best Buy Plan 3, includes the same restoration alternative at Bayswater Point State Park and adds a tidal marsh at Fresh Creek with basin filling. To emphasize the incremental relationship between these plans, Best Buy Plan 3 is depicted as “Plan 2 + Fresh Creek” in the table below.

The same alternative per site, however, was not chosen each time. For two of the sites, Fresh Creek and Bayswater Point State Park, different restoration alternatives passed the ICA. In such cases, the components of the plan (numbers 5 & 7) are written out and the change at a given site is italicized in the Table 3-10 below.

Table 3-10: CE/ICA Results of Best Buy Plans for Jamaica Bay Perimeter Restoration Sites.

No.	Plan Description	AAFCU	Annual Cost ($1000)	Avg. Cost ($1000)/ AAFCU	Incremental Cost per AAFCU ($)
1	No action	0	0	0	0
2	Bayswater Point State Park tidal channel with coastal dunes	41	54	1.32	1.32



No.	Plan Description	AAFCU	Annual Cost ($1000)	Avg. Cost ($1000)/ AAFCU	Incremental Cost per AAFCU ($)
3	Plan 2 + Fresh Creek tidal marsh with basin filling to Jamaica Bay	249	498	2.00	2.13
4	Plan 3 + Bayswater Point State Park T-groin	284	516	2.04	2.31
5	Plan 4 + Dubos Point tidal channel with continuous toe protection	342	597	2.15	2.71
6	Plan 5 + Hawtree Point coastal dunes	348.5	754	2.16	2.77
7*	Plan 5 + Fresh Creek basin filling to Jamaica Bay and detention basin	386.5	893	2.31	3.66
8	Plan 7 + Dead Horse Bay tidal creek and trash removal	799.5	2,767	3.46	4.54
9	Plan 8 + Paerdegat fringe marsh with basin fill to Jamaica Bay	1214.5	4,870	4.01	5.07
10*	Plan 9 + Spring Creek tidal channel marsh system and coastal dunes	1,546.5	7,113	4.60	6.77
11*	Plan 10 + Brant Point tidal marsh with shore protection	1,573.5	7,308	4.64	7.22

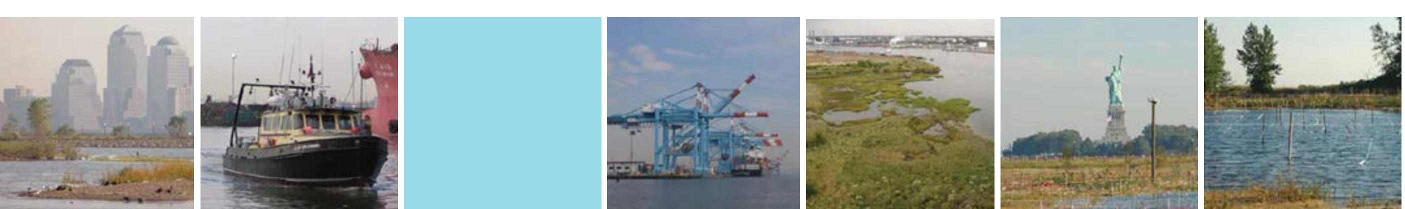
* Plans of Interest

The CE/ICA through IWR-PLAN software identified two break points, where there is a marked increase in incremental costs, beyond the general range of preceding costs, from which three plans of Interest were identified (Best Buy Plans 7, 10, 11). The first break point was at Best Buy Plan 7, which includes a suite of tidal creek systems, fringe marsh systems, basin filling and recontouring, coastal dune restoration, and shore protection in the form of toe dike protection, tidal pools, and natural plantings at Fresh Creek, Hawtree Point, Bayswater Point State Park, and Dubos Point for a total habitat output of 386.5 AAFCUs with a project first cost of $16,603,000, at an average annual cost of $893,000. The second break point was at Best Buy Plan 10, which includes all the elements of Best Buy Plan 7, and extends the suite of measures to the sites of Dead Horse Bay, Paerdegat Basin, and Spring Creek, for a total habitat output of 1,546.5 AAFCUs with a project first cost of $132,381,000, at an average annual cost of $7,113,000. The last remaining plan, Best Buy Plan 11, includes all the elements of Best Buy Plan 10 and adds wetland restoration and shore protection at Brant Point. Additional information on the results of the CE/ICA is found in Appendix M.

3.14 Key Uncertainties

A certain degree of risk and uncertainty is inherent in any restoration project. The key uncertainties that have the potential for resulting in high risks are the following:

- Absent performance of tree surveys, location, species, condition, and health of trees are not known.
- Data collection for the EPW, wetland mapping, habitat assessments, stream conditions, and water levels were conducted via field visit once during the summer.
- Wetlands were mapped, but not delineated.
- User bias may have affected the EPW and SVAP analyses.
- Restoration site plan development was not informed by public perception, knowledge, and opinions.
- Stormwater inputs, water quality levels, and existing issues were not fully quantified for restoration sites.



- Stream morphology/geomorphology or reference reach studies were not undertaken.
- Restoration site access issues may render construction impractical or require water access instead of land access.
- Zoning/planning changes may require new permits/approvals which could lead to scheduling issues.
- Absent performance of cultural resource surveys, presence of cultural resources could impact costs and schedule.

Chapter 4: The Tentatively Selected Plan and Implementation

The Tentatively Selected Plan (TSP) is a suite of ecosystem restoration sites within the Hudson-Raritan Estuary (HRE) that address long-term and large-scale degradation of aquatic habitat. It would provide for the restoration of up to 360 acres of estuarine wetland habitat, 12 acres of freshwater riverine wetland habitat, 81 acres of coastal and maritime forest habitat, 5.5 acres of riparian forest habitat, and 59 acres of oyster habitat. Two (2) fish ladders would be installed and three (3) weirs would be modified to re-introduce or expand fish passage along the Bronx River along with 3.83 miles of bank stabilization and 2.35 miles of stream channel restoration for the freshwater sites. The plan would provide an increase of 1,970 average annual functional capacity units (AAFCUs) and many other ecosystem benefits distributed at the 33 sites throughout the region (Figure 4-1). The total first cost is $640,850,000.

The HRE Comprehensive Restoration Plan (CRP) identifies 296 sites for restoration, 275 of which are within the purview of the United States Army Corps of Engineers (USACE) ecosystem restoration mission. Of these sites, up to 33 are recommended for construction authorization in this decision document, and are presented as the TSP in this chapter. A number of other sites included in the CRP have been or are being restored by other agencies or through other USACE authorities. Additional restoration opportunities may be investigated by the USACE through “new phase” future “spin-off” feasibility studies, as described in “Recommended Restoration Opportunities for Future Study” (Section 4.20).

The 33 sites span five (5) planning regions and would allow for the restoration of diverse native habitat throughout the estuary that support the HRE program goal, "*to develop a mosaic of habitats that provides society with renewed and increased benefits from the estuary environment*" Tables 4-1 through 4-4 summarize the restoration measures and techniques at each site. The recommended combinations of measures for estuarine and freshwater riverine restoration sites reflect the “best buy” plan as identified using cost effectiveness/incremental cost analysis (CE/ICA) (Appendix M). Appendix K provides summary information (e.g., water resource problems, restoration opportunities, alternatives, costs, benefits and the selected TSP design) for each site. Additional detailed supporting information including baseline conditions, Evaluation of Planned Wetlands (EPW), alternative development and designs for each site are presented in Appendix E.

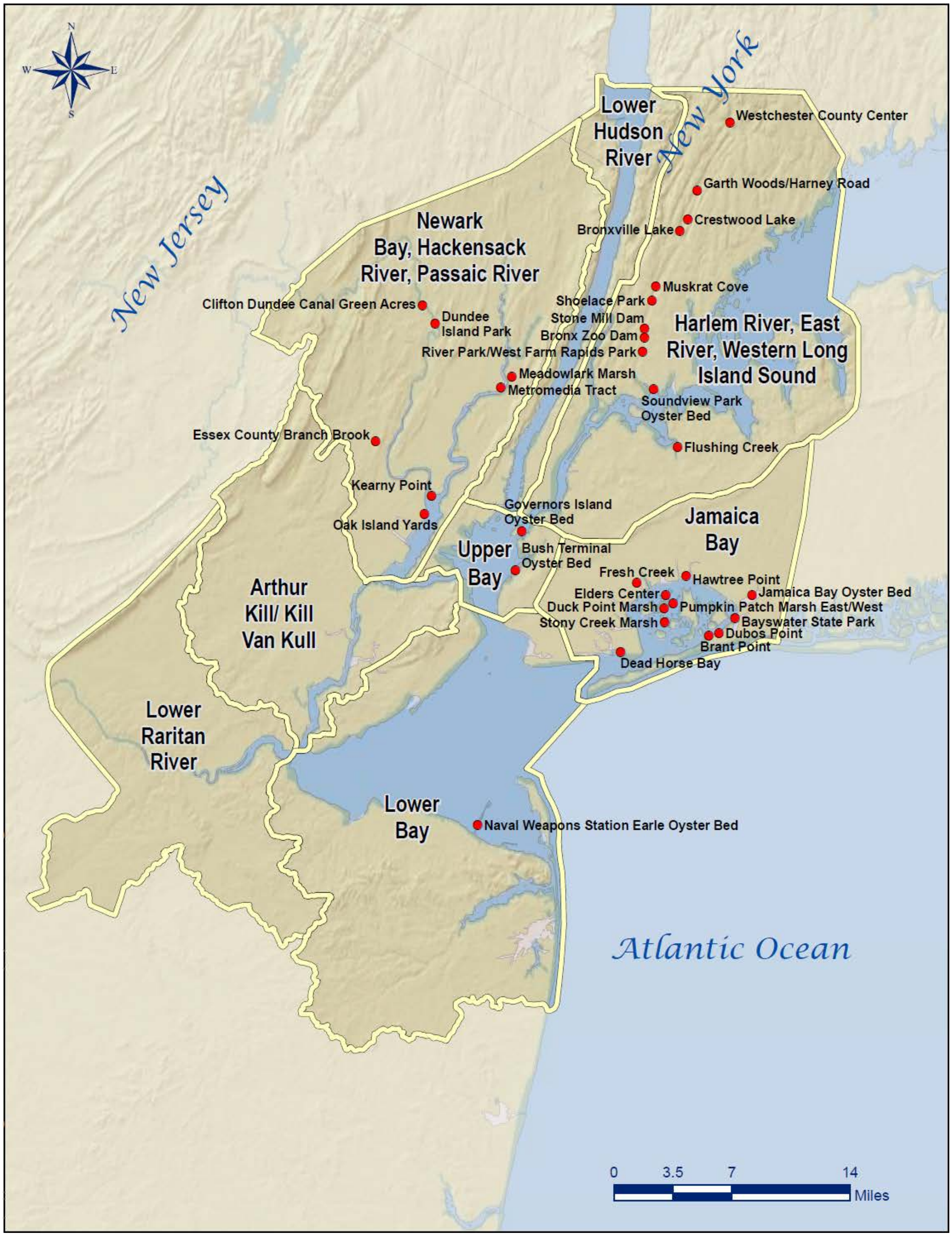


Figure 4-1: The Tentatively Selected Plan: Restoration Sites Recommended for Construction

4.1 Planning Objective 1: Estuarine Habitat Restoration

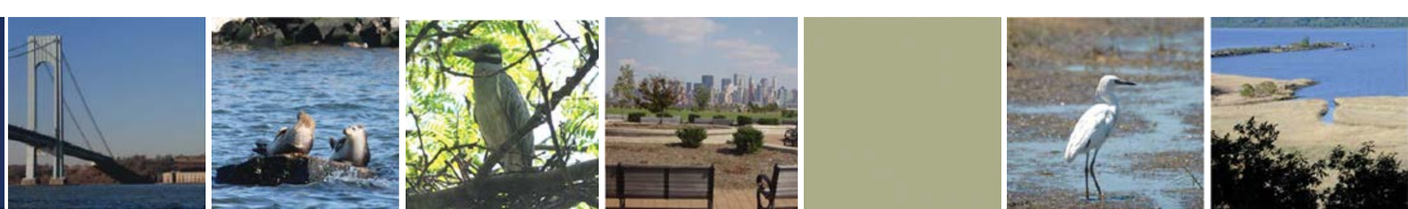
Study Objective 1: *Restore the structure, function and connectivity, and increase the extent of estuarine habitat in the Hudson-Raritan Estuary.*

The TSP includes the near-term construction of estuarine habitat restoration at 11 sites in three (3) planning regions (Table 4-1). This includes two (2) sites to be constructed following remedial actions conducted by the United States Environmental Protection Agency (USEPA). Low elevation marsh habitat, or "low marsh," would be restored at all sites. High elevation marsh habitat, or "high marsh," would be restored at six (6) sites. Maritime forest, and tidal channels, basins, and pools would be restored at all sites except for Flushing Creek.

Table 4-1: Restoration Measures Applied at Each Estuarine Habitat Restoration Site.

Restoration Site	Restoration Measures												
	Beach/dune creation	Coastal scrub/shrub and grassland restoration	Dune creation	High marsh restoration	Low marsh restoration	Scrub/shrub wetland restoration	Wetland protection	Invasive species removal and native plantings	Landfill removal	Maritime forest restoration	Meadow restoration	Public access improvement	Tidal channel/basin/pool restoration
Jamaica Bay Planning Region													
Dead Horse Bay			★	★	★		★		★	★			★
Fresh Creek				★	★					★			★
Hawtree Point		★		★									
Bayswater Point State Park	★			★	★		★						★
Dubos Point				★	★					★			★
Brant Point					★		★			★	★		
Harlem River, East River, and Western Long Island Sound Planning Region													
Flushing Creek					★								
Newark Bay, Hackensack River, and Passaic River Planning Region													
Metromedia Tract				★	★	★				★			★
Meadowlark Marsh				★	★			★		★			★
Oak Island Yards, Tier 2					★			★					★
Kearny Point, Tier 2					★			★				★	★

★ Indicates restoration measure applied at site.



4.2 Planning Objective 2: Freshwater Riverine Habitat Restoration

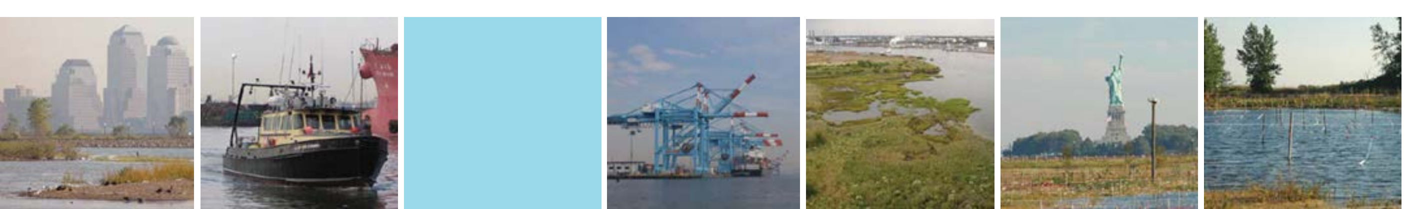
The TSP includes the near-term construction of freshwater riverine habitat restoration at 12 sites in two (2) planning regions (Table 4-2). Emergent wetland, forested and scrub/shrub wetland habitat would be restored at seven (7) sites. Invasive species removal and native vegetation planting will take place at all sites except Stone Mill Dam. Bank stabilization or shoreline softening is recommended at seven (7) sites. Bed or channel restoration is recommended at eight (8) sites.

Study Objective 2: *Restore the structure, function and connectivity, and increase the extent of freshwater riverine habitat in the Hudson-Raritan Estuary.*

Table 4-2: Restoration Measures at Freshwater Riverine Habitat Restoration Sites.

Restoration Site	Restoration Measures														
	Bank stabilization	Shoreline softening	Bed restoration	Channel dredging/ modification/realignment	Instream structures	Emergent wetland restoration	Forested and scrub/shrub wetland restoration	Fish ladder installation	Invasive species removal	Native plantings	Riparian forest restoration	Riprap forebay installation	Sediment control BMP installation	Water quality BMP installation	Weir modification for fish passage
Harlem River, East River, and Western Long Island Sound Planning Region															
River Park/West Farm Rapids Park		★	★			★			★	★					
Bronx Zoo and Dam						★		★	★	★			★		
Stone Mill Dam								★							
Shoelace Park	★			★	★				★	★			★	★	
Muskrat Cove	★			★					★	★			★		
Bronxville Lake			★	★		★	★		★	★		★	★	★	★
Crestwood Lake				★	★	★			★	★		★			★
Garth Woods/Harney Road		★		★		★	★		★	★				★	★
Westchester County Center	★			★	★	★			★	★					
Newark Bay, Hackensack River, and Passaic River Planning Region															
Essex County Branch Brook Park	★			★					★	★					
Dundee Island Park	★	★							★	★					
Clifton Dundee Canal Green Acres						★			★	★	★		★		

★ Indicates restoration measure applied at site.



4.3 Planning Objective 3: Jamaica Bay Marsh Island Restoration

***Study Objective 3:** Restore the structure, function and connectivity, and increase the extent of marsh island habitat in Jamaica Bay.*

The TSP includes the near-term construction of marsh restoration at five (5) Jamaica Bay marsh islands (Table 4-3). High marsh and low marsh restoration would be restored at all sites. Tidal channel creation would be included at all sites except Elders Point Center.

Table 4-3: Restoration Measures at Jamaica Bay Marsh Island Restoration Sites.

Restoration Site	Restoration Measures				
	Atoll terrace creation	High marsh restoration	Low marsh restoration	Scrub/shrub habitat creation	Tidal channel creation
Jamaica Bay Planning Region					
Stony Creek		★	★	★	★
Duck Point	★	★	★		★
Elders Point Center		★	★		
Pumpkin Patch West		★	★		★
Pumpkin Patch East		★	★		★

★ Indicates restoration measure applied at site.

4.4 Planning Objective 4: Oyster Restoration

***Study Objective 4:** Restore the structure, function and connectivity, and increase the extent of oyster reefs in the Hudson-Raritan Estuary.*

The TSP includes the near-term construction of small-scale oyster restoration at up to five (5) sites (Table 4-4). Based on prior investigations, a variety of oyster restoration techniques would be employed individually or in combination with other techniques including oyster condos, reef balls, spat on shell, wire cages/gabions or oyster bed restoration would be used at each small-scale oyster restoration site. The most appropriate oyster restoration feature that maximizes success would be used.

Oyster reef restoration pilot programs, including the Oyster Restoration Research Project and other programs by the Urban Assembly New York Harbor School (Harbor School), Billion Oyster Project, NY/NJ Baykeeper, the Hudson River Foundation and New York City Department of Environmental Protection (NYCDEP), have already provided encouraging results as oysters have been observed to survive for multiple years after placement on artificial substrate. The research provided by these pilot

programs has been built upon, serving as the foundation of the recommendations for specific restoration techniques, site considerations, and management of existing reefs.

Oyster restoration projects in the HRE would be especially beneficial as their creation would have positive synergistic effects with other restoration projects in the harbor at both a local and regional scale. For instance, oyster reefs in Jamaica Bay would attenuate wave velocity and provide additional subtidal habitat with nearby tidal wetlands. All proposed oyster restoration sites are located adjacent ongoing efforts underway by New York City Department of Environmental Protection (NYCDEP), New York City Department of Parks and Recreation (NYC Parks), Harbor School, NY/NJ Baykeeper and/or Hudson River Foundation which will enhance connectivity of habitat and increase ecological benefits. Finally, since the passage of the Clean Water Act, the water quality in New York Harbor has increased allowing marine life numbers to increase. It is estimated that an oyster reef, when developed, can increase the biomass of fish and large motile crustaceans (e.g., crabs, etc.) by over 1,000 kilograms per acre (Peterson et al. 2003).

Table 4-4: Restoration Techniques Included at Small-Scale Oyster Restoration Sites.

Restoration Site	Restoration Techniques					
	Oyster bed restoration	Oyster condos	Reef balls	Spat on shell	Super trays	Wire cages/gabions
Jamaica Bay Planning Region						
Jamaica Bay, Head of Bay	★				★	
Harlem River, East River, and Western Long Island Sound Planning Region						
Soundview Park				★		★
Upper Bay Planning Region						
Bush Terminal		★		★	★	★
Governors Island		★			★	★
Lower Bay Planning Region						
Naval Weapons Station Earle			★	★		★

★ Indicates restoration measures at site.

4.5 Proposed Restoration Sites

This section includes a description of recommended restoration actions at each site, organized by planning region. Figure 4-1 shows the locations of the proposed sites within the study area.

4.5.1 Jamaica Bay Planning Region

4.5.1.1 Estuarine Habitat Restoration

Table 4-5 summarizes the areal extent of the principal restoration measures that would be applied under the TSP at the estuarine habitat restoration sites in the Jamaica Bay Planning Region (See Figure 3-1). The TSP includes estuarine habitat restoration at six (6) shoreline sites along the periphery of Jamaica Bay:

- **Dead Horse Bay:** The Dead Horse Bay site is adjacent to Floyd Bennett Field and includes tidal wetlands, sandy beach, upland scrub/shrub and a small tidal pond. The entire area was filled, covering the historic marsh with fills, including the solid waste landfill to the south. Currently, erosion is claiming the west marsh peninsula, exposing the landfill. The site also suffers from extensive stands of monotypic nonnative invasive plant species.

The TSP would maximize marsh habitat by creating a tidal channel in the northern portion of the site and restore more than 30 acres of high and low marsh on the southern point, landfill at the shoreline would be removed and replaced with clean fill and sand from the northern portion of the site. The landfill removal would also enable the fringe marsh to support native wetland plant species with high habitat value. Additionally, the fill and sand would be covered with maritime plants and trees to stabilize the fill, which would act as a protective buffer for intertidal habitat, and create additional habitat associated with maritime forests that constitute a major historical feature within the bay and are integral to the ecosystem. Landfill materials would be excavated from the water's edge, and reused on site as much as possible and capped by clean sand to create dunes further inland. Excavated materials that could not be reused onsite would be removed and processed at a registered landfill facility. Dunes will be created and will restore maritime forest on the southern parcel of the project area. Existing beach will be preserved to the north. Restoration at Dead Horse Bay is an important part of the collaboration with USEPA Trash Free Waters Program, National Park Service (NPS) Gateway National Recreation Area General Management Plan, and other partner initiatives including New York State Department of Conservation (NYSDEC), New York State Department of State (NYSDOS), NYCDEP, NYC Parks, New York City Department of Sanitation. The partners have formed an Advisory Committee in July 2016 to coordinate efforts on the site.

- **Fresh Creek:** The Fresh Creek site is located in and along the tidal wetlands and adjacent upland bordering Fresh Creek, a tributary to Jamaica Bay. It includes beach, mudflat, salt marsh, coastal scrub/shrub forest, mature woodlands, and invasive plant species. The site is surrounded by dense urban development and subject to combined sewer overflow (CSO) and stormwater outfalls. The Fresh Creek site has poor water quality and benthic habitat from past dredging, existing CSOs and untreated stormwater runoff, along with the extensive historic loss of wetland due to filling.

The TSP would create or restore a tidal creek, tidal pool and shallow water habitat, low marsh, high marsh, coastal scrub/shrub habitat, and maritime forest. Restoration at Fresh Creek would complement NYC Parks' small-scale restoration efforts and NYCDEP's salt marsh mitigation along the creek.

- **Hawtree Point:** The Hawtree Point site is located in the northern portion of the bay and includes Charles Memorial Park, a developed area with recreational facilities and a large mowed area. Hawtree Point was filled during the development of the communities of Howard Beach and Hamilton Beach. It contains monotypic stands of nonnative invasive plant species and is continually disturbed by the use of all-terrain vehicles along the shoreline.

The TSP would restore high marsh, and coastal scrub/shrub and grassland habitat. Boulders would be placed along the landside boundary of the site as a barrier to motorized vehicles. Restoration proposed at Hawtree Point will serve as a Natural and Nature Based Feature (NNBF) complementing the Governor's Office of Storm Recovery (GOSR) New York Rising Community Reconstruction Program to protect and provide benefits to the Howard Beach Community.

- **Bayswater Point State Park:** Bayswater Point State Park is comprised of grassland, small tidal marshes, monocultures of invasive species, and native and opportunistic woody vegetation. The site contains the last patch of a mature native oak forest on Jamaica Bay. A deteriorating seawall contributes to severe shoreline erosion and loss of habitat. The site is also dominated by nonnative, invasive plant species, which is a threat to existing desirable wetland habitat.

The TSP would create a tidal channel and a tidal pool, restore low marsh and high marsh, and create beach and dune habitat. Armoring along a portion of the shoreline and training structures at the mouth of the channel would be constructed to protect the existing habitats and stabilize the channel. The restoration at Bayswater Point State Park will be integrated with planned public access improvements implemented by the New York State Department of Parks, Recreation and Historic Preservation, as well as NYC parks plans for ~1.5 acres of coastal wetland and forest restoration

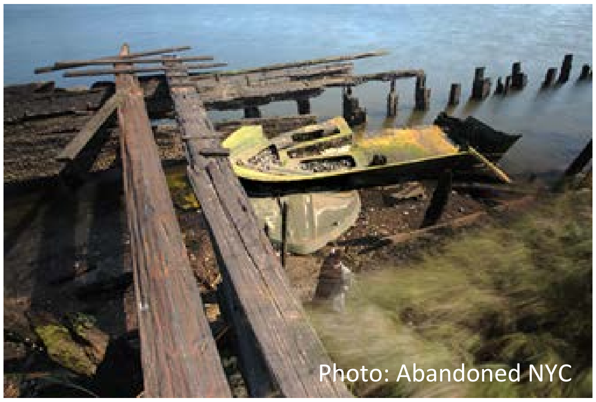


Photo: Abandoned NYC

- **Dubos Point:** Dubos Point is home to a native flora and cover types ranging from tidal marsh to upland scrub/shrub. The site has been disturbed by dumped trash and debris, fill material in the marsh, and the proliferation of nonnative, invasive plant species. A high energy littoral zone along western and northern shorelines contributes to severe shoreline erosion.

The TSP would restore tidal channels, low marsh, high marsh, and maritime forest. Piles would be installed along the entire shoreline of the site, replacing existing piles, to protect the shore.

- **Brant Point:** Brant Point is located in the southern portion of Jamaica Bay. A grounded barge located offshore has acted as an erosion control device and created high quality benthic habitat behind the structure. However, the site still suffers from shoreline erosion and loss of wetlands and has a high proportion of invasive, nonnative plant species. Excessive dumping of soil, trash, and other debris and the covering of the historic marsh with fill material has compromised the natural habitat.

At the Brant Point site, the TSP would preserve coastal marsh, and restore low marsh, high marsh, upland meadow, and maritime forest. Three (3) rock mounds would be constructed along a portion of the shoreline to protect the point from ongoing erosion. Restoration will complement the floating islands adjacent the site that were constructed by NYCDEP.



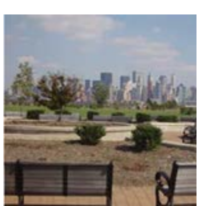
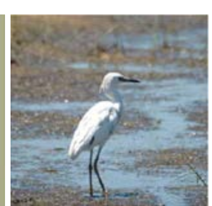




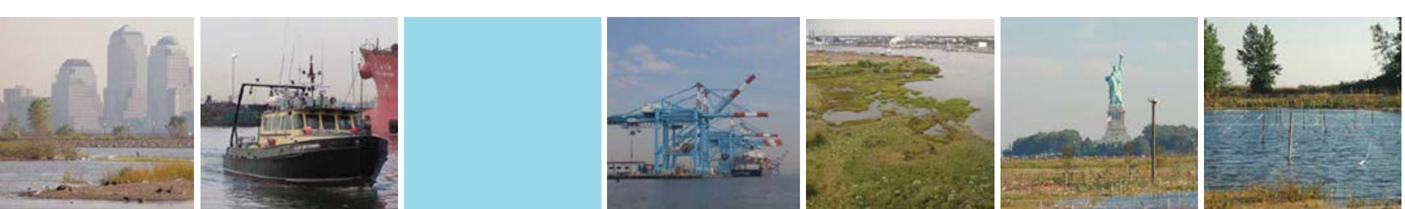

Table 4-5: Restored Estuarine Habitat in Jamaica Bay.

Restoration Site	Restoration Measures												
	Beach/dune creation	Coastal scrub/shrub and grassland restoration	Dune creation	High marsh restoration	Low marsh restoration	Scrub/shrub wetland restoration	Wetland protection	Invasive species removal and native plantings	Landfill removal	Maritime forest restoration	Meadow restoration	Public access improvement	Tidal channel/basin/pool restoration
Jamaica Bay Planning Region													
Dead Horse Bay	-	-	28.0 ac.	7.0 ac.	31.0 ac.	-	-	-	31.0 ac.	61.0 ac.	-	-	4.0 ac.
Fresh Creek	-	-	-	2.5 ac.	13.6 ac.	-	-	-	-	11.3 ac.	-	-	43.0 ac.
Hawtree Point	-	1.7 ac.	-	0.07 ac.	-	-	-	-	-	-	-	-	-
Bayswater Point State Park	0.7ac.	-	-	0.4 ac.	2.5 ac.	-	-	-	-	-	-	-	0.81 ac.
Dubos Point	-	-	-	0.9 ac.	3.3 ac.	-	-	-	-	2.0 ac.	-	-	0.7 ac.
Brant Point	-	-	-	0.7 ac.	1.9 ac.	-	1.2 ac.	-	-	2.4 ac.	2.5 ac.	-	-
TOTAL	0.7 ac.	1.7 ac.	28.0 ac.	11.57 ac.	52.3 ac.	-	1.2 ac.	-	31.0 ac.	76.7 ac.	2.5 ac.	-	48.51 ac.

4.5.1.2 Jamaica Bay Marsh Island Restoration

Table 4-6 summarizes the areal extent of the principal restoration measures that would be applied under the TSP at the Jamaica Bay marsh island restoration sites in the Jamaica Bay Planning Region (See Figure 3-2). The TSP includes restoration of five (5) islands in the center of the bay:

- **Stony Creek and Elders Point Center:** The existing condition remnant marsh found at Stony Creek Marsh Island is well defined and characterized by relatively high elevations. Almost 60 percent of the marsh island has been lost in the past 42 years. Elders Point Marsh was historically one (1) island but marsh loss in the center of the island created two (2) distinct islands separated by a mud flat (USACE, 2006). When the restoration of Elders Point East and Elders Point West were planned and implemented, it was infeasible to restore Elders Point Center based on the depth of the substrate in that area. Presently, no marsh island exists above water between the two (2) islands.



At the Stony Creek and Elders Point Center marsh island sites, the TSP would restore low marsh and high marsh. The restoration at Elders Point Center and other marsh islands would complement adjacent restoration planned for Spring Creek South (FEMA Hazard Mitigation Grant Program) and GOSR's New York Rising Reconstruction Program providing secondary coastal storm risk management benefits for the Howard Beach Community.

- **Duck Point:** The existing elevations at Duck Point represent approximately 17 acres, more than half of which are at the lower end of the low marsh range. Duck Point has experienced a high rate of marsh loss: approximately 2.8 acres per year between 1974 and 1994.

At the Duck Point marsh island site, the TSP would restore low and high marsh, as well as construct an offshore, atoll terrace, based on recommendations by City University of New York (CUNY) and the Rockefeller Foundation's Structures of Coastal Resilience (2016) research. The atoll terrace feature serves as a "sand engine" for the marsh island improving sediment accretion and sustainability while promoting wave and turbidity attenuation..

- **Pumpkin Patch West and Pumpkin Patch East:** Pumpkin Patch West is currently approximately four (4) acres. Pumpkin Patch East is currently approximately eight (8) acres. The average loss rate for Pumpkin Patch as a whole is approximately 1.3 acres/year between 1974 and 1994, with variation up to 2.5 acres/year between 2003 and 2005.

At the Pumpkin Patch West and Pumpkin Patch East marsh island sites, the TSP would restore low marsh and high marsh, and increase the extent of uplands on the islands.

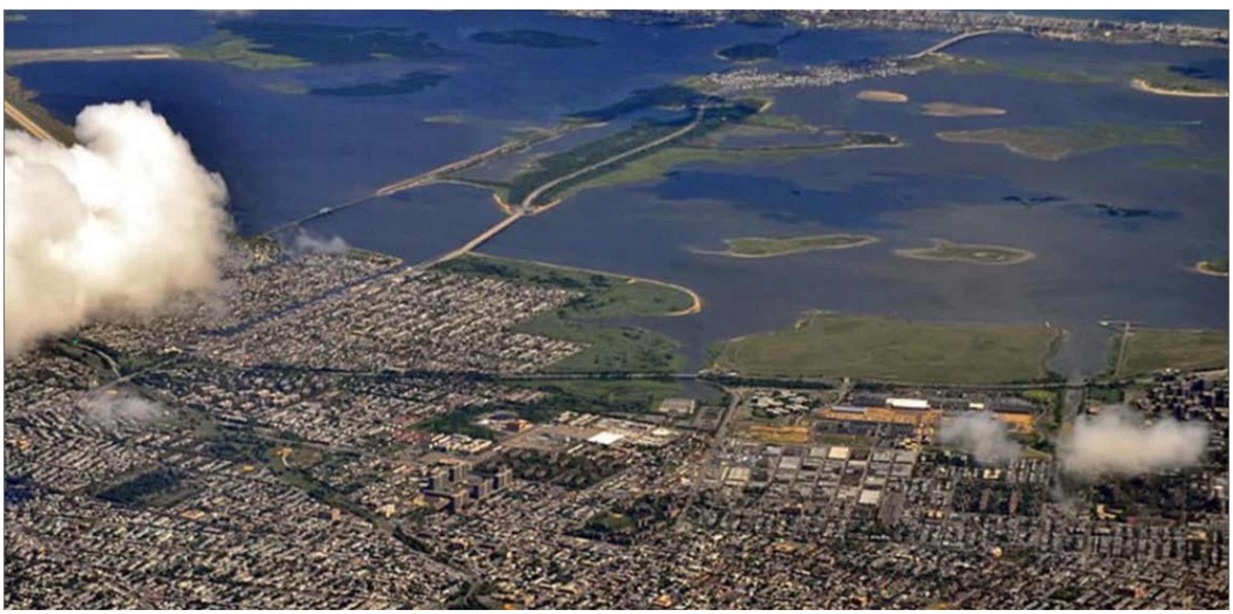


Table 4-6: Restored Marsh Habitat in Jamaica Bay

Restoration Site	Restoration Measures				
	Atoll terrace creation	High marsh restoration	Low marsh restoration	Scrub/shrub habitat creation	Tidal channel creation
Jamaica Bay Planning Region					
Stony Creek	-	25.3 ac.	26.0 ac.	-	-
Duck Point	9.0 ac.	12.5 ac.	15.4 ac.	-	-
Elders Point Center	-	7.5 ac.	8.5 ac.	-	-
Pumpkin Patch West	-	5.5 ac.	10.8 ac.	-	-
Pumpkin Patch East	-	16.8 ac.	18.5 ac.	-	-
Total	9.0 ac.	67.6 ac.	79.2 ac.		

4.5.1.3 Small-Scale Oyster Restoration

Table 4-7 summarizes the areal extent of the principal restoration measures, specifically techniques, which would be applied under the TSP at the small-scale oyster restoration site in the Jamaica Bay Planning Region (See Figure 3-7). The TSP includes oyster restoration at the Head of Bay site, along the eastern end of Jamaica Bay:

Jamaica Bay, Head of Bay: At the Head of Bay restoration site, the TSP would restore oysters and oyster habitat by installing super trays and constructing oyster beds. Oyster restoration in Jamaica Bay will expand the reef that was recently constructed by the NYCDEP.

Table 4-7: Restored Oyster Habitat in Jamaica Bay.

Restoration Site	Restoration Acreage					
	Oyster bed restoration	Oyster condos	Reef balls	Spat on shell	Super trays	Wire cages/gabions
Jamaica Bay Planning Region						
Jamaica Bay, Head of Bay	1.5 ac.	-	-	-	0.5 ac.	-

4.5.2 Harlem River, East River, and Western Long Island Sound Planning Region

4.5.2.1 Estuarine Habitat Restoration

Table 4-8 summarizes the areal extent of the principal restoration measures that would be applied under the TSP at the estuarine habitat restoration site in the Harlem River, East River, and Western Long Island Sound Planning Region. The TSP includes estuarine habitat restoration at one (1) shoreline site along Flushing Creek:

- **Flushing Creek:** The Flushing Creek restoration site comprises approximately 15.4 acres of shoreline and the tidally influenced Flushing Creek and is roughly two (2) miles upstream from the East River. Previously a sinuous tidal creek in an extensive tidal wetland system, the site suffers from significant straightening of the stream, filled and degraded wetlands, and eroded shorelines dominated by invasive species. Poor water quality limits the diversity of fish and benthic communities.

At the Flushing Creek restoration site, the TSP would restore low marsh and preserve existing upland forest. Restoration at Flushing Creek is integral to the NYCDEP surface water improvements in Flushing Creek and Bay resulting from the implementation of NYCDEP's Long Term Control Plan, CSO Abatement efforts and environmental dredging activities.

Table 4-8: Restored Marsh Habitat at Flushing Creek.

Restoration Site	Restoration Measures												
	Beach/dune creation	Coastal scrub/shrub and grassland restoration	Dune creation	High marsh restoration	Low marsh restoration	Scrub/shrub wetland restoration	Wetland protection	Invasive species removal and native plantings	Landfill removal	Maritime forest restoration	Meadow restoration	Public access improvement	Tidal channel/basin/pool restoration
Harlem River, East River, and Western Long Island Sound Planning Region													
Flushing Creek	-	-	-	-	2.4 ac.	-	-	-	-	-	-	-	-

4.5.2.2 Freshwater Riverine Habitat Restoration

Table 4-9 summarizes the areal extent of the principal restoration measures that would be applied under the TSP at the freshwater riverine habitat restoration sites in the Harlem River, East River, and

Western Long Island Sound Planning Region (See Figure 3-4). The TSP includes freshwater riverine habitat restoration at nine (9) shoreline sites along the Bronx River:

- **River Park/West Farm Rapids Park:** The River Park/West Farm Rapids Park site surrounds the Bronx River in a developed, urban area interspersed with small fragmented woodlots and sparsely vegetated wetlands dominated by invasive species. The site is impaired by garbage and stormwater runoff. The stream channel is mostly armored and the benthic substrate largely consists of construction debris and boulders.

The TSP would restore the bed along a segment of the river channel, remove debris from another segment, and soften shorelines on both banks of the river. Invasive vegetation would be removed, native wetland vegetation and upland shrubs and trees would be planted, and emergent wetlands would be created. Public access improvements would be installed. The restoration proposed would complement ongoing NYC Parks restoration activities.

- **Bronx Zoo and Dam:** The Bronx Zoo and Dam restoration site is generally flat and occupied with roadways, parking lots, and the installations of the Bronx Zoo. Flow from the Bronx River is affected by a dam system consisting of two (2) dams abreast of each other separated by a mid-stream island. The site suffers from poor water quality, limited instream habitat, invasive species, and barriers to fish movements.

The TSP would remove debris from between the dams and install a fish ladder at the west dam to promote fish passage. Invasive vegetation would be removed, native wetland vegetation and upland vegetation would be planted at several locations, emergent, scrub/shrub, and forested wetlands would be created on both banks upstream of the dams, and emergent wetlands would be created on the west bank downstream of the dams. A sediment trap and public access improvements would be installed.

- **Stone Mill Dam:** The Stone Mill Dam restoration site is situated in a steep valley within the New York Botanical Garden. Wetlands consist only of a few, very small, discontinuous pockets of emergent vegetation adjacent to the shoreline and uplands consist of wooded slopes with large rock outcrops.

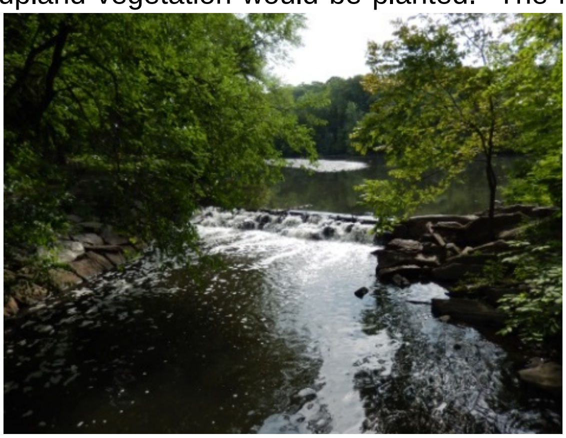
The TSP would install a fish ladder to link the slow-flowing pool upstream of the dam and the faster-flowing channel downstream of the dam, and would place clay-pipe fish attractors at both the upstream and downstream ends of the fish ladder. Invasive vegetation would be removed and native vegetation would be planted.

- **Shoelace Park:** The Shoelace Park restoration site is located along the Bronx River and is surrounded by dense, urban development. The site is characterized by an over-widened channel with steep vertical banks and eroded shoreline. Stream banks are sparsely vegetated and wetlands are limited to very narrow, dispersed strips of emergent vegetation. The wetlands and large portions of the upland riverine corridor provide low quality upland buffer and are dominated by invasive species. Stream habitat is degraded by poor water quality and increased sediment load.

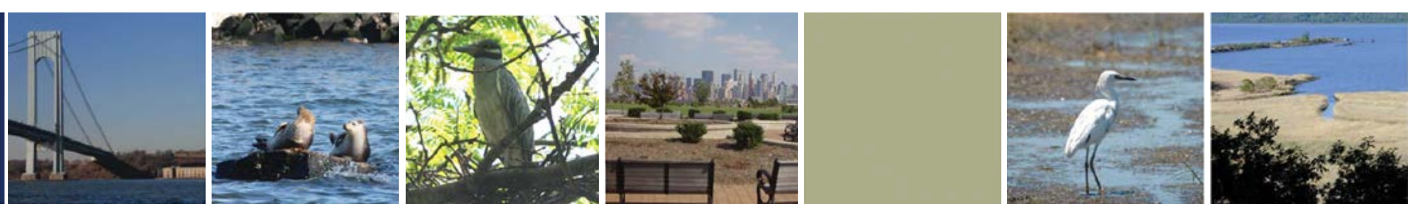
The TSP would realign the river channel with instream structures, slight meanders, and pool and riffle complexes. The river banks would be stabilized, invasive vegetation would be removed, native vegetation would be planted, forested wetlands along the banks and riparian woodlands would be restored, and sediment control and water quality best management practices (BMPs) would be implemented, including green infrastructure to reduce slow stormwater runoff. The restoration at Shoelace Park has been coordinated and complements NYC Parks' efforts within the park to conduct invasive species removal and native plantings and NYCDEP's CSO Abatement Program to improve water quality.

- **Muskrat Cove:** The Muskrat Cove restoration site surrounds the Bronx River where it flows through a small, narrow valley. The river and aquatic environment were highly engineered with armored banks with the goal of conveying water past large arterials (e.g., rail lines, roads, etc.) which resulted in impacts on the local ecology. Due to the past and ongoing disturbances at the site, habitats are small fragmented limited fish and wildlife habitat value and often dominated with large stands of invasive species.

The TSP would reconstruct an instream sediment basin at an existing outfall, modify two (2) segments of the river channel, install instream structures, stabilize banks along sections of the river, and replace bank armor with soil bioengineering techniques and native plants and materials along other sections. Invasive vegetation would be removed and native upland vegetation would be planted. The restoration at Muskrat Cove was designed to act in concert with NYC Parks activities.



- **Bronxville Lake:** The Bronxville Lake restoration site is a suburban park that surrounds a portion of the Bronx River that uses a weir to form a lake. Most of the site consists of maintained lawn, with patches of natural vegetation interspersed. Small pockets of mowed wetlands form in shallow depressions and around the lake and contain little ecological value. The lack of shaded cover, shallowness of the lake, and lack of submerged aquatic vegetation or instream cover limit the habitat value of the lake for aquatic species.



The TSP would construct a riprap forebay upstream of the lake, restore the bed of the river channel, and modify the existing rock weir at the lake outlet to promote fish passage. Invasive vegetation would be removed, native wetland vegetation and upland shrubs and trees would be planted, and emergent, scrub/shrub, and forested wetlands would be created. Sediment control and water quality BMPs and public access improvements would be installed.

- **Crestwood Lake:** At the southern end of the Crestwood Lake restoration site, the Bronx River is dammed, forming the broad shallow lake which is subject to nutrient enriched runoff from surrounding lawns. Fringing wetlands and surrounding uplands are dominated by nonnative invasive species. Sediment bars are formed within the stream at the confluence of Troublesome Creek tributary.

The TSP would construct two (2) riprap forebays with access roads at the upstream end of the lake and at the Troublesome Creek tributary confluence, realign the river channel, replace river bed material, install instream structures, and modify the existing rock weir at the lake outlet to promote fish passage. Invasive vegetation would be removed, native wetland vegetation and upland shrubs and trees would be planted, and emergent wetlands would be created between the river channel and the lakeshores. Public access improvements would be installed.

- **Garth Woods/Harney Road:** Garth Woods and Harney Road are two (2) adjacent restoration sites surrounding the Bronx River in Westchester County. Within the site, the stream channel is over-widened and shallow, and the banks show signs of moderate erosion. Vegetation is sparse and dominated by nonnative invasive species, except for a large forested area within the Garth Woods site.

The TSP would construct three (3) culverts under the southbound lanes of the Bronx River Parkway to transfer river water to emergent wetlands created in a lawn area west of the parkway, modify two (2) sections of the river channel by replacing river bed material and installing instream structures, modify the existing weir at the downstream end of the site to promote fish passage, and soften a segment of river bank. Invasive vegetation would be removed, native herbaceous and scrub/shrub wetland vegetation, and upland shrubs and trees would be planted, and emergent, scrub/shrub, and forested wetlands would be created. Sediment control and water quality BMPs would be installed. The restoration efforts proposed complement the activities of the Westchester County Department of Planning at Garth Woods which includes channel realignment and riverbed restoration.

- **Westchester County Center:** The Westchester County Center restoration site is traversed by the Bronx River and includes the confluence of two (2) tributaries, the Manhattan Brook and Fulton Brook. Undisturbed wetland and upland habitats are sparse and dispersed across the largely maintained park. Much of the park consists of right-of-way lawns and largely of nonnative, invasive species. The stream is subject to strong and high flows during storm events causing active erosion on the banks, sediment deposits, and collection of garbage and debris.

The TSP would construct instream sediment basins in the Manhattan Brook and Fulton Brook confluences with the Bronx River, modify the river channel, replace river bed material, install instream structures, construct channel plugs at the upstream and downstream ends of the channel on the west side of the instream island, and stabilize sections of the river banks. Invasive vegetation would be removed, native wetland vegetation and upland shrubs and trees would be planted, and emergent wetlands would be created along both shores of the Bronx River and Manhattan Brook. A paved path would be constructed to divert pedestrian traffic away from the created emergent wetlands.

Table 4-9: Restored Freshwater Habitat Along the Bronx River.

Restoration Site	Restoration Measures													
	Bank stabilization	Shoreline softening	Bed restoration	Channel dredging/ modification/realignment	Instream structures	Emergent wetland restoration	Forested and scrub/shrub wetland restoration	Fish ladder installation	Invasive species removal	Native plantings	Riparian forest restoration	Riprap forebay installation	Sediment control BMP installation	Water quality BMP installation	Weir modification for fish passage
Harlem River, East River, and Western Long Island Sound Planning Region															
River Park/ West Farm Rapids Park	-	0.31 ac.	0.83 ac.	0.04 ac.		-	-	-	-		0.2 ac.	-	-	-	-
Bronx Zoo and Dam	-	-	-	-		-	0.54 ac.	-	-		0.56 ac.	-	-	-	-
Stone Mill Dam	-	-	-	-		-	-	-	-		-	-	-	-	-

Restoration Site	Restoration Measures														
	Bank stabilization	Shoreline softening	Bed restoration	Channel dredging/ modification/realignment	Instream structures	Emergent wetland restoration	Forested and scrub/shrub wetland restoration	Fish ladder installation	Invasive species removal	Native plantings	Riparian forest restoration	Riprap forebay installation	Sediment control BMP installation	Water quality BMP installation	Weir modification for fish passage
Harlem River, East River, and Western Long Island Sound Planning Region															
Shoelace Park	11,620 LF	-	-	6,860 LF		-	-	-	6.5 ac.		-	-	-	-	-
Muskrat Cove	1,350 LF	-	-	1.2 ac.	-	-	-	-	0.49 ac.		-	-	-	-	-
Bronxville Lake	-	-	1.3 ac.	-	-	0.59 ac.	2.9 ac.	-	1.4 ac.		-	0.43 ac.	0.24 ac.		-
Crestwood Lake	-	-	-	1.2 ac.		4.8 ac.	-	-	1.3 ac.		-	-	-	-	-
Garth Woods/ Harney Road	-	190 LF	-	0.85 ac.	-	0.79 ac.	0.03 ac.	-	0.22 ac.		-	-	-	-	-
Westchester County Center	285 LF	-	-	0.83 ac.		2.6 ac.	-	-	3.7 ac.		-	-	-	-	-
TOTAL	13,255 LF	0.31 ac.*	2.13 ac.	4.12 ac.*		8.78 ac.	3.47 ac.	-	13.61 ac.		0.76 ac.	0.43 ac.	0.24 ac.		-

LF Indicates linear feet. * Does not include restoration measures in LF.

4.5.2.3 Small-Scale Oyster Restoration

Table 4-10 summarizes the areal extent of the principal restoration measures that would be applied under the TSP at the small-scale oyster restoration site in the Harlem River, East River, and Western Long Island Sound Planning Region (See Figure 3-7). The TSP includes oyster restoration at the Soundview Park site, at the mouth of the Bronx River:

- **Soundview Park:** At the Soundview Park restoration site, the TSP would restore oysters and oyster habitat by placing spat on shell and installing wire cages/gabions, which would build on previous successful oyster restoration under the direction of the Harbor School and Billion Oyster Project. Restoration will occur in an area with subtidal rock outcrops to form approximately 2.75 acres of reef/bed complex.

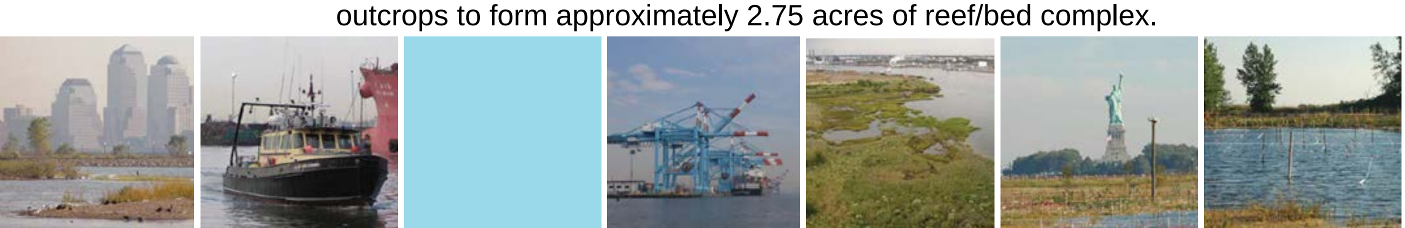


Table 4-10: Restored Oyster Habitat Along the Bronx River

Restoration Site	Restoration Acreage					
	Oyster bed restoration	Oyster condos	Reef balls	Spat on shell	Super trays	Wire cages/gabions
Harlem River, East River, and Western Long Island Sound Planning Region						
Soundview Park	-	-	-	0.83 ac.	-	0.14 ac.

4.5.3 Newark Bay, Hackensack River, and Passaic River Planning Region

4.5.3.1 Estuarine Habitat Restoration

Table 4-11 summarizes the areal extent of the principal restoration measures that would be applied under the TSP at the estuarine habitat restoration sites in the Newark Bay, Hackensack River, and Passaic River Planning Region (See Figure 3-5). The TSP includes estuarine habitat restoration at two (2) shoreline sites along the Hackensack River and two (2) Tier 2 sites (following USEPA remedial actions) along the mainstem of the Lower Passaic River:

- **Metromedia Tract:** Bordered on the east and south by the Hackensack River, and on the north by Marsh Resources Meadowlands Mitigation Bank, the Metromedia Tract surrounds the Metromedia Broadcast site and towers. This restoration site is undeveloped and characterized as generally poor habitat, largely dominated by invasive common reed (*Phragmites australis*).

To reconnect fragmented habitats on the restoration site, the TSP would create and restore tidal channels. Low marsh and high marsh, scrub/shrub wetland, and maritime forest habitat would be created. Once the Metromedia Tract is restored, it will combine with an adjacent previously restored tract to create a contiguous connected expanse of approximately 200 acres.

- **Meadowlark Marsh:** The Meadowlark Marsh restoration site is located north of Bellman's Creek within the Hackensack Meadowlands District. The site is primarily comprised of *Phragmites*-dominated (monoculture) emergent wetlands divided by utility access roads and other areas of historic fill material. Upland areas on the site are currently being used as an all-terrain vehicle course or a utility access road, and consist of relatively low quality habitat.

At the Meadowlark Marsh restoration site, the TSP would remove invasive vegetation and plant native marsh, scrub/shrub, and forest vegetation. Tidal channels, mudflats, low marsh, and high marsh would be restored, and maritime forest habitat would be created. Two (2) open-span bridges and a culvert would be installed to maintain gas pipeline access.

- **Oak Island Yards, Tier 2:** The Oak Island Yards restoration site contains Newark's largest extent of tidal marsh, tidal creeks, and palustrine emergent wetland. This estuarine ecosystem is documented to have historic fill, vacant structural elements, debris in the tidal channel, and unused pipelines running throughout. The site is dominated by non-native invasive vegetation, limiting ecological value.

The TSP would remove debris, fill, and invasive vegetation, and plant native marsh, scrub/shrub, and riparian forest vegetation. Tidal channels would be created, low marsh would be restored, an existing path would be upgraded, an overlook pier and dock would be constructed, and portions of the shoreline along Newark Bay would be stabilized. USEPA remedial action would be required prior to restoration. The restoration at Oak Island Yards would connect valuable habitat with an adjacent 12-acre restoration site currently advancing to buffer against shoreline erosion, improve flood control and remove invasive species as part of the National Fish and wildlife Foundation (NFWF) Hurricane Sandy Coastal Resiliency Competitive Grant Program.

- **Kearny Point, Tier 2:** The Kearny Point restoration site is a decommissioned industrial facility built entirely of historic fill and dominated by invasive species. It contains a forested area on the eastern half of the site which is the location of an active bald eagle nest.

The TSP would remove debris, fill, and invasive vegetation, and plant native marsh, scrub/shrub, and forest vegetation. Tidal channels would be created, low marsh and high marsh would be restored, an elevated path system would be constructed, and a portion of the shoreline along Newark Bay would be stabilized. USEPA remedial action would be required prior to restoration.

Table 4-11: Restored Estuarine Habitat Along the Hackensack River and Lower Passaic River.

Restoration Site	Restoration Measures												
	Beach/dune creation	Coastal scrub/shrub and grassland restoration	Dune creation	High marsh restoration	Low marsh restoration	Scrub/shrub wetland restoration	Wetland protection	Invasive species removal and native plantings	Landfill removal	Maritime forest restoration	Meadow restoration	Public access improvement	Tidal channel/basin/pool restoration
Newark Bay, Hackensack River, and Passaic River Planning Region													
Metromedia Tract	-	-	-	4.1 ac.	50.6 ac.	3.5 ac.	-	-	-	1.1 ac.	-	-	-
Meadowlark Marsh	-	-	-	4.6 ac.	60.2 ac.	-	-	1.9 ac.	-	3.2 ac.	-	-	12.7 ac.
Oak Island Yards, Tier 2	-	-	-	-	7.1 ac.	-	-	4.0 ac.	-	-	-	-	1,821 LF
Kearny Point, Tier 2	-	-	-	-	8.8 ac.	-	-	2.5 ac.	-	-	-	4,455 LF	0.49 ac.
TOTAL	-	-	-	8.7 ac.	126.7 ac.	3.5 ac.	-	8.4 ac.	-	4.3 ac.	-	4,455 LF	13.19 ac*

LF Indicates linear feet of restoration. * Does not include restoration measures in LF.

4.5.3.2 Freshwater Riverine Habitat Restoration

Table 4-12 summarizes the areal extent of the principal restoration measures that would be applied under the TSP at the freshwater riverine habitat restoration sites in the Newark Bay, Hackensack River, and Passaic River Planning Region (See Figure 3-5). The TSP includes freshwater riverine habitat restoration at two (2) shoreline sites along the Lower Passaic River and one (1) site on Branch Brook, a tributary to the river:

- **Essex County Branch Brook Park:** The Essex County Branch Brook Park restoration site contains approximately 4,200 linear feet of Branch Brook and adjacent parkland in Newark, New Jersey. The stream and adjacent forest areas experience considerable amounts of anthropogenic trash and are characterized by the presence of invasive vegetation. Three (3) ponds, created by weirs, suffer from algal blooms and eutrophication indicative of excess nutrient inputs.

At the Essex County Branch Brook Park site, the TSP would remove debris and invasive vegetation, plant native upland vegetation, dredge the existing stream channel, and soften the stream shoreline. Interpretive signs would be installed to support ongoing public access improvements.

- **Dundee Island Park:** The Dundee Island Park restoration site consists of approximately 2,370 linear feet of the western shoreline of the Lower Passaic River approximately 1.3 miles downstream of the Dundee Dam in Passaic, NJ. The site includes a park with a soccer field, benches, a playground, a boat launch and fish consumption advisory signage. Within the boundary of the site the stream bank is very steep and stabilized with rip-rap and concrete. Flood-driven woody debris and floatable trash have been deposited along the shore. Large ash trees were removed from the shoreline and bank is now dominated by invasive Japanese knotweed.

The TSP would stabilize the bank and soften the shoreline of the river, remove debris and invasive vegetation, and plant native shrubs and trees. An existing trail would be enhanced and extended to support planned public access improvements. The restoration would be a key component of the local plans for the community park that is planned to be improved by the Trust for Public Land, County of Passaic and City of Passaic through a NJDEP grant originating from the Natural Resource Damage settlement on the Lower Passaic River.

- **Clifton Dundee Canal Green Acres:** The Clifton Dundee Canal Green Acres Purchase site consists of approximately 1,800 linear feet of the western shoreline of the Lower Passaic River downstream of the Dundee Dam in Clifton, NJ. Within the site is Dundee Island Preserve, which includes a trail network, benches, interpretive signage, trash and recycling bins, and fish consumption advisory signage. The site also includes property which is subject to a New Jersey Department of Environmental Protection (NJDEP) environmental investigation/cleanup. Large volumes of flood-driven woody debris and floatable trash have been deposited along the shore of the central portion of the site and nonnative invasive plant species are found throughout.

The TSP would remove debris and invasive vegetation, plant native shrubs and trees, restore and stabilize riparian forest, install cobble and riffle structures to restore shallow water habitat, and install a sediment basin to treat stormwater runoff. Trails, an overlook, and a boat launch with access road would be constructed to support plans to improve public access. The restoration would be coordinated with local plans for improved public access and amenities with the Passaic River Coalition, Clifton and Passaic County who recently received NJDEP grant funds originating from the Natural Resource Damage settlement on the Lower Passaic River.

Table 4-12: Restored Freshwater Habitat Along the Hackensack River and Lower Passaic River.

<table>
<tr><th rowspan="2">Restoration Site</th><th colspan="15">Restoration Measures</th></tr>
<tr><th>Bank stabilization</th><th>Shoreline softening</th><th>Bed restoration</th><th>Channel dredging/ modification/realignment</th><th>Instream structures</th><th>Emergent wetland restoration</th><th>Forested and scrub/shrub wetland restoration</th><th>Fish ladder installation</th><th>Invasive species removal</th><th>Native plantings</th><th>Riparian forest restoration</th><th>Riprap forebay installation</th><th>Sediment control BMP installation</th><th>Water quality BMP installation</th><th>Weir modification for fish passage</th></tr>
<tr><td colspan="16">Newark Bay, Hackensack River, and Passaic River Planning Region</td></tr>
<tr><td rowspan="2">Essex County Branch Brook Park</td><td rowspan="2">10,320 LF</td><td rowspan="2">-</td><td rowspan="2">-</td><td rowspan="2">23.5 ac.</td><td rowspan="2">-</td><td rowspan="2">-</td><td rowspan="2">-</td><td rowspan="2">-</td><td>-</td><td>10,320 LF</td><td rowspan="2">-</td><td rowspan="2">-</td><td rowspan="2">-</td><td rowspan="2">-</td><td rowspan="2">-</td></tr>
<tr><td colspan="2">13.7 ac.</td></tr>
<tr><td>Dundee Island Park</td><td colspan="2">0.71 ac.</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>1.2 ac.</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>Clifton Dundee Canal Green Acres</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>0.1 ac.</td><td>-</td><td>-</td><td>-</td><td>2.8 ac.</td><td>5.5 ac.</td><td>-</td><td>0.11 ac.</td><td>-</td><td>-</td></tr>
<tr><td>TOTAL</td><td colspan="2">0.71 ac.</td><td>-</td><td>23.5 ac.</td><td>-</td><td>0.1 ac.</td><td>-</td><td>-</td><td colspan="2">17.7 ac.*</td><td>5.5 ac.</td><td>-</td><td>0.11 ac.</td><td>-</td><td>-</td></tr>
</table>

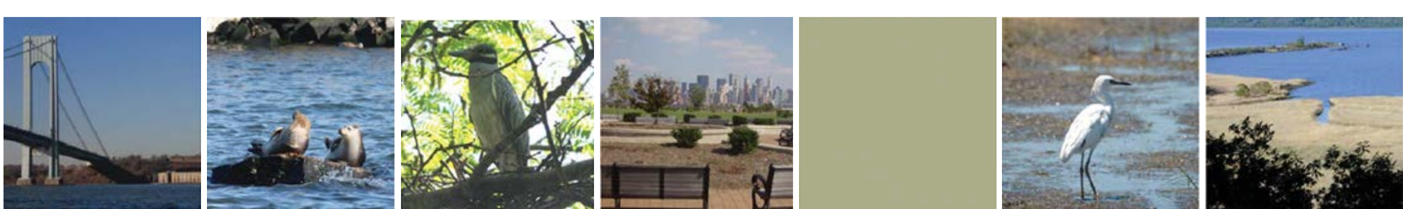
LF Indicates linear feet of restoration. * Does not include restoration measures in LF.

4.5.4 Upper and Lower Bay Planning Regions

4.5.4.1 Small-Scale Oyster Restoration

Table 4-13 summarizes the areal extent of the principal restoration measures that would be applied under the TSP at the small-scale oyster restoration sites in the Upper and Lower Bay Planning Regions (Figures 3-7). The TSP includes oyster restoration at two (2) sites in Upper Bay, along the eastern shore of the Hudson River, near the river mouth and one (1) site at Naval Weapons Station Earle in Lower Bay:

- **Bush Terminal:** At the Bush Terminal restoration site, the TSP would restore oysters and oyster habitat by placing spat on shell, and installing oyster condos, super trays, and wire cages/gabions. The TSP would complement other restoration work by the NYC Parks at the adjacent Bush Terminal Piers Park and pilot studies for the Billion Oysters Project by the Harbor School.



- **Governors Island:** The TSP would restore oysters and oyster habitat by installing oyster condos, super trays, and wire cages/gabions. The Harbor School on Governors Island conducts numerous oyster studies. Restoration efforts would maximize efforts of the Billion Oyster Project and benefit the students through expanded scientific study opportunities.

- **Naval Weapons Station Earle:** This site is located along the northern New Jersey shore in the south end of Sandy Hook Bay and features a 2.9-mile pier. The naval facility is considered an ideal restoration area and the presence of naval security forces and exclusion areas would likely result in a low disturbance of the restoration area. Restoration activities would occur under the pier at a location closer to land away from naval ship activity. The TSP would build on previous successful oyster restoration by the NY/NJ Baykeeper at Naval Weapons Station Earle.

Table 4-13: Restored Oyster Habitat in the Upper and Lower Bay Planning Regions.

Restoration Site	Restoration Acreage					
	Oyster bed restoration	Oyster condos	Reef balls	Spat on shell	Super trays	Wire cages/gabions
Upper Bay Planning Region						
Bush Terminal	-	3.5 ac.	-	31.7 ac.	0.1 ac.	8.5 ac.
Governors Island	-	1.8 ac.	-	-	0.68 ac.	1.7 ac.
Lower Bay Planning Region						
Naval Weapons Station Earle	-	-	1.3 ac.	3.1 ac.	-	3.2 ac.
TOTAL	-	5.3 ac.	1.3 ac.	34.8 ac.	0.78 ac.	13.4 ac.

4.5.5 Summary of all Sites in the Tentatively Selected Plan

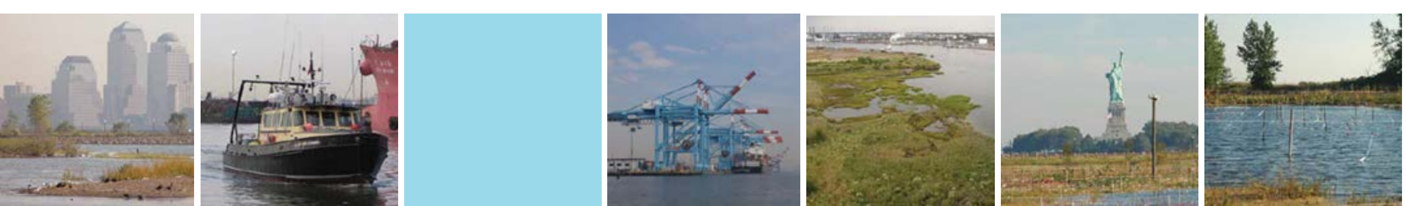
Table 4-14 summarizes the pertinent information regarding benefits and costs for each of the 33 sites including:

- CRP #: The HRE Comprehensive Restoration Plan (CRP) Site ID (Appendix N);
- AAFCU: The ecosystem benefits represented by the Evaluation of Planned Wetlands (EPW) average annual functional capacity units (AAFCUs) predicted for the selected alternative (Appendix E);
- Primary restoration measures and associated Target Ecosystem Characteristics (TEC) proposed for the recommended alternative (summarized from above and Appendix E);
- First Level Costs presented as current year (i.e., 2016) values without escalation including initial construction costs, contingency (29%-40%), Planning, Engineering and Design (PED), construction management, monitoring for up to 10 years (1%) and adaptive management (3%) (Appendix L);
- Average Annual Cost calculated using First Level Costs amortized at the FY2017 discount rate of 2.875 percent over a 50 year period of analysis and duration of construction (Appendix L); and
- Cost/AAFCU for the cost-effective plan determined by dividing the cost of the alternative by the ecosystem benefits (AAFCU). The plan with the lowest average cost was selected as the most cost effective “best buy” plan (Appendix M).

The TSP addresses the region's restoration objectives and responds to the many ecosystem problems within the HRE study area. However, the ecosystem benefits presented in Table 4-14 only represent benefits (calculated AAFCUs) for estuarine and freshwater wetland habitat and does not consider the ecological benefits associated with adjacent upland forest restoration, streambank stabilization, oyster restoration, and restoring fish passage. Therefore, the total AAFCUs underestimates all of the potential ecosystem benefits provided by the TSP.

Table 4-14: Benefit and Cost Summary for Recommended Sites in the TSP

Planning Region	Restoration Site	CRP#	AAFCU	Measures/TEC	Average Annual Cost $	Cost/ AAFCU	Total First Cost $
Jamaica Bay	**Perimeter Sites**						
	Dead Horse Bay	732	413[1]	• Tidal channel • Wetlands (low marsh) • Wetlands (high marsh) • Dunes • Maritime forest (beneficial use of sand) • Removal of landfill	$3,274,464	$200,409	$82,769,000
	Fresh Creek	730	246[1]	• Wetland (low marsh) • Wetland (high marsh) • Tidal creek/pool • Maritime forest • Shallow water habitat through channel regrading	$1,933,316	$184,850	$45,473,000
	Hawtree Point	161	6.5[1]	• Coastal scrub/shrub and grassland • Wetlands	$57,878	$225,077	$1,463,000
	Bayswater Point State Park	148	76[1]	• Wetlands (low marsh) • Wetlands (high marsh) • Beach/dune • Tidal channel • Tidal pool	$230,050	$76,513	$5,815,000
	Dubos Point	149	58[1]	• Wetlands (low marsh) • Wetlands (high marsh) • Tidal creek/pool • Maritime forest	$378,208	$164,828	$9,560,000
	Brant Point	102	27[1]	• Wetlands (existing) • Wetlands (low marsh) • Meadow • Maritime forest	$295,920	$277,037	$7,480,000

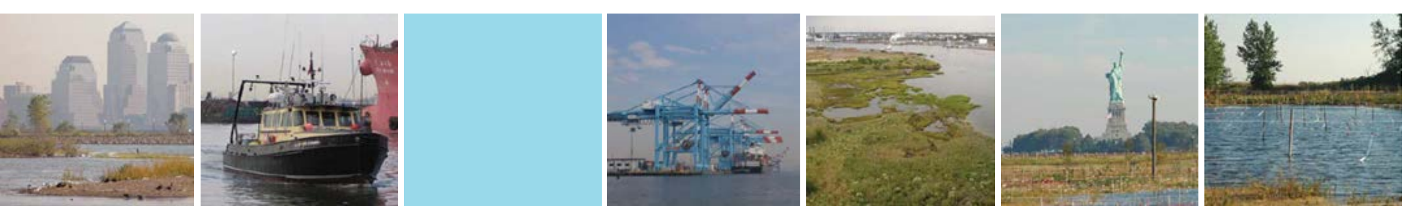


Planning Region	Restoration Site	CRP#	AAFCU	Measures/TEC	Average Annual Cost $	Cost/ AAFCU	Total First Cost $
		Total	**826.5**				**$152,560,000**
	Marsh Islands						
Jamaica Bay	Stony Creek	937	124.44	• Wetlands	$1,209,526	$9,897	$30,520,000
	Duck Point	935	57.99	• Wetlands	$1,100,935	$16,885	$27,780,000
	Elders Point Center	939	39.92	• Wetlands	$821,542	$45,896	$20,730,000
	Pumpkin Patch West	936	40.54	• Wetlands	$794,197	$26,561	$20,040,000
	Pumpkin Patch East	936	69.31	• Wetlands	$1,503,981	$23,759	$37,950,000
		Total	**332.2**				**$137,020,000**
Harlem River, East River, and Western Long Island Sound	Flushing Creek	188	12.50	• Wetlands	$233,000	$18,640	$5,900,000
	Bronx River						
	River Park/West Farm Rapids Park	860	0.379	• Shoreline softening • Emergent wetlands • Bed restoration • Invasive removal/native plantings • Riverbed restoration	$152,870	$403,360	$4,000,000
	Bronx Zoo and Dam	944	1.369	• Invasive removal/native plantings • Fish ladder • Sediment trap • Emergent wetlands	$147,140	$107,480	$3,850,000
	Stone Mill Dam	945	NA	• Fish ladder	$27,855	NA	$720,000
	Shoelace Park	113	3.304	• Channel realignment w/in-stream structures • Bank stabilization • Invasive removal/native plantings • Sediment load reduction/ rain gardens/bioretention basins	$959,250	$290,330	$25,010,000

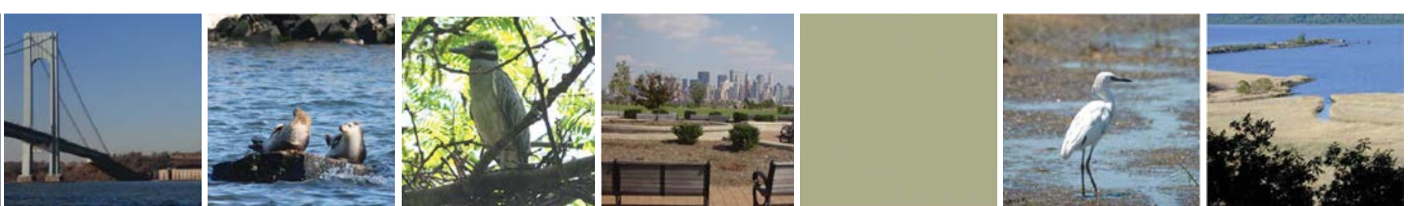





Planning Region	Restoration Site	CRP#	AAFCU	Measures/TEC	Average Annual Cost $	Cost/ AAFCU	Total First Cost $
Harlem River, East River, and Western Long Island Sound	Muskrat Cove	862	0.757	• Channel modification • River bank stabilization • Installation of sediment basins for load reduction • Invasive removal/native plantings	$300,700	$397,220	$7,840,000
	Bronxville Lake	851	5.342	• Native plantings • Rip rap forebay • Channel bed restoration • Emergent wetlands • Forested scrub/shrub wetlands • Modification of rock weir for fish passage • Invasive removal and native plantings • Sediment dredging • Sediment load reduction/ vegetated swales/retention basins/rain gardens	$565,750	$104,080	$14,530,000
	Crestwood Lake	852	13.267	• Modification of existing rock weir for fish passage • Creation of emergent wetlands • Channel realignment, bed material construction, 11 instream cross vanes • Two (2) riprap forebays • Invasive removal/ native planting	$1,058,970	$79,820	$27,610,000



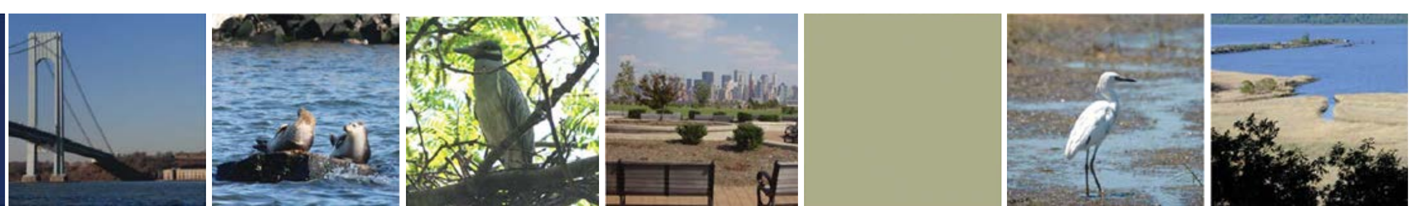
Planning Region	Restoration Site	CRP#	AAFCU	Measures/TEC	Average Annual Cost $	Cost/ AAFCU	Total First Cost $
Harlem River, East River, and Western Long Island Sound	Garth Woods/Harney Park	942/943	3.227	• Modification of weir for fish passage • River channel modification (15 in-stream cross vanes) • Shoreline softening • Rain gardens/bioretention area • Invasive removal/native planting • Emergent wetlands • Garth Woods: forested scrub/shrub wetlands	$275,830	$85,470	$7,200,000
	Westchester County Center	854	7.259	• Emergent wetlands • Bank stabilization • In-stream structures, 10 cross vanes and six (6) J-hooks, channel modification • Invasive species removal/ native planting	$555,590	$76,540	$14,520,000
		Total	**34.904**				**$105,280,000**
	Hackensack River Sites						
Newark Bay, Hackensack River, and Passaic River	Metromedia Tract		198.37	• Low marsh restoration • High marsh restoration • Scrub/shrub habitat • Maritime upland	$1,285,268	$6,869	$32,510,000
	Meadowlark Marsh	719	294.22	• Low marsh restoration • High marsh restoration • Restore mudflats, tidal channels and interior marsh • Invasive removal/native plantings • Maritime forest	$1,618,870	$5,500	$41,660,000



Planning Region	Restoration Site	CRP#	AAFCU	Measures/TEC	Average Annual Cost $	Cost/ AAFCU	Total First Cost $
Newark Bay, Hackensack River, and Passaic River		Total	492.59				$74,170,000
	Lower Passaic River Future "Deferred Sites"						
	Deferred site: Oak Island Yards	866	30.77	• Restoration low marsh • Creation of new tidal channels • Invasive removal/native plantings	$1,134,140	$36,860	$29,640,000
	Deferred site: Kearny Point	865	125.27	• Restoration low marsh • Invasive removal/native plantings • Restoration of new tidal channels • Public access/path	$2,245,670	$17,930	$57,790,000
		Total	156.04				$87,430,000
	Lower Passaic River Near-Term Sites						
	Essex County Branch Brook Park	887	99.70	• Invasive removal/native plantings • Channel dredging to restore freshwater stream and floodplain • Erosion control of banks/plantings	$849,610	$8,520	$21,890,000
	Dundee Island Park	900	1.29	• Riparian restoration (invasive removal/native planting) • Bank stabilization/shoreline softening	$106,247	$8,039	$2,720,000
	Clifton Dundee Canal Green Acres Site	26 (902	14.43	• Emergent wetland • Invasive removal/native planting • Restoration/stabilization of riparian forest • Sediment basin	$457,250	$31,690	$11,950,000
		Total	115.42				$36,560,000

Planning Region	Restoration Site	CRP#	AAFCU	Measures/TEC	Average Annual Cost $	Cost/ AAFCU	Total First Cost $
	Oyster Restoration Sites						
Jamaica Bay	Jamaica Bay, Head of Bay	29	NA	• Oyster beds (1.5 ac) • Hanging trays (>0.5 ac)	$31,190	$410,000[2]	$820,000
Harlem River, East River, and Western Long Island Sound	Soundview Park	30	NA	• Spat on shell (0.83 ac) • Gabion blocks (0.14 ac)	$28,940	$762,886[2]	$760,000
Upper Bay	Bush Terminal	31	NA	• Spat on shell (31.65 ac) • Gabion blocks (8.48 ac) • Oyster condos (3.49 ac) • Hanging trays (0.1 ac)	$1,274,635	$731,015[2]	$32,950,000
	Governors Island	32	NA	• Gabion blocks 1.66 ac) • Oyster condos (1.79 ac) • Hanging trays (0.68 ac)	$188,130	$1,145,278[2]	$4,880,000
Lower Bay	Naval Weapons Station Earle	33	NA	• Spat on shell (3.1 ac) • Gabion blocks (3.2 ac) • Reef balls (1.3 ac)	$285,657	$947,368[2]	$7,420,000
Oyster Restoration Total			**NA**				**$46,830,000**
GRAND TOTAL			**1970.135**				**$644,170,000**

1: Evaluation of Planned Wetland (EPW) Average Annual Functional Capacity Units (AAFCUs) are from pre-draft 2010 Jamaica Bay, Marine Park, and Plumb Beach Feasibility Study. EPW results were verified by the East Rockaway/Jamaica Bay Reformulation Study Team in 2016.
2: Cost per acre of oyster restoration
NA: Not Applicable



4.6 Systems/Watershed Context

As stated in Section 1.53 and Appendix B, regional partners are working together to achieve the overall goals and Targets of the HRE CRP. The restoration projects that are proposed in this FR/EA were high priorities for the region and have been coordinated and integrated with ongoing efforts to restore the New York-New Jersey (NY/NJ) Harbor and specific planning regions. These restoration projects provide ecosystem benefits and can also serve as natural and nature based features (NNBFs) providing secondary benefits for coastal storm risk management, improving the resiliency and sustainability of the region's shorelines.

A brief synopsis of the integration of the TSP at the watershed level for the various study areas is provided below.

4.6.1 Jamaica Bay

Jamaica Bay is a tidal waterway in an urban area which is connected to the lower bay of New York Harbor by Rockaway Inlet. The bay is located 17 miles south and east of the Battery in Manhattan and 22 miles from midtown Manhattan. Jamaica Bay is about eight (8) miles long, four (4) miles wide, and covers an area of approximately 26 square miles. The bay spans the southern portions of the two (2) most populated boroughs in the New York City, Brooklyn (Kings County) and Queens (Queens County), and the western boundary of Nassau County. The bay is fringed by remnant salt marshes, heavily modified tidal creeks, disturbed upland ecosystems, parks, landfills, dense residential communities, commercial and retail facilities, public transportation, and John F. Kennedy (JFK) International Airport. The Belt Parkway bisects its northern boundary and two (2) large man-made intrusions, Flatbush Avenue and Cross Bay Boulevard, bisect it east to west. The bay itself is composed of salt marsh islands, mudflats, tidal creeks, navigational channels, and open water.

Jamaica Bay hosts large and diverse fish, shellfish, invertebrate, and bird populations, though they are not as rich as they were historically. Approximately 50 species of fish live in its waters, and the area is designated as essential fish habitat for 22 of those species (NOAA, 2016). Many of these fish use the bay as a nursery, particularly winter flounder and striped bass (RPA, 2003). There were once also thriving shellfish fisheries in the area, but pollution, habitat loss, and overharvesting led to the collapse of the oyster, clam, and crab industries in the area. Jamaica Bay currently serves as an essential stopping point along the Atlantic Flyway for migratory birds (USACE, 2006), a role that is linked closely to the population of horseshoe crabs in the area and at the marsh islands in particular (JBERRT, 2002). Over 300 species of birds inhabit or migrate through Jamaica Bay annually (RPA, 2003). However, existing species in the area are at risk from the reduction in available habitat. There has been a 75 percent loss of historic marsh island habitat in Jamaica Bay. Further analysis indicates that the marsh islands are disappearing at an accelerating rate and could vanish entirely without intervention (RPA 2003, NPS 2007). Just one (1) percent of historic freshwater wetlands remain along the perimeter of the bay due to filling and sewer diversions (NYCDEP, 2007). Other ecological challenges facing Jamaica Bay include CSO, landfill leaching, municipal waste discharge, runoff, the establishment of invasive species, and sea level rise.

USACE has already restored several marsh islands in the Jamaica Bay Planning Region: Elders Point East, Elders Point West, Yellow Bar Hassock, Black Wall, and Rulers Bar. Together, these islands amount to over 160 acres, which provide habitat for finfish, shellfish, birds, plants, and other wildlife in the Jamaica Bay region. USACE and other organizations have also been involved with restoring perimeter wetland sites, such as Gerritsen Creek. The six (6) proposed shoreline projects and the five (5) proposed marsh islands have been considered key critical components to restoring Jamaica Bay as part of the NYCDEP Jamaica Bay Watershed Protection Plan, the NYC Waterfront Development Plan, NYC Special Initiative for Rebuilding and Resiliency and the Science and Resilience Institute of Jamaica Bay efforts. Together, these actions would restore close to 400 acres of habitat. Restoration activities at each site recommended within Jamaica Bay work in concert with one another and with previously constructed projects to provide increased habitats for wildlife throughout the bay, and improve water quality through the reestablishment of salt marshes. See Figure 1-4 and Figure 4-2 for ongoing and future resilience efforts in the Jamaica Bay Planning Region.

In addition to the ecological benefits, the recommendations complement actions that are advancing by others resulting from National Fish and Wildlife Foundation Sandy Recovery grants and NY Rising Reconstruction efforts provided to improve the resilience of the shoreline. The five (5) proposed marsh island restorations and the perimeter sites will build upon the lessons learned from previous marsh island restoration to advance the ecological integrity of Jamaica Bay.

Figure 4-2: HRE and Other Restoration Sites Advancing within Jamaica Bay (Note: Colors have no meaning.)

4.6.2 Hackensack River and Lower Passaic River

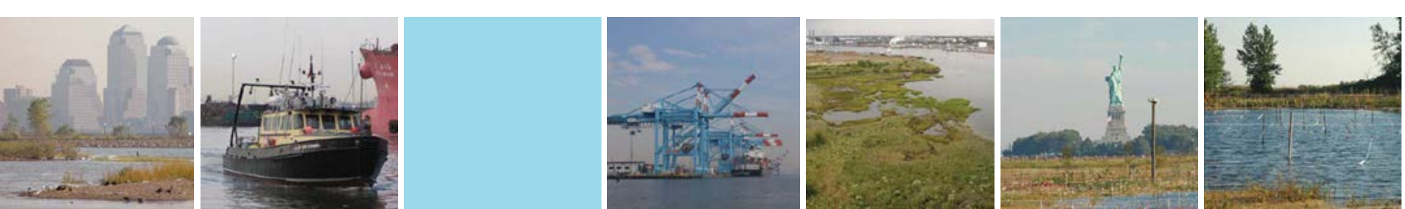
Habitat reduction and significant loss, primarily freshwater and tidal wetlands, and poor water quality are notable environmental stressors for the Passaic and Hackensack. The TSP for each site recommended works to reduce these stressors and increase native habitat through the creation of wetlands, sediment load reduction, and the strengthening and softening of shorelines to reduce erosion. Many of the restoration activities at each site contribute to provide increased and improved habitats for wildlife throughout the rivers, improve water quality through the reestablishment of freshwater and tidal salt marshes, and reduce the sediment load entering the rivers.

The Lower Passaic River sites alternatives were designed with the NJDEP Natural Resource Damage Division, and will be coordinated with NJDEP's program and Natural Resource Damage Assessment settlement with Diamond Alkali. The Essex County Branch Brook Park site also was coordinated with the Essex County Department of Parks, Recreation, and Cultural Affairs and the Branch Brook Park Alliance, transitioning towards Care of the Park Movement. The Lower Passaic River recommendations are initial steps to advance restoration in the Lower Passaic River in advance of large-scale remedial actions planned by USEPA for the lower 8.3 miles of the river. The remaining 47 restoration opportunities, and more specifically 27 restoration sites requiring EPA remediation, will be needed to realize comprehensive restoration of the watershed. In order to illustrate this point, this FR/EA includes recommendations for habitat restoration at Kearny Point and Oak Island Yards to be implemented following USEPA cleanup actions. These sites symbolize the leveraging of federal, state and private (potential responsible parties) resources to remediate and restore the river advancing the goals of the Urban Waters Federal Partnership. See Figure 1-3 for ongoing and future resilience efforts in the Newark Bay, Hackensack River, and Lower Passaic River Planning Region.

4.6.3 Bronx River

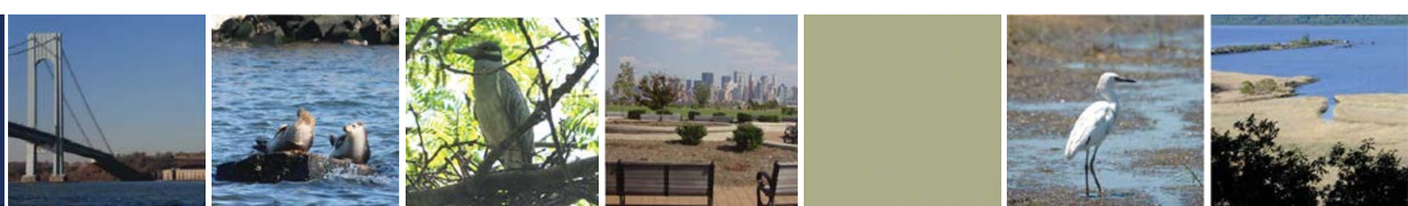
The Bronx River is 23 miles long, flowing through both suburban and highly urban communities in the Bronx and Westchester Counties. For much of its length, the river runs through numerous parks and parallels and intersects the Bronx River Parkway and the Metro North Harlem commuter rail line. The majority of the river is fresh water, with tidal influences in the most downstream section of the river where it exchanges flow with the East River and the Long Island Sound. Centered in a densely populated region and with a long history of industrialization, the Bronx River has been significantly altered and disturbed over the past 200 years.

Habitat degradation and poor water quality are notable environmental stressors for the Bronx River. The TSP for each site results in the reduction of these stressors through the creation of wetlands, sediment load reduction, and strengthening shorelines to reduce erosion. When appropriate, the TSP also increases tributary connections at sites with dams by placing fish ladders or modifying weirs to allow for anadromous and catadromous fish movement to and from the upper reaches of the river. The restoration projects recommended improve habitat connectivity and quality for wildlife in this highly urbanized environment. These activities are important components and complements to NYCDEP's Long Term Control Plan improving water quality in the Bronx River, and the NYC Parks plan to improve habitat along the shoreline and prevent erosion in NYC Parks' property (including restoration activities at Shoelace Park and Muskrat Cove), Bronx River Alliance, and the Bronx River/Harlem River Urban Waters Federal Partnership.



4.6.4 Oyster Restoration

Small-scale oyster restoration is proposed in order to expand existing, ongoing oyster restoration efforts conducted by NYCDEP, New York Harbor School, NY/NJ Baykeeper, Hudson River Foundation. This recommendation would provide significant contributions to the regional efforts of the Harbor School and the Billion Oyster Project providing improved habitat for fish and benthic communities and improved water quality in multiple areas within the HRE. The USACE seeks to accomplish the Oyster Reefs TEC objective of establishing 20 acres of oyster reef habitat by 2020, granted missing the target year. The restoration plans, developed with significant input from regional technical expertise, would create over 50 acres of oyster reef habitat throughout New York Harbor. The creation of over 50 acres allows for mortality or damage to occur from unforeseen events and still attaining the goal of 20 acres by 2020.



4.7 Environmental Benefits

4.7.1 Synergy with the HRE Comprehensive Restoration Plan & Contribution to Regional Targets

As described in Chapters 1 and 3, the HRE CRP was the foundation of plan formulation for this FR/EA. The HRE CRP was developed in collaboration with more than 129 federal, state and local agencies; non-governmental organizations; stakeholder groups; academic institutions; research groups; and private consulting firms to restore the NY/NJ Harbor Estuary. The HRE CRP was developed to address the objectives of regional stakeholders first expressed in the New York-New Jersey Harbor Estuary Program (HEP) Comprehensive Conservation and Management Plan (CCMP) (HEP, 1996) to develop a comprehensive regional master plan for restoration within the HRE and outlines a system for coordinating restoration efforts on local, state, and federal levels. All partners are working together and coordinating efforts to achieve the overall goal of advancing the TEC targets through participation in the NY/NJ HEP Restoration Work Group.

Each site recommended for construction contributes to the overall goal of developing a mosaic of habitats throughout this highly urbanized study area. Each project contributes to the TECs and the overall planning objectives and sub-objectives outlined in Section 3.1. Table 4-16 summarizes those TECs that are within the USACE's aquatic ecosystem restoration mission and are addressed by the TSP for construction. Restoration actions for most TECs are included in the plan. Restoration of TECs not included in the TSP may be included in plans for sites investigated in future feasibility studies.

Tables 4-15 through 4-19 identifies which sub-objectives are addressed by each project included in the TSP.

Table 4-15: TECs Within USACE Restoration Mission Addressed by the TSP.

Planning Region	Target Ecosystem Characteristics							
	Wetlands	Habitat for Waterbirds	Coastal and Maritime Forests	Oyster Reefs	Eelgrass Beds	Shorelines and Shallows	Habitat for Fish, Crab, and Lobsters	Tributary Connections
Jamaica Bay	★	★	★	★	●	★	★	●
Lower Bay	●	●	●	★	●	●	★	
Lower Raritan River	●	●	●	●	●	●	●	●
Arthur Kill/Kill Van Kull	●	●	●			●	●	●
Newark Bay, Hackensack River, and Passaic River	★	●	★	●	●	★	★	★
Lower Hudson River	●	●	●	●	●	●	●	●

Planning Region	Target Ecosystem Characteristics							
	Wetlands	Habitat for Waterbirds	Coastal and Maritime Forests	Oyster Reefs	Eelgrass Beds	Shorelines and Shallows	Habitat for Fish, Crab, and Lobsters	Tributary Connections
Harlem River, East River, and Western Long Island Sound	★	●	★	★	●	★	★	★
Upper Bay	●	●	●	★		●	★	

● Indicates TECs within the planning region.
★ Indicates TECs within the planning region restored or improved by the TSP.

Table 4-16: Contribution of TSP to Sub-Objectives Associated with Restoring Estuarine Habitat.

Restoration Site	Improve wetland habitat	Increase diversity and abundance	Increase wetland connectivity	Improve hydrologic connectivity	Reduce shoreline erosion	Reduce invasive monocultures, replace with natives	Restore tidal marsh systems	Improve roosting, nesting, and foraging habitat	Increase nests and improve feeding habitat	Ensure sustainability of adjacent habitat	Provide vegetated buffer and transitional zone	Provide habitat and food, stabilize shoreline, retain soils	Soften hardened shorelines	Restore buffer riparian zones	Develop mosaic of diverse habitats	Restore natural stream geomorphology	Reduce sediment loads	Wetland, eelgrass beds, and oyster reef objectives	Increase riparian habitat connectivity	Improve hydrologic connectivity	Enhance basin and tributary bathymetry configuration	Reduce shoreline erosion	Remove invasive species and replace with natives	Increase migratory fish habitat
Jamaica Bay Planning Region																								
Dead Horse Bay	★	★	★	★	★	★	★	★	★	★	★				★	★				★	★		★	★
Fresh Creek	★	★	★	★		★	★	★	★	★	★				★	★				★	★		★	★
Hawtree Point	★	★	★			★	★	★	★	★	★													
Bayswater Point State Park	★	★	★	★	★	★	★	★	★						★					★	★		★	★
Dubos Point	★	★	★	★	★	★	★	★	★	★	★				★									
Brant Point	★	★	★		★	★	★	★	★	★	★													
Harlem River, East River, and Western Long Island Sound Planning Region																								
Flushing Creek	★	★	★			★	★	★	★															
Newark Bay, Hackensack River, and Passaic River Planning Region																								
Metromedia Tract	★	★	★			★	★	★	★	★	★												★	
Meadowlark Marsh	★	★	★	★		★	★	★	★	★	★				★	★				★	★		★	★
Oak Island Yards, Tier 2	★	★	★			★	★	★	★							★				★	★		★	★
Kearny Point, Tier 2	★	★	★		★	★	★	★	★							★				★	★	★	★	★

★ Indicates site restoration would contribute to meeting the sub-objective.

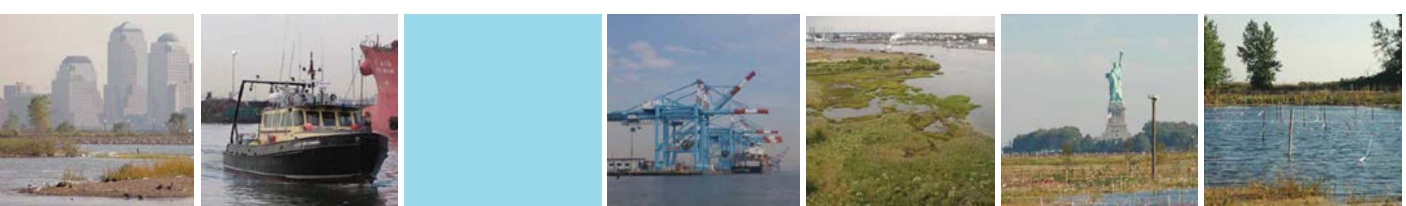
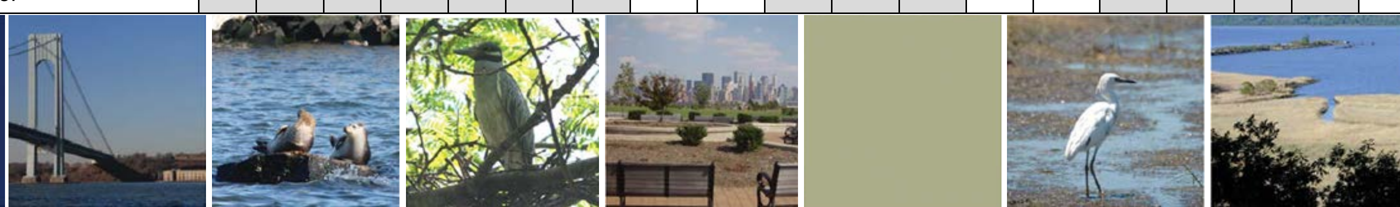


Table 4-17: Contribution of TSP to Restoring Freshwater Riverine Habitat.

Restoration Site	Improve wetland habitat	Increase diversity and abundance	Increase connectivity	Improve hydrologic connectivity	Reduce shoreline erosion	Reduce invasive monocultures, replace with natives	Restore tidal marsh systems	Improve roosting, nesting, and foraging habitat	Increase nests and improve feeding habitat	Ensure sustainability of adjacent habitat	Provide vegetated buffer and transitional zone	Provide habitat and food, stabilize shoreline, retain soils	Soften hardened shorelines	Restore buffer riparian zones	Develop mosaic of diverse habitats	Restore natural stream geomorphology	Reduce sediment loads	Wetland, eelgrass beds, and oyster reef objectives	Increase riparian habitat connectivity	Improve hydrologic connectivity	Enhance basin and tributary bathymetry configuration	Reduce shoreline erosion	Remove invasive species and replace with natives	Increase migratory fish habitat
Harlem River, East River, and Western Long Island Sound Planning Region																								
River Park/West Farm Rapids Park	★	★	★			★		★	★	★	★		★	★		★							★	★
Bronx Zoo and Dam	★	★	★			★		★	★		★	★		★		★	★		★	★	★		★	★
Stone Mill Dam																★							★	★
Shoelace Park	★	★			★	★				★	★	★		★	★	★	★		★	★	★	★	★	★
Muskrat Cove					★	★									★	★	★			★	★	★	★	★
Bronxville Lake	★	★	★			★		★	★					★	★	★	★		★	★	★		★	★
Crestwood Lake	★	★	★			★		★	★						★	★	★		★	★	★		★	★
Garth Woods/Harney Road	★	★	★			★		★	★		★	★	★	★		★			★	★	★		★	★
Westchester County Center	★	★	★		★	★		★	★			★			★	★			★	★	★	★	★	★



Restoration Site	Improve wetland habitat	Increase diversity and abundance	Increase connectivity	Improve hydrologic connectivity	Reduce shoreline erosion	Reduce invasive monocultures, replace with natives	Restore tidal marsh systems	Improve roosting, nesting, and foraging habitat	Increase nests and improve feeding habitat	Ensure sustainability of adjacent habitat	Provide vegetated buffer and transitional zone	Provide habitat and food, stabilize shoreline, retain soils	Soften hardened shorelines	Restore buffer riparian zones	Develop mosaic of diverse habitats	Restore natural stream geomorphology	Reduce sediment loads	Wetland, eelgrass beds, and oyster reef objectives	Increase riparian habitat connectivity	Improve hydrologic connectivity	Enhance basin and tributary bathymetry configuration	Reduce shoreline erosion	Remove invasive species and replace with natives	Increase migratory fish habitat
Newark Bay, Hackensack River, and Passaic River Planning Region																								
Essex County Branch Brook Park					★	★		★	★	★	★	★		★					★			★	★	
Dundee Island Park					★							★	★									★	★	
Clifton Dundee Canal Green Acres	★	★	★					★	★	★				★					★				★	

★ Indicates site restoration would contribute to meeting the sub-objective.

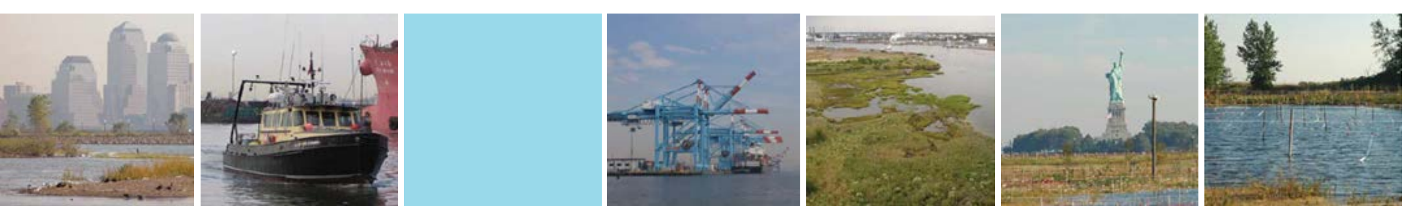


Table 4-18: Contribution of TSP to Restoring Jamaica Bay Marsh Islands.

Restoration Site	Improve wetland habitat	Increase diversity and abundance	Increase connectivity	Improve hydrologic connectivity	Reduce shoreline erosion	Reduce invasive monocultures, replace with natives	Restore tidal marsh systems	Improve roosting, nesting, and foraging habitat	Increase nests and improve feeding habitat	Soften hardened shorelines	Restore buffer riparian zones	Develop mosaic of diverse habitats	Restore natural stream geomorphology	Reduce sediment loads	Wetland, eelgrass beds, and oyster reef objectives	Increase riparian habitat connectivity	Improve hydrologic connectivity	Enhance basin and tributary bathymetry configuration	Reduce shoreline erosion	Remove invasive species and replace with natives	Increase migratory fish habitat
Jamaica Bay Planning Region																					
Stony Creek	★	★	★	★		★	★	★	★								★	★		★	
Duck Point	★	★	★	★	★	★	★	★	★								★	★	★	★	
Elders Point Center	★	★	★			★	★	★	★											★	
Pumpkin Patch West	★	★	★	★		★	★	★	★								★	★		★	
Pumpkin Patch East	★	★	★	★		★	★	★	★								★	★		★	

★ Indicates site restoration would contribute to meeting the sub-objective.

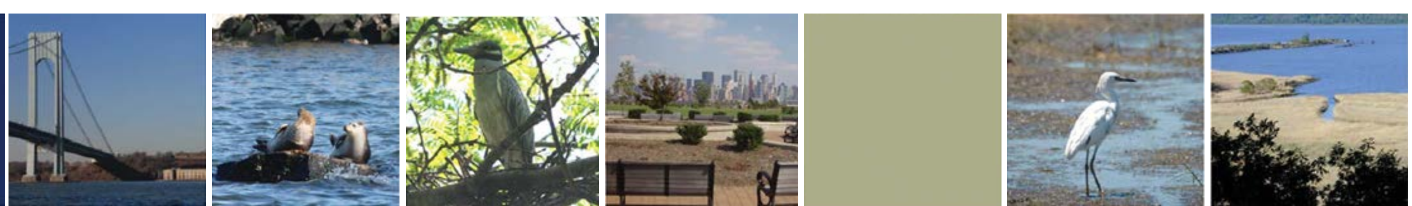


Table 4-19: Contribuion of TSP to Increasing Oyster Reefs

Restoration Site	Incorporate diverse habitat structure	Soften hardened shorelines	Restore buffer riparian zones	Develop mosaic of diverse habitats	Restore natural stream geomorphology	Reduce sediment loads	Wetland, eelgrass beds, and oyster reef objectives
Jamaica Bay Planning Region							
Jamaica Bay, Head of Bay	★			★			★
Harlem River, East River, and Western Long Island Sound Planning Region							
Soundview Park	★			★			★
Upper Bay Planning Region							
Bush Terminal	★			★			★
Governors Island	★			★			★
Lower Bay Planning Region							
Naval Weapons Station Earle	★			★			★

★ Indicates site restoration would contribute to meeting the sub-objective.

The regional partners of the HEP Restoration Work Group will continue to coordinate and advance the 296 restoration opportunities that are outlined in the HRE CRP. To date, the HEP RWG has tracked progress of restoration in the region since the release of the 2009 Draft CRP. Progress reports (2009-2014; 2014-2016) in Appendix B illustrates the success of partners towards achieving the region's restoration goals. However, the reports also demonstrate the need to implement the TSP – the next phase of top priority restoration projects in the region. Construction of the TSP will advance the regional TEC statements and short-term and long-term restoration targets (Tables 3-1 and 3-3) which is critical to achieve the regional goals in the HRE CRP (2016).

4.8 Acceptability, Completeness, Effectiveness, and Efficiency

Per the USACE Planning Guidance Notebook (Engineering Regulation 1105-2-100, April 22, 2000), planning for federal water resources projects constructed by the USACE is based on the principles and guidelines adopted by the United States Water Resources Council (1983). Acceptability, completeness, effectiveness, and efficiency are the four (4) evaluation criteria specified that the USACE uses in the screening of alternative plans. Alternatives considered in any planning study, not just ecosystem restoration studies, should meet minimum subjective standards of these criteria in order to qualify for

further consideration and comparison with other plans. The alternatives for each of the recommended 33 sites were formulated to meet these criteria.

4.8.1 Acceptability

Acceptability is the workability and viability of the alternative plan with respect to acceptance by state and local entities and the public and compatibility with existing laws, regulations, and public policies (United States Water Resources Council, 1983). An ecosystem restoration plan should be acceptable to federal and state resource agencies, local governments, and stakeholders in the study area. There should be evidence of broad based public consensus and support for the plan. A recommended plan must also be acceptable to the non-federal cost-sharing partners.

The HRE Ecosystem Restoration Feasibility study was developed in a collaborative fashion in which planning and design meetings screened and refined habitat restoration measures. The federal, state and local groups that participated in these activities are discussed in Chapter 8. The stakeholders played a significant role in the development of the needs and opportunities report (RPA, 2003) and the HRE CRP (USACE and PANYNJ, 2009 and 2016). Their participation ensured that the program meets the needs of the region's interested agencies and non-governmental organizations. Stakeholders have reached a broad consensus on a harbor-wide restoration goal and restoration targets, as well as a shared vision of a restored future state. In December 2009, the HEP, which brought together federal, state, local, and non-governmental organizations interested in improving ecological conditions within the HRE, adopted the HRE CRP as a path forward for restoration within the HRE. The TSP advances and supports the goals of the HRE CRP, and is acceptable to the non-federal sponsor and stakeholders.

The no action alternative provides no ecosystem improvements (with the exception of smaller scale restoration actions by partners) and does not meet the federal objective, the non-federal sponsor's goals and stakeholder desires. The TSP is the most acceptable in terms of the federal objective and non-federal sponsor/stakeholder vision for reestablishing the mosaic of sustainable and viable habitats within the HRE study area. Taking the federal objective, study objectives, and non-federal sponsor/stakeholder needs into consideration, the TSP addresses many of the problems within the study area and would provide critical restoration for the diverse habitat types within HRE and therefore is the most acceptable.

4.8.2 Completeness

Completeness is the extent to which a given alternative plan provides and accounts for all necessary investments or other actions to ensure the realization of the planned effects (United States Water Resources Council, 1983). Completeness also includes consideration of real estate issues, operation and maintenance, monitoring, and sponsorship factors. Adaptive management plans formulated to address project uncertainties also have to be considered. The alternatives considered were unique in that all contribute to the goals of the HRE CRP, the consensus-based multi-stakeholder regional plan for ecosystem restoration. The TSP is the most complete in that it would address the habitat types identified by stakeholders as experiencing environmental degradation and in need of restorative actions. The TSP is the national ecosystem restoration plan and is the most efficient investment of federal funds. The TSP, in conjunction with the coordinated restoration actions outlined in the HRE CRP, contributes to the goals of the regional plan. Given the expansive area of this study, future 'spin-off' feasibility studies of other restoration opportunities will be needed for planning regions and areas that are not represented in the TSP in order to advance the other projects outlined in the HRE CRP.

These remaining CRP projects identified for future "spin-off" feasibility studies are outlined in Appendix N.

4.8.3 Effectiveness

Effectiveness is the extent to which an alternative plan alleviates the specified problems and achieves the specified opportunities (United States Water Resources Council, 1983). An ecosystem restoration plan must make a significant contribution to addressing the specified restoration problems or opportunities (i.e. restore important ecosystem structure or function to some meaningful degree). The problems identified that may be addressed under this ecosystem restoration authority include impaired hydrology, geomorphology, and wetland plant communities. The TSP addresses objectives that include the improvement of hydrogeomorphology, habitat complexity, native plant species richness, removal of invasive species and restoring lost critical habitats. All alternatives provide positive net habitat benefits over the period of analysis, and greater net benefits than those under the future without-project condition, as measured by AAFCUs. The alternatives contribute to the planning objectives and together support the region's mosaic of habitats. Sections 3.10 and 3.12 summarizes the habitat benefits of the TSP by various metrics (AAFCUs, linear feet of restored shoreline, etc.).

4.8.4 Efficiency

Efficiency is the extent to which an alternative plan is the most cost effective means of alleviating the specified problems and realizing the specified opportunities, consistent with protecting the Nation's environment (United States Water Resources Council, 1983). An ecosystem restoration plan must represent a cost-effective means of addressing the restoration problem or opportunity.

For those sites with more than one (1) alternative, the plans were compared primarily by their measure of efficiency, i.e., their habitat outputs over time, via the CE/ICA analysis. The CE/ICA identified the subset of cost effective plans that offer the greatest increases in output for the least increases in cost are those plans that are most efficient in production and superior financial investments – i.e., the "best buy" plans. Best buy plans are the most efficient plans at producing the output variable (i.e., AAFCUs). They provide the greatest increase in the value of the output parameter variable for the least increase in the value of the cost parameter variable. Cost efficient, best buy plans were chosen as the recommended actions for the sites.

4.8.5 Risk and Uncertainty

When the costs and outputs of alternative restoration plans are uncertain and/or there are substantive risks that outcomes will not be achieved, which may often be the case, the selection of a recommended alternative becomes more complex. It is essential to document the assumptions made and uncertainties encountered during the course of planning analyses. Restoration of some types of ecosystems may have relatively low risk. For example, removal of urban fill to restore hydrology to a wetland area. Other activities may have higher associated risks such as restoration of coastal marsh in an area subject to hurricanes. The associated risk and uncertainty of achieving the proposed level of outputs by implementing the TSP was considered. For example, if two (2) plans have similar outputs but one (1) plan costs slightly more, according to cost effectiveness guidelines, the more expensive plan would be dropped from further consideration. However, it might be possible that, due to uncertainties beyond the control or knowledge of the planning team, the slightly more expensive plan will actually produce greater ecological output than originally estimated, in effect qualifying it as a cost effective plan. But without taking into account the uncertainty inherent in the estimate of outputs, that plan would have been excluded from further consideration.

The major drivers of uncertainty are typical of aquatic ecosystem restoration projects. Native plantings have an associated risk of not establishing due to a variety of unforeseen events. Predation from herbivorous animals and insects is a possibility and can be reasonably estimated based on baseline surveys of the existing flora and fauna. However, weather also plays a large role in the establishment success of new plantings. Periods of drought or early frost may alter the survival percentage of plantings. Although historical records can help to predict the best possible location and timing of new plantings, single unforeseen events may lead to failure. In addition, climate change in the years to come may play a role in impacting the project outcome. Increased temperatures or rainfall may lead to changes in the ecosystem of the project area. Complete eradication of invasive species always presents a certain level of risk and uncertainty as the chances of reinvasion are likely to occur without proper management, increasingly so when native species have not yet established. Changes in nutrient cycling processes and soil chemistry (due to impaired hydrology and prolonged invasive species establishment) further increases uncertainty with the eradication of invasive species.

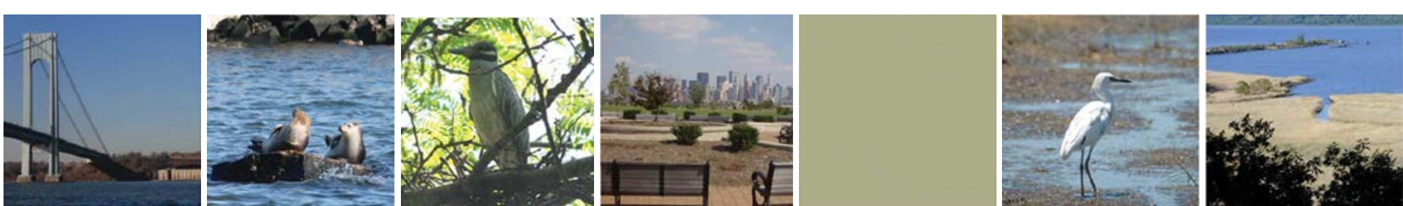
The constructed project will be adaptively managed, as detailed in a Monitoring and Adaptive Management Plan (Appendix O). Adaptive management is a structured, iterative process of robust decision making in the face of uncertainty, with an aim to reducing uncertainty over time via system monitoring. To mitigate these risks, planting over several years, overplanting and/or adaptive management and monitoring may be incorporated into the overall plan. Measures that prevent further degradation to soils and measures that alleviate impaired hydrology can reduce the invasibility of the ecosystem and should lessen the risk and uncertainty associated with invasive species removal. Management actions may be incorporated into the final plan as appropriate. Adaptively managing the project will greatly reduce risk and uncertainty, and support project success.

4.9 P&G Evaluation Accounts

The Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (P&G) (US Water Resources Council, 1983) require evaluation of alternative plans according to the following four (4) evaluation accounts:

- National Economic Development: Per the P&G and the USACE Planning Guidance Notebook (Engineering Regulation 1105-2-100, April 22, 2000), the prime federal goal in water and related land resources planning is to contribute to national economic development, consistent with protecting the nation's environment, in accordance with national environmental statutes, applicable executive orders, and other federal planning requirements. Contributions to national economic development (national economic development outputs) are increases in the net value of the national output of goods and services, expressed in monetary units, and are the direct net benefits that accrue in the planning area and the rest of the nation.

  Ecosystem restoration projects differ from traditional USACE planning studies because ecological benefits typically are not expressed in monetary terms. For all project purposes except ecosystem restoration, the national economic development account displays changes in the economic value of the national output of goods and services, expressed in monetary units. For this study, there is no evaluation for national economic development, as benefits of the alternative plans are not monetized and no measurable economic benefits would accrue.



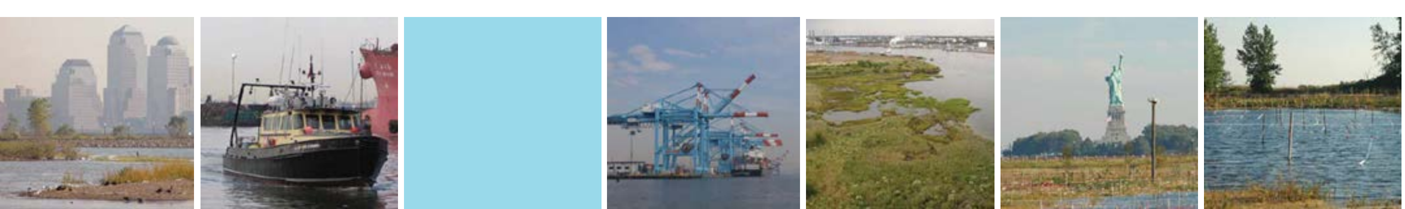
- Regional Economic Development: This account registers changes in the distribution of regional economic activity that result from each alternative plan. As for national economic development, there is no evaluation for regional economic development, as benefits of the alternative plans are not monetized and no measurable economic benefits would accrue. Chapter 5 provides a detailed assessment of the potential economic effects that would result from implementing the TSP.

- Environmental Quality: This account displays non-monetary effects on significant natural and cultural resources. The expected environmental quality effects of implementing the TSP are primarily beneficial, although there would be short-term adverse effects during construction. Chapter 5 provides a detailed assessment of the potential environmental quality effects that would result from implementing the TSP. In the long term, environmental quality will be greatly enhanced by construction of the project. Improving the habitat and aesthetic values of the 33 sites within the HRE would be achieved via the TSP. This project would provide leadership with an example for other large metropolis and urban areas that highly degraded water bodies can be reclaimed for the public and nature to enhance environmental quality and recreational opportunities.

- Other Social Effects: This account registers plan effects from perspectives that are relevant to the planning process, but are not reflected in the other three (3) accounts. Social effects refer to how the constituents of life that influence personal and group definitions of satisfaction, well-being, and happiness, are affected by some water resources condition or proposed intervention. Chapter 5 provides a detailed assessment of the potential social effects that would result from implementing the TSP. The expected social effects of implementing the TSP are primarily beneficial, although there would be short-term adverse effects during construction such as noise and dust in the local vicinity. The TSP provides for the enhancement of many important educational and recreational areas that are important to the region, especially for urban communities that don't have access to many natural areas.

4.10 Consideration of Climate Change

The design and implementation of coastal habitat restoration projects within the HRE requires consideration of the effects of climate change, including global sea level rise. The foundation for coordinated action on climate change preparedness and resilience across the Federal government was established by Executive Order 13514 of October 5, 2009, and the Interagency Climate Change Adaptation Task Force led by the Council on Environmental Quality (CEQ). In October 2011, the Task Force developed a National Action Plan that provided an overview of the challenges a changing climate presents for the management of the nation's freshwater resources. Climate preparedness and resilience actions have also been established by the USACE, as demonstrated by the annual release of the Climate Change Adaptation Plan, prepared under the direction of the USACE Committee on Climate Preparedness and Resilience (CCPR) (USACE, 2015a). USACE established an overarching USACE Climate Change Adaptation Policy Statement and a governance structure to support mainstreaming adaptation in 2011, following the release of the Executive Order (USACE, 2015a). Per Engineer Regulation 1100-2-8162, Incorporating Sea Level Change in Civil Works Program, released in December 2013, followed by Engineer Technical Letter 1100-2-1, Procedures to Evaluate Sea Level Change: Impacts, Responses and Adaptation in July 2014, USACE plans and incorporates climate change into Civil Works projects.



Since 1920, in the HRE region, the northeast has witnessed increases in average temperatures of more than 1.5 degrees Fahrenheit (°F). These changes have resulted in warmer winters and hotter summers and other changes in the form of fewer but heavier snow and heavier, more intense rainfall and storms. The warming produced by global climate change causes sea level to rise because warmer water takes up more space, and higher temperatures are melting ice sheets around the globe. New York Harbor has experienced an increase in sea level of more than 15 inches in the past 150 years, with harbor tide gauges showing a rise of between four (4) and six (6) inches since 1960 (NYSSLRTF, 2011).

Presently, the rate of sea level rise in the HRE area is approximately 0.1 inches per year, which exceeds the global average of 0.07 inches per year (IPCC 2007, Kirshner et al. 2008, Needelman et al. 2012). The higher observed average rate of sea level rise in the NYC area is partially the result of post-glacial rebound, exacerbating the amount of observed wetland/shoreline subsidence attributed to eustatic sea level rise, (i.e., an increase in the volume of the world's oceans solely due to thermal expansion) (Hartig et al., 2002, Needelman et al., 2012). NPCC estimates that the rate of sea level rise is increasing and predicts the sea level will be between 4.0 and 11.0 inches above current elevations by the 2020s. By the 2050s, the NPCC predicts that the sea level could be between 11.0 inches and nearly 3 feet above current elevations (NYC, 2013).

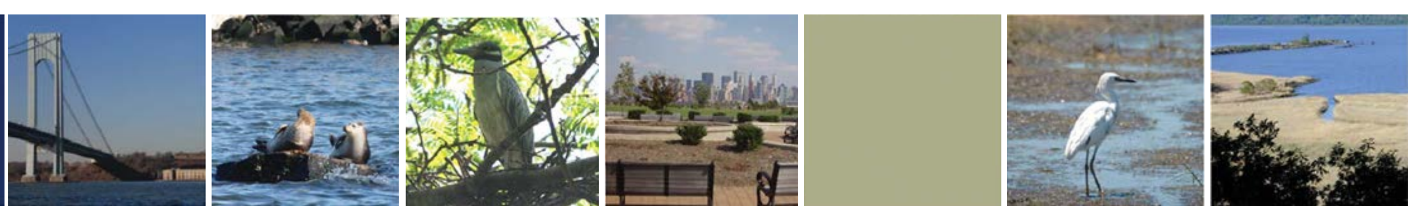
NYC's Comprehensive Waterfront Plan (NYC CWP; a component of the city's "Vision 2020") lists coastal wetland restoration as one option for the City for increasing resiliency of natural and man-made systems in the face of rising sea level (NYC, 2011). Research is underway to better understand sediment accretion rates in coastal wetlands throughout NYC in comparison to wetlands in adjacent regions. Remote sensing (e.g., LiDAR) datasets are being evaluated to identify potential areas where migration of wetlands inland can be accommodated or where historic fill can be removed, creating opportunities for migration and or creation of new wetlands (NYC, 2011). Recognizing the success of the Marsh Island Restoration Project in Jamaica Bay, the City recognizes that the beneficial use of dredged material can be undertaken in other HRE planning regions to increase the resilience of coastal communities. The approach could be used to restore and reinforce eroding wetlands, maintain wetlands under threat of submergence due to sea level rise, or create new wetlands in areas that could benefit from enhanced wave attenuation.

New York State has adopted official sea-level rise projections in February 2017 with the following notes:

- Temperature: Modelling shows that New York should anticipate more warming. Compared to the 1971 to 2000 period, average temperature will increase up to 3°F warmer by the 2020s, up to 6°F warmer by the 2050s, and up to 10°F warmer by the 2080s (NYSDEC, 2017a). By 2100, the growing season could be about a month longer, with intense summers (extreme heat and heat waves) and milder winters.

- Precipitation: Modelling shows that New York is also likely to experience more precipitation and more variability in precipitation. Compared to the 1971-2000 period, average precipitation in New York will increase with temperatures up to eight (8) percent by the 2020s, up to 12 percent by the 2050s, and up to 15 percent by the 2080s.

For the HRE restoration sites, restoration activities were targeted to confront and remedy immediate environmental stressors, namely coastal and shoreline erosion, habitat loss, and restoration of previous habitats, and to complement existing and ongoing restoration efforts by other agencies. When possible, many restorations, especially the Bronx River riverine sites, considered increased fluvial velocities and



volumes in their anticipated construction to control bank loss. Typical soft edges were often discounted and replaced with crib walls and/or stacked rock walls with vegetated fasciae.

Indeed, under worst case scenarios certain restoration actions that occur under as part of the HRE (e.g., tidal wetlands) may be lost at the end of next century if there is a landward advance of the sea and a permeant submergence of current intertidal habitats. Future generations would need to possibly save these habitats through future actions. While the future may look perilous for these habitats, the benefit they will provide over the next few decades would be immeasurable and would attenuate the habitat loss that would occur if the project is not implemented.

4.11 Resilience & Sustainability

As part of plan formulation, USACE considers how the TSP contributes to resiliency of affected ecological communities and affects the sustainability of environmental conditions in the affected area. Resiliency is defined in the February 2013 USACE-NOAA Infrastructures Systems Rebuilding Principles white paper as the ability to adapt to changing conditions, and withstand and rapidly recover from disruption due to emergencies. Sustainability is defined as the ability to continue, in existence or a certain state, or in force or intensity, without interruption or diminution.

The TSP is a resilient, sustainable ecosystem solution that integrates multiple habitat features that can adapt to changes, and can recover after a major disturbance naturally. The 33 sites included in the TSP were identified as important restoration opportunities in the HRE CRP that should be restored to address long-term regional ecosystem degradation trends. The TSP addresses the most feasible and highest priority sites for USACE participation in the near-term. It complements ongoing and future restoration work in support of the goals of the HRE CRP, the region's framework for restoration. The TSP will work in concert with completed restoration work by the USACE and others, in addition to ongoing and future projects to improve the sustainability of the HRE. The USACE will continue to work with the non-federal sponsors and stakeholders to ensure the sustainability of restoration actions, especially for those parks and public lands for which there are master plans.

The increase in spatio-temporal and biodiversity that will result with implementation of the TSP encourages resilience. The addition of diverse native species, novel physical features, and functional redundancy into the ecosystem will allow restored areas to better adapt to changing conditions, and withstand and rapidly recover from disruption. This is important as climate change, sea level change, water quality degradation, the introduction and proliferation of invasive species, and other stressors continue to influence the region.

Recognizing the federal government’s commitment to ensure no inducement of development in the floodplain, pursuant to Executive Order 11988, the implemented TSP will ensure that development within the floodplain will not occur.

Many sites recommended as part of the TSP and remaining HRE CRP sites for future feasibility study also have the potential to provide secondary coastal and storm risk management (CSRM) benefits. CSRM benefits include wave attenuation, fetch reduction, and shoreline stabilization/erosion prevention, while improving resiliency and environmental sustainability, through Natural and Nature Based Features (NNBFs).

Coastal systems are increasingly vulnerable to flooding and flood damages due to the combined influence of coastal storms, development and population growth, geomorphic change, and sea level rise. This problem has given rise to efforts to make greater use of ecosystem-based approaches to

reduce risks from coastal storms, approaches which draw from the capacity of wetlands, beaches and dunes, biogenic reefs, and other natural features to reduce the impacts of storm surge and waves. NNBFs are those feature that define natural coastal landscapes, and are either naturally occurring or have been engineered to mimic natural conditions. The devastating effects of Hurricane Sandy, which impacted the Atlantic Coast in October 2012, emphasized the need for coastal resilience and climate adaptation in the region. In the aftermath of the storm, federal, state, and municipal assessments and planning documents emphasized the need for NNBFs that may reduce the risk of damages due to coastal flooding (USACE, 2015a, 2015b). The evaluation of opportunities to incorporate NNBFs into future federal, state, and local costal storm risk management projects can be integrated into future studies using the HRE or other authorities and programs.

HRE CRP sites, including the TSP sites, with the potential to serve as NNBFs were identified through a three (3) -step screening analysis.

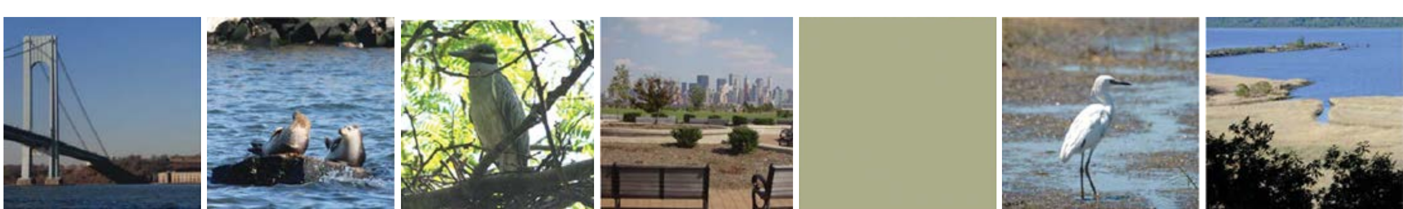
- The initial screening selected HRE CRP sites with identified TECs and restoration measures which correlated to the NNBF categories including Vegetated Features, Maritime Forests/Shrub Communities, Oyster and Coral Reefs and Barrier Islands (e.g., Jamaica Bay Marsh Islands) (USACE, 2015).
- Secondary screening considered landscape position by selecting only those HRE CRP sites within the Federal Emergency Management Agency's Special Flood Hazard Zone (one [1] percent annual chance/100-year flood zone).
- Landscape context was also considered, because size is an important factor contributing to the value of NNBFs. The final screening eliminated small (<20 acres), isolated sites would provide little to no flood protection functions on their own. Restoration sites smaller than 20 acres, contiguous to larger natural areas and which could supplement the NNBF protective features of those areas, were retained.

Following this evaluation, 138 HRE CRP Sites were identified as having the potential to serve as NNBFs, with nearly half being located within the Jamaica Bay and Lower Bay planning regions. The breakdown of HRE CRP sites, by planning region, with potential NNBF categories is as follows:

- 36 in the Jamaica Bay Planning Region;
- 15 in the Harlem River, East River, and Western Long Island Sound Planning Region;
- 24 in the Newark Bay, Hackensack River, and Passaic River Planning Region;
- Four (4) in the Upper Bay Planning Region;
- 32 in the Lower Bay Planning Region;
- 16 in the Arthur Kill/Kill Van Kull Planning Region;
- Six (6) in the Lower Hudson Planning Region; and
- Five (5) in the Lower Raritan Planning Region;

Sites included in the TSP that have been identified as having the potential to serve as NNBFs with potential CSRM benefits are identified in Appendix N.

Most of the TSP sites were identified as NNBFs as illustrated in Figure 4-3 to 4-7 for the Jamaica Bay; Harlem River, East River, and Western Long Island Sound; and Newark Bay, Hackensack River and Lower Passaic River planning regions.



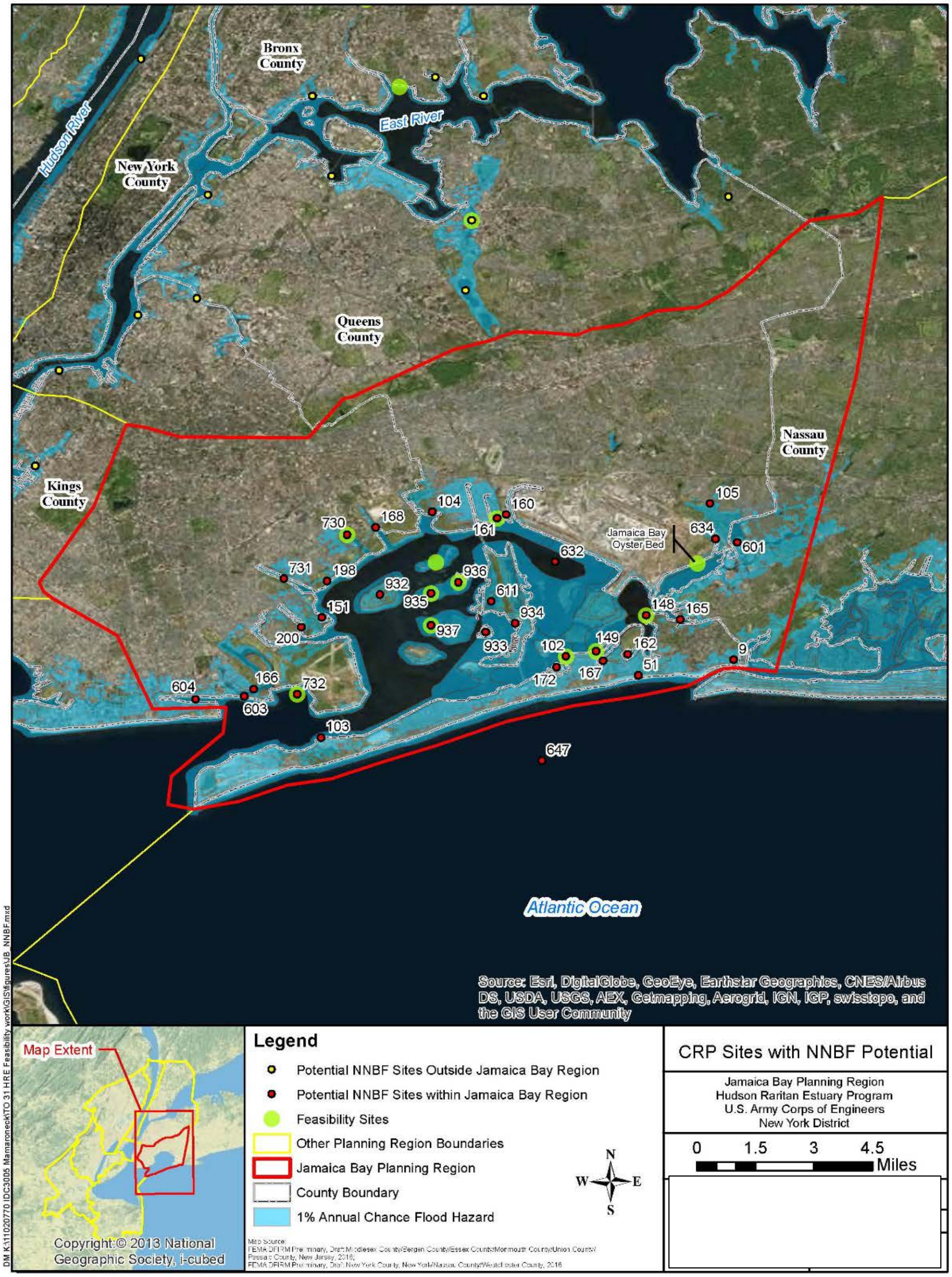


Figure 4-3: CRP and TSP Sites that Could Serve as NNBFs in Jamaica Bay Planning Region

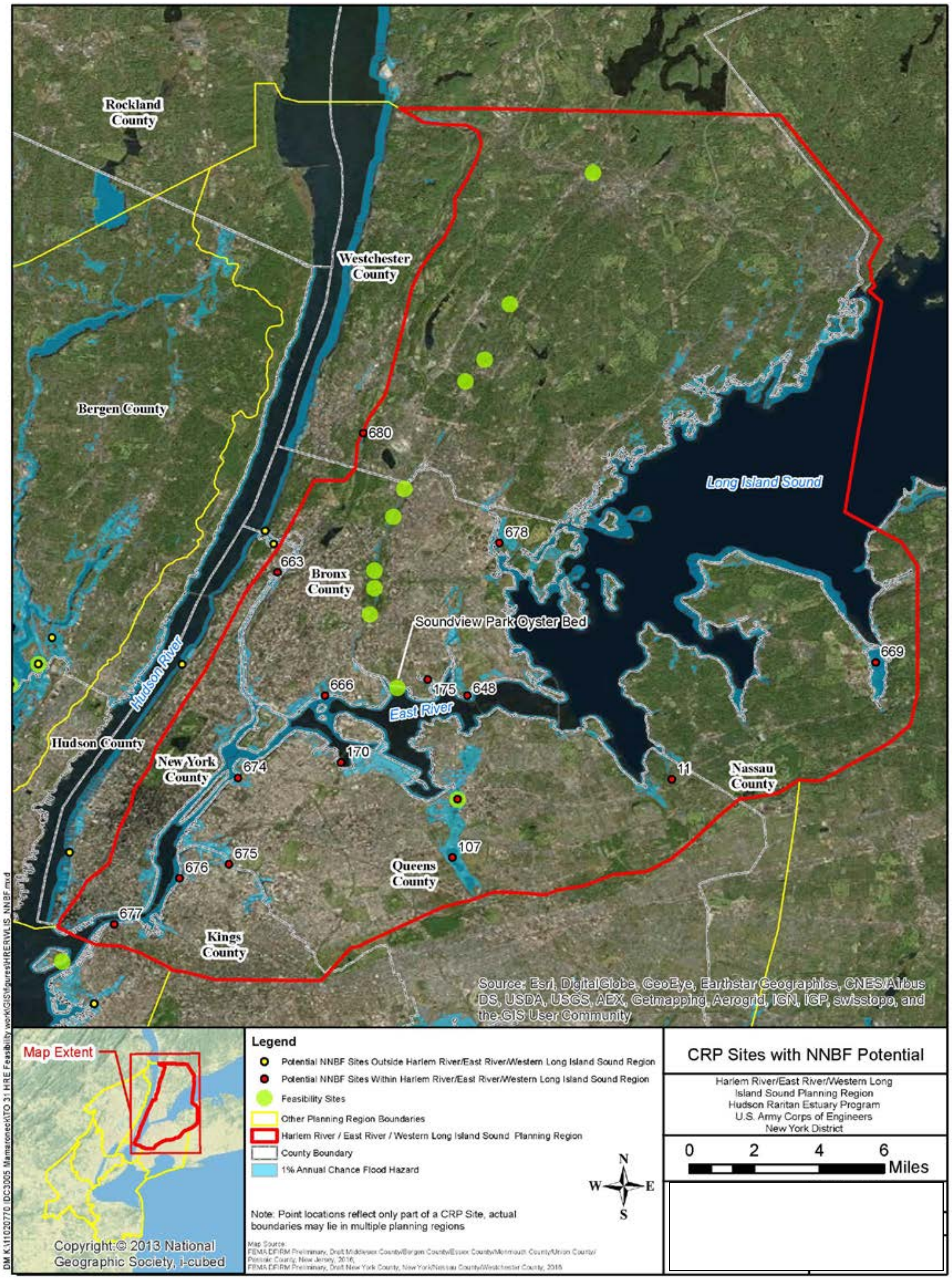


Figure 4-4: CRP and TSP Sites that Could Serve as NNBFs in the Harlem River/East River/Western Long Island Sound Planning Region

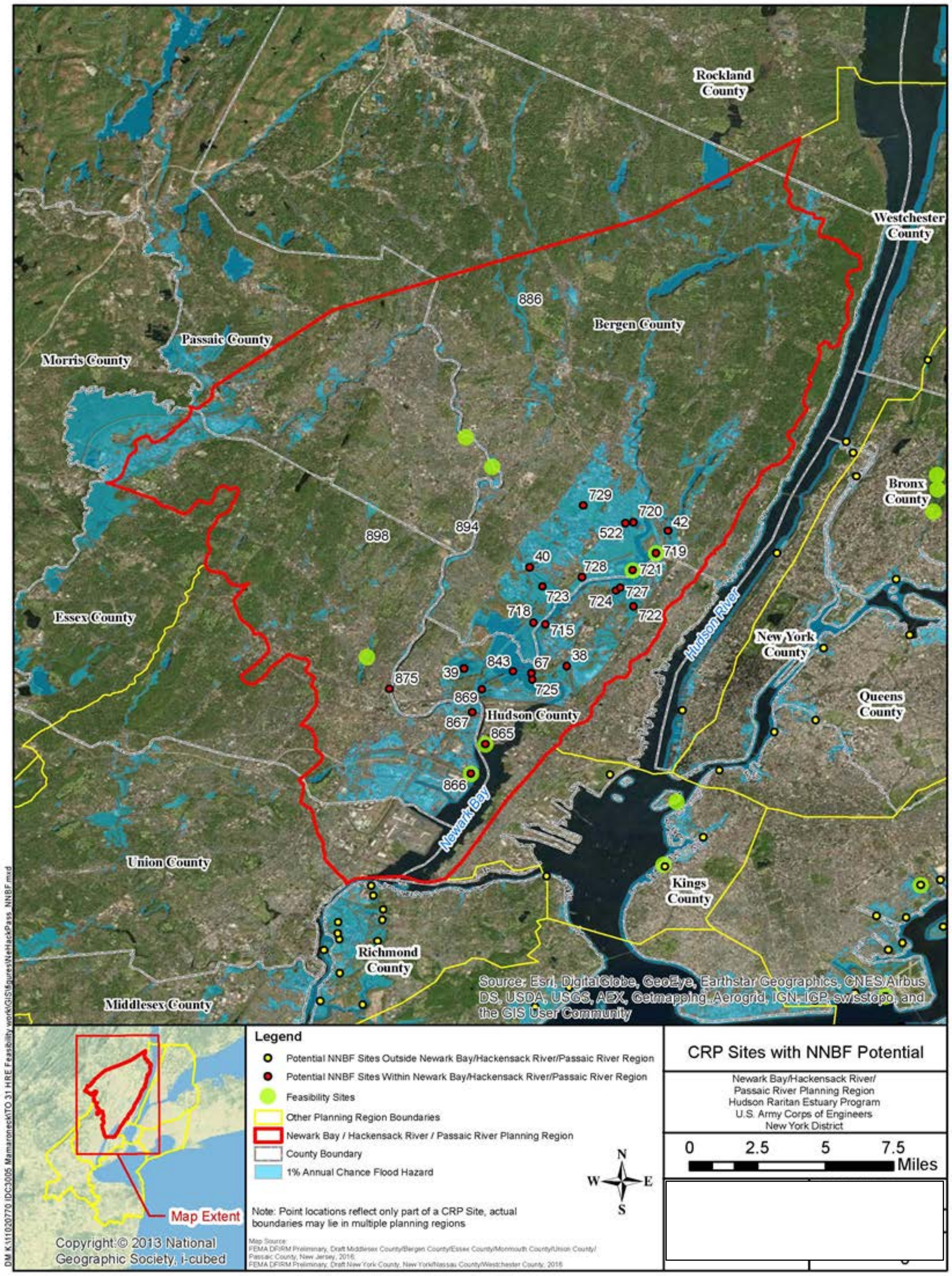


Figure 4-5: CRP and TSP Sites that Could Serve as NNBFs in the Newark Bay, Hackensack River, Lower Passaic River Planning Region

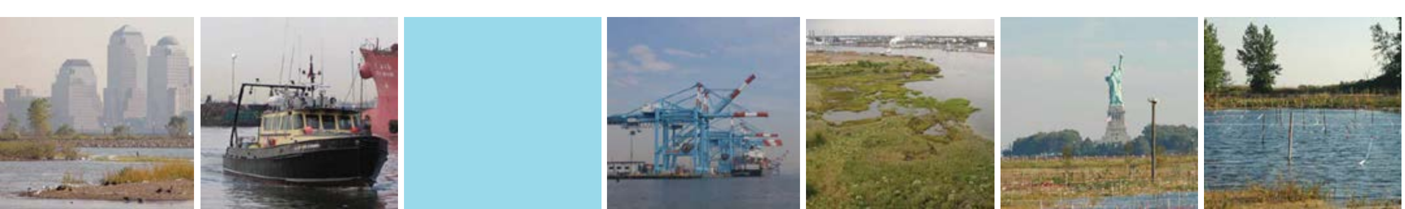
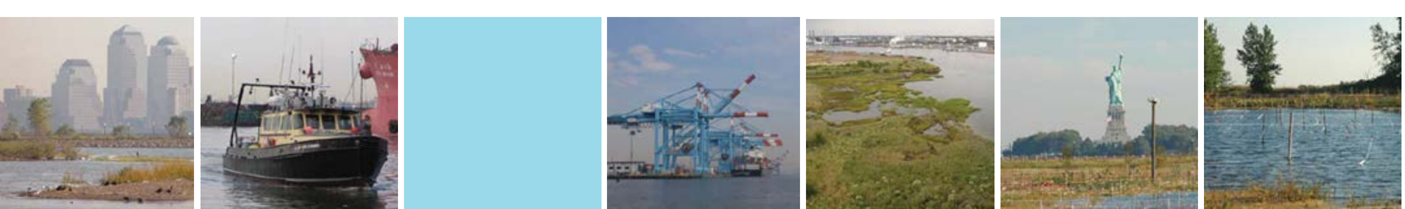


Figure 4-6: CRP and TSP Sites that Could Serve as NNBFs in the Upper Bay Planning Region

Figure 4-7: CRP and TSP Sites that Could Serve as NNBFs in the Lower Bay Planning Region



4.12 Design and Construction Considerations

The study team has taken a risk-based approach to the level of design developed in the feasibility phase. The preliminary designs included in this FR/EA (Appendix E) are not detailed enough to support certifiable cost estimates and defensible Section 902 cost limit. Detailed designs and cost estimates will be prepared between the draft and final version of the feasibility study. The study team will more formally identify the necessary studies and data collection to be performed during the pre-construction Planning, Engineering, and Design (PED) phase to manage specific risks and uncertainties. A preliminary list of studies which have been identified in Appendix D (Engineering), G (Regulatory Correspondence), H (Hazardous Toxic Radioactive Waste [HTRW]), I (Cultural Resources Documentation) and P (Real Estate Plan) including:

- Property and utility investigations: Parcel ownership, property boundaries and utility survey, needed to confirm acquisition requirements and refine real estate and relocation costs.
- Data collection: Topography, bathymetry, tidal gauging and soils testing needed to support civil and ecological design as well as hydraulic and hydrologic analyses.
- Hydraulic and hydrologic analysis and modeling: Riverine, coastal and sedimentation studies, needed to optimize design features, refine construction cost estimates, confirm areas of environmental benefits, identify areas of induced flooding and predict/minimize actions for operations and maintenance.
- Geotechnical analyses: Foundation design, analysis of settlement and seepage of project features and identification of disposal and borrow sites, needed to finalize design features and refine cost estimates.
- HTRW sampling: Contaminant concentrations in soil and sediment sampling to identify additional activities and costs associated with the restoration action.
- Cultural Resources:

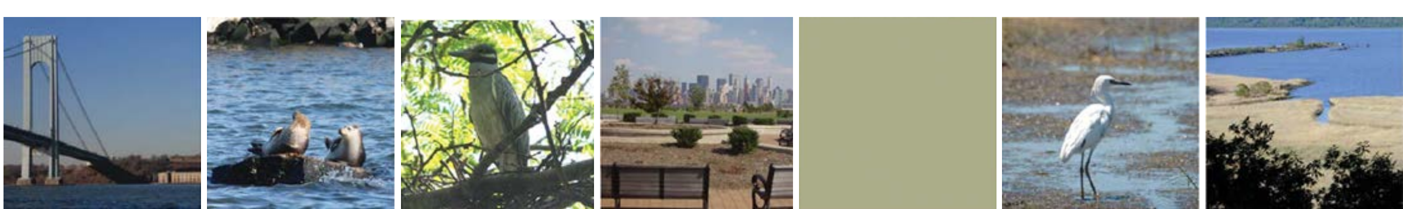
4.13 Construction Phasing

The project is spanned over five (5) planning regions and 33 different site and will require a phased approach for the design and construction of the restoration measures at the site. The detailed phasing for the design and construction activities will be developed during the feasibility design stage and will be updated as needed during the Preconstruction Engineering and Design (PED) stage of the project.

The general construction phasing/sequencing will be identified during the preparation of fully funded cost estimates. Sequencing of the 33 sites is expected to be influenced by sponsor readiness and priorities, in addition to geographic distribution among the planning regions.

Sites that require remedial actions would be restored following remediation. Kearny Point and Oak Island Yards sites on the Lower Passaic River will require remediation by USEPA which is expected to be completed by 2030. The remaining sites are assumed to not require a remedial action. However, if during PED, contamination is identified at an unacceptable level and remedial actions are required prior to restoration, the site would be sequenced accordingly.

The general construction sequencing applicable to the all restoration site project is presented below.



- Dewatering and subsequent contamination remediation, if applicable to any site prior to earthwork activities and prior to construction of the project would be needed to be performed. Continuation
  of dewatering would likely continue throughout construction of the project and monitoring and treatment would need to be performed by the non-federal sponsor.
- Removal of HTRW impacted soils would be performed by the non-federal sponsor to the depth and grade required for restoration standards at the restoration site.
- Upon completion of the remediation or HTRW impacted soil removal if required, the normal construction sequence at the project site will include the following activities.
  1. Mobilization;
  2. Installation of construction fence and staging features;
  3. Vector pest control, if necessary;
  4. Installation of soil erosion and sediment control features;
  5. Installation of temporary work access road;
  6. Site clearing, including removal of existing vegetation, where applicable;
  7. Excavation and grading where applicable;
  8. Installation of shoreline stabilization structures where applicable;;
  9. Installation of herbivory fencing;
  10. Planting and seeding;
  11. Installation of site amenities; and
  12. Demobilization.

4.14 Risk & Uncertainty

A certain degree of risk and uncertainty is inherent in any restoration project. Risk to public health and safety is reduced to the degree possible during the planning and design process, and known risks are described in associated environmental documentation. Uncertainty is found where some factors are beyond the control of the project design team; for example, precipitation rates, new types of invasive species, or changes in human use of the site. A Monitoring and Adaptive Management Plan is provided in Appendix O and addresses uncertainty through identification of limiting conditions and suggests adaptive management strategies that may be employed to investigate and correct limiting conditions.

4.15 Real Estate Considerations

The TSP includes 33 sites that have a total real estate footprint of 641.58 acres. Based on the current project footprints, and as most of the properties are sponsor or government owned, only approximately 27 landowners would be affected.

Due to the conceptual level of detail of current project designs, land values were estimated based on fee value. As project designs are refined and additional data is gathered during feasibility design and PED, specific real estate interests will be identified and assigned to the project lands as applicable. At this time, standard real estate interests anticipated for the project lands include legal and administrative fee, and perpetual easements. From the preliminary design both standard and non-standard estates will be required for this project; the need for any additional non-standard estates will be identified during PED.

In addition, tribal lands and interests, utility/facility relocation items, as well as uniform relocation assistance (PL 91-646) requirements will be further defined during PED. An initial assessment of utilities that could be impacted includes electrical, water/sewer, telecommunications, roads, and bridges. See Appendix P for additional real estate detail and associated maps.

4.16 Project Implementation

As a non-federal construction partner, project sponsors must sign a design agreement that will carry the project through the PED phase, which includes development of Plans and Specifications (P&S). The PED phase will be followed by project construction. Funds must be budgeted by the federal government and the non-federal partner to support these activities. A project management plan will be prepared to identify tasks, responsibilities, and financial requirements of the federal government and the non-federal partner during PED. A project schedule will be established based on reasonable assumptions for the detailed design and construction schedules.

Although the TSP includes 33 project sites, design agreements and project partnership agreements may be signed separately for individual sites, depending on non-federal sponsor priorities and available funding. It is very likely that a number of state/local agencies, such as NJDEP, NYSDEC, NYC Parks, and NYCDEP will be interested in using existing funds in damages accounts to implement individual sites. From the federal perspective, air conformity regulations may also require the staggered implementation of the tentatively selected sites and short-term construction impacts bay-wide, including any closures of access to people or vessels would be reduced if projects were staggered. Accordingly, cost apportionment and schedules are presented on a per site basis, rather than as if the tentatively selected plan was a single, homogenous suite of activities.

4.17 Environmental Operating Principles & USACE Campaign Plan

The USACE has reaffirmed its long-standing commitment to environmental conservation by formalizing a set of environmental operating principles (EOPs) applicable to decision-making in all programs. The EOPs outline the USACE's role and responsibility to sustainably use and restore our natural resources in a world that is complex and changing. The TSP meets the intent of the EOPs.

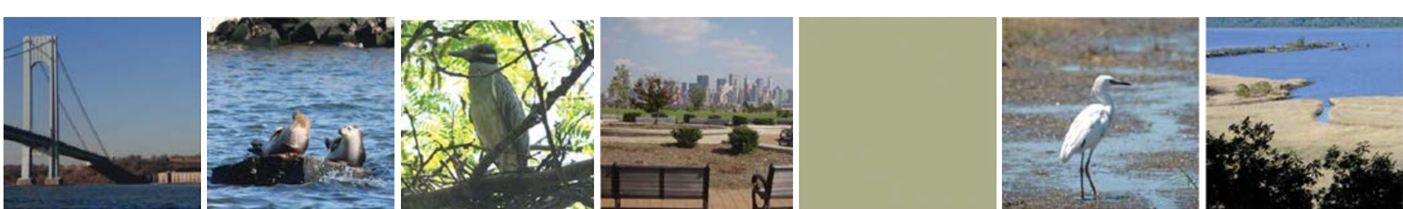
The USACE campaign plan includes specific goals and objectives to deliver integrated, sustainable, water resources solutions. This project primarily supports the campaign plan goals 2 and 4. These goals include transformation of the Civil Works process to deliver enduring and essential water resource solutions using effective transformation strategies as well as build resilient people, teams, systems, and processes to sustain a diverse culture of collaboration, innovation, and participation to shape and deliver strategic solutions. The project meets the intent of these campaign plan goals.

4.18 Implementation Requirements and Cost Sharing

Table 4-20 presents the total first costs for each site recommended in the TSP broken down by federal and non-federal contributions. Upon approval of the FR/EA, project partnership agreements would be executed between the USACE and the non-federal sponsor.

Table 4-20: Cost Allocation, Sponsors and Total First Costs for TSP

Planning Region	Restoration Site	Federal Cost	Non-Federal Cost	Total Cost ($)	Non-Federal Sponsor
Jamaica Bay	Dead Horse Bay	53,799,850	28,969,150	82,769,000	NYCDEP, NYC Parks, NYSDEC
	Fresh Creek	29,557,450	15,915,550	45,473,000	NYCDEP, NYC Parks, NYSDEC



Planning Region	Restoration Site	Federal Cost	Non-Federal Cost	Total Cost ($)	Non-Federal Sponsor
Jamaica Bay	Hawtree Point	950,950	512,050	1,463,000	NYCDEP, NYC Parks, NYSDEC
	Bayswater Point State Park	3,779,750	2,035,250	5,815,000	NYS Department of Parks and Recreation
	Dubos Point	6,214,000	3,346,000	9,560,000	NYCDEP, NYC Parks, NYSDEC
	Brant Point	4,862,000	2,618,000	7,480,000	NYCDEP, NYC Parks, NYSDEC
	Stony Creek	19,838,800	10,682,200	30,520,000	NYSDEC, NYCDEP
	Duck Point	18,057,000	9,723,000	27,780,000	NYSDEC, NYCDEP
	Elders Point Center	13,474,500	7,255,500	20,730,000	NYSDEC, NYCDEP
	Pumpkin Patch-West	13,026,000	7,014,000	20,040,000	NYSDEC, NYCDEP
	Pumpkin Patch-East	24,667,500	13,282,500	37,950,000	NYSDEC, NYCDEP
	Oyster Restoration: Jamaica Bay-Head of Bay	533,000	287,000	820,000	NYCDEP
Harlem River, East River, and Western Long Island Sound	Flushing Creek	3,835,000	2,065,000	5,900,000	NYCDEP
	River Park/West Farm Rapids Park	2,600,000	1,400,000	4,000,000	NYCDEP, NYC Parks
	Bronx Zoo and Dam	2,502,500	1,347,500	3,850,000	NYCDEP, NYC Parks
	Stone Mill Dam	468,000	252,000	720,000	NYCDEP, NYC Parks
	Shoelace Park	16,256,500	8,753,500	25,010,000	NYCDEP, NYC Parks
	Muskrat Cove	5,096,000	2,744,000	7,840,000	NYCDEP, NYC Parks
	Bronxville Lake	10,094,500	5,435,500	14,530,000	Westchester County Planning
	Crestwood Lake	17,946,500	9,663,500	27,610,000	Westchester County Planning
	Garth Woods/ Harney Road	4,680,000	2,520,000	7,200,000	Westchester County Planning
	Westchester County Center	9,438,000	5,082,000	14,520,000	Westchester County Planning
	Oyster Restoration: Soundview Park	494,000	266,000	760,000	NY/NJ Baykeeper, Hudson River Foundation

Planning Region	Restoration Site	Federal Cost	Non-Federal Cost	Total Cost ($)	Non-Federal Sponsor
Newark Bay, Hackensack River and Passaic River	Deferred Site: Oak Island Yards	19,266,000	10,374,000	29,640,000	NJDEP
	Deferred Site: Kearny Point	37,563,500	20,226,500	57,790,000	NJDEP
	Metromedia Tract	21,131,500	11,378,500	32,510,000	NJSEA, NJDEP
	Meadowlark Marsh	27,079,000	14,581,000	41,660,000	NJSEA, NJDEP
	Essex County Branch Brook Park	14,228,500	7,661,500	21,890,000	NJDEP
	Dundee Island Park	1,768,000	952,000	2,720,000	NJDEP
	Clifton Dundee Canal Green Acres	7,767,500	4,182,500	11,950,000	NJDEP
Upper Bay	Oyster Restoration: Bush Terminal	21,417,500	11,532,500	32,950,000	NY Harbor Foundation/School
	Oyster Restoration: Governors Island	3,172,000	1,708,000	4,880,000	
Lower Bay	Oyster Restoration: Naval Weapons Station Earle	4,823,000	2,597,000	7,420,000	NY/NJ Baykeeper

[1]Sponsor contributes 25 percent during the design phase and the remaining 10 percent the construction phase. The LERR&D costs were assumed per site and subject to change with updates to the Real Estate Plan.
[2]Non-federal cash amount must be five (5) percent or more in accordance with Section 103 of WRDA 1986.

Table 4-21 shows the total cost of construction by planning region.

Table 4-21: Total Cost by Planning Region (FY 2016)

Planning Region	Total Cost
Jamaica Bay	$289,580,000
Harlem River, East River, and Western Long Island Sound	$111,180,000
Newark Bay, Hackensack River, and Lower Passaic River	$198,160,000
Upper Bay	$37,830,000
Lower Bay	$7,420,000
Total	**$644,170,000**

4.18.1 Division of Plan Responsibilities

The Water Resources Development Act (WRDA) of 1986 (Public Law 99-662) and various administrative policies have established the basis for the division of federal and non-federal responsibilities in the construction, maintenance, and operation of federal water resource projects accomplished under the direction of the USACE. Anticipated federal and non-federal responsibilities are described in this section. The final division of specific responsibilities will be formalized in the project partnership agreement.

4.18.1.1 Federal Responsibilities

The estimated federal share of the total first cost of the project is 65 percent of first costs related to ecosystem restoration. First costs are typically all costs to implement the project inclusive of Lands, Easements, Rights-of-way, and Disposal sites (LERRD), but do not include Operation Maintenance, Repair, Replacement and Rehabilitation (OMRR&R) costs or remediation of hazardous substances regulated by CERCLA. The federal government's responsibilities are anticipated to be:

- Sharing a percentage of the costs for PED, including preparation of the plans and specifications, which is cost-shared at the same percentage that applies to construction of the project.
- Sharing a percentage of construction costs for the project.
- Administering contracts for construction and supervision of the project after authorization funding and receipt of non-federal assurances.

4.18.2 OMRR&R

After completion of construction, the non-federal sponsor(s) will assume OMRR&R responsibility for the entire project footprint. These estimates and a summary of OMRR&R activities for each site will be developed during feasibility-level detailed activities for the final FR/EA. The OMRR&R cost includes maintenance of all the infrastructure that are included in the project. Although they are being modified, many of these features are already being maintained currently by local entities. Detailed OMRR&R manuals will be developed for each site during the PED phase.

4.18.3 Monitoring and Adaptive Management

Even the most well planned restoration actions can yield unexpected results. To reduce the risk of project failure, the TSP provides for monitoring and adaptive management of restoration sites. USACE Implementation Guidance for Section 2039 of the WRDA of 2007 (amended by WRRDA 2016) defines monitoring as "the systematic collection and analysis of data that provides information useful for assessing project performance, determining whether ecological success has been achieved, or whether adaptive management may be needed to attain project benefits" (USACE 2009). Monitoring includes documenting and diagnosing these results, especially in the early, formative stages of a project, which can provide information useful for taking corrective action. In this way, monitoring reduces the risk of failure and enables effective, responsive management of restoration actions.

Adaptive management is the organized and documented undertaking of goal-directed actions, while evaluating their results to determine future actions. It is based on the approach of "learning by doing" (Walters and Holling, 1990), which is an important planning and assessment tool in ecosystem restoration. Adaptive management requires monitoring the condition of the system using selected indicators, assessing progress using previously established goals and performance criteria, and making decisions when corrective actions are needed. An adaptive management program involves incorporating successful techniques and lessons learned into successive projects within the same program or geographic range.

A plan for pre- and post-construction monitoring and adaptive management activities is included in Appendix O. Adaptive management will be implemented if specific restoration standards are not met or if it appears that actual conditions will diverge sufficiently far from the intended conditions to threaten the achievement of overall project goals. Funding for adaptive management will be included in the project cost estimates so that this option will be available in the future if needed.

Wetland Habitat

The focus of specific parameters for adaptive management for wetland restoration/creation are vegetation density, and health and vigor. After two (2) years post-restoration, the monitoring protocol will integrate the standard of 75% vegetative cover with a broad functional assessment focusing on the four ecological parameters listed above. If the restored site fails to meet the requirements of 75% vegetation cover during the first two (2) years, the additional native vegetation will be planted to meet this goal. If, in the unlikely event, a native, sustainable ecosystem cannot be established within five (5) years at the site, changes and modifications to the project site will be initiated immediately by restoration ecologists. A redesign of the site will continue to occur on an ongoing basis in response to project failure. A new monitoring plan will be redrawn to accommodate these changes and monitor the success of the alteration.

Riverine/Streambank Habitat

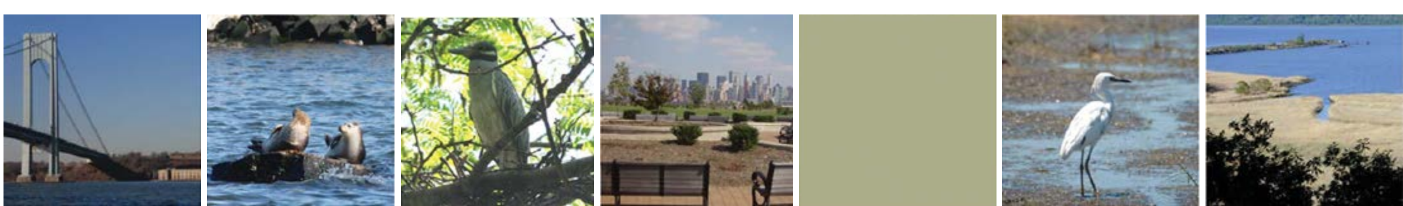
The focus of specific parameters for adaptive management for riverine habitat restoration/creation are the same as those for wetland restoration/creation. Therefore, the adaptive management approach is the same. Parameters unique to fish passage are being developed in coordinating with the non-Federal sponsor. They will be included in a future version of the plan.

Oyster Reefs

For oyster reef creation, adaptive management will primarily consist of monitoring the substrate in years after initial planting and decide whether it is necessary to add more shell to provide additional clean settlement sites and monitoring recruitment and decide if the site is recruitment-limited and provide justification for brood stock enhancement).

4.18.4 Non-Federal Sponsor's Financial Capability

The non-federal sponsor(s) have committed to provide their share of total project costs, as well as all LERRD required for the project including LERDD that is excluded from reimbursement. The non-federal sponsor has also made a commitment to undertake all necessary response and remediation for CERCLA contaminants required for the project, including providing lands free of soil contamination prior to construction of the project features on those lands and handling groundwater contamination during construction activities. The sponsor contributes 25 percent during the design phase and the remaining 10 percent the construction phase. The LERR&D costs were assumed per site and subject to change with updates to the Real Estate Plan. Non-federal amount must be five (5) percent or more in accordance with Section 103 of WRDA 1986.



4.19 Recommended Restoration Opportunities for Future Study

The TSP includes a recommendation for the future study into the feasibility of constructing sites included in the HRE CRP that are within the USACE aquatic restoration mission.

A total of 296 HRE CRP sites have been identified as opportunities for restoration or acquisition. Of those sites, 275 sites are within the purview of the USACE's aquatic ecosystem restoration mission.
Of these, only 33 are included in the TSP for near-term construction. Such studies are expected to be initiated using the following existing authorizations.

4.19.1 USACE General Investigations "New Phase" Spin-Off Feasibility Studies

As stated in Section 4.8.2 (Completeness), additional CRP opportunities (Appendix N) in the federal interest, within any planning region, that are not recommended in this TSP for near-term construction could be recommended as a New Phase future Spin-Off Feasibility Study under the HRE Ecosystem Restoration Feasibility Study Authorization. Per EC 11-2-2-214 (31 March 2018), these studies may start the feasibility phase without competing as a New Start, but are considered a new investment decision.

4.19.2 USACE Continuing Authorities Program

The USACE is authorized by Section 206 of WRDA 1996 to carry out small aquatic ecosystem restoration projects that will improve the quality of environment, are in the public interest, and are cost-effective. A study into the feasibility of constructing a project under this authority could be undertaken by the USACE and a non-federal sponsor. Several of the projects recommended in this FR/EA may also be implemented and advanced in the design and construction phase utilizing the CAP authority.

Chapter 5: Environmental Consequences of the Alternatives*

Sections 1500.1(c) and 1508.9(a)(1) of the National Environmental Policy Act (NEPA) of 1969, as amended (42 United States Code 4321 et seq.) require federal agencies to "provide sufficient evidence and analysis for determining whether to prepare an environmental impact statement or a finding of no significant impact" on actions authorized, funded, or conducted by the federal government to insure such actions adequately address "environmental consequences, and take actions that protect, restore, and enhance the environment." This chapter provides an assessment of the potential environmental consequences or impacts that would result from implementing the tentatively selected plan (TSP) presented in Chapter 4 of this integrated feasibility report and environmental assessment (FR/EA) for the Hudson-Raritan Estuary (HRE) Ecosystem Restoration Feasibility Study (HRE Feasibility Study). Tables 4-2 through 4-5, in Chapter 4, show the principal restoration measures applied under the TSP at each site to achieve the target ecosystem characteristic (TEC) objectives. This chapter also supplements the ecosystem benefits outlined in Chapters 3 and 4 for each project.

As this study includes recommendations for construction of restoration opportunities that are designed at a feasibility level of detail, as well as possible new phase future spin-off studies for restoration opportunities, a qualitative evaluation of impacts resulting from the restoration measures associated with the TSP is discussed in this chapter. Chapter 2 serves as the baseline for the impact analysis and cumulative impacts of implementing the TSP are discussed in Chapter 6.

As the FR/EA does not include recommendations for construction at any sites in the following three (3) planning regions, these planning regions are not addressed in this chapter:

- Lower Raritan River
- Arthur Kill/Kill Van Kull
- Lower Hudson River

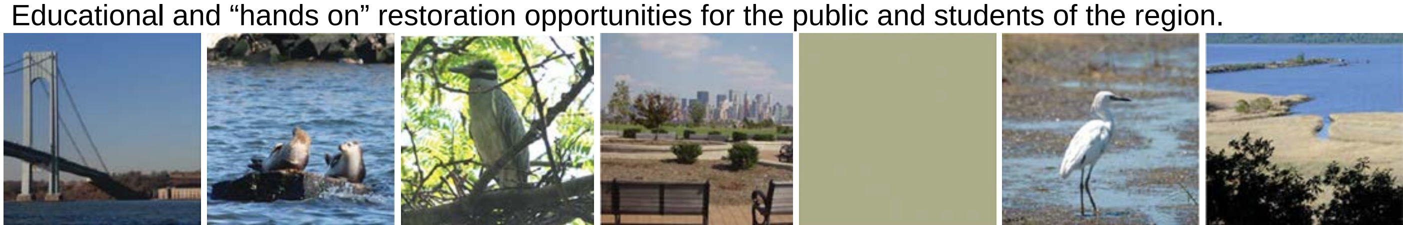
In addition, impacts in the Upper Bay and Lower Bay planning regions are focused on small-scale oyster restoration only and have been combined in this chapter.

The report sections marked with an asterisk (*) include required content for compliance with NEPA.

5.1.1 Tentatively Selected Plan – Overview

The expected environmental effects of implementing the TSP would be overwhelmingly beneficial to the flora and fauna of the HRE, and beneficial to the public living in the HRE study area. Implementation of the TSP would be a substantial first step in the large-scale restoration of the HRE. Implementation of the TSP would realize habitat restoration and expansion of available habitat for a host of fauna, including anadromous and catadromous species, and small-scale restoration of the eastern oyster (*Crassostrea virginica*), a once omnipresent keystone species in the HRE. Secondary benefits would include, but not be limited to, the following:

- Immediate and long-term improvements to water quality and storage of floodwaters;
- Removal of large swathes of invasive species;
- Immediate and long-term benefits for coastal storm risk management through wave attenuation;
- Removal of waterway obstructions and debris;
- Short-term job creation during construction;
- Improved public access to the estuary and its resources; and
- Educational and "hands on" restoration opportunities for the public and students of the region.



For the purposes of this FR/EA, the terms “impacts” and “effects” are used interchangeably; they are synonymous. Impacts can be short-term or long-term. In general, short-term impacts are those that would occur only with respect to a particular discontinuous activity or for a finite period, or only during the time required for construction activities. Long-term impacts are those that are more likely to be persistent and chronic. Impacts of a proposed action can be positive or negative. A positive impact is one having beneficial outcomes on an environmental resource. A negative impact is one having adverse, unfavorable, or undesirable outcomes. A single action might result in positive impacts on one environmental resource and negative impacts on another.

Implementation of the TSP would result in some short-term, negative impacts to the environment; however, these impacts would be temporary and localized. All restoration measures would be implemented in accordance with regulatory agency stipulations and construction contractors would employ best management practices (BMPs) at all times—e.g., use of silt curtains and adherence to sediment and erosion control plans.

5.1.2 No Action Alternative (Future Without-Project Condition)

The no action alternative, which is synonymous with the future without-project condition, would be the state of the HRE study area under the anticipated future condition if no action were implemented by the United States Army Corps of Engineers (USACE), New York District under the HRE Feasibility Study. The no action alternative provides a basis upon which a comparison of the potential impacts associated with implementing the TSP can be made.

Under the no action alternative, ongoing and planned restoration and conservation actions, undertaken by agencies, municipalities, and non-governmental entities would continue. Small-scale restoration requiring extensive local and state funding not supported by large-scale federal investment would continue based largely on an opportunistic approach. Although there are many ongoing programs in the HRE study area, they are typically conducted independent of one another or in isolation from the rest of the estuary. While small-scale restoration efforts would continue under the no action alternative, the large-scale effort proposed in the TSP would provide a more comprehensive approach to restoring the HRE that would be more effective in preventing further degradation of the ecosystem.

5.2 Jamaica Bay Planning Region

It is anticipated that without restoration there would be a further degradation of existing estuarine habitats within Jamaica Bay, due to continuing natural erosive forces and rising sea levels, and anthropogenic stressors, like urbanization, dredging, compromised water quality, landfilling and landfill leachate intrusions, illegal dumping, and off-road vehicle traffic. Additionally, invasive plant species that dominate degraded sites would continue to pose colonization pressures to nearby, still relatively pristine native habitats. Without restoration, the remaining marsh islands could be lost to continued erosional forces and rising sea levels (Gornitz et al., 2002). The loss of Jamaica Bay marsh islands could, in turn, unleash accelerated erosional forces upon the shorelines along the perimeter of the bay (Gedan et al., 2011).

Implementation of the TSP would restore estuarine, marsh island, and oyster habitat at 12 sites in the Jamaica Bay Planning Region:

- **Estuarine habitat restoration**, including the elimination of invasive-dominated communities and restoration of native vegetation communities, would be conducted at six (6) locations—

Brant Point, Bayswater Point State Park, Dubos Point, Hawtree Point, Fresh Creek, and Dead Horse Bay. The restoration would total approximately 223 acres, predominantly comprising the restoration of low and high salt marsh, maritime forest, tidal waterbodies and shallow water, and beach and dune habitats.

- **Jamaica Bay Marsh Island restoration** would be undertaken at five (5) locations—Duck Point, Pumpkin Patch East, Pumpkin Patch West, Stoney Creek, and Elders Center. Approximately 147 acres of low and high salt marsh would be restored, as well as a small area of scrub/shrub habitat.
- **Small-scale oyster restoration** would be undertaken at one (1) site, at Head of Bay, where approximately two (2) acres of oyster reef habitat would be created.

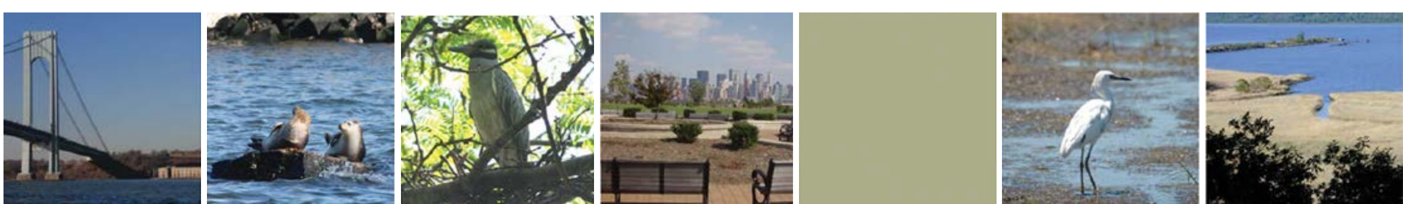
5.2.1 Geomorphology and Sediment Transport

Under the no action alternative, tidal action and stormwater runoff would continue to erode soils, particularly where vegetation is not well established. For the estuarine habitat restoration sites, without action, continued shoreline erosion and loss of salt marsh would occur. Increased degradation from all-terrain vehicles (ATV) use and dumping of construction debris, mixed soils or other rubbish would persist. Marsh island loss from erosion, which has been estimated at 47 acres per year, would continue without restoration.

Excavation and regrading at the estuarine habitat and marsh island restoration sites would result in a long-term change to local topography. Excavations will be done along the shorelines to allow for the influx of tidal waters to create the tidal marshes. These elevations more closely reflect the historical elevations of each of the project sites, prior to fill activities, and utilize biobenchmarking to help establish elevations that currently support the desired habitat type in the bay. The excavation and regrading of the sites would involve the displacement and the replacement of soils. Suitable materials excavated from the shorelines would be reused onsite to establish maritime habitats that would support and add to the values of the recreated wetland/aquatic restorations, as well as buffer them from human intrusion. Excavation of the fill layers from the water's edge to create tidal marsh is expected to return this area to a more historic elevation and historic soil complex, possibly even re-exposing the old peat surfaces of the buried marsh.

During restoration construction under the TSP, it is unlikely that geological resources would be impacted, as construction would occur only at very shallow depths. Grading and earthmoving activities, dredging, and sediment resuspension from vessel movements and prop wash could result in temporary disturbances to sediment transport. However, these activities and their effects would be short-term and localized. On land, silt fences and other BMPs would be employed to reduce erosion and sedimentation. As appropriate, silt curtains or cofferdams may be used to minimize sediment transport in open water areas, precluding resuspended sediments being transported by currents and forming new shoals or sandbars. Even absent these practices, such geomorphic features likely would be temporary and would disappear as the system reaches a new post-construction equilibrium.

Implementing the TSP at the restoration sites within the Jamaica Bay Planning Region would restore or create wetlands, tidal channels, and maritime forest, armor and stabilize shorelines, and establish oyster habitat. Vegetated intertidal zones help protect adjacent areas from flood damage and maintain bank stability during flood events, and tidal marshes with natural channel configurations buffer coastal areas from storm surges and provide floodwater storage functions. Restoration would have long-term, positive effects, through attenuating wave velocities, controlling erosion, retaining sediments, and



reducing sediment loads, thereby establishing more resilient shorelines, riverbanks and streambanks, and wetlands that can better withstand flooding and strong storms associated with climate change.

Under the TSP, habitat restoration and associated construction activities would cause short-term release or resuspension of sediments and a concomitant short-term increase in turbidity, in nearby waters in Jamaica Bay. The restored habitats would reduce long-term turbidity by filtering and retaining stormwater runoff, providing storm surge and flood buffering, attenuating waves, and thereby reducing shoreline erosion. Oyster beds established under the TSP would reduce turbidity, by mitigating shoreline erosion and filtering suspended solids and phytoplankton (Meyer et al., 1997; Coen et al., 2007; Scyphers et al., 2011). The resulting reduction in turbidity under the TSP would provide long-term habitat enhancement for shellfish and fish communities, and aquatic vegetation (Cahoon et al., 1999; Paul and Meyer, 2001; Steinberg et al., 2004).

Restoration Sites	Potential Environmental Consequences*
All Sites	• BMPs employed to minimize erosion and sedimentation, and control stormwater runoff. • Long-term wave and turbidity attenuation, sediment accretion, erosion and sedimentation control, sediment load reduction, and coastal resiliency improvements. • During construction, negligible, short-term local soil and sediment disturbance and sedimentation from in-water offshore, nearshore, shoreline, or onshore earthmoving activities, and vessel and equipment movement. • Long-term changes to local topography.
Duck Point	• During construction, minor, short-term local sediment disturbance and sedimentation from in-water offshore construction of atoll terrace.

5.2.2 Water Resources

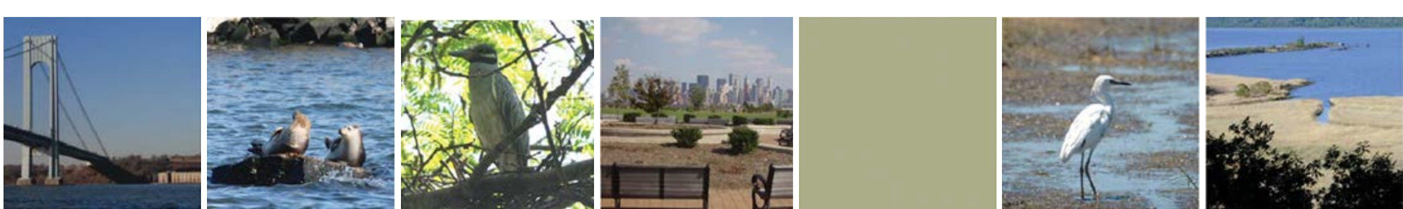
Under the no action alternative, the Jamaica Bay Planning Region would experience continuing or worsening degradation of hydrologic conditions, depending on the magnitude and effects of sea level rise (SLR) and climate change. Continued loss of salt marsh at the estuarine habitat restoration sites would reduce tidal flushing and stormwater storage capacity. Without restoration of the marsh island sites, the ability of the islands to act as natural wave attenuation areas would be reduced. Without oyster reef restoration at Head of Bay, localized water quality improvements from the natural filter feeding benefits would not occur.

Under the TSP, grading and earthmoving activities, dredging, temporary construction-related structures, and resulting temporary geomorphologic features—e.g., shoals and pools—would cause short-term disruption of local wave and current regimes, hydrology, and stormwater runoff. These activities and their effects would be short-term and localized.

The change of existing elevations from excavation and regrading of material on the estuarine habitat and marsh island restoration sites would allow for more land to be inundated by the daily tides. Tidal creeks would be created on many of the estuarine habitat sites and large areas would be excavated down to low marsh elevations, both actions allowing for better overall tidal inundation. The alteration of tidal influences is necessary to provide the proper hydrology and inundation frequencies to support the desired marsh plant communities.

Wetlands restored and oyster beds established under the TSP would provide long-term regulation of water flow, and storm surge and flood buffering, wave attenuation, and protection of shorelines, per the findings of Woodward and Wui (2001), Zelder and Kercher (2005), Koch et al. (2009), Barbier et al. (2011), Gedan et al. (2011), and Shepard et al. (2011). Likewise, restored maritime forest and scrub/shrub habitat on the estuarine restoration sites would provide stormwater runoff mitigation (Bolund and Hunhammar, 1999; Bonan, 2002; Neary et al., 2009). Creating or restoring tidal channels and basins would improve tidal flushing, restore salinity regimes, and reduce water residency times. In the Jamaica Bay Planning Region, under the TSP, restoration would contribute to more natural hydrology and hydraulics by creating more resilient shorelines, channel banks, and wetlands that can better withstand flooding and strong storms associated with climate change.

Restoration Sites	Potential Environmental Consequences*
All Sites	• During construction, negligible, short-term disruption of local wave and current regimes, hydrology, and stormwater runoff from in-water offshore, nearshore, shoreline, or onshore earthmoving activities and temporary structures. • BMPs employed to minimize erosion and sedimentation, and control stormwater runoff. • Long-term improvements in regulation of water flow, storm surge and flood buffering, and wave attenuation, and/or shoreline protection and stormwater runoff control.
Duck Point	• During construction, minor, short-term disruption of local wave and current regimes, and hydrology from in-water offshore construction of atoll terrace.
Fresh Creek Bayswater Point State Park	• Creating or restoring basins would improve dissolved oxygen throughout the water column by improving flushing of the entire basin.
Pumpkin Patch East Pumpkin Patch West Stony Creek Elders Point Center	• During construction, negligible, short-term disruption of local wave and current regimes, hydrology, and stormwater runoff from in-water nearshore, shoreline, and onshore earthmoving activities and temporary structures. • BMPs employed to minimize erosion and sedimentation, and control stormwater runoff. • Long-term improvements in regulation of water flow, storm surge and flood buffering, wave attenuation, shoreline protection, and stormwater runoff control.
Jamaica Bay, Head of Bay	• During construction, negligible, short-term disruption of local wave and current regimes, and hydrology from offshore construction of oyster beds and installing super trays. • BMPs employed to minimize erosion and sedimentation. • Long-term improvements in regulation of water flow, storm surge and flood buffering, and wave attenuation.



5.2.3 Vegetation

It is anticipated that, under the no action alternative, there would be further demise or degradation of existing terrestrial, emergent, and aquatic plant communities, due to continued erosional forces, rising sea levels, anthropogenic disturbances, and further expansion and colonization of invasive plant species. In the absence of estuarine habitat restoration, it is anticipated that invasive species would continue to dominate and expand throughout the proposed sites, resulting in the ongoing loss of salt-marsh wetlands. Without restoration, the marsh islands would lose substantial areas of salt marsh due to erosion and SLR.

In the short term, construction associated with implementation of the TSP would remove or disturb existing vegetation. The impact footprint would include the restoration area, construction yards, temporary access roads, and dredge sites and resulting sediment plumes. Subsequent to completion of construction, disturbed areas would be planted and seeded in order to mitigate any impacts. Onshore construction activities and dredging and soil deposition would likely cause short-term release or resuspension of sediments in Jamaica Bay and a concomitant short-term increase in turbidity. This increase in turbidity could have a short-term, negative impact on aquatic macrophytes (Erftemeijer and Lewis, 2006). BMPs such as hay bales and/or erosion control fabric and floating turbidity barriers would be installed prior to and maintained throughout construction to prevent and/or minimize temporary increases in turbidity.

Restoration involving habitat modification would result in some long-term, habitat-specific vegetation trade-offs. Activities of this nature include filling of wetlands to create upland habitats and lowering elevations for coastal marsh creation. There would also be a permanent elimination of any submerged aquatic macrophytes in bay bottom areas targeted for deposition of fill for marsh island enlargement, conversion of mudflat to salt marsh, and for oyster restoration. However, the increases in new habitat from restoration activities are expected to outweigh any loss of existing habitat.

Estuaries and coasts, in general, and restored ecosystems, in particular, are prone to introductions of nonnative species (Kettenring and Adams, 2011; Williams and Grosholz, 2008). Restoration plantings, soil inputs, vegetation clearing, construction-related disturbance, or incomplete habitat conversion may facilitate colonization of invasive plant species. Wetlands are often prone to invasion due to high levels of resources—e.g., high fertility and high moisture. Additionally, exotic species may be the first to colonize after a planned disturbance even if they were not present in the pre-disturbance community and may alter successional processes that would otherwise lead to a native assemblage. Removal of invasive species may also adversely alter some ecological processes, such as reducing native plant pollinator levels (Carvaleiro et al., 2008) and reducing denitrification services (Findlay et al., 2003). If herbicides are employed for invasive species removal, there is a possibility of residual herbicidal impacts on newly transplanted vegetation (Cornish and Burgin, 2005).

Implementation of vegetation components of the TSP would include restoration of approximately 370 acres of various native plant communities within the Jamaica Bay Planning Region. Restoration of these communities likely would cause a qualitative improvement of their biodiversity and ecological services (Rey-Benayas et al., 2009; Duffy, 2009). The resilience of the Jamaica Bay ecosystem would be enhanced due to an increase in regulating ecological services, which can attenuate the impact of shocks on ecosystems. The reduction or elimination of nonnative plant species would enhance native biodiversity and ecological community functioning, and the created or restored habitats would provide for an increased diversity of plant species, in part by exporting native seed to nearby habitats. Likewise, increasing the size of habitat patches would promote higher levels of biodiversity (Gilbert-Norton et al., 2010; Damschen and Brudvig, 2012; Beninde et al., 2015).

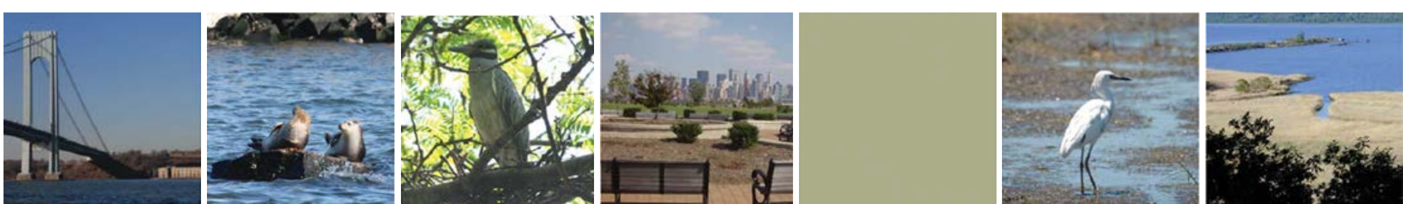
Creation or restoration of tidal channels and basins would improve tidal flushing and natural salinity regimes, which may inhibit further expansion and colonization of the invasive common reed (*Phragmites australis*) in coastal marshes (Raposa, 2008; Chambers et al., 2012) and may allow the establishment of native aquatic vegetation. Restoration of oyster beds would provide water filtration and an attendant reduction in turbidity (Coen et al., 2007), which would provide long-term benefits to aquatic macrophytes.

Restoration Sites	Potential Environmental Consequences*
All Sites	• During construction, minor, short-term disturbance of existing terrestrial and aquatic vegetation. • BMPs employed to limit vegetation disturbance, minimize erosion and sedimentation, or control stormwater runoff. • Negligible, long-term removal of existing terrestrial and/or aquatic vegetation, and disruption of associated ecosystem services. Risk of minor, long-term establishment or reestablishment of invasive, nonnative vegetation. • For estuarine habitat and marsh island restoration, long-term improvement of terrestrial vegetation community biodiversity and associated ecosystem services. • For oyster restoration, long-term benefit to aquatic vegetation through water filtration and turbidity reduction.

5.2.4 Finfish

Under the no action alternative, continued loss or degradation of fish habitats and nursery grounds is anticipated in the estuarine habitat and marsh island restoration sites. This outcome would result from continued compromised water quality due to sediment suspension from shoreline erosion and stormwater runoff, and anthropogenic inputs, such as landfill leachate and illegal dumping. Water quality may be enhanced by combined sewer outfall (CSO) improvements at the proposed Fresh Creek restoration site which may increase fish species richness and abundance. Without action, finfish would not be able to benefit from the additional habitat and prey from the creation of oyster habitat at the Head of Bay restoration site.

Under the TSP, construction associated with in-water and onshore restoration would result in short-term, negative impacts to fish. Fish may be displaced due to noise, changes in currents or stream flow, and changes in water quality, including increases in turbidity from onshore construction activities and dredging. Suspension or resuspension of sediments or other materials may be injurious to fish, provide less suitable nursery habitats, or reduce hatching success and larvae development (Auld and Schubel, 1978; Wilber and Clarke, 2001; Bilkovic, 2011). Reduced water clarity can also affect fish by interfering with their ability to feed or by changing the composition of prey species (Newcombe and MacDonald, 1991). On land, silt fences and other BMPs would be employed to reduce runoff into waterways. As appropriate, silt curtains or cofferdams may be used to minimize sediment transport in open water areas. Short-term, negative impacts to fish populations also would occur if construction activities deterred fish from using essential migratory pathways, breeding, foraging, or seeking shelter from predators. However, under the TSP, construction effects would have only short-term, localized



influence and fish would return to the area shortly after the cessation of construction activities. These short-term adverse effects would be outweighed by substantive long-term benefits.

In the long term, wetland habitat restoration in Jamaica Bay would directly benefit multiple life stages of resident, transient, and migratory fish species, by providing forage, spawning, nursery, and refuge habitat. Creation of tidal channels and basin re-contouring, by improving tidal flushing and restoring natural salinity regimes, also would contribute to an improved habitat for fish (Dibble and Meyerson, 2012). Shoreline stabilization would reduce long-term turbidity levels by reducing shoreline erosion. Oyster restoration would provide beneficial fish habitat (Grabowski and Peterson, 2007; Peterson et al., 2003; Scyphers et al., 2011). Additionally, establishment of oyster reefs would provide water filtration and an attendant reduction in turbidity (Coen et al., 2007) and larval, juvenile, and adult oysters would provide a prey resource for many fish species, which would provide long-term benefits to fish.

Restoration Sites	Potential Environmental Consequences*
All Sites (except Hawtree Point)	• BMPs employed to limit vegetation disturbance, minimize erosion and sedimentation, and control stormwater runoff. • Long-term positive impacts to fish from improved water quality and provision of forage, spawning, nursery, and refuge habitat.
Brant Point Bayswater Point State Park Dubos Point Fresh Creek Dead Horse Bay Pumpkin Patch East Pumpkin Patch West Stony Creek Elders Point Center	• During construction, negligible, short-term local displacement of fish due to noise, changes in currents or stream flow, and water quality impact, including increased turbidity. • Negligible, short-term, local adverse effects to managed and associated species.
Hawtree Point	• No short-term or long-term impacts to fish.
Duck Point	• During construction, minor, short-term local displacement of fish from offshore construction of atoll terrace, noise, changes in currents or stream flow, and water quality impact, including increased turbidity. • Minor, short-term, local adverse effect to managed and associated species.
Jamaica Bay, Head of Bay	• During construction, negligible, short-term local displacement of fish due to offshore construction of oyster beds and installing super trays. • Negligible, short-term, local negative impacts to fish from water quality impact, including increased turbidity. • Negligible, short-term, local adverse effect to managed and associated species.

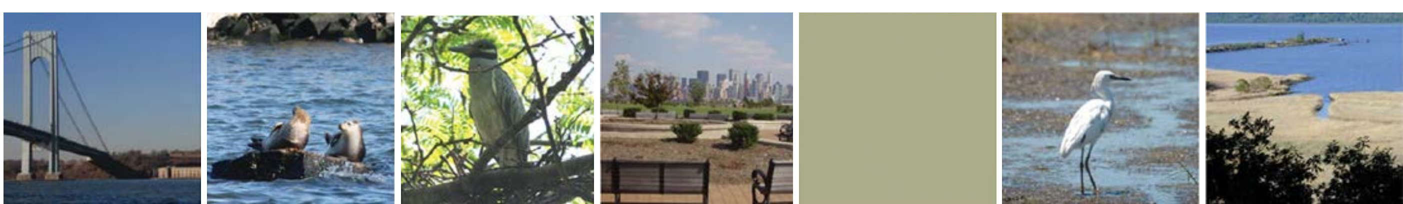
5.2.5 Essential Fish Habitat

Under the no action alternative, continued loss or degradation of essential fish habitats and nursery grounds is anticipated. This outcome would result in continued compromised water quality due to sediment suspension from shoreline erosion and stormwater runoff, and anthropogenic inputs, such as landfill leachate and illegal dumping. CSO improvements may increase essential fish habitat (EFH) at the proposed Fresh Creek restoration site by improving water quality. Without the creation of oyster habitat at the Head of Bay restoration site, EFH from additional shelter would not occur.

With respect to EFH, construction activities under the TSP would employ BMPs to reduce construction impacts. A minor increase in turbidity and sedimentation would be generated by the proposed construction activities. BMPs would be employed to reduce runoff into waterways and to minimize sediment transport in open water areas. If eggs and larvae are present during construction, they could be affected. During the construction period, adult and juvenile fish would leave the area of construction and move to nearby suitable locations outside the area of disturbance. Also, for a short period of time after construction, there would be a reduction in benthic organisms immediately adjacent to the in-water construction footprint; however, this area would be recolonized quickly.

In the long term, due to marsh island and tidal channel restoration, and shoreline armoring, adverse effects would result from the removal of water column and benthic EFH. Given that these impacts would occur over comparatively small, discrete areas and would not adversely impact local water flow and circulation, implementation of the TSP may adversely affect EFH, but likely would result in minimal adverse effects on EFH, as the resulting changes to EFH and its ecological functions would be relatively small and insignificant. On balance, however, it is anticipated that ecosystem restoration would result in long-term, net benefits to managed species (all life stages), associated species, and EFH (Appendix F). Agency consultation for federally listed threatened and endangered marine species is discussed in Section 5.2.8.

Restoration Sites	Potential Environmental Consequences*
All Sites (except Hawtree Point)	• BMPs employed to limit vegetation disturbance, minimize erosion and sedimentation, and control stormwater runoff. • On balance, long-term benefits to EFH.
Brant Point Bayswater Point State Park Dubos Point Fresh Creek Dead Horse Bay Pumpkin Patch East Pumpkin Patch West Stony Creek Elders Point Center	• During construction, negligible, short-term local displacement of fish due to noise, changes in currents or stream flow, and water quality impact, including increased turbidity. • Negligible, short-term, local adverse effect to EFH.
Hawtree Point	• No short-term or long-term impacts to EFH.
Duck Point	• Minor, short-term, local adverse effect to EFH.



Restoration Sites	Potential Environmental Consequences*
Jamaica Bay, Head of Bay	• During construction, negligible, short-term local displacement of fish due to offshore construction of oyster beds and installing super trays. • Negligible, short-term, local negative impacts to fish from water quality impact, including increased turbidity. Negligible, short-term, local adverse effect to EFH.

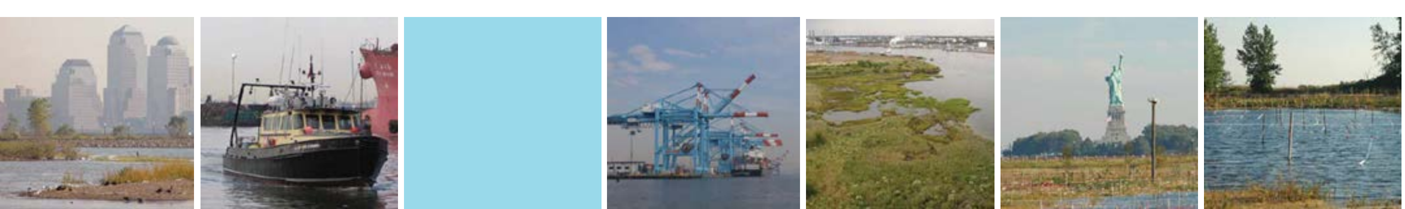
5.2.6 Shellfish and Benthic Resources

Under the no action alternative, continued loss or degradation of shellfish and benthic habitats is anticipated. This would result from continued compromised water quality due to sediment suspension from shoreline erosion and stormwater runoff, and anthropogenic inputs, such as landfill leachate and illegal dumping. Water quality may be enhanced by CSO improvements at the proposed Fresh Creek restoration site which may increase macroinvertebrate species richness and abundance. Without action, oyster recovery from the creation of oyster habitat at the Head of Bay restoration site would not occur.

Restoration of the estuarine and marsh island habitats would have an overall beneficial effect on shellfish and macroinvertebrates that utilize the project area. Once construction is complete additional habitat would be available for these species. Tidal creeks constructed during the estuarine habitat restoration would provide additional shellfish and benthic habitat. Also by improving water quality at Fresh Creek and improving the bottom habitat characteristics, benthic habitat is expected to greatly improve its long-term sustainability.

The projects may have temporary impacts on local shellfish and benthic macroinvertebrate populations during construction, principally through an increase in sedimentation and turbidity. BMPs would be employed to reduce runoff into waterways and to minimize sediment transport in open water areas. The filling of Fresh Creek will be timed to occur during the period of poorest water quality in the basins where population tends to be lowest. By completing the filling of the basin during the summer, when dissolved oxygen levels are lowest, the number of motile species should be diminished as they would have migrated to better quality habitat. However, due to the poor habitat quality that exists and the low species numbers found at the sites during sampling, the impact is not expected to result in a significant loss of species and re-colonization is expected to begin quickly after completion of the construction and flourish under improved sediment and water quality.

Wetlands restoration would improve long-term water quality in Jamaica Bay and, therefore, would provide enhanced environments for invertebrates. Tidal channel and basin creation or restoration would improve tidal flushing, which likewise would contribute to improved habitat for shellfish (Portnoy and Allen, 2006). Also in the long term, oyster restoration would provide suitable habitat for other shellfish species (Steimle and Zetlin, 2000; Peterson et al., 2003; Scyphers et al., 2011). Increases in intertidal and subtidal habitat acreage, establishment of native tidal wetland vegetation, improved tidal connectivity and flushing, and improved sediment and water quality would result in a more diverse and abundant benthic invertebrate resource.



Restoration Sites	Potential Environmental Consequences*
All Sites (except Hawtree Point)	• During construction, minor, short-term negative impacts from benthic invertebrate mortality in areas undergoing aquatic habitat conversion or restoration, typically with rapid recovery expected. • Negligible, short-term, local negative impacts to benthic invertebrates from water quality impact, including increased turbidity. • BMPs employed to minimize erosion and sedimentation, and/or control stormwater runoff. • Long-term positive impacts to shellfish and micro invertebrates from improved water quality and habitat restoration.
Hawtree Point	• No short-term or long-term impacts to shellfish.
Jamaica Bay Head of Bay	• Long-term positive impacts to shellfish from oyster habitat creation.

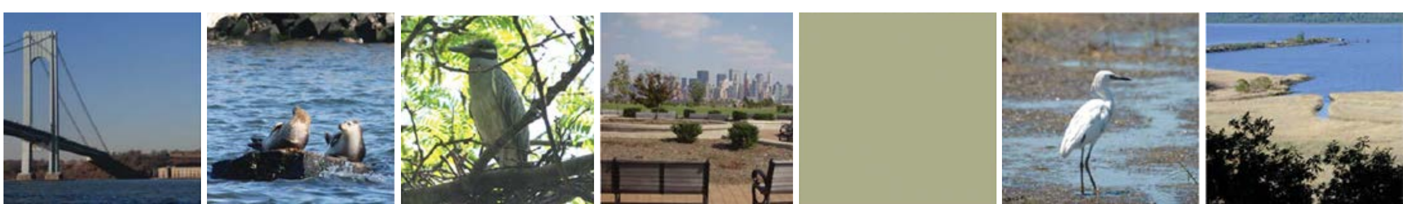
5.2.7 Wildlife

Under the no action alternative, wildlife would continue to suffer from the poor ecological value of the estuarine habitat restoration locations due to invasive species dominance, ATV use, and dumping of construction debris. Continued loss of salt marsh habitat in the marsh island and estuarine habitat restoration sites would decrease the availability of suitable habitat for marine and avian wildlife in the region.

Construction associated with estuarine habitat and marsh island restoration in Jamaica Bay would result in both adverse and beneficial effects on mammals; although, adverse impacts are anticipated be short term and minor. Short-term impacts from construction include species displacement and the potential for species mortality. Muskrats and other small mammal species that are associated with surface waters, wetlands, or coastal habitats could be displaced to nearby comparable habitats but dens, nesting areas and individuals may be harmed or destroyed during construction activities. Harbor seals might avoid construction areas in Jamaica Bay because of the environmental disturbance (noise, turbidity, increased traffic, and human presence) associated with construction. Potential long-term impacts including changes to habitat type and disturbances associated with increased public access. These impacts are likely to be offset by increases in habitat, as well as habitat enhancement. No population-level effects are expected.

Some negative short-term impact on bird species that utilize scrub uplands or marsh may result from operation of construction equipment. The Migratory Bird Treaty Act (MBTA) requires a restriction on shrub and tree removal during construction activities to protect bird species that may potentially nest within the project areas. In order to comply with the MBTA, trees and shrubs will be cleared outside of a March 15 through July 31 (NJDEP, 2006) window to avoid adverse impacts to the listed species that are covered under this act.

Reptiles and amphibians resident to the project sites and in the immediate vicinity will be susceptible to the same kinds of disturbance factors as previously described for mammals, birds and fish. However, many reptile and amphibian species are much less capable of disbursing quickly, or to distances that remove them to habitats unaffected by project activities. Many will simply try and hide. Thus, the threat



of direct adverse impacts due to active construction may be greater to reptile and amphibian species initially inhabiting or utilizing the project site. However, once the restoration has been completed, the new, restored or enhanced habitats will have a long-term beneficial impact on reptiles and amphibians that could result in measureable differences in the size and distribution of reptile and amphibian populations.

Construction associated with small-scale oyster restoration at Jamaica Bay Head of Bay would not impact terrestrial wildlife, as restoration would occur from the water. However, construction activities may result in mortality among sessile and less mobile aquatic fauna. Some aquatic wildlife may be displaced temporarily, but eventually would populate or return to using the restored habitats. BMPs would be employed to minimize sedimentation that would impact aquatic wildlife.

In the long term, restoration that involves habitat alteration would create conditions more favorable for certain wildlife groups and species, and uninhabitable or more challenging to others. Overall, however, restored habitats would be higher in quality and function than the existing habitats they replace. For a myriad of wildlife, created or restored habitats would provide refugia—i.e., habitats that, under changing environmental conditions, the wildlife retreat to, persist in, and potentially can expand from (Askins and Philbrick, 1987; Keppel et al., 2012; Soga et al., 2014). In particular, restoring aquatic, wetland, and upland habitats by removing invasive vegetation, planting native vegetation, and improving hydrology and connectivity would benefit wildlife. With the growth and maturation of restored habitats, wildlife communities of greater diversity and ecological value are anticipated.

Restoration Sites	Potential Environmental Consequences*
All Sites	• During construction, minor, short-term negative impacts from mortality of sessile wildlife in areas undergoing habitat conversion or restoration. • Negligible, short-term local displacement of mobile wildlife due to habitat alteration, and construction-related noise and human activity, with rapid recovery expected. • BMPs employed to limit vegetation disturbance, minimize erosion and sedimentation, and control stormwater runoff. • Long-term positive impacts to wildlife from establishment of higher-quality habitats and refugia.

5.2.8 Rare, Threatened, and Endangered Species

Under the no action alternative, further pressure on rare species is anticipated due to displacement by nonnative species and continued loss and degradation of habitats from rising sea levels, erosion, and anthropogenic disturbances.

In the short term, construction associated with implementation of the TSP potentially could displace or disturb rare, threatened, and endangered species on or in the vicinity of the restoration sites. Such effects would result from clearing vegetation, changes in currents or stream flow, changes in water quality, including increases in turbidity, and construction-related noise and human activity.

All appropriate federal and state agencies were consulted regarding the documentation of rare, threatened, and endangered species, and species of special concern within the Jamaica Bay Planning Region project sites and their vicinities. The United States Fish and Wildlife Service (USFWS) and

National Oceanic and Atmospheric Administration National Marine Fisheries Service (NMFS) were contacted regarding federally listed threatened and endangered species under the Endangered Species Act (ESA), while the New York State Department of Environmental Conservation (NYSDEC) Division of Fish, Wildlife, and Marine Resources was contacted regarding state listed species in the New York Natural Heritage Program (NYNHP). Numerous endangered, threatened, or rare plant and animal species exist within the boundaries of the bay, and correspondences with the agencies are in Appendix G. Prior to restoration activities, onsite surveys will be conducted at each restoration site to fully assess any potential impacts on biological resources and confirm whether any documented species are present in restoration areas. If rare, threatened, and endangered species are confirmed at the sites and could be adversely impacted by restoration activities, precautions will be taken to avoid, minimize, or mitigate the impacts as determined by the appropriate agency.

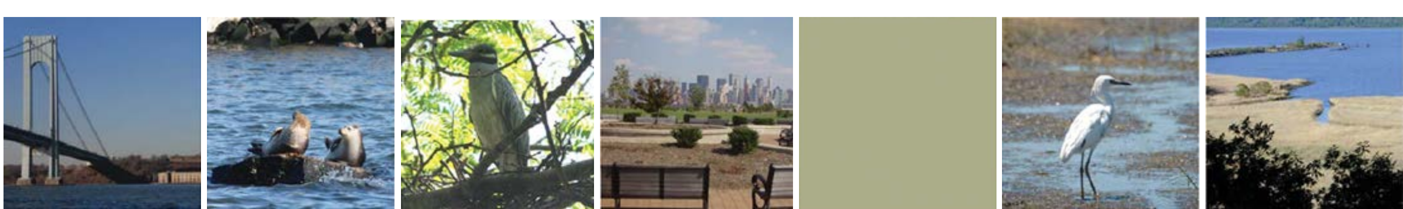
According to NMFS correspondence, four (4) different species of protected marine turtles and the endangered Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) may be present in the bay. Disruptions to marine wildlife are expected to be insignificant and short-term during construction, and BMPs would be employed to minimize impacts from suspended sediments. If construction activities are determined to make the water habitat unsuitable for wildlife, the use of timing restrictions or noise attenuating tools will be implemented.

The NYNHP identified several rare, federal- or state-listed bird species on or within one-half mile of potential restoration sites. These include the state-endangered Peregrine Falcon (*Falco peregrinus)* and Short-eared Owl (*Asio flammeus)*; the state-threatened Piping Plover (*Charadrius melodus*), Northern Harrier (*Circus cyaneus)*, Upland Sandpiper (*Bartramia longicauda)* and Common Tern (*Sterna hirundo);* and the state-protected Barn Owl *(Tyto alba)* and Laughing Gull (*Leucophaeus atricilla).* The USFWS also identified the endangered Roseate Tern (*Sterna dougallii*) and threatened Red Knot (*Caliris canutus rufa)* as bird species that could potentially be affected by construction activities. As most of these species are highly mobile and capable of avoiding construction activities, disturbance would be short-term and localized. For some species, such as the Piping Plover, construction buffers and/or timing restrictions would be employed during nesting season, which typically occurs between March and August.

Butterfly species white-m hairstreak (*Parrhasius m-album)* and red-banded hairstreak (*Calycopis cecrops)* were observed in Floyd Bennett Field near Dead Horse Bay. As these species are mobile, except for the larval stage, they would not be expected to be affected by restoration activities and restoration of Dead Horse Bay would provide additional habitat for the butterflies to prosper.

The low salt marsh found throughout Jamaica Bay is considered a significant natural community of high ecological and conservation value. New York state-listed vascular plants were documented at or near the Dubos Point, Brant Point, Bayswater Point State Park, Dead Horse Bay, and Head of Bay restoration sites. Prior to construction activities, these sites will be surveyed for the existence of the plants. If listed plants are found, measures will be taken to avoid disturbance, such as fencing and signage placed around the plants.

As the restoration goals include creating, restoring, and protecting wildlife habitat, impacts to rare, threatened, and endangered species are expected to be short-term and insignificant. In the long term, implementation of the TSP would benefit rare, threatened, and endangered species by increasing favorable habitat and improving the quality of existing habitat.



Restoration Sites	Potential Environmental Consequences*
All Sites	• No long-term negative impacts to protected species. • Long-term positive impacts to rare, threatened, or endangered species from habitat and ecosystem restoration. • BMPs employed to limit vegetation disturbance, minimize erosion and sedimentation, and control stormwater runoff.
Dead Horse Bay Hawtree Point Bayswater Point State Park Dubos Point Brant Point	• Negligible, short-term impacts to rare, federal- or state-listed bird species due to construction activities. • Construction buffers and/or timing restrictions may be required to avoid impacts during breeding or nesting periods.
Dubos Point Brant Point Bayswater Point State Park Dead Horse Bay Head of Bay	• Potential impacts of state-listed vascular plants would be avoided by monitoring and protection using fencing and signage.

5.2.9 Land Use

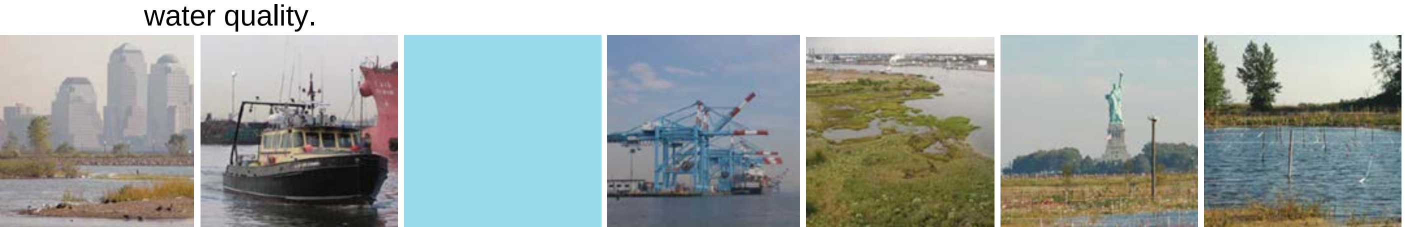
The proposed restoration sites in the Jamaica Bay Planning Region are on existing open land owned by various agencies including National Park Service (NPS), New York City Department of Parks and Recreation (NYC Parks), and New York State Office of Parks, Recreation, and Historic Preservation (NYSOPRHP). No permanent housing exists on these sites. Under the no action alternative, no changes to the land use of the estuarine habitat, marsh island, or oyster restoration sites are planned. Without restoration, the Fresh Creek, Hawtree Point and Brant Point estuarine habitat sites would continue to be degraded by anthropogenic threats from ATV use or onsite dumping of debris.

Implementation of the TSP at each site would not change the existing land use of the site. The sites would remain in the same ownership with public access remaining similar to or better than existing conditions.

Restoration Sites	Potential Environmental Consequences*
All Sites	• Implementation of the TSP at each site would not change the existing land use of the site.

5.2.10 Hazardous, Toxic, and Radioactive Waste

It is anticipated that, under the no action alternative, the Jamaica Bay Planning Region would continue to degrade, due to poor sediment and water quality derived from a combination of sewage inputs, landfill leaching, industrial activity, and runoff from roads and developed areas. Water quality may be enhanced by CSO improvements at the proposed Fresh Creek restoration site. Jamaica Bay sediments often have high amounts of trace metals and other contaminants. It is anticipated that, in the planning region, large amounts of suspended sediments would remain in the water column, contributing to poor water quality.



Removal of the solid waste landfill at the Dead Horse Bay restoration site may require investigation and special handling of fill if contaminants are present. At all sites, soils to be removed are fill soils that have been placed along the shorelines in the past, burying salt marsh, mudflat and shallow water communities that occupied the areas before. Hazardous, toxic, and radioactive waste reports for these areas show minimal contamination, typical of ambient levels found in urban contexts, with most fill comprising sands dredged from the bay. Recontouring the land would not place contaminated soils onto clean soils, rather it is expected that similar soils and contaminant levels exist throughout the sites. Moreover, restoration plans include placement of a clean planting growing media following soil/sediment regrading on each site. Further testing will be conducted during Preconstruction Engineering and Design (PED) phase. The removal of any soil or sediment would be accomplished with the use of appropriate BMPs to limit and/or eliminate the transport of materials during construction by alluvial and/or aeolian forces.

In the long term, creating or restoring wetlands and maritime forest, armoring and stabilizing shorelines, and establishing oyster habitat would improve water quality and provide nutrient removal and denitrification services. Improved tidal flushing and reduced water residency time, due to creating or restoring tidal channels and basins, would increase dissolved oxygen levels and reduce fecal coliform levels (Portnoy and Allen, 2006). Restored wetlands likewise would improve tidal flushing and increase dissolved oxygen levels.

Restoration Sites	Potential Environmental Consequences*
All Sites	• During construction, risk of local water quality impact from construction-related, accidental spills. • Safeguards employed to prevent and respond to spills. • Long-term surface water quality improvements—i.e., increased turbidity reduction, nutrient removal, and denitrification, and/or increased dissolved oxygen levels and reduced fecal coliform levels.
Dead Horse Bay	• Removal of landfill may require investigation and special handling and disposal of fill.

5.2.11 Air Quality

No long-term impacts to air quality are expected from implementing the no action alternative. Population growth and increased use of roadways in the region may cause minor worsening in future air quality, however these may also be offset by more stringent emissions standards and technological improvements moving forward.

The proposed action may have temporary minor adverse impacts on highly localized air quality at the construction sites; construction may take months to years depending on the site. For all sites, BMPs would keep fugitive dust under control during land clearing activities. Heavy equipment would produce hydrocarbons in exhaust emissions although the incremental contribution would be extremely small compared to all sources of exhaust emissions in the region. Construction contractors would be required to keep all equipment in good working order to minimize emissions and to apply applicable BMPs, such as turning off machines when not working and using low sulfur fuels. Exhaust emissions would not be at a level that puts human health at risk, and the restoration sites would not have any permanent source of air pollutant emissions.

A preliminary estimate of construction emissions for each estuarine habitat restoration sites is shown in Table 5-1. All restoration sites are located in an ozone non-attainment area under the Clean Air Act (CAA). In the project area, the general conformity applicability trigger levels for 'moderate' ozone nonattainment areas are: 100 tons per year (any year of the project) for nitrogen oxides (NOx) and 50 tons per year for volatile organic compounds (VOC) (40 CFR§93.153(b)(1)). For areas designated as 'maintenance' for particulate matter (PM) 2.5, the applicability trigger levels are: 100 tons for direct PM2.5, sulfur dioxide, and carbon monoxide (CO) per year (40 CFR§93.153(b)(2)).

Table 5-1: Estimate of total emissions for each estuarine habitat restoration site in the Jamaica Bay Planning Region.

	Pollution in tons			
Site	**VOC**	**CO**	**NOx**	**PM-10**
Dead Horse Bay	1.10	4.50	9.94	0.99
Fresh Creek	1.13	3.78	14.92	1.03
Hawtree Point	0.03	0.10	0.22	0.02
Bayswater State Park	0.37	1.60	3.49	0.40
Dubos Point	0.38	1.87	3.11	0.35
Brant Point	0.21	1.01	3.43	0.21

According to Section 176(c) of the CAA, any project sited in a non-attainment area must satisfy the General Conformity Rule of the CAA. Conformity ensures that projects do not cause or contribute to a new air quality standard violation; increase the frequency or severity of an existing violation; or delay timely attainment of a standard or any required interim emission reduction milestone. Perimeter sites are estimated at below the conformity threshold value.

In the long term, under the TSP, improvements to the environment potentially would stimulate the local economy by increasing activities such as fishing, hiking, boating, and bird watching, and tourism in general. In turn, these increased activities would result in very minor increases in travel-related vehicular and boat engine emissions.

Although a short-term increase in greenhouse gases may result from the initial removal of vegetation, this will be offset by benefits from replanting native vegetation. Beneficial impacts to climate are likely to result from implementing measures that involve restoration of terrestrial and aquatic plant communities. Restoration of these communities would promote primary productivity and increase removal of carbon dioxide and other air pollutants from the atmosphere. The creation of vegetated habitats under the TSP would reduce or offset the emission of carbon dioxide. Wetland creation, and afforestation or reforestation in urban areas could lead to increased sequestration of atmospheric carbon. For these reasons, this project would have no significant impact to air quality in the HRE Study area.

Restoration Sites	Potential Environmental Consequences*
All Sites	• During construction, negligible, short-term contribution to local emissions from the operation of construction equipment and vehicles. • BMPs employed to minimize exhaust emissions. • Long-term air quality mitigation through the removal of carbon dioxide and other gaseous air pollutants from the atmosphere.

5.2.12 Noise

Under the no action alternative, restoration would not take place and short-term increases in ambient noise levels due to construction activities would not occur. Population growth and increased use of railways and roadways in the region may cause noise levels to rise in the future.

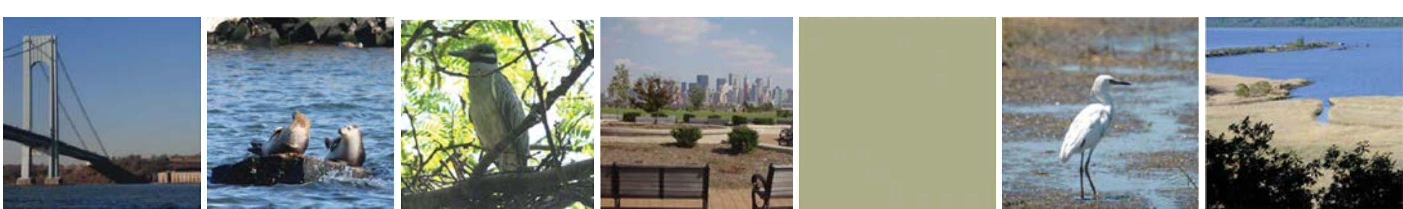
At each of the Jamaica Bay Planning Region restoration sites there would be a temporary increase in noise levels in the immediate project area during construction due to the increase in traffic and the operation of construction equipment. However, these impacts are expected to be short-term. The temporary impacts to ambient noise levels from construction equipment would occur during normal working hours, in compliance with local noise ordinances. The TSP would not negatively impact long-term ambient noise levels at any of the restoration sites. In the long term, sites with maritime forest restoration, such as Dead Horse Bay, Fresh Creek, Dubos Point and Brant Point, mature trees may even create a natural buffer to reduce ambient noise levels.

Restoration Sites	Potential Environmental Consequences*
All Sites	• Short-term increases in noise levels from construction equipment would occur during normal daytime working hours. • Implementation of the TSP at each site would not cause any negative long-term noise impacts.
Dead Horse Bay Fresh Creek Dubos Point Brant Point	• Long-term potential to reduce ambient long-term noise when trees mature in maritime forest.

5.2.13 Social and Economic Resources

Under the no action alternative, construction activities would not take place and changes to social and economic resources would not occur. The degraded condition of the Jamaica Bay ecosystem would continue into the future decreasing public access and recreational opportunities in the planning region, and potentially adversely affecting social and economic resources.

Restoration under the TSP would result in both short- and long-term social and economic benefits for the regional economy. Construction activities would generate jobs, and it is assumed that the majority of the workforce would be from the local area. In the short term, this employment would contribute to local earnings, induced spending for goods and services, and tax revenues. Implementing the TSP would give local community groups and educational institutions opportunities to participate in the restoration efforts, providing valuable educational experiences that would bolster environmental



education. As no permanent jobs will be created, there are no anticipated long-term effects to the local economy or income and there would be no increase in housing demands.

Larger populations of waterbirds in Jamaica Bay and throughout the planning region, particularly in the vicinity of John F. Kennedy International Airport, could lead to a greater potential for bird-aircraft strikes, potentially requiring increased expenditures by the Port Authority of New York and New Jersey (PANYNJ) to mitigate the heightened hazard. Due to the increasing concern regarding aircraft-wildlife strikes, the Federal Aviation Administration (FAA) has implemented standards, practices, and recommendations for holders of Airport Operating Certificates issued under Title 14, CFR, Part 139, Certification of Airports, Subpart D (Part 139), to comply with the wildlife hazard management requirements of Part 139. Airports that have received federal grant-in-aid assistance must use these standards. In accordance with the FAA Advisory Circular 150/5200-33B and the Memorandum of Agreement with FAA to address aircraft-wildlife strikes, when considering proposed flood risk management measures and mitigation (and restoration) areas, USACE must take into account whether the proposed action could increase wildlife hazards.

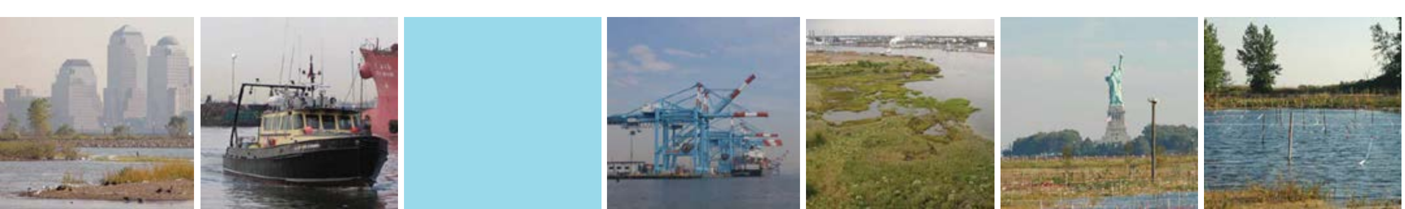
The FAA recommends minimum separation criteria for land-use practices that attract hazardous wildlife to the vicinity of airports. These criteria include land uses that cause movement of hazardous wildlife onto, into, or across the airport's approach or departure airspace or air operations area (AOA). These separation criteria include:

- Perimeter A: For airports serving piston-powered aircraft, hazardous wildlife attractants must be 5,000 feet from the nearest AOA
- Perimeter B: For airports serving turbine-powered aircraft, hazardous wildlife attractants must be 10,000 feet from the nearest AOA; and
- Perimeter C: Five-mile range to protect approach, departure, and circling airspace.

Hawtree Point, Brant Point, Bayswater State Park, and Dubos Point, which are east of the Cross Bay Veterans Memorial Bridge, are within the limits of the five-mile perimeter of John F. Kennedy International Airport. The proposed plans for these sites included habitats that were designed as feeding habitats only so as to not to introduce additional hazardous wildlife into the area. Coordination with the FAA will occur during the comment period for concurrence in the design.

At the scale of the HRE study area, improvements to the environment, notably cleaner water and greater abundance and diversity of desirable terrestrial wildlife, fish, and vegetation, potentially would stimulate the local economy by increasing activities such as fishing, hiking, boating, and bird watching, and tourism in general. Improved quality of life would strengthen the desirability of living in the region and maintain, if not increase, property values. Increased shoreline stabilization may reduce municipal expenditures, including those for emergency services. Ongoing restoration and monitoring activities would give local community groups and educational institutions opportunities to participate, providing valuable educational experiences.

Restoration Sites	Potential Environmental Consequences*
All Sites	• During construction, minor, short-term increases in local employment, earnings, induced spending, and tax revenues, and provision of educational opportunities.



Restoration Sites	Potential Environmental Consequences*
Brant Point Bayswater Point State Park Dubos Point Hawtree Point Fresh Creek Dead Horse Bay	• Combined total first cost of approximately $152,560,000 • Negligible, long-term increased expenditures to mitigate heightened bird-aircraft strike hazard. • Provides potential educational opportunities.
Duck Point Pumpkin Patch East Pumpkin Patch West Stony Creek Elders Point Center	• Combined total first cost of approximately $137,020,000. • Long-term stimulation of the local economy and provision of educational opportunities.
Jamaica Bay, Head of Bay	• Total first cost of approximately $820,000. • Provides provision of educational opportunities.

5.2.14 Navigation

Under the no action alternative, no restoration will occur and no changes or impacts to navigation would occur.

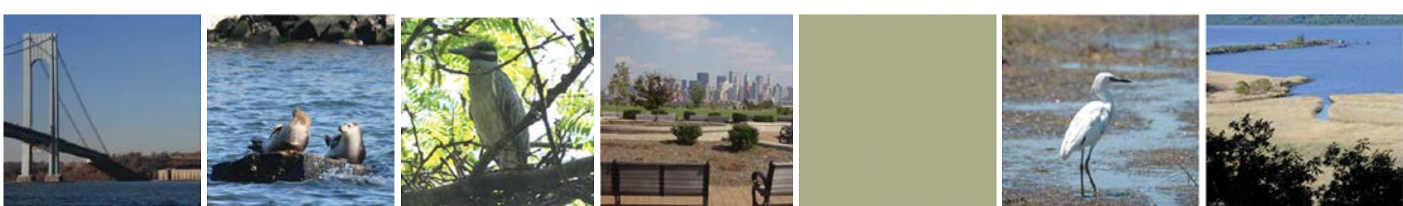
Construction activities may create short-term limitations to the local boat traffic, to curtail the agitation of the water to allow the suspended sediments to settle, and to avoid accidents. These would be minimal, of short durations and likely not affect the full span of the waterways at one time.

The TSP at most of the sites would have no long-term impact on navigation near the project site, as construction and planting activities do not involve the neighboring waterways. The head of Fresh Creek would be filled to intertidal marsh, thus permanently limiting boat traffic to only small craft such as canoes and kayaks. However, the impacts to the head waters above the marinas are expected to be negligible as deeper draft recreational crafts generally do not venture into the head of creeks since the bay proper is the destination of the vast majority of larger craft. The TSP may provide additional points of access into the salt marsh by canoe or kayak through the tidal creeks.

Restoration Sites	Potential Environmental Consequences*
All Sites	• Minimal, short-term limitations to local boat craft during construction activities.
Fresh Creek	• Negligible, long-term impact due to filling head of creek to intertidal marsh, limiting boat traffic to small craft.

5.2.15 Recreation

Under the no action alternative erosion, short-term construction impacts would not occur; however, long-term improvements to passive recreational activities from enhanced wildlife and viewing opportunities at the estuarine habitat restoration and marsh island sites would also not occur. ATV use at Hawtree Point would continue, but would also further damage vegetation.



The TSP would have very minor temporary construction-related impacts on existing recreational resources. At sites which currently offer recreational resources, there may be adverse temporary impacts during construction due to the closing of the interior footpaths and some fishing access. However, construction would be phased to occur during the colder winter months when the paths are not as heavily utilized. Boat activity would not be substantially impacted at most sites during construction, with the exception of Fresh Creek.

After the TSP is implemented, there would be positive impacts to the recreational and educational features of the sites. Improvements to the environment, notably cleaner water and greater abundance and diversity of desirable terrestrial wildlife, fish, and vegetation, potentially would increase activities such as fishing, hiking, boating, and bird watching. The interior walking trails would be reestablished but would traverse a much more diverse landscape with enhanced wildlife habitat and viewing opportunities. The bike trail would remain in the same location but would also overlook a diverse salt marsh landscape with an increased possibility of viewing waterfowl and other wildlife. The projects at most sites would not affect boating activity, with the exception of Fresh Creek which may have permanent restricted access for larger vessels to the head of the basin. Additionally, Hawtree Point is regularly used by ATVs that continually disturb the existing vegetation. The TSP would restore native plant communities and place boulders (permanent barriers) along the landside boundary of the site as a blockade to motorized vehicles.

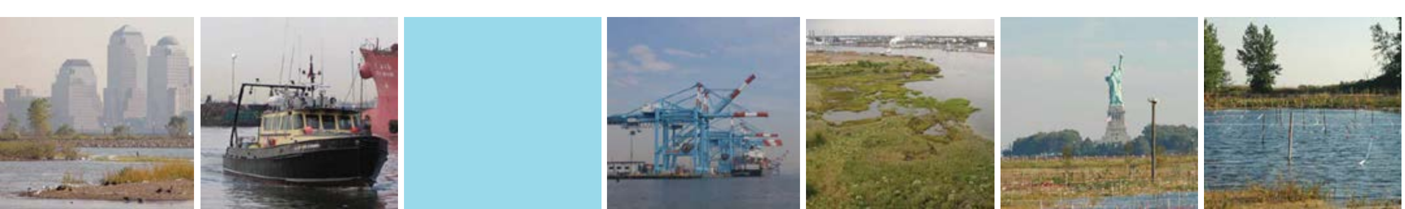
Restoration Sites	Potential Environmental Consequences*
All Sites	• Minor, short-term negative impacts from limited access to recreational resources during construction. • Long-term improvement in recreational opportunities for wildlife viewing, hiking, recreational fishing, kayaking, and canoeing through habitat improvement.
Fresh Creek	• Areas of permanent restricted access for larger vessels.
Hawtree Point	• Permanently exclude motorized vehicles ATVs along the shoreline.

5.2.16 Cultural Resources

Under the no action alternative impacts to cultural resources are expected to be minimal; however, loss of historic resources due to SLR and erosion could occur.

Enough data does not currently exist to determine the extent of impacts to cultural resources from implementation of the TSP in the Jamaica Bay Planning Region. A number of surveys were completed by USACE in recent years in connection with this study and prior related studies:

- *Cultural Resources Baseline Study, Jamaica Bay Ecosystem Restoration Project, Kings, Queens, and Nassau Counties, New York (Panamerican Consultants Inc., 2003);*
- *Cultural Resources Baseline Study: Flushing Bay Ecosystem Restoration Project, Queens County, New York (Panamerican Consultants, Inc., 2003);*
- *Phase IA Documentary Study for the Jamaica Bay Islands Ecosystem Restoration Project, Kings and Queens Counties, New York (Panamerican Consultants Inc., 2004);*

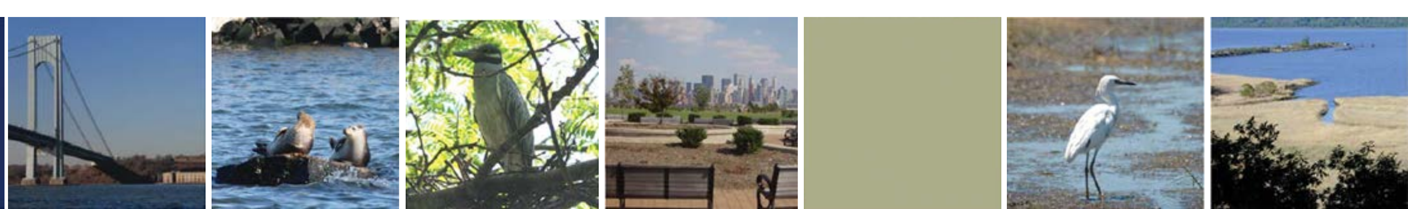


- *Phase IB Investigation of Bayswater State Park and Pardegat Basin, Jamaica Bay Ecosystem Restoration Project, Kings, Queens, and Nassau Counties, New York (Panamerican Consultants Inc., 2006); and*
- *Cultural Resources Overview for the Hudson-Raritan Estuary Comprehensive Restoration Plan (Harris et al., 2014).*

All existing cultural resources data relevant to the CRP candidate restoration sites in the HRE were inventoried during the Cultural Resources Overview (Harris et al., 2014). Ten historic properties and 14 archeological sites were identified within one (1) mile of the restoration sites under the TSP for Jamaica Bay. Until additional surveys are conducted to determine the presence or absence of cultural resources at the sites it is unknown whether additional resources exist within the project areas. At this time it is assumed that under the TSP, construction activities on the restoration sites have the potential to adversely affect cultural resources if those activities occur in close proximity to significant resources. The effects may include disturbance to archaeological sites, alterations to historic properties, and impacts to historic viewsheds.

The USACE drafted two (2) programmatic agreements (PA) (see Appendix I) that cover the restoration sites within New York State and New Jersey and stipulate the actions the USACE will take with regard to cultural resources as the project proceeds. The draft PAs will ensure that the USACE satisfies its responsibilities under Section 106 of the National Historic Preservation Act and other applicable laws and regulations. The draft PAs were provided to the Advisory Council on Historic Preservation, the NPS Gateway National Recreation Area, the New York City Landmarks Preservation Commission, and Native American Tribes with an expressed interest in the area, for their review and participation. In addition, a list of potentially interested parties is currently being developed. The draft PAs are available for public review and will serve as the USACE Section 106 public coordination. The final PAs will incorporate comments received on the draft documents, as appropriate.

Restoration Sites	Potential Environmental Consequences*
All Sites	• Additional survey is required under the stipulations of the draft PAs to determine whether resources are present within the project area. • Mitigation would be required for impacts to significant resources. • Long-term positive impacts to cultural resources from increased protection and contextual enhancement.
Brant Point Bayswater Point State Park Dubos Point Dead Horse Bay	• Seven (7) historic properties, as well as Fort Tilden and Jacob Riis Park Historic Districts, are within one (1) mile of the restoration sites. • Four (4) archaeological sites were recorded within one (1) mile of the study areas. • Dead Horse Bay is considered archaeologically sensitive.
Hawtree Point Fresh Creek	• Six (6) archaeological sites are listed near or within one (1) mile of the restoration sites. The sites are considered archaeologically sensitive. • One (1) historic property is listed within one (1) mile of Hawtree Point.



Restoration Sites	Potential Environmental Consequences*
Duck Point Pumpkin Patch East Pumpkin Patch West Elders Point Center	• No historic or archaeological resources are listed within one (1) mile of the restoration sites.
Stony Creek	• One (1) archaeological resource is listed within one (1) mile of the restoration site.
Jamaica Bay, Head of Bay	• Two archaeological resources are within one (1) mile of the restoration site. The site is considered archaeologically sensitive.

5.2.17 Aesthetics

The future without project conditions is anticipated to involve further expansion of invasive species and commercial and residential development pressures, which are likely to cause further aesthetic degradation to all sites in the Jamaica Bay Planning Region. Erosion and illegal filling/dumping at certain of the estuarine habitat restoration sites are also expected to continue, causing further degradation of the habitat and loss of wetlands. Further loss of marsh islands to erosion would reduce their aesthetic value.

During construction of the TSP there would be temporary impacts to the aesthetic and scenic resources on site due to the presence of construction equipment, vegetation clearing, and earthwork.

The existing project sites do not provide a quality viewshed for the surrounding environs. A substantial amount of disturbed area is within the project site due to past fill activities. The sites are overgrown with invasive species such as common reed and mugwort. The proposed restoration would replace these invasive species with diverse vegetation including maritime forest and tidal marsh species. This would provide increased aesthetic and scenic resources.

Restoration Sites	Potential Environmental Consequences*
All Sites	• Minor, short-term negative impacts to aesthetic and scenic resources during construction. • Long-term improvement in scenic resource value with vegetation restoration and overall habitat improvement.

5.2.18 Coastal Zone Management

Under the no action alternative, no restoration will occur and no impacts to state or local coastal zone management plans would occur.

Restoration activities within the Jamaica Bay Planning Region were evaluated with respect to their consistency with New York State's *State Coast Policies* and New York City's *The New Waterfront Revitalization Program* and the goals are directly in line with the respective coastal zone policies. The restoration activities are consistent with state and local coastal zone management programs (Appendix J).

Restoration Sites	Potential Environmental Consequences*
All Sites	• Restoration activities are consistent with state and local coastal zone management programs.

5.3 Newark Bay, Hackensack River, and Passaic River Planning Region

It is anticipated that without restoration further demise and degradation of existing estuarine habitats would occur within the planning region, due to continuing natural erosive forces and rising sea levels, and poor sediment and water quality, derived from a combination of sewage inputs, landfill leaching, industrial activity, and runoff from roads and developed areas. Additionally, invasive plant species that dominate degraded sites would continue to pose colonization pressures to nearby habitats.

Implementation of the TSP would restore estuarine and freshwater riverine habitat at seven (7) sites in the Newark Bay, Hackensack River, and Passaic River Planning Region:

- **Estuarine habitat restoration** would be conducted at four (4) locations—Meadowlark Marsh and Metromedia Tract on the Hackensack River, and the Kearny Point and Oak Island Yards Tier 2 sites on the Lower Passaic River. The restoration would total approximately 139 acres of high marsh, low marsh, and scrub/shrub wetland restoration, and additional areas of tidal channel and maritime forest restoration, and invasive species removal and planting of native vegetation.
- **Freshwater riverine habitat restoration** would be undertaken at three (3) locations—Essex County Branch Brook Park, Dundee Island Park, and Clifton Dundee Canal Green Acres on the Lower Passaic River. Approximately 24 acres of freshwater stream channel would be dredged, 5.5 acres of riparian forest would be restored, banks would be stabilized, and native vegetation would be planted.

5.3.1 Geomorphology and Sediment Transport

Natural shorelines along Newark Bay, and the Hackensack and Lower Passaic Rivers have been largely replaced by bulkheads and riprap. Shoreline armoring resulted in substantial erosion, and many shoreline structures in the region are actively failing and contributing to further erosion. Under the no action alternative, the Newark Bay, Hackensack River, and Passaic River Planning Region would continue to degrade due to natural erosive forces and rising sea levels and poor sediment and water quality. The estuarine habitat sites would remain fragmented by fill material onsite. Tidal action would continue to erode shorelines. Stormwater runoff would continue to erode soils, particularly along riverbanks or where vegetation is not well established in the freshwater riverine sites, depositing sediment downstream. The shorelines of many the restoration sites are highly eroded and it is anticipated that, without restoration, additional wetlands and shoreline would be lost.

During restoration construction under the TSP, it is unlikely that geological resources would be impacted, as construction would occur only at very shallow depths. Excavation and regrading at the estuarine habitat restoration sites would result in a long-term change to local topography. Excavations will be done along the shorelines to allow for the influx of tidal waters to create the tidal marshes. Excavation of the fill layers from the water’s edge to create tidal marsh is expected to return this area to a more historic elevation and historic soil complex. Channel dredging and modification, bank stabilization and sediment control features at the freshwater riverine habitat restoration sites would affect the transportation and deposition of sediments.

Grading and earthmoving activities, dredging, and sediment resuspension from vessel movements and prop wash could result in temporary disturbances to sediment transport. However, these activities and their effects would be short-term and localized. On land, silt fences and other BMPs would be employed to reduce erosion and sedimentation. As appropriate, silt curtains or cofferdams may be used to minimize sediment transport in open water areas, precluding resuspended sediments being transported by currents and forming new shoals or sandbars. Even absent these practices, such geomorphic features likely would be temporary and would disappear as the system reaches a new post-construction equilibrium. None of the proposed restoration measures are anticipated to cause the release and resuspension of sediments in quantities that could form new shoals or sandbars that potentially would affect aquatic habitats or navigation.

Implementing the TSP at the restoration sites would restore or create wetlands, channels, and maritime and riparian forest, armor and stabilize shorelines, and establish native vegetation. Vegetated intertidal and riparian zones help protect adjacent areas from flood damage and maintain bank stability during flood events, and tidal marshes with natural channel configurations buffer coastal areas from storm surges and provide floodwater storage functions. Restoration would have long-term, positive effects, through attenuating wave velocities, controlling erosion, retaining sediments, and reducing sediment loads, thereby establishing more resilient shorelines, riverbanks and streambanks, and wetlands that can better withstand flooding and strong storms associated with climate change.

Restoration Sites	Potential Environmental Consequences*
All Sites	• During construction, negligible, short-term local soil and sediment disturbance and sedimentation from in-water, shoreline, and onshore earthmoving activities and construction, and vessel and equipment movement. • BMPs employed to minimize erosion and sedimentation, and control stormwater runoff. • Long-term changes to local topography. • Long-term wave and turbidity attenuation and sediment accretion, and/or erosion and sedimentation control, sediment load reduction, and coastal resiliency improvements.

5.3.2 Water Resources

The hydrology and hydraulics of the proposed restoration sites in the planning region have been altered considerably by industrial and commercial development over the last two (2) centuries. Vast areas of wetlands have been altered and filled, and dense growth of invasive common reed has impaired the natural hydrology of tidal marsh systems. Under the no action alternative, the planning region would experience continuing or worsening degradation of hydrologic conditions, depending on the magnitude and effects of SLR and climate change. Riverbanks would continue to be scoured by tidal or stormwater surges, alternately resulting in channel deepening and shoaling downstream. Wetlands would remain hydrologically isolated from rivers and streams, and limited in their capacity to provide beneficial ecological functions. On the estuarine habitat restoration sites, habitat would continue to be hydrologically disconnected. Under the no action alternative, flood storage and conveyance would not improve at the freshwater riverine sites.

Under the TSP, grading and earthmoving activities, dredging, temporary construction-related structures, and resulting temporary geomorphologic features—e.g., shoals and pools—would cause short-term disruption of local streamflow, wave, and current regimes, hydrology, and stormwater runoff. These activities and their effects would be short-term and localized, and BMPs would be employed to minimize sediment transport in open water areas.

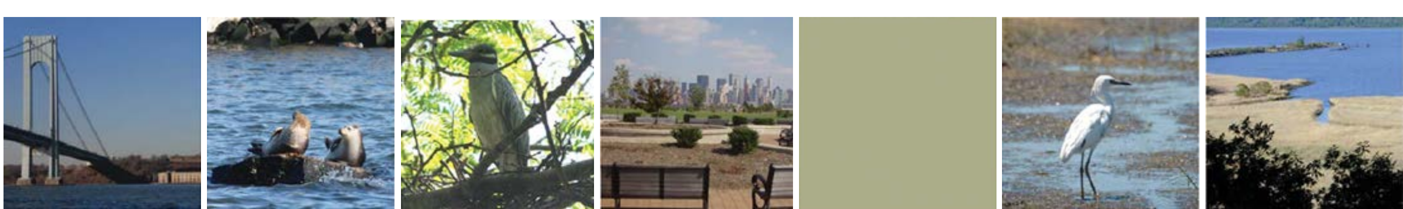
In the long term, bed restoration and channel modification, would help reestablish beneficial flow regimes and decrease downstream velocities by restoring river and stream channels, pools, and riffles. Shoreline softening and bank stabilization would help restore tidal and riverine hydrology, and withstand storm surges and rising sea levels. Wetlands restored under the TSP would provide long-term regulation of water flow, and storm surge and flood buffering, wave attenuation, and protection of shorelines, per the findings of Woodward and Wui (2001), Zelder and Kercher (2005), Koch et al. (2009), Barbier et al. (2011), Gedan et al. (2011), and Shepard et al. (2011). Expansion of forest cover and scrub/shrub habitat would provide stormwater runoff mitigation (Bolund and Hunhammar, 1999; Bonan, 2002; Neary et al., 2009) and flood control. In the Newark Bay, Hackensack River, and Passaic River Planning Region, under the TSP, restoration would contribute to more natural hydrology and hydraulics by creating more resilient shorelines, streambanks, and wetlands that can better withstand flooding and strong storms associated with climate change.

Restoration Sites	Potential Environmental Consequences*
All Sites	• During construction, negligible, short-term disruption of local wave and current regimes, hydrology, and stormwater runoff from in-water, shoreline, and onshore earthmoving activities and temporary structures. • BMPs employed to minimize erosion and sedimentation, and control stormwater runoff. • Long-term improvements in regulation of water flow, storm surge and flood buffering, wave attenuation, shoreline protection, and stormwater runoff control.

5.3.3 Vegetation

It is anticipated that, under the no action alternative, there would be further demise or degradation of existing terrestrial, emergent, and aquatic plant communities, due to continued erosional forces, rising sea levels, anthropogenic disturbances, and further expansion and colonization of invasive plant species. The estuarine habitat restoration sites would continue to be dominated by common reed and habitats would remain degraded. Under the no action alternative, the condition of vegetation at the freshwater riverine sites would remain unchanged and in a degraded state, with most of the riparian areas affected by invasive species, steepened banks, or revetments.

In the short term, construction associated with implementation of the TSP would remove or disturb existing vegetation. The impact footprint would include the restoration area, construction yards, temporary access roads, and dredge sites and resulting sediment plumes. Onshore construction activities and dredging and dredged material deposition would likely cause short-term release or resuspension of sediments in the Hackensack and Lower Passaic Rivers and a concomitant short-term increase in turbidity. This increase in turbidity could have a short-term, negative impact on aquatic macrophytes (Erftemeijer and Lewis, 2006). BMPs would be employed to reduce runoff and minimize sediment transport in open water areas.



Restoration involving habitat modification would result in some long-term, habitat-specific vegetation trade-offs. Activities of this nature include lowering elevations for riverine and coastal marsh creation, and replacing mudflats with wetlands.

Estuaries and coasts, in general, and restored ecosystems, in particular, are prone to introductions of nonnative species (Kettenring and Adams, 2011; Williams and Grosholz, 2008). Restoration plantings, soil inputs, vegetation clearing, construction-related disturbance, or incomplete habitat conversion may facilitate colonization of invasive plant species. Wetlands are often prone to invasion due to high levels of resources—e.g., high fertility and high moisture. Additionally, exotic species may be the first to colonize after a planned disturbance even if they were not present in the pre-disturbance community and may alter successional processes that would otherwise lead to a native assemblage. Removal of invasive species may also adversely alter some ecological processes, such as reducing native plant pollinator levels (Carvaleiro et al., 2008) and reducing denitrification services (Findlay et al., 2003). If herbicides are employed for invasive species removal, there is a possibility of residual herbicidal impacts on newly transplanted vegetation (Cornish and Burgin, 2005).

Implementation of vegetation components of the TSP would include restoration of approximately 175 acres of various native plant communities within the Newark Bay, Hackensack River, and Passaic River Planning Region. Restoration of these communities likely would cause a qualitative improvement of their biodiversity and ecological services (Rey-Benayas et al., 2009; Duffy, 2009). The ecosystem resilience of the Hackensack and Lower Passaic rivers would be enhanced due to an increase in regulating ecological services, which can attenuate the impact of shocks on ecosystems. The reduction or elimination of nonnative plant species would enhance native biodiversity and ecological community functioning, and the created or restored habitats would provide for an increased diversity of plant species, in part by exporting native seed to nearby habitats. Likewise, increasing the size of habitat patches would promote higher levels of biodiversity (Gilbert-Norton et al., 2010; Damschen and Brudvig, 2012; Beninde et al., 2015).

Bed restoration and channel modification, by restoring river and stream channels, pools, and riffles, would help reestablish beneficial flow regimes, which may inhibit further expansion and colonization of the invasive vegetation and may allow the establishment of native aquatic vegetation.

Restoration Sites	Potential Environmental Consequences*
All Sites	• During construction, minor, short-term disturbance of existing terrestrial and aquatic vegetation. • BMPs employed to limit vegetation disturbance, minimize erosion and sedimentation, and control stormwater runoff. • Negligible, long-term removal of existing terrestrial and aquatic vegetation, and disruption of associated ecosystem services. • Risk of minor, long-term establishment or reestablishment of invasive, nonnative vegetation. • Long-term improvement of terrestrial vegetation community biodiversity and associated ecosystem services.

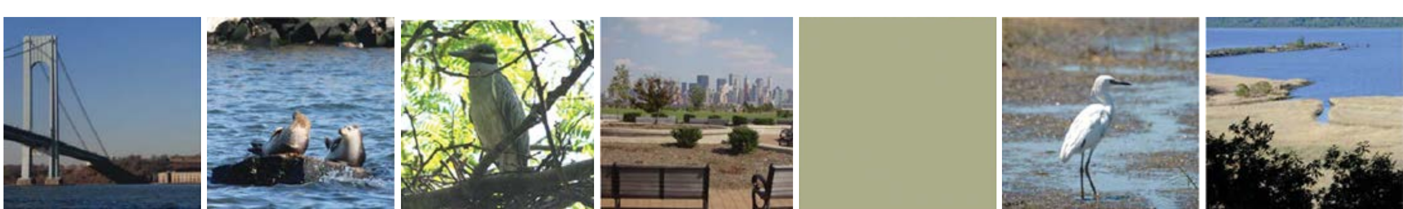
5.3.4 Finfish

Under the no action alternative, continued loss or degradation of fish habitats and nursery grounds is anticipated. This outcome would result from hydrologic impairments and continued compromised water quality due to shoreline erosion, sewage inputs, landfill leaching, industrial activity, and runoff from roads and developed areas. The estuarine habitat restoration sites would continue to have low ecological value for finfish without restoration of tidal channels and marsh creation. The freshwater riverine habitat would continue to be unfavorable for finfish, due to excess nutrient inputs, sedimentation and in-channel debris in the no action alternative.

Under the TSP, construction associated with in-water and shoreline restoration would result in short-term, negative impacts to fish. Fish may be displaced due to noise, changes in currents or stream flow, and changes in water quality, including increases in turbidity from onshore construction activities and dredging. Suspension or resuspension of sediments or other materials may be injurious to fish, provide less suitable nursery habitats, or reduce hatching success and larvae development (Auld and Schubel, 1978; Wilber and Clarke, 2001; Bilkovic, 2011). Reduced water clarity can also affect fish by interfering with their ability to feed or by changing the composition of prey species (Newcombe and MacDonald, 1991). BMPs would be employed to reduce runoff and minimize sediment transport in open water areas. Short-term, negative impacts to fish and fish populations also would occur if construction activities deterred fish from using essential migratory pathways, breeding, foraging, or seeking shelter from predators. However, under the TSP, construction effects would have only short-term, localized influence and fish would return to the area shortly after the cessation of construction activities. These short-term, adverse effects would be outweighed by substantive long-term benefits.

In the long term, wetland habitat restoration in and along the Hackensack and Lower Passaic rivers would directly benefit multiple life stages of resident, transient, and migratory fish species, by providing forage, spawning, nursery, and refuge habitat. Bed restoration and channel modification, by restoring river and stream channels, pools, and riffles, would help reestablish beneficial flow regimes, which would also contribute to improved habitat for fish (Dibble and Meyerson, 2012). Shoreline stabilization would reduce long-term turbidity levels by reducing shoreline erosion.

Restoration Sites	Potential Environmental Consequences*
All Sites	• BMPs employed to limit vegetation disturbance, minimize erosion and sedimentation, and control stormwater runoff. • Long-term positive impacts to fish from improved water quality and provision of forage, spawning, nursery, and refuge habitat. • On balance, long-term benefits to managed and associated species. • Negligible, short-term, local adverse effect to managed and associated species. • During construction, negligible, short-term local displacement of fish due to noise, changes in currents or stream flow, and water quality deterioration, including increased turbidity.
Essex County Branch Brook Park Dundee Island Park Clifton Dundee Canal Green Acres	• During construction, minor, short-term local displacement of fish from dredging, bed restoration, channel modification, and installation of instream structures.



5.3.5 Essential Fish Habitat

Under the no action alternative, continued loss or degradation of essential fish habitats and nursery grounds is anticipated. Low-quality, fragmented habitat dominated by invasive species would remain at the estuarine habitat restoration sites. Freshwater riverine habitat sites would continue to suffer from sedimentation and turbidity due to streambank erosion and nutrient inputs, reducing the quality of essential fish habitat.

With respect to EFH (Appendix F), construction activities under the TSP would employ BMPs to reduce construction impacts. A minor increase in turbidity and sedimentation would be generated by the proposed construction activities. BMPs would be employed to reduce runoff and minimize sediment transport in open water areas. If eggs and larvae are present during construction, they could be affected. During the construction period, adult and juvenile fish would leave the area of construction and move to nearby suitable locations outside the area of disturbance. Also, for a short period of time after construction, there would be a reduction in benthic organisms immediately adjacent to the in-water construction footprint; however, this area would be recolonized quickly. In the long term, due to tidal channel restoration and shoreline armoring, adverse effects would result from the removal of water column and benthic EFH. Given that these impacts would occur over comparatively small, discrete areas and would not adversely impact local water flow and circulation, implementation of the TSP may adversely affect EFH, but likely would result in minimal adverse effects on EFH, as the resulting changes to EFH and its ecological functions would be relatively small and insignificant. On balance, however, it is anticipated that ecosystem restoration would result in long-term, net benefits to managed species (all life stages), associated species, and EFH. Agency consultation for federally listed threatened and endangered marine species is discussed in Section 5.3.8.

Restoration Sites	Potential Environmental Consequences*
All Sites	• BMPs employed to limit vegetation disturbance, minimize erosion and sedimentation, and control stormwater runoff. • Long-term positive impacts to fish from improved water quality and provision of forage, spawning, nursery, and refuge habitat. • On balance, long-term benefits to EFH. • Negligible, short-term, local adverse effect to EFH.

5.3.6 Shellfish and Benthic Resources

Under the no action alternative, benthic macroinvertebrate populations would continue to be low in diversity from continued compromised water quality, due to shoreline erosion, sewage inputs, landfill leaching, industrial activity, and runoff from roads and developed areas. Estuarine habitat sites would remain of low-quality and without tidal connectivity, although USEPA remediation at the Oak Island Yards and Kearny Point sites would reduce contamination and may allow the return of pollution-intolerant species. Benthic invertebrate populations in the freshwater riverine sites would continue to suffer from turbidity and low water quality in the no action alternative.

Under the TSP, construction associated with in-water and onshore restoration would result in short-term, negative impacts on benthic invertebrates, especially in aquatic areas designated for habitat conversion. Bivalves are slow-moving or sessile and would experience some degree of mortality or removal during construction in intertidal waters and subtidal shallows, and crab mortality and displacement likely would also occur during construction. Permanent loss of specific invertebrate populations and replacement with others would result from habitat changes such as the replacement of

soft mud with a sand cap. However, impacts to benthic organisms would be limited and short-term due to limited existing species diversity and pollution tolerant composition. Mortality of sessile and less motile species is expected on shellfish beds and habitats targeted for dredging, shoreline stabilization, regrading, and removal of remnant shoreline structures and debris. However, it is anticipated that the restoration efforts of the HRE will benefit, and not adversely affect, the continued existence of any endangered and/or threatened species which occur in the project area.

Onshore construction activities and dredging and dredged material deposition would cause short-term release or resuspension of sediments in the Hackensack and Lower Passaic rivers, and a concomitant short-term increase in turbidity. Although BMPs would be employed to reduce runoff and minimize sediment transport in open water areas, this increase in turbidity and resuspension of sediments could have a short-term, negative impact on shellfish (Wilber and Clarke, 2001; Knott et al., 2009). However, where benthic habitats suitable for shellfish are created or restored, and where existing shellfish habitat is not substantively changed or is restored, recovery of shellfish populations to levels that occurred prior to construction is expected to occur relatively rapidly.

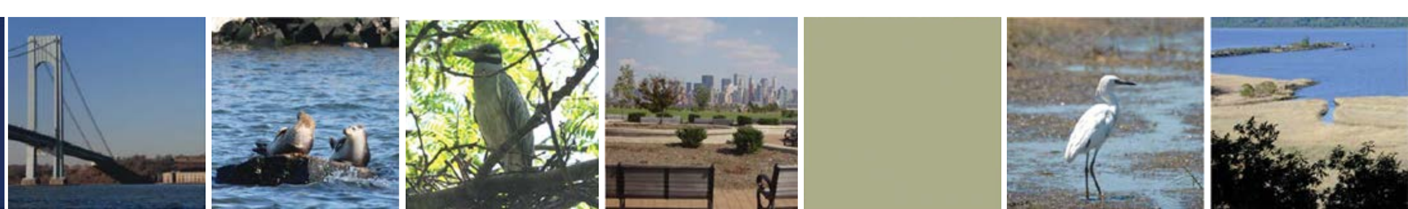
Wetlands restoration would improve long-term water quality in the rivers and, therefore, would provide enhanced environments for benthic invertebrates. Bed restoration and channel modification, by restoring river and creek channels and pools, would help reestablish beneficial flow regimes, which likewise would contribute to improved habitat for shellfish (Portnoy and Allen, 2006). Increases in intertidal and subtidal habitat acreage, establishment of native tidal wetland vegetation, improved tidal connectivity and flushing, and improved sediment and water quality would result in a more diverse and abundant shellfish and benthic invertebrate resource.

Restoration Sites	Potential Environmental Consequences*
All Sites	• During construction, minor, short-term negative impacts from shellfish mortality in areas undergoing aquatic habitat conversion or restoration, typically with rapid recovery expected. • Negligible, short-term, local negative impacts to shellfish from water quality deterioration, including increased turbidity. • BMPs employed to minimize erosion and sedimentation, and control stormwater runoff. • Long-term positive impacts to shellfish from improved water quality, and habitat expansion and restoration.

5.3.7 Wildlife

Under the no action alternative, there would be further loss or degradation of existing terrestrial, wetland, and aquatic faunal communities, due to continued habitat degradation and further pressures from nonnative species, erosional forces, rising sea levels, and anthropogenic disturbances. Wildlife in the estuarine habitat sites would continue to suffer from fragmented habitats and wetlands of low ecological value. Some improvements to wildlife habitat may result from USEPA remedial action at the Oak Island Yards and Kearny Point restoration sites although quality would remain low since wetlands would not be restored pursuant the Superfund program.

Construction associated with estuarine and freshwater riverine restoration would result in both adverse and beneficial effects on mammals. Short-term impacts from construction include species displacement and the potential for species mortality. Muskrats and other small mammal species that are associated



with surface waters, wetlands or riverine habitats could be displaced to nearby comparable habitats but dens, nesting areas and individuals may be harmed or destroyed during construction activities. Potential long-term impacts including changes to habitat type and disturbances associated with increased public access. These impacts are likely to be offset by increases in habitat, as well as habitat enhancement. No population-level effects are expected.

Some negative short-term impact on bird species that utilize scrub uplands or marsh may result from operation of construction equipment. The MBTA requires a restriction on shrub and tree removal during construction activities to protect bird species that may potentially nest within the project areas. In order to comply with the MBTA, trees and shrubs will be cleared outside of a March 15 through July 31 (NJDEP, 2006) window to avoid adverse impacts to the listed species that are covered under this act.

Reptiles and amphibians resident to the project sites and in the immediate vicinity will be susceptible to the same kinds of disturbance factors as previously described for mammals, birds and fish. However, many reptile and amphibian species are much less capable of disbursing quickly, or to distances that remove them to habitats unaffected by project activities. Many will simply try and hide. Thus, the threat of direct adverse impacts due to active construction may be greater to reptile and amphibian species initially inhabiting or utilizing the project site. However, once the restoration has been completed, the new, restored or enhanced habitats will have a long-term beneficial impact on reptiles and amphibians that could result in measureable differences in the size and distribution of reptile and amphibian populations.

In the long term, restoration that involves habitat alteration would create conditions more favorable for certain wildlife groups and species, and uninhabitable or more challenging to others. Overall, however, restored habitats would be higher in quality and function than the existing habitats they replace. For a myriad of wildlife, created or restored habitats would provide refugia—i.e., habitats that, under changing environmental conditions, the wildlife retreat to, persist in, and potentially can expand from (Askins and Philbrick, 1987; Keppel et al., 2012; Soga et al., 2014). In particular, restoring aquatic, wetland, and upland habitats by removing invasive vegetation, planting native vegetation, and improving hydrology and connectivity would benefit wildlife. With the growth and maturation of restored habitats, wildlife communities of greater diversity and ecological value are anticipated.

Restoration Sites	Potential Environmental Consequences*
All Sites	• During construction, minor, short-term negative impacts from mortality of sessile wildlife in areas undergoing habitat conversion or restoration. • Negligible, short-term local displacement of mobile wildlife due to habitat alteration, and construction-related noise and human activity, with rapid recovery expected. • BMPs employed to limit vegetation disturbance, minimize erosion and sedimentation, and control stormwater runoff. • Long-term positive impacts to wildlife from establishment of higher-quality habitats and refugia.

5.3.8 Rare, Threatened, and Endangered Species

Under the no action alternative, further pressure on rare species is anticipated due to displacement by nonnative species and continued loss and degradation of habitats from rising sea levels, erosion, and anthropogenic disturbances. Rare, threatened and endangered species in the estuarine habitat sites would continue to suffer from fragmented habitats and wetlands of low ecological value. Some improvements to habitat may result from USEPA remedial action at the Oak Island Yards and Kearny Point restoration sites although quality would remain low since wetlands are not restored.

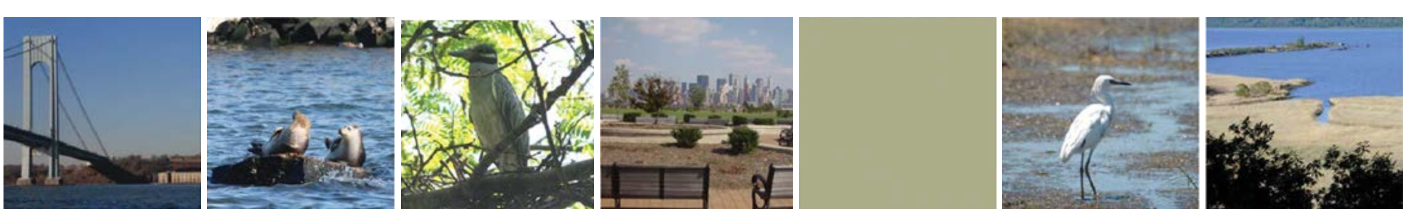
In the short term, construction associated with implementation of the TSP potentially could displace or disturb rare, threatened, and endangered species on or in the vicinity of the restoration sites. Such effects would result from clearing vegetation, changes in currents or stream flow, changes in water quality, including increases in turbidity, and construction-related noise and human activity.

All appropriate federal and state agencies were consulted regarding the documentation of rare, threatened, and endangered species, and species of special concern within the Newark Bay, Hackensack River, and Passaic River Planning Region project sites and their vicinities. The USFWS was contacted regarding federally listed threatened and endangered species under the ESA, and the New Jersey Department of Environmental Protection (NJDEP) Division of Parks and Forestry was contacted regarding state listed species in the New Jersey Natural Heritage Program (NJNHP). While no federally-listed endangered, threatened, or rare plant and animal species exist in the vicinity of the restoration sites, several state-listed species were identified at all sites except for Oak Island Yards and Kearny Point. Correspondences with the agencies are in Appendix G. Prior to restoration activities, onsite surveys will be conducted at each restoration site to fully assess any potential impacts on biological resources and confirm whether any documented species could be impacted by any restoration activities. If rare, threatened, and endangered species are confirmed at the sites that could be adversely impacted by restoration activities, precautions will be taken to avoid, minimize, or mitigate the impacts as determined by the appropriate agency.

The NJNHP identified several rare or state-listed bird species on or within one-quarter mile of potential restoration sites. Species that may forage in or around the restoration sites include the state-endangered Bald Eagle (*Haliaeetus leucocephalus);* the state-threatened Cattle Egret (*Bubulcus ibis*), Yellow-crowned Night-heron (*Nyctanassa violacea),* and Black-crowned Night-heron (*Nycticorax nycitorax)*; and other state species of concern. As these birds are highly mobile and capable of avoiding construction activities, disturbance from construction activities would be short-term and localized.

Some birds are documented as nesting or breeding in or near the restoration sites. A Bald Eagle nest was documented in the vicinity of the Meadowlark Marsh site, and an urban nest for the state-endangered Peregrine Falcon (*Falco peregrinus)* was documented at the Meadowlark Marsh and Metromedia sites. Breeding and non-breeding sightings for the state-endangered Northern Harrier (*Circus cyaneus)* were documented at and around the Metromedia site and in the vicinity of the Meadowlark site. Breeding sightings were also documented at and around the Essex County Branch Brook Park for the state-threatened Red-headed Woodpecker (*Melanerpes erythrocephalus).* If pre-construction surveys confirm the presence of nesting or breeding species, construction buffers and/or timing restrictions would be employed during nesting season, which typically occurs between March and August.

As the restoration goals include creating, restoring, and protecting wildlife habitat, impacts to rare, threatened, and endangered species are expected to be short-term and insignificant. In the long term, implementation of the TSP would benefit rare, threatened, and endangered bird species in the Newark Bay, Hackensack River, and Passaic River Planning Region by increasing favorable habitat and improving the quality of existing habitat.



Restoration Sites	Potential Environmental Consequences*
All Sites	• No long-term negative impacts to protected species. • Long-term positive impacts to rare, threatened, or endangered species from habitat and ecosystem restoration.
All Sites (except Kearny Point and Oak Island Yards	• Negligible, short-term impacts to state-listed bird species due to construction activities. • Construction buffers and/or timing restrictions may be required to avoid impacts during breeding or nesting periods.

5.3.9 Land Use

The potential restoration sites in the Newark Bay, Hackensack River, and Passaic River Planning Region are typically a combination of public open space, public parkland, or former industrial land use. No permanent housing exists on these sites. Under the no action alternative, the freshwater riverine sites would continue as parkland maintained by city governments and may undergo minor improvements if city budgets allow. The Metromedia Tract and Meadowlark Marsh estuarine habitat restoration sites would likely remain open space if no action is taken, although the Oak Island Yards and Kearny Point sites could potentially be developed as portions of the site are currently zoned industrial and/or commercial.

Sites with parcels formerly used for industrial purposes would be converted to public land. Site access would remain similar to or better than existing conditions.

Restoration Sites	Potential Environmental Consequences*
Metromedia Tract Meadowlark Marsh Oak Island Yards Kearny Point	• Long-term impacts from former industrial land converted to open space, preventing future development opportunities.
Essex County Branch Brook Park Dundee Island Park Clifton Dundee Canal Green Acres	• Implementation of the TSP would not change the existing land use of the sites. • Minimal short-term impacts from restricting public access to existing park areas.

5.3.10 Hazardous, Toxic, and Radioactive Waste

It is anticipated that, under the no action alternative, water quality would continue to degrade due to poor sediment and water quality derived from a combination of sewage inputs, landfill leaching, industrial activity, and runoff from roads and developed areas. However, legacy sediments will be removed and capped as a result of the USEPA remedial action in the lower 8.3 miles of the Lower Passaic River. This cleanup will take place prior to restoration of the Oak Island Yards and Kearny Point sites. Each site would require additional HTRW sampling during PED to determine if additional remedial activities are required prior to restoration.

Under the TSP, habitat restoration and associated construction activities would cause short-term release or resuspension of sediments and a concomitant short-term increase in turbidity, in nearby waters in Hackensack and Lower Passaic rivers. BMPs would be employed to reduce erosion and

sedimentation. Removal of the debris and fill at the Oak Island Yards and Kearny Point restoration sites may require investigation and special handling and disposal of fill if contaminants are present. Channel dredging at the Essex County Branch Brook Park site and tidal channel creation at the Meadowlark Marsh, Oak Island Yards and Kearny Point restoration sites may also require special handling of sediments if contaminants are found.

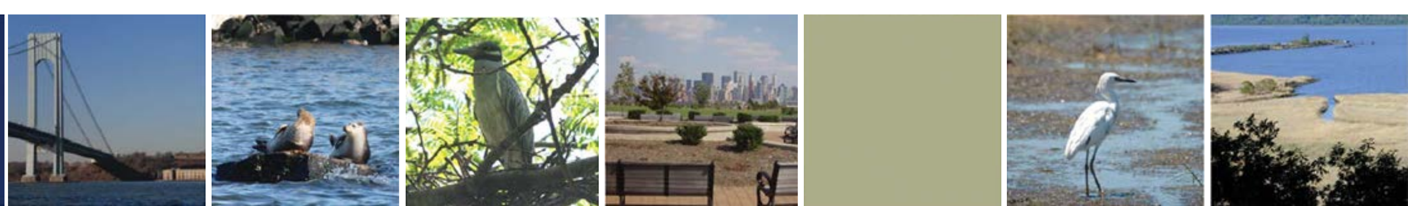
In the long term, creating or restoring wetlands, and maritime and riparian forest, and armoring and stabilizing shorelines would improve water quality and provide nutrient removal and denitrification services. The restored habitats would reduce long-term turbidity by filtering and retaining stormwater runoff, providing storm surge and flood buffering, attenuating waves, and thereby reducing shoreline erosion. Improved tidal flushing and reduced water residency time, due to creating or restoring tidal channels and basins, would increase dissolved oxygen levels and reduce fecal coliform levels (Portnoy and Allen, 2006). Restored wetlands likewise would improve tidal flushing and increase dissolved oxygen levels. Groundwater resources may also benefit from restored wetlands, as wetlands filter pollutants moving between surface water and groundwater.

Restoration Sites	Potential Environmental Consequences*
All Sites	• During construction, risk of local water quality deterioration from construction-related, accidental spills. • Safeguards employed to prevent and respond to spills. • Long-term surface water quality improvements—i.e., increased turbidity reduction, nutrient removal, denitrification, and/or increased dissolved oxygen levels, and reduced fecal coliform levels.
Essex County Branch Brook Park Dundee Island Park Clifton Dundee Canal Green Acres	• Possible long-term groundwater quality improvements.
Essex County Branch Brook Park Meadowlark Marsh Oak Island Yards Kearny Point	• Handling or removal of debris, fill, or sediments during restoration, channel dredging, or tidal creation activities may require investigation and special handling and disposal if contaminated sediment is found.

5.3.11 Air Quality

No long-term impacts to air quality are expected from implementing the no action alternative. Population growth and increased use of roadways in the region may cause minor reductions in future air quality, however these may also be offset by more stringent emissions standards and technological improvements moving forward.

In the short term, implementation of the TSP would contribute to emissions of greenhouse gases during construction, from the combustion of fossil fuels, as well as the possible use of controlled burning to remove invasive vegetation. The major sources of greenhouse gas emissions would be construction activities and equipment used at each restoration site. The extent of these emissions would depend on the type of equipment used and the duration of their use. To minimize the impact of increased



greenhouse gas emissions, applicable BMPs, such as turning off machines when not working and using low sulfur fuels, would be utilized. The limited amount of emissions would not contribute to global warming to any discernible extent, as individual sources of greenhouse gas emissions are not large enough to have an appreciable effect on climate change.

Although a short-term increase in greenhouse gases may result from the initial removal of vegetation, this will be offset by benefits from replanting native vegetation. Beneficial impacts to local air quality are likely to result from implementing measures that involve restoration of terrestrial and aquatic plant communities. Restoration of these communities would promote primary productivity and increase removal of carbon dioxide, a major greenhouse gas, from the atmosphere. The creation of vegetated habitats under the TSP would reduce or offset the emission of carbon dioxide. The increase of cover from created forest and shrub communities could alter local biophysical and biochemical processes, which in turn would minimally impact air quality. Wetland creation, and afforestation or reforestation in urban areas could lead to increased sequestration of atmospheric carbon. On a small scale, increased forest cover in urban areas can generally reduce temperatures and anthropogenic energy use (Bolund and Hunhammar, 1999; Anderson et al., 2011; Nowak et al., 2013).

Restoration of the terrestrial and aquatic plant communities of the HRE also would help protect these communities, and neighboring habitats and infrastructure by reducing coastal flooding, and shoreline erosion and transgression. Restoration measures that increase wave attenuation, shoreline stability, and shoreline resiliency, such as bank stabilization, would provide additional protection.

Restoration Sites	Potential Environmental Consequences*
All Sites	• During construction, negligible, short-term contribution to air pollution, primarily from the operation of construction equipment and vehicles. • BMPs employed to minimize emissions. • Negligible, long-term mitigation through the removal of carbon dioxide from the atmosphere.

5.3.12 Noise

Under the no action alternative, restoration would not take place and short-term, temporary increases in ambient noise levels due to construction activities would not occur. Population growth and increased use of railways and roadways in the region may cause noise levels to rise in the future.

Heavy equipment used during construction may contribute to short-term increase in noise levels. However, noise levels would not exceed those cited in local ordinances and would occur only during normal daytime working hours. In the long term, sites with riparian or maritime forest restoration, such as Clifton Dundee Canal Green Acres, Metromedia Tract and Meadowlark Marsh, mature trees may create a natural buffer to reduce ambient noise levels.

Restoration Sites	Potential Environmental Consequences*
All Sites	• Short-term increases in noise levels from construction equipment would occur during normal daytime working hours. • Implementation of the TSP at each site would not cause any negative long-term noise impacts.

Restoration Sites	Potential Environmental Consequences*
Clifton Dundee Canal Green Acres Metromedia Tract Meadowlark Marsh	• Long-term potential to reduce ambient long-term noise from mature trees in riparian and maritime forest.

5.3.13 Social and Economic Resources

Under the no action alternative, construction would not take place and no short-term employment benefits would occur. Lack of public access at the estuarine habitat restoration sites and degraded conditions at the freshwater riverine restoration sites could potentially limit long-term social and economic opportunities.

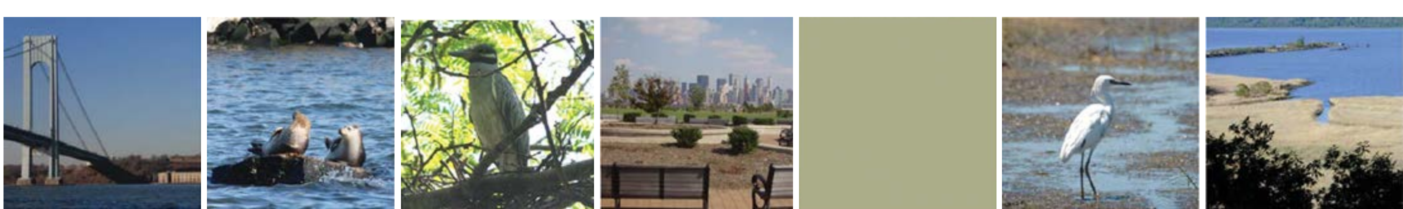
Restoration under the TSP would result in both short- and long-term social and economic benefits for the regional economy. Construction activities would generate jobs, and it is assumed that the majority of the workforce would be from the local area. In the short term, this employment would contribute to local earnings, induced spending for goods and services, and tax revenues. Implementing the TSP would give local community groups and educational institutions opportunities to participate in the restoration efforts, providing valuable educational experiences that would bolster environmental education. No permanent or long-lasting economic effects are anticipated as a result of construction activities.

Larger populations of waterbirds throughout the planning region, particularly in the vicinity of Newark International Airport, could lead to a greater potential for bird-aircraft strikes, potentially requiring increased expenditures by the PANYNJ to mitigate the heightened hazard. Due to the increasing concern regarding aircraft-wildlife strikes, the FAA has implemented standards, practices, and recommendations for holders of Airport Operating Certificates issued under Title 14, CFR, Part 139, Certification of Airports, Subpart D (Part 139), to comply with the wildlife hazard management requirements of Part 139. Airports that have received federal grant-in-aid assistance must use these standards. In accordance with the FAA Advisory Circular 150/5200-33B and the Memorandum of Agreement with FAA to address aircraft-wildlife strikes, when considering proposed flood risk management measures and mitigation (and restoration) areas, USACE must take into account whether the proposed action could increase wildlife hazards.

The FAA recommends minimum separation criteria for land-use practices that attract hazardous wildlife to the vicinity of airports. These criteria include land uses that cause movement of hazardous wildlife onto, into, or across the airport's approach or departure airspace or AOA. These separation criteria include:

- Perimeter A: For airports serving piston-powered aircraft, hazardous wildlife attractants must be 5,000 feet from the nearest AOA;
- Perimeter B: For airports serving turbine-powered aircraft, hazardous wildlife attractants must be 10,000 feet from the nearest AOA; and
- Perimeter C: Five-mile range to protect approach, departure, and circling airspace.

Oak Island Yards and Kearny Point are within the five-mile perimeter of Newark International Airport but are not being considered for near-term construction until EPA's Superfund Program completes the remedy of the Lower Passaic River.



Improvements to the environment, notably cleaner water and greater abundance and diversity of desirable terrestrial wildlife, fish, and vegetation, potentially would stimulate the local economy by increasing activities such as fishing, hiking, boating, and bird watching, and tourism in general. Improved quality of life would strengthen the desirability of living in the region and maintain, if not increase, property values. Increased shoreline stabilization may reduce municipal expenditures, including those for emergency services. Ongoing restoration and monitoring activities would give local community groups and educational institutions opportunities to participate, providing valuable educational experiences.

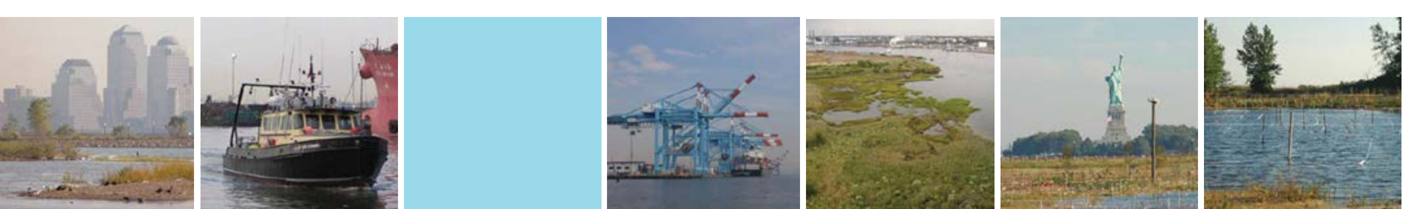
Restoration Sites	Potential Environmental Consequences*
All Sites	• Minor, short-term negative impacts to access to recreational resources. • During construction, minor, short-term increases in local employment, earnings, induced spending, and tax revenues, and provision of educational opportunities. • Minor, long-term stimulation of the local economy and provision of educational opportunities.
Kearny Point Oak Island Yards	• Negligible, long-term increased expenditures to mitigate heightened bird-aircraft strike hazard.
Meadowlark Marsh Metromedia Tract	• Combined total first cost of approximately $74,170,000 for Hackensack River sites.
Essex County Branch Brook Park Dundee Island Park Clifton Dundee Canal Green Acres Kearny Point Oak Island Yards	• Combined total first cost of approximately $36,560,000 for Tier 1 restoration sites and $87,540,000 for Tier 2 sites for near-term construction following remedial action.

5.3.14 Navigation

Under the no action alternative, no restoration will occur and no changes or impacts to navigation would occur.

Short-term impacts to navigation in the Newark Bay, Hackensack River and Passaic River Planning Region would be limited to recreational boat usage during in-water construction activities. The freshwater riverine restoration sites are not located on waters used by shipping traffic. Estuarine habitat restoration activities would take place on land or in the shallows and would not be in close proximity to heavily used navigation channels. No long-term impacts are expected from the restoration activities.

Restoration Sites	Potential Environmental Consequences*
All Sites	• Minimal, short-term limitations to local boat craft usage during construction activities. • Implementation of the TSP would not impact navigation at the restoration sites.



5.3.15 Recreation

Under the no action alternative erosion, the estuarine habitat restoration sites would remain in their degraded state, and walking trails and other improvements to public access would not occur. The freshwater riverine restoration sites would remain as existing parkland; however public access improvements that would otherwise enhance community use and experience would not take place.

Under the TSP, access to recreational resources may be negatively affected temporarily during construction. At sites which currently offer recreational resources, there may be adverse temporary impacts during construction due to the closing of the interior footpaths and some fishing access restrictions. However, construction would be phased to occur during the colder winter months when the paths are not as heavily utilized.

After the TSP is implemented, positive impacts to the recreational and educational features of the sites would be realized. Within the estuarine habitat restoration sites, improvements include upgrades to an existing path at Oak Island Yards and construction of an elevated path at Kearny Point. Upland areas at Meadow Marsh are currently used by ATVs. Under the TSP, vehicle access would be prohibited in restoration areas. Within the freshwater riverine habitat restoration sites improvements at the Essex County Branch Brook Park include installation of interpretive signs to support ongoing public access improvements. The TSP for Dundee Island Park includes enhancement and extension of an existing trail and Clifton Dundee Canal Green Acres includes construction of new trails, an overlook, and a boat launch with access roads constructed to support improved public access.

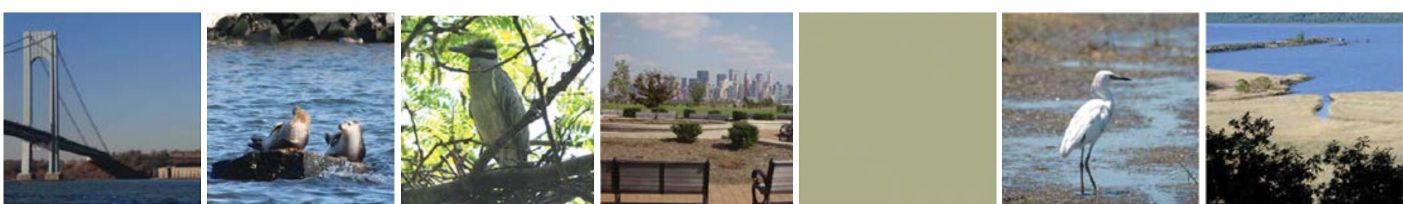
In addition to public access improvements, estuarine and freshwater riverine habitat restoration would provide improvements to the environment, notably cleaner water and greater abundance and diversity of desirable terrestrial wildlife, fish, and vegetation, which potentially would increase activities such as fishing, hiking, boating, and bird watching.

Restoration Sites	Potential Environmental Consequences*
All Sites	• Minor, short-term negative impacts from limited access to recreational resources during construction. • Long-term improvement in recreational opportunities for wildlife viewing, hiking, recreational fishing, kayaking, and canoeing through habitat improvement.
All Sites (except Metromedia Tract, Meadowlark Marsh	• Long-term benefits from improved public access.

5.3.16 Cultural Resources

Under the no action alternative, although impacts to cultural resources are expected to be minimal, loss of historic resources due to SLR and erosion could occur.

Enough data does not currently exist to determine the extent of impacts to cultural resources from implementation of the TSP in the Newark Bay, Hackensack River and Passaic River Planning Region. A limited number of surveys were completed by USACE in recent years in connection with this study:



- *Cultural Resources Investigation of Ten Sites in the Hackensack Meadowlands, Hackensack Meadowlands Ecosystem Restoration Project, Hudson and Bergen Counties, New Jersey (Hunter Research Inc., 2006);*
- *Historic Context Development, Hackensack Meadowlands Drainage Systems and Features, Hackensack Meadowlands Ecosystem Restoration Project, Hudson and Bergen Counties, New Jersey (Hunter Research Inc., 2010); and*
- *Cultural Resources Overview for the Hudson-Raritan Estuary Comprehensive Restoration Plan (Harris et al., 2014).*

The Meadowlark Marsh and Metromedia sites, along with eight (8) other potential restoration areas, were evaluated in the Hackensack Meadowlands survey. Drainage features that are potentially eligible for the National Register of Historic Places were identified within the study area requiring additional investigation, as well as the potential for prehistoric archaeological sites beneath areas of meadow mat.

All existing cultural resources data relevant to the CRP candidate restoration sites in the HRE were inventoried during the Cultural Resources Overview (Harris et al., 2014). Over 2,000 historic properties and districts were identified within one (1) mile of the restoration sites in the planning region. The majority of the sites are located in and around the Branch Brook Park site in Newark, NJ. Branch Brook Park is a historic district in the National Register of Historic Places. The Morris Canal Historic District and the City of Newark Subways Historic District are also within the Branch Brook restoration site. The Clifton Dundee Canal Green Acres site includes within its boundaries the Dundee Canal Industrial Complex Historic District which includes the Dundee Textile Complex. Also notable are the Lehigh Valley Railroad Historic District, Pennsylvania Railroad New York Bay Branch Historic District and the Lehigh Valley Railroad Oak Island Yard Historic District which overlap the Oak Island Yards restoration site. In addition to these historic properties, 48 archeological sites were recorded within one (1) mile of the restoration sites, four (4) of which are located within the boundaries of the Clifton Dundee Canal Green Acres restoration site.

Until additional surveys are conducted to determine the presence or absence of cultural resources at the restoration sites it is unknown whether additional resources exist within the project areas. At this time it is assumed that under the TSP, construction activities on the restoration sites in the planning region have the potential to adversely affect cultural resources if those activities occur in close proximity to the resources. The effects may include disturbance to archaeological sites, alterations to historic properties, and impacts to historic viewsheds.

The USACE drafted two (2) PAs (see Appendix I) that cover the restoration sites within New York State and New Jersey and stipulate the actions the USACE will take with regard to cultural resources as the project proceeds. The draft PAs will ensure that the USACE satisfies its responsibilities under Section 106 of the National Historic Preservation Act and other applicable laws and regulations. The draft PAs were provided to the Advisory Council on Historic Preservation, the NPS Gateway National Recreation Area, the New York City Landmarks Preservation Commission, and Native American Tribes with an expressed interest in the area for their review and participation. In addition, a list of potentially interested parties is currently being developed. The draft PAs are available for public review and will serve as the USACE Section 106 public coordination. The final PAs will incorporate comments received on the draft documents, as appropriate.

Restoration Sites	Potential Environmental Consequences*
All Sites	• Potential for archaeological resources at all the sites. • Additional survey is required under the stipulations of the draft PAs to determine whether other resources are present within the project area. • Mitigation would be required for impacts to significant resources.
Meadowlark Marsh Metromedia Tract Kearny Point Oak Island Yards	• Numerous resources are listed within one (1) mile of the sites.
Oak Island Yards Essex County Branch Brook Park Clifton Dundee Canal Green Acres	• Significant cultural resources were documented within the restoration sites.

5.3.17 Aesthetics

Under the no action alternative, the degraded condition of the region is anticipated to continue into the future, decreasing aesthetic and scenic resource value in the planning region. Areas of historic fill at the estuarine habitat restoration sites would remain dominated by unsightly invasive species and lack of vegetative diversity. Anthropogenic trash and invasive species dominance would increasingly degrade the freshwater riverine restoration sites. Lack of public access improvements would continue to limit scenic viewing opportunities in the region.

During construction of the TSP temporary impacts to the aesthetic and scenic resources would occur on site due to the presence of construction equipment, vegetation clearing, and earthwork. However, the sites are overgrown with invasive species and the proposed restoration would replace invasive species with diverse vegetation including native low marsh, high marsh, scrub/shrub wetland, and maritime forest species at the estuarine habitat restoration sites, and native riparian forest vegetation within freshwater riverine habitat restoration sites, thus improving aesthetic and scenic resource value. Additionally, the construction and enhancement of trails and overlooks would provide improved public access to scenic resources.

Restoration Sites	Potential Environmental Consequences*
All Sites	• Minor, short-term negative impacts to aesthetic and scenic resources during construction. • Long-term improvement in scenic resource value with vegetation restoration and overall habitat improvement.
All Sites (except Metromedia Tract, Meadowlark Marsh	• Long-term benefits from improved public access.

5.3.18 Coastal Zone Management

Under the no action alternative, no restoration will occur and no impacts to state or local coastal zone management plans would occur.

Restoration activities within the Newark Bay, Hackensack River, and Passaic River Planning Region were evaluated with respect to their consistency with NJDEP Coastal Zone Management Program and the restoration activities were found to be consistent with the coastal zone management rules (Appendix J).

Restoration Sites	Potential Environmental Consequences*
All Sites	• Restoration activities are consistent with state and local coastal zone management programs.

5.4 Harlem River, East River, and Western Long Island Sound Planning Region

It is anticipated that without restoration there would be a further demise and degradation of existing estuarine and riverine habitats within the planning region, due to continuing natural erosive forces and rising sea levels, and anthropogenic stressors such as urbanization, dredging, compromised water quality, landfilling and landfill leachate intrusions, illegal dumping, and off-road vehicle traffic. Additionally, invasive plant species that dominate degraded sites would continue to pose colonization pressures to nearby native habitats. Habitat along the Bronx River would remain fractured and low-quality.

Implementation of the TSP would restore estuarine, freshwater riverine, and oyster habitat at 11 sites in the Harlem River, East River, and Western Long Island Sound Planning Region:

- **Estuarine habitat restoration** would be conducted at one (1) site, at Flushing Creek, where approximately 2.4 acres of low marsh would be restored, including the elimination of invasive-dominated communities and restoration of native vegetation communities.
- **Freshwater riverine habitat restoration** would be undertaken at nine (9) locations—Shoelace Park, Bronxville Lake, Crestwood Lake, Westchester County Center, River Park/West Farm Rapids Park, Muskrat Cove, Garth Woods/Harney Road, Bronx Zoo and Dam, and Stone Mill Dam. Approximately 9.4 acres of emergent wetland and 2.9 acres of forested and scrub/shrub wetland would be restored, two (2) fish ladders would be installed, and three (3) weirs would be modified for fish passage.
- **Small-scale oyster restoration** would be undertaken at one (1) site, at Soundview Park, where approximately one (1) acre of oyster reef habitat would be created.

5.4.1 Geomorphology and Sediment Transport

Under the no action alternative in the Harlem River, East River, and Western Long Island Sound Planning Region, stormwater runoff and tidal action would continue to erode soils, particularly along riverbanks or where vegetation is not well established. At the Flushing Creek estuarine habitat restoration site, the altered stream geomorphology would remain and erosion and sedimentation would continue. Without action at the freshwater riverine restoration sites along Bronx River, the existing sediment imbalances throughout the watershed, streambank erosion, and channel instability would continue. This could lead to continue filling of the ponded areas behind impoundments. Both Westchester County and the City of New York have extensive plans for green infrastructure along the

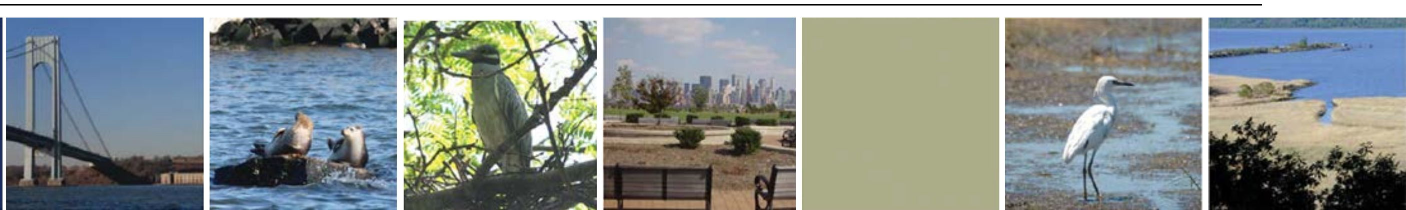
Bronx River corridor that would help reduce, but not alleviate, the amount of stormwater run-off and sedimentation entering the river.

During restoration construction under the TSP, it is unlikely that geological resources would be impacted, as construction would occur only at very shallow depths. Local topography at the Flushing Creek restoration site would result in minimal changes to topography from regrading. Bed restoration, channel dredging and modification, bank stabilization and sediment control features at the Bronx River freshwater riverine habitat restoration sites would affect the transportation and deposition of sediments.

Grading and earthmoving activities, dredging, and sediment resuspension from vessel movements and prop wash could result in temporary disturbances to sediment transport. Weir modification for fish passage may disturb sediments and cause the release and downstream transport of sediments retained by the structures. However, these activities and their effects would be short-term and localized. On land, silt fences and other BMPs would be employed to reduce erosion and sedimentation. As appropriate, silt curtains or cofferdams may be used to minimize sediment transport in open water areas, precluding resuspended sediments being transported by currents and forming new shoals or sandbars. Even absent these practices, such geomorphic features likely would be temporary and would disappear as the system reaches a new post-construction equilibrium.

Implementing the TSP at the restoration sites would restore or create wetlands, channels, and riparian forest, armor and stabilize shorelines, and establish native vegetation and oyster habitat. Small-scale oyster restoration would provide long-term, incremental improvements to shoreline stability, by attenuating waves and boat wakes, and retaining sediments, potentially reducing shoreline and bottom erosion, and reducing the sediment load. Vegetated intertidal and riparian zones help protect adjacent areas from flood damage and maintain bank stability during flood events, and tidal marshes with natural channel configurations buffer coastal areas from storm surges and provide floodwater storage functions. Restoration would have long-term, positive effects, through attenuating wave velocities, controlling erosion, retaining sediments, and reducing sediment loads, thereby establishing more resilient shorelines, riverbanks and streambanks, and wetlands that can better withstand flooding and strong storms associated with climate change.

Restoration Sites	Potential Environmental Consequences*
All Sites (except Soundview Park)	• During construction, negligible, short-term local soil and sediment disturbance and sedimentation from shoreline and onshore earthmoving activities, and equipment and vehicle or vessel movement. • BMPs employed to minimize erosion and sedimentation, and control stormwater runoff. • Long-term erosion and sedimentation control, sediment load reduction, and/or coastal resiliency improvements.
Soundview Park	• During construction, negligible, short-term local sediment disturbance and sedimentation from offshore placing spat on shell, installing wire cages/gabions, and vessel and equipment movement. • BMPs employed to minimize erosion and sedimentation. • Long-term wave and turbidity attenuation, sediment accretion, erosion and sedimentation control, sediment load reduction, shoreline protection, and coastal resiliency improvements.



5.4.2 Water Resources

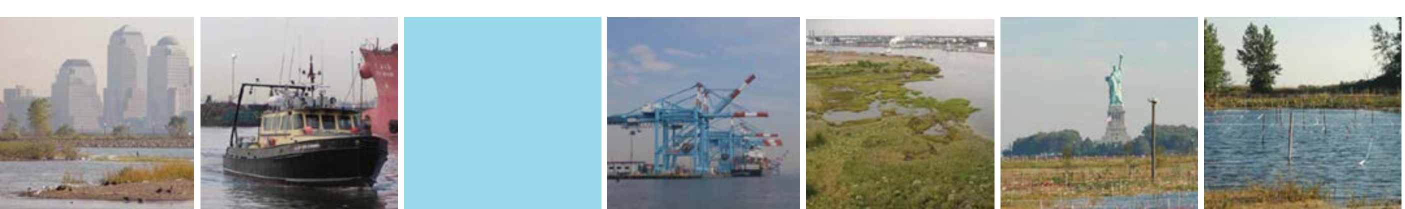
Under the no action alternative, the planning region would experience continuing or worsening degradation of hydrologic conditions, depending on the magnitude and effects of SLR and climate change. At the Flushing Creek estuarine habitat restoration site, poor hydrologic connection, water circulation, and tidal flushing between Flushing Bay, Flushing Creek, and Meadow Lake would persist. Flash flooding would continue along the Bronx River. Without action at the freshwater riverine restoration sites along Bronx River, the existing sediment imbalances throughout the watershed, streambank erosion, and channel instability would continue. This could lead to increased flooding along the Bronx River Parkway. Multiple dams and impoundments along the Bronx River create additional flow restrictions, trap sediments, and prevent fish passage. While the Bronx River Intermunicipal Watershed Management Plan indicates that impoundments should be removed or modified to improve fish passage and water flow, based on the current priorities of the county and state resources, there is no expectation that these impoundments would be modified in the absence of federal action.

Under the TSP, grading and earthmoving activities, dredging, temporary construction-related structures, and resulting temporary geomorphologic features—e.g., shoals and pools—would cause short-term disruption of local streamflow, wave, and current regimes, hydrology, and stormwater runoff. These activities and their effects would be short-term and localized, and BMPs would be employed to minimize sediment transport in open water areas.

Urbanization in the Bronx River Basin has resulted in the degradation of existing riparian habitat, water quality, and channel capacity. Restoration alternatives may accommodate and provide some ancillary flood risk management benefits, but the primary goal would not be flood risk management. Ecosystem restoration opportunities would not increase flooding or present additional flood risks in the Bronx River Basin.

In the long term, bed restoration and channel modification would help reestablish beneficial flow regimes and decrease downstream velocities by restoring river and stream channels, pools, and riffles. Shoreline softening and bank stabilization would help restore tidal and riverine hydrology, and withstand storm surges and rising sea levels. Wetlands restored and oyster beds established under the TSP would provide long-term regulation of water flow, and storm surge and flood buffering, wave attenuation, and protection of shorelines, per the findings of Woodward and Wui (2001), Zelder and Kercher (2005), Koch et al. (2009), Barbier et al. (2011), Gedan et al. (2011), and Shepard et al. (2011). Expansion of forest cover and scrub/shrub habitat would provide stormwater runoff mitigation (Bolund and Hunhammar, 1999; Bonan, 2002; Neary et al., 2009) and flood control. In the Harlem River, East River, and Western Long Island Sound Planning Region, under the TSP, restoration would contribute to more natural hydrology and hydraulics by creating more resilient shorelines, streambanks, and wetlands that can better withstand flooding and strong storms associated with climate change.

Restoration Sites	Potential Environmental Consequences*
All Sites	• Long-term improvements in regulation of water flow, storm surge and flood buffering, wave attenuation, shoreline protection, and stormwater runoff control.



Restoration Sites	Potential Environmental Consequences*
All Sites (except Soundview Park)	• During construction, negligible, short-term disruption of local streamflow, wave, and current regimes, hydrology, and/or stormwater runoff from in-water, shoreline, and/or onshore earthmoving activities and/or temporary structures. • BMPs employed to minimize erosion and sedimentation, and control stormwater runoff.
Soundview Park	• During construction, negligible, short-term disruption of local hydrology from offshore placing spat on shell and installing wire cages/gabions. • BMPs employed to minimize erosion and sedimentation.

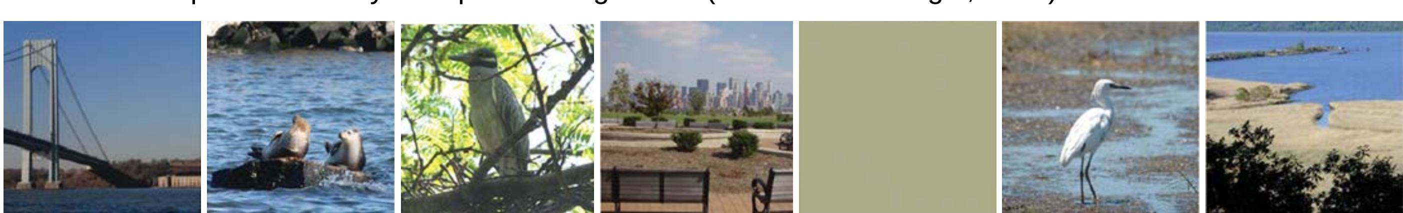
5.4.3 Vegetation

It is anticipated that, under the no action alternative, there would be further demise or degradation of existing terrestrial, emergent, and aquatic plant communities, due to continued erosional forces, rising sea levels, anthropogenic disturbances, and further expansion and colonization of invasive plant species. The Flushing Creek estuarine habitat restoration site would continue to suffer from exposed mudflats and dominant invasive vegetation. The freshwater riverine restoration sites along Bronx River would remain degraded due to lack of riparian buffers, loss of wetlands, and dominance of invasive species. Although the Bronx River Intermunicipal Watershed Management Plan recommends wetland restoration, few specific projects are identified for restoration of these wetland areas. NYC Parks has developed a master plan for Shoelace Park; however, the predominant restoration opportunities for this park are upland forests outside of the floodplain.

In the short term, construction associated with implementation of the TSP would remove or disturb existing vegetation. The impact footprint would include the restoration area, construction yards, temporary access roads, and dredge sites and resulting sediment plumes. Onshore construction activities and dredging and soil deposition would likely cause short-term release or resuspension of sediments in the Bronx River and Flushing Creek and a concomitant short-term increase in turbidity. Although BMPs would be employed to reduce runoff and minimize sediment transport in open water areas, this increase in turbidity could have a short-term, negative impact on aquatic macrophytes (Erftemeijer and Lewis, 2006).

Restoration involving habitat modification would result in some long-term, habitat-specific vegetation trade-offs. Activities of this nature include lowering elevations for riverine and coastal marsh creation. There would also be a permanent elimination of any submerged aquatic macrophytes in bay bottom areas targeted for oyster restoration.

Estuaries and coasts, in general, and restored ecosystems, in particular, are prone to introductions of nonnative species (Kettenring and Adams, 2011; Williams and Grosholz, 2008). Restoration plantings, soil inputs, vegetation clearing, construction-related disturbance, or incomplete habitat conversion may sometimes result in the colonization of invasive plant species. However, TSP would include invasive species removal and adaptive management plans in order to avoid or minimize invasive species colonization. Removal of invasive species may also adversely alter some ecological processes, such as reducing native plant pollinator levels (Carvaleiro et al., 2008) and reducing denitrification services (Findlay et al., 2003). If herbicides are employed for invasive species removal, there is a possibility of residual herbicidal impacts on newly transplanted vegetation (Cornish and Burgin, 2005).



Implementation of vegetation components of the TSP would include restoration of approximately 27 acres of various native plant communities within the Harlem River, East River, and Western Long Island Sound Planning Region. Restoration of these communities likely would cause a qualitative improvement of their biodiversity and ecological services (Rey-Benayas et al., 2009; Duffy, 2009). The resilience of the Bronx River and Flushing Creek ecosystem would be enhanced due to an increase in regulating ecological services, which can attenuate the impact of shocks on ecosystems. The reduction or elimination of nonnative plant species would enhance native biodiversity and ecological community functioning, and the created or restored habitats would provide for an increased diversity of plant species, in part by exporting native seed to nearby habitats. Likewise, increasing the size of habitat patches would promote higher levels of biodiversity (Gilbert-Norton et al., 2010; Damschen and Brudvig, 2012; Beninde et al., 2015).

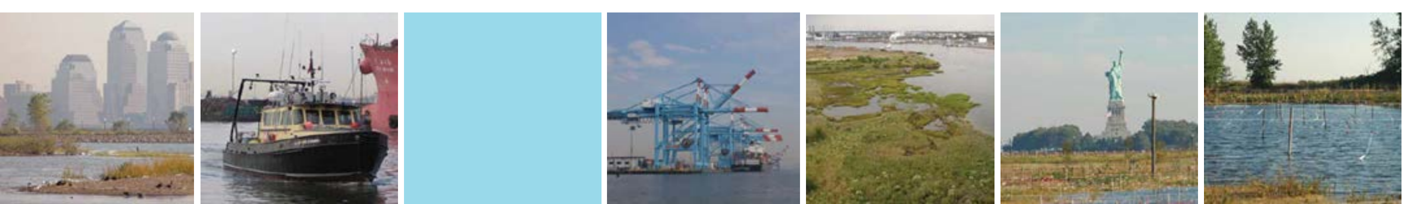
Bed restoration and channel modification, by restoring river and stream channels, pools, and riffles, would help reestablish beneficial flow regimes, which may inhibit further expansion and colonization of the invasive vegetation and may allow the establishment of native aquatic vegetation. Restoration of oyster beds would provide water filtration and an attendant reduction in turbidity (Coen et al., 2007), which would provide long-term benefits to aquatic macrophytes.

Restoration Sites	Potential Environmental Consequences*
All Sites	• During construction, minor, short-term disturbance of existing terrestrial and/or aquatic vegetation. • BMPs employed to limit vegetation disturbance, minimize erosion and sedimentation, and/or control stormwater runoff.
All Sites (except Flushing Creek)	• Negligible, long-term removal of existing terrestrial and/or aquatic vegetation, and disruption of associated ecosystem services.
All Sites (except Soundview Park)	• Long-term improvement of terrestrial vegetation community biodiversity and associated ecosystem services.
Soundview Park	• Long-term benefit to aquatic vegetation through water filtration and turbidity reduction.

5.4.4 Finfish

Under the no action alternative, continued loss or degradation of fish habitats and nursery grounds is anticipated. Fisheries resources would continue to be limited in species diversity and abundance due to poor water quality at the Flushing Creek estuarine habitat restoration site. Without action, the freshwater riverine restoration sites along the Bronx River would continue to lack healthful breeding and nursery grounds for fish due to poor water quality issues and unnatural riverine flows. The need to modify impoundments to improve water flow and fish passage along the river is recognized but unlikely to occur in the absence of federal action because of budget constraints on the county and state levels.

Under the TSP, construction associated with in-water and shoreline restoration would result in short-term, negative impacts to fish. BMPs would be employed to reduce runoff and minimize sediment transport in open water areas. Fish may be displaced due to noise, changes in currents or stream flow, and changes in water quality, including increases in turbidity from onshore construction activities and dredging. Suspension or resuspension of sediments or other materials may be injurious to fish, provide

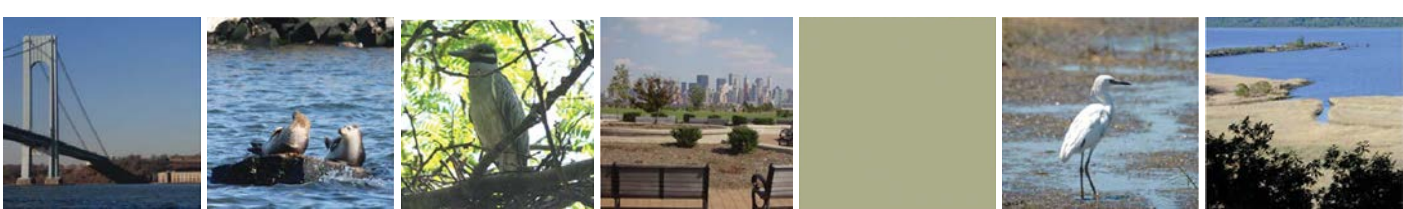


less suitable nursery habitats, or reduce hatching success and larvae development (Auld and Schubel, 1978; Wilber and Clarke, 2001; Bilkovic, 2011). Reduced water clarity can also affect fish by interfering with their ability to feed or by changing the composition of prey species (Newcombe and MacDonald, 1991). Short-term, negative impacts to fish and fish populations also would occur if construction activities deterred fish from using essential migratory pathways, breeding, foraging, or seeking shelter from predators. However, under the TSP, construction effects would have only short-term, localized influence and fish would return to the area shortly after the cessation of construction activities. These short-term, adverse effects would be outweighed by substantive long-term benefits.

In the long term, wetland habitat restoration in and along the Bronx River and along Flushing Creek would directly benefit multiple life stages of resident, transient, and migratory fish species, by providing forage, spawning, nursery, and refuge habitat. Bed restoration and channel modification, by restoring river and stream channels, pools, and riffles, would help reestablish beneficial flow regimes, which would also contribute to improved habitat for fish (Dibble and Meyerson, 2012). Shoreline stabilization would reduce long-term turbidity levels by reducing shoreline erosion.

In the Bronx River, installing fish ladders and modifying weirs for fish passage would enhance the connectivity of the waterway and enable fish migration. Oyster restoration would provide beneficial fish habitat (Grabowski and Peterson, 2007; Peterson et al., 2003; Scyphers et al., 2011). Additionally, establishment of oyster reefs would provide water filtration and an attendant reduction in turbidity (Coen et al., 2007) and larval, juvenile, and adult oysters would provide a prey resource for many fish species, which would provide long-term benefits to fish.

Restoration Sites	Potential Environmental Consequences*
All Sites	• Negligible, short-term, local adverse effect to managed and associated species. • BMPs employed to limit vegetation disturbance, minimize erosion and sedimentation, and/or control stormwater runoff. • Long-term positive impacts to fish from improved water quality and provision of forage, spawning, nursery, and refuge habitat. • On balance, long-term benefits to managed and associated species.
All Sites (except Soundview Park)	• During construction, negligible, short-term local displacement of fish due to noise and water quality deterioration, including increased turbidity.
All Sites (except Flushing Creek and Soundview Park)	• During construction, minor, short-term local displacement of fish from dredging, bed restoration, channel modification, changes in currents or stream flow, and installation of instream structures.
Soundview Park	• During construction, negligible, short-term local displacement of fish due to offshore placing spat on shell and installing wire cages/gabions. • Negligible, short-term, local negative impacts to fish from water quality deterioration, including increased turbidity. • Long-term positive impacts to fish from provision of a prey resource.



5.4.5 Essential Fish Habitat

Under the no action alternative, continued loss of essential fish habitat is anticipated due to sediment suspension from shoreline erosion and stormwater runoff, and anthropogenic inputs, such as landfill leachate and illegal dumping. Continued compromised water quality at the Flushing Creek estuarine restoration site, the freshwater riverine restoration sites along the Bronx River, and the oyster restoration site at Soundview Park would continue to degrade breeding and nursery grounds for fish.

With respect to EFH (Appendix F), construction activities under the TSP would employ BMPs to reduce construction impacts. Although BMPs would be employed to minimize sediment transport in open water areas, a minor increase in turbidity and sedimentation could be generated by the proposed construction activities. If eggs and larvae are present during construction, they could be affected. During the construction period, adult and juvenile fish would leave the area of construction and move to nearby suitable locations outside the area of disturbance. Also, for a short period of time after construction, there would be a reduction in benthic organisms immediately adjacent to the in-water construction footprint; however, this area would be recolonized quickly. All adverse impacts on managed species, associated species, and EFH are expected to be temporary and localized. Implementation of the TSP may adversely affect EFH, but likely would result in minimal adverse effects on EFH, as the resulting changes to EFH and its ecological functions would be relatively small and insignificant. On balance, however, it is anticipated that ecosystem restoration would result in long-term, net benefits to managed species (all life stages), associated species, and EFH. Moreover, removal of barriers to fish passage, through installing fish ladders and modifying weirs, would increase the habitat available to diadromous fish that use the Bronx River. Agency consultation for federally listed threatened and endangered marine species is discussed in Section 5.4.8.

Restoration Sites	Potential Environmental Consequences*
All Sites	• Negligible, short-term, local adverse effect to EFH. • BMPs employed to limit vegetation disturbance, minimize erosion and sedimentation, and/or control stormwater runoff. • Long-term positive impacts to fish from improved water quality and provision of forage, spawning, nursery, and refuge habitat. • On balance, long-term benefits to EFH.

5.4.6 Shellfish and Benthic Resources

Under the no action alternative, shellfish and benthic habitat would continue to be poor quality, supporting a low-diversity of species. The freshwater riverine restoration sites along the Bronx River would continue to suffer from poor water quality and impacts from sedimentation from shoreline erosion and stormwater runoff. Anthropogenic inputs to Flushing Bay would further degrade benthic habitat if estuarine habitat restoration does not occur, and communities would continue to be dominated by pollution-tolerant species. Although preliminary oyster restoration at Soundview Park is already happening, opportunities to further expand oyster habitat and populations would be missed.

In general, habitat for benthic invertebrates would improve under the TSP. Restoration of freshwater riverine habitat along the Bronx River would reduce transport and deposition of sediment, stabilizing habitat for benthic invertebrates. Estuarine habitat restoration in Flushing Creek would create beneficial marsh habitat and improve sediment and water quality.

Permanent loss of specific invertebrate populations and replacement with others would result from habitat changes such as the replacement of soft mud with a sand cap or a sand bottom with an oyster reef. However, adverse impacts to benthic organisms would be limited and short-term due to limited existing species diversity and pollution tolerant composition.

Onshore construction activities and dredging and dredged material deposition could cause short-term release or resuspension of sediments in the Bronx River and Flushing Creek, and a concomitant short-term increase in turbidity. This increase in turbidity and resuspension of sediments could have a short-term, negative impact on shellfish (Wilber and Clarke, 2001; Knott et al., 2009) and micro invertebrates. However, where benthic habitats suitable for shellfish are created or restored, and where existing shellfish habitat is not substantively changed or is restored, recovery of shellfish populations to levels that occurred prior to construction is expected to occur relatively rapidly. Additionally, BMPs would be employed to reduce runoff and minimize sediment transport in open water areas.

Wetlands restoration would improve long-term water quality in the river and creek and, therefore, would provide enhanced environments for benthic invertebrates. Bed restoration and channel modification, by restoring river and stream channels, pools, and riffles, would help reestablish beneficial flow regimes, which likewise would contribute to improved habitat for shellfish (Portnoy and Allen, 2006). Also in the long term, oyster restoration would provide suitable habitat for other shellfish species (Steimle and Zetlin, 2000; Peterson et al., 2003; Scyphers et al., 2011).

Restoration Sites	Potential Environmental Consequences*
All Sites	• Negligible, short-term, local negative impacts to shellfish from water quality deterioration, including increased turbidity. • BMPs employed to minimize erosion and sedimentation, and/or control stormwater runoff. • Long-term positive impacts to shellfish from improved water quality and habitat restoration.
All Sites (except Flushing Creek)	• During construction, minor, short-term negative impacts from shellfish mortality in areas undergoing aquatic habitat conversion or restoration, or due to offshore placing spat on shell and installing wire cages/gabions (Soundview Park), typically with rapid recovery expected.

5.4.7 Wildlife

Under the no action alternative, there would be further loss or degradation of existing terrestrial, wetland, and aquatic faunal communities, due to continued habitat degradation and anthropogenic disturbances. The already sparse wetlands at the Flushing Creek estuarine habitat restoration site would continue to degrade and be lost to mud flats and invasive species, limiting habitat for waterfowl and wading birds. Without action, habitat along the Bronx River freshwater riverine habitat restoration sites would continue to support wildlife species commonly found in urban habitats, but the continued degradation of wetlands and water quality may reduce their abundance.

Under the TSP, construction associated with estuarine habitat and freshwater riverine restoration would result in both adverse and beneficial effects on mammals. Short-term impacts from construction include species displacement and the potential for species mortality. Displaced animals may be more vulnerable to predation and other threats. Muskrats and other small mammal species that are

associated with surface waters, wetlands or riverine habitats could be displaced to nearby comparable habitats but dens, nesting areas and individuals may be harmed or destroyed during construction activities. Construction associated with small-scale oyster restoration at Soundview Park would not impact terrestrial wildlife, as restoration would occur from the water. However, construction activities may result in mortality among sessile and less mobile aquatic fauna. Some wildlife may be displaced temporarily, but eventually would populate or return to using the restored habitats. No population-level effects are expected.

Some negative short-term impact on bird species that utilize scrub uplands or marsh may result from operation of construction equipment. The MBTA requires a restriction on shrub and tree removal during construction activities to protect bird species that may potentially nest within the project areas. In order to comply with the MBTA, trees and shrubs would be cleared outside of a March 15 through July 31 (NJDEP, 2006) window to avoid adverse impacts to the listed species that are covered under this act.

Reptiles and amphibians resident to the project sites and in the immediate vicinity will be susceptible to the same kinds of disturbance factors as previously described for mammals, birds and fish. However, many reptile and amphibian species are much less capable of disbursing quickly, or to distances that remove them to habitats unaffected by project activities. Many will simply try and hide. Thus, the threat of direct adverse impacts due to active construction may be greater to reptile and amphibian species initially inhabiting or utilizing the project site. However, once the restoration has been completed, the new, restored or enhanced habitats will have a long-term beneficial impact on reptiles and amphibians that could result in measureable differences in the size and distribution of reptile and amphibian populations.

In the long term, restoration that involves habitat alteration would create conditions more favorable for certain wildlife groups and species, and uninhabitable or more challenging to others. Potential long-term impacts include changes to habitat type and disturbances associated with increased public access. These impacts are likely to be offset by increases in habitat, as well as habitat enhancement. Overall, restored habitats would be higher in quality and function than the existing habitats they replace. For a myriad of wildlife, created or restored habitats would provide refugia—i.e., habitats that, under changing environmental conditions, the wildlife retreat to, persist in, and potentially can expand from (Askins and Philbrick, 1987; Keppel et al., 2012; Soga et al., 2014). In particular, restoring aquatic, wetland, and upland habitats by removing invasive vegetation, planting native vegetation, and improving hydrology and connectivity would benefit wildlife. With the growth and maturation of restored habitats, wildlife communities of greater diversity and ecological value are anticipated.

Restoration Sites	Potential Environmental Consequences*
All Sites	• During construction, minor, short-term negative impacts from mortality of sessile wildlife in areas undergoing conversion to low marsh (Flushing Creek), offshore placing spat on shell and installing wire cages/gabions (Soundview Park), or habitat conversion or restoration (all freshwater riverine restoration sites). • Negligible, short-term local displacement of mobile wildlife due to habitat alteration, and construction-related noise and human activity, with rapid recovery expected. • BMPs employed to limit vegetation disturbance, minimize erosion and sedimentation, and/or control stormwater runoff. • Long-term positive impacts to wildlife from establishment of higher-quality habitats and refugia.

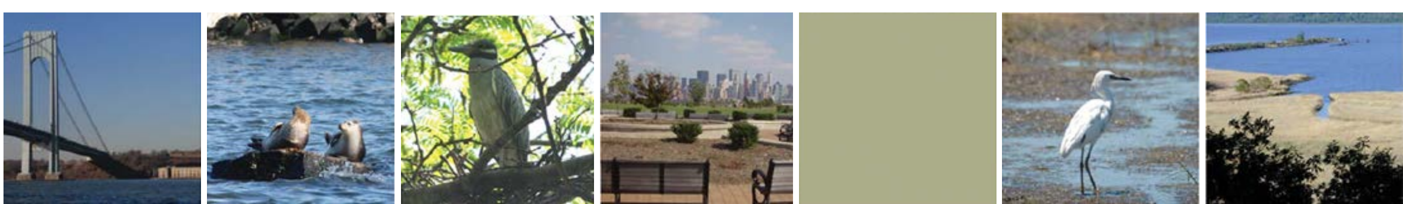
5.4.8 Rare, Threatened, and Endangered Species

Under the no action alternative, further pressure on rare species is anticipated due to displacement by nonnative species and continued loss and degradation of habitats from rising sea levels, erosion, and anthropogenic disturbances. Already sparse wetlands in the Flushing Creek estuarine habitat and Bronx River freshwater riverine habitat sites would continue to degrade and limit the availability of high-ecological value habitats that would support rare, threatened and endangered species in the planning region.

In the short term, construction associated with implementation of the TSP potentially could displace or disturb rare, threatened, and endangered species on or in the vicinity of the restoration sites. Such effects would result from clearing vegetation, changes in currents or stream flow, changes in water quality, including increases in turbidity, and construction-related noise and human activity.

All appropriate federal and state agencies were consulted regarding the documentation of rare, threatened, and endangered species, and species of special concern within the Harlem River, East River and Western Long Island Sound Planning Region project sites and their vicinities (Appendix G). The USFWS and NMFS were contacted regarding federally listed threatened and endangered species under the ESA, while the NYSDEC Division of Fish, Wildlife, and Marine Resources was contacted regarding state listed species in the NYNHP. Numerous endangered, threatened, or rare plant and animal species exist within the boundaries of the bay, and correspondences with the agencies are in Appendix G. Prior to restoration activities, onsite surveys will be conducted at each restoration site to fully assess any potential impacts on biological resources and confirm whether any documented species may be impacted by any restoration activities. If rare, threatened, and endangered species are confirmed at the sites that could be adversely impacted by restoration activities, precautions will be taken to avoid, minimize, or mitigate the impacts as determined by the appropriate agency.

According to NMFS correspondence, the endangered Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) and shortnose sturgeon (*Acipenser brevirostrum*) may be present in the East River and their adjacent bays and tributaries, which could include the Flushing Creek, Soundview Park, and Bronx River restoration sites. Disruptions to marine wildlife are expected to be insignificant and short-term during construction, and BMPs would be employed to minimize impacts from suspended sediments. If



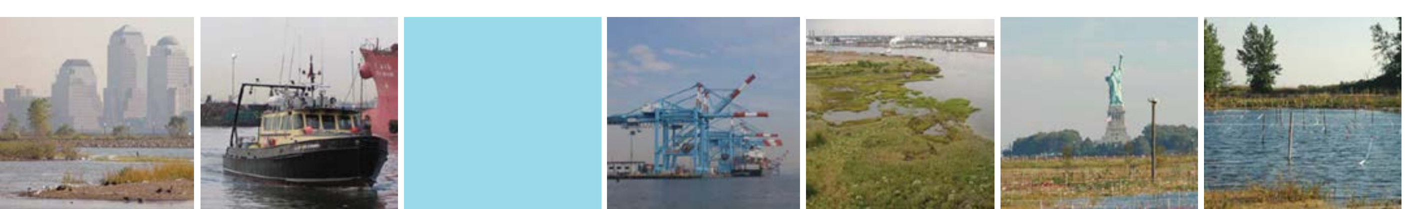
construction activities are determined to make the water habitat unsuitable for wildlife, the use of timing restrictions or noise attenuating tools will be implemented.

The NYSDEC does not have any recent records of rare or state-listed bird species on or within one-half mile of potential restoration sites, although historical records exist for the dragonfly Arrowhead Spiketail (*Cordulegaster obliqua)* at Bronx River Park and the Bronx Zoo. Historic records also exist for vascular plants at the Bronxville Lake, Crestwood Lake, Bronx River Park, Garth Woods/Harney Road, and Bronx Zoo restoration sites. The USFWS documented the threatened seabeach amaranth (*Amaranthus pumilus)* as potentially affected by construction the Flushing Creek restoration site. Prior to construction activities, restoration sites will be surveyed for the existence of rare or state-listed plants. If found, measures will be taken to avoid disturbance, such as fencing and signage placed around the plants.

The USFWS identified the threatened Piping Plover (*Charadrius melodus*) as potentially occurring along the Bronx River where site restoration may take place. The USFWS also identified the endangered Roseate Tern (*Sterna dougallii*) and the threatened Red Knot (*Caliris canutus rufa)* and Piping Plover as bird species that could potentially be affected by construction activities at the Flushing Creek site. As most these species are highly mobile and capable of avoiding construction activities, disturbance would be short-term and localized. For some species, such as the Piping Plover, construction buffers and/or timing restrictions would be employed during nesting season, which typically occurs between March and August.

As the restoration goals include creating, restoring, and protecting wildlife habitat, impacts to rare, threatened, and endangered species are expected to be short-term and insignificant. In the long term, implementation of the TSP would benefit rare, threatened, and endangered species by increasing favorable habitat and improving the quality of existing habitat.

Restoration Sites	Potential Environmental Consequences*
All Sites	• No long-term negative impacts to protected species. • Long-term positive impacts to rare, threatened, or endangered species from habitat and ecosystem restoration. • Potential impact to Atlantic and shortnose sturgeon would be avoided by sediment control and timing restrictions as necessary.
River Park/West Farm Rapids Park and Bronx Zoo and Dam	• Historic records for protected insect may need survey confirmation prior to construction and disturbance avoidance measures during construction.
River Park/West Farm Rapids Park Bronx Zoo and Dam Bronxville Lake Crestwood Lake Garth Woods/Harney Road	• Historic records for protected plant species may need survey confirmation prior to construction and disturbance avoidance measures during construction.



Restoration Sites	Potential Environmental Consequences*
Flushing Creek	• Potential impacts of seabeach amaranth plant would be avoided by monitoring and protection using fencing and signage. • Potential short-term disturbance to federally listed birds. Construction buffers and/or timing restrictions utilized if present during nesting season.
Bronx River	• Potential short-term disturbance to Piping Plover. Construction buffers and/or timing restrictions utilized if present during nesting season.

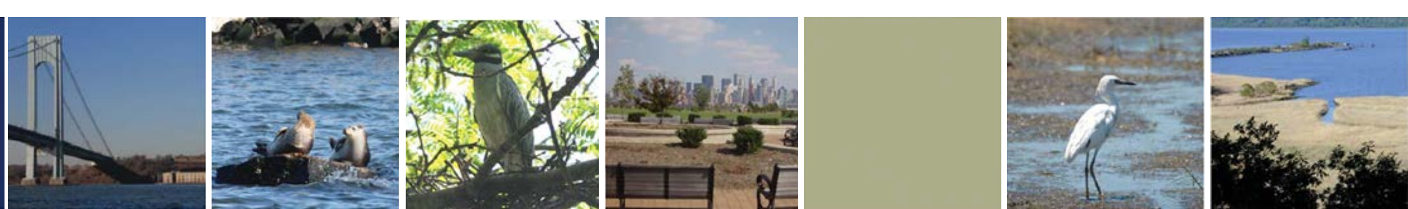
5.4.9 Land Use

In the no action alternative, land use changes are expected to be minimal. The location of the Fresh Creek estuarine habitat restoration site is currently undeveloped and would be expected to remain undeveloped without federal action. The Soundview Park oyster restoration site is over shallow open water and would remain as such under the no action alternative. Both Westchester County and Bronx County are subject to long-range plans that call for reclamation of waterfront, redevelopment of urban neighborhoods, strengthening of transportation corridors, and protection of open space. If these plans were to be fully implemented, current land use patterns at the freshwater riverine restoration sites would not change by very much in terms of losing open space to development. The open space areas of the Bronx Zoo, New York Botanical Gardens and other parks and recreation areas along the Bronx River corridor would remain as this land use type over the period of analysis and is unlikely to change as they are protected from development by state law.

The proposed estuarine habitat and freshwater riverine restoration sites are all on existing parkland or open space owned by various public agencies. No permanent housing exists on these sites. Implementation of the TSP at each site would not change the existing land use of the site. The sites would remain in the same ownership with public access remaining similar to, or better than, existing conditions.

During construction activities at the Bronx River freshwater riverine restoration sites, short-term public access restriction may occur but would be of short duration. Oyster restoration activities at Soundview Park may create short-term limitations to recreational boat traffic to minimize the agitation of the water, to allow the suspended sediments to settle, and to avoid accidents. These impacts would be minimal, of short durations and likely not affect commercial boat traffic in the navigation channel.

Restoration Sites	Potential Environmental Consequences*
All Sites	• Implementation of the TSP at each site would not change the existing land use of the site.
All freshwater riverine restoration sites	• Short-term restrictions to public access at park locations along the Bronx River.
Soundview Park	• Short-term limitations to recreational boat traffic during construction activities.



5.4.10 Hazardous, Toxic, and Radioactive Waste

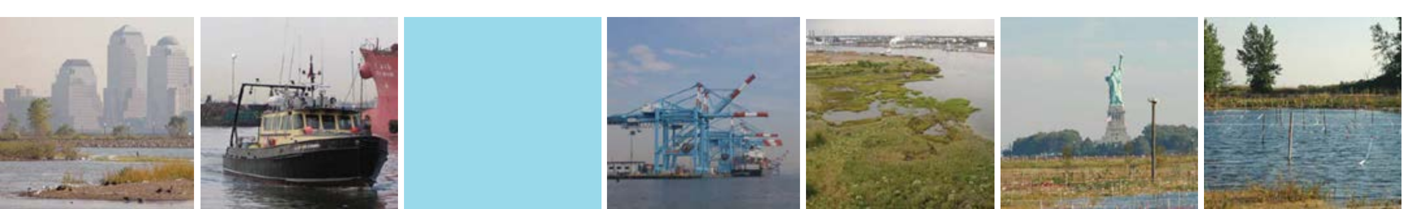
It is anticipated that, under the no action alternative, there would be continued or worsening degradation of water quality in the Harlem River, East River, and Western Long Island Sound Planning Region, due to shoreline erosion, stormwater runoff, and anthropogenic inputs, such as landfill leachate and illegal dumping. Some local efforts would reduce direct inputs into the Bronx River and Flushing Creek. Improvements to CSO volume discharges to the Bronx River were completed by the NYCDEP in 2009, but no further improvements are planned. The NYCDEP Interim Floatable Containment Program is expected to continue to remove floatable debris from the Bronx River to prevent its discharge into the East River and Long Island Sound. Municipal programs that reduce pollution from stormwater discharge would continue to be developed and upheld. Improvements to stormwater and CSO inputs to Flushing Creek would continue per NYCDEP Long Term Control Plan, but without structural measures to improve water quality, such as dredging, the future degradation of bay and creek sediments would persist.

Under the TSP, habitat restoration and associated construction activities would cause short-term release or resuspension of sediments and a concomitant short-term increase in turbidity, in nearby waters in the Bronx River and Flushing Creek. BMPs would be employed to reduce erosion, turbidity and sedimentation. Removal of sediments during channel dredging, modification or realignment activities may require investigation and special handling and disposal if contaminated sediment is present. Phase I environmental investigations at potential Flushing Creek restoration sites found metal contamination that would require special disposal of sediment.

In the long term, creating or restoring wetlands and maritime forest, armoring and stabilizing shorelines, and establishing oyster habitat would improve water quality and provide nutrient removal and denitrification services. The restored habitats would reduce long-term turbidity by filtering and retaining stormwater runoff, providing storm surge and flood buffering, attenuating waves, and thereby reducing shoreline erosion. Improved tidal flushing and reduced water residency time, due to creating or restoring tidal channels and basins, would increase dissolved oxygen levels and reduce fecal coliform levels (Portnoy and Allen, 2006). Restored wetlands likewise would improve tidal flushing and increase dissolved oxygen levels. Groundwater resources may also benefit from restored wetlands, as wetlands filter pollutants moving between surface water and groundwater.

Oyster beds established under the TSP would reduce turbidity, by mitigating shoreline erosion and filtering suspended solids and phytoplankton (Meyer et al., 1997; Coen et al., 2007; Scyphers et al., 2011). The resulting reduction in turbidity under the TSP would provide long-term habitat enhancement for shellfish and fish communities, and aquatic vegetation (Cahoon et al., 1999; Paul and Meyer, 2001; Steinberg et al., 2004).

Restoration Sites	Potential Environmental Consequences*
All Sites	• Safeguards employed to prevent and respond to spills. • Long-term surface water quality improvements—i.e., decreased turbidity, nutrient removal, and denitrification. • BMPs employed to minimize erosion and sedimentation, and control stormwater runoff.



Restoration Sites	Potential Environmental Consequences*
Bronxville Lake Crestwood Lake Westchester County Center River Park/West Farm Rapids Park Muskrat Cove Garth Woods/Harney Road	• Removal of sediments during channel dredging, modification or realignment activities may require investigation and special handling and disposal if contaminated sediment is found.

5.4.11 Air Quality

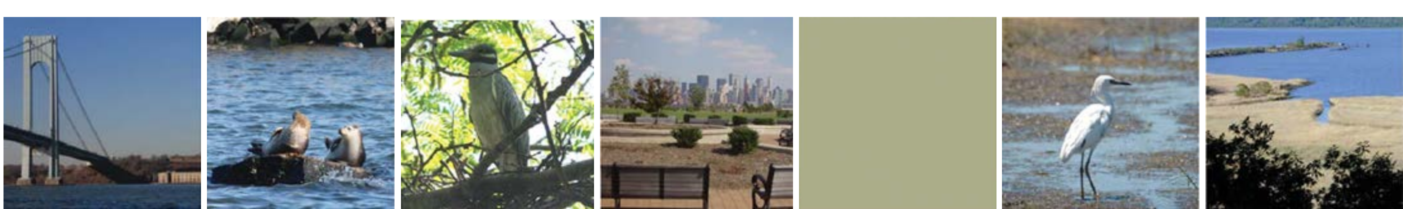
No long-term impacts to air quality are expected from implementing the no action alternative. Population growth and increased use of roadways in the region may cause minor reductions in future air quality, however these may also be offset by more stringent emissions standards and technological improvements moving forward.

In the short term, implementation of the TSP would contribute to emissions during construction from the combustion of fossil fuels. The major sources of greenhouse gas emissions would be construction activities and equipment used at each restoration site. To minimize the impact of increased greenhouse gas emissions, applicable BMPs, such as turning off machines when not working and using low sulfur fuels, would be utilized.

In the long term, under the TSP, improvements to the environment potentially would stimulate the local economy by increasing activities such as fishing, hiking, boating, and bird watching, and tourism in general. In turn, these increased activities would result in very minor increases in travel-related vehicular and boat engine emissions, and contributions to air pollution.

Although a short-term increase in greenhouse gases may result from the initial removal of vegetation, this will be offset by benefits from replanting native vegetation. Beneficial impacts are likely to result from implementing measures that involve restoration of terrestrial and aquatic plant communities. Restoration of these communities would promote primary productivity and increase removal of carbon dioxide, a major greenhouse gas, from the atmosphere. The creation of vegetated habitats under the TSP would reduce or offset the emission of carbon dioxide. The increase of cover from created forest and shrub communities could alter local biophysical and biochemical processes, which in turn would minimally impact air quality. Wetland creation, and afforestation or reforestation in urban areas could lead to increased sequestration of atmospheric carbon.

Restoration Sites	Potential Environmental Consequences*
All Sites	• During construction, negligible, short-term contribution to air pollution, primarily from the operation of construction equipment and vehicles. • BMPs employed to minimize emissions. • Long-term air pollution mitigation through the removal of carbon dioxide from the atmosphere.



5.4.12 Noise

Under the no action alternative, restoration would not take place and short-term, temporary increases in ambient noise levels due to construction activities would not occur. Population growth and increased use of railways and roadways in the region may cause noise levels to rise in the future.

Heavy equipment used during construction may contribute to short-term increase in noise levels. However, noise levels would not exceed those cited in local ordinances and would occur only during normal daytime working hours. In the long term, sites with forested and scrub/shrub wetland restoration, such as Bronxville Lake and Garth Woods/Harney Road, mature trees may even create a natural buffer to reduce ambient noise levels.

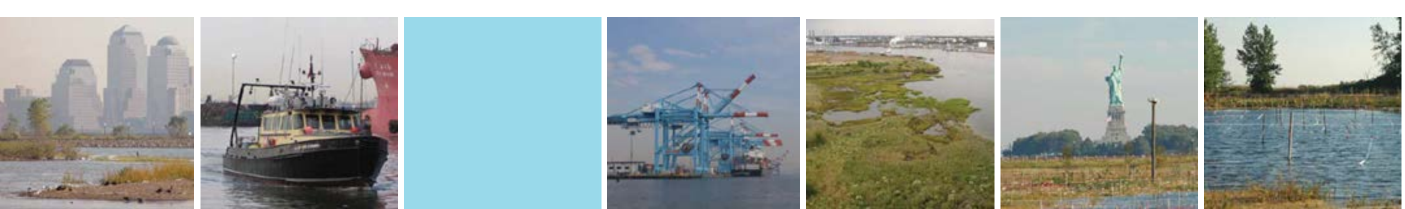
Restoration Sites	Potential Environmental Consequences*
All Sites	• Short-term increases in noise levels from construction equipment will occur during normal daytime working hours. • Implementation of the TSP at each site would not cause any negative long-term noise impacts.
Bronxville Lake Garth Woods/Harney Road	• Long-term potential to reduce ambient noise from mature trees in forested and scrub/shrub wetlands.

5.4.13 Social and Economic Resources

Under the no action alternative, no change to the social and economic resources would occur from short-term job opportunities. The degraded condition of the Harlem River, East River, and Western Long Island Sound ecosystem is anticipated to continue into the future, decreasing public access and recreational opportunities in the planning region, and potentially adversely affecting social and economic resources.

Restoration under the TSP would result in both short- and long-term social and economic benefits for the regional economy. Construction activities would generate jobs, and it is assumed that the majority of the workforce would be from the local area. In the short term, this employment would contribute to local earnings, induced spending for goods and services, and tax revenues. Implementing the TSP would give local community groups and educational institutions opportunities to participate in the restoration efforts, providing valuable educational experiences that would bolster environmental education. No permanent or long-lasting economic effects are anticipated as a result of temporary construction activities.

At the scale of the HRE study area, improvements to the environment, notably cleaner water and greater abundance and diversity of desirable terrestrial wildlife, fish, and vegetation, potentially would stimulate the local economy by increasing activities such as fishing, hiking, boating, and bird watching, and tourism in general. Improved quality of life would strengthen the desirability of living in the region and maintain, if not increase, property values. Increased shoreline stabilization and stormwater management along the Bronx River may reduce municipal expenditures, including those for emergency services. Ongoing restoration and monitoring activities would give local community groups and educational institutions opportunities to participate, providing valuable educational experiences.



Restoration Sites	Potential Environmental Consequences*
All Sites	• Combined total first cost of approximately $107,040,000. • During construction, minor, short-term increases in local employment, earnings, induced spending, and tax revenues, and provision of educational opportunities. • Long-term stimulation of the local economy and provision of educational opportunities.

5.4.14 Navigation

A 2.5-mile federal navigation channel on the lower Bronx River, from its confluence with the East River to East 172nd Street, is used frequently by commercial barges. Although not the primary purpose of the ecosystem restoration effort, a need for safe and reliable navigation channels on the Bronx River still exists. In the no action alternative, federal navigation channels in Flushing Creek, the East River, and the tidal Bronx River would be unchanged and maintained as needed. Upper portions of the Bronx River would continue to have obstacles to canoe and kayak navigation, requiring portage over and around man-made dams and weirs. While the Bronx River Intermunicipal Watershed Management Plan indicates that impoundments should be removed or modified to improve water flow, based on the current priorities of the county and state resources, there is no expectation that these impoundments would be modified in the absence of federal action.

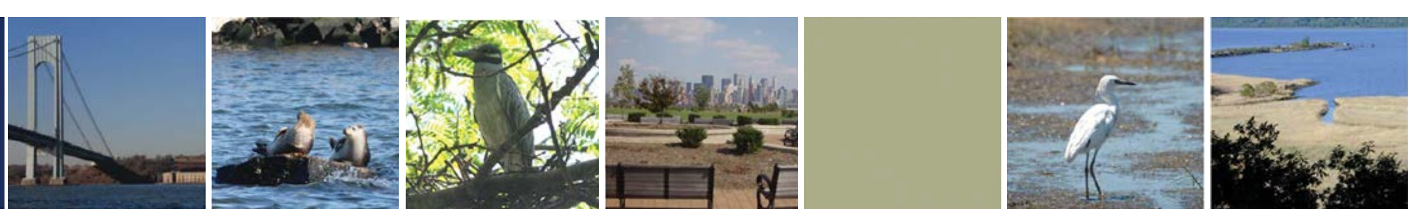
Short-term restrictions of small craft use in portions of the Bronx River during construction may occur but would be limited in duration. Oyster restoration activities at Soundview Park may create short-term limitations to the local boat traffic to minimize the agitation of the water, to allow the suspended sediments to settle, and to avoid accidents. These would be minimal, of short durations and is not expected to affect the navigation channel where major boat traffic is likely to occur.

Implementation of the TSP would not be contrary in the long term to navigation or create possible obstructions to navigation. Restoration efforts may even serve to benefit future navigation maintenance by reducing future operations costs. Channel dredging and modifications for fish passage may improve ease and safety of boat navigation, and public access for small craft would be improved in some Bronx River restoration sites.

Restoration Sites	Potential Environmental Consequences*
All Sites	• Minimal, short-term limitations to local boat craft during construction activities. • No adverse long-term impacts from implementation of the TSP.
All Freshwater Riverine Restoration Sites (Bronx River)	• Potential long-term positive improvements to small craft access and navigation.

5.4.15 Recreation

Under the no action alternative erosion, estuarine and freshwater riverine habitat restoration would not occur, decreasing public access and recreational opportunities in the planning region. Public access improvements would not occur at any freshwater riverine restoration sites. Upper portions of the Bronx



River would continue to have obstacles to canoe and kayak navigation, requiring portage over and around man-made dams and weirs and limiting small craft use on the river.

Under the TSP, access to recreational resources may be negatively affected temporarily, during construction. At sites which currently offer public access for recreational use, there may be adverse temporary impacts during construction due to the closing of the interior footpaths. However, construction would be phased to occur during the colder winter months when the paths are not as heavily utilized.

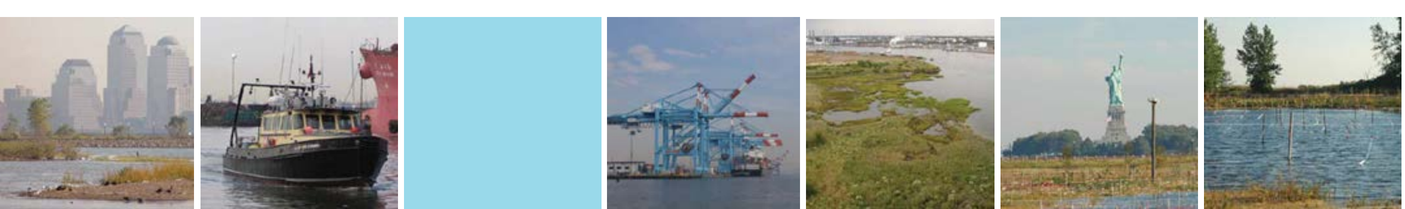
After the TSP is implemented, positive impacts to the recreational and educational features of the sites would be realized. Within the freshwater riverine habitat restoration sites, five (5) of the nine (9) sites are recommended for improvements to public access. In addition to public access improvements, estuarine and freshwater riverine habitat restoration would provide improvements to the environment, notably cleaner water and greater abundance and diversity of desirable terrestrial wildlife, fish, and vegetation, which potentially would increase activities such as fishing, hiking, boating, and bird watching. Additionally, oyster habitat restoration is proposed at the mouth of the Bronx River which would provide shoreline stabilization, habitat, and water quality improvements that would ultimately benefit the health of the Bronx River and increase overall recreational value and educational opportunities.

Restoration Sites	Potential Environmental Consequences*
All Sites	• Minor, short-term negative impacts from limited access to recreational resources during construction. • Long-term improvement in recreational opportunities for wildlife viewing, hiking, recreational fishing, kayaking, and canoeing through habitat improvement.
Bronxville Lake Crestwood Lake Westchester County Center River Park/West Farm Rapids Park Bronx Zoo and Dam	• Long-term benefits from improved public access.
Soundview Park	• Localized water quality improvement. • Long-term improvement in educational and research opportunities.

5.4.16 Cultural Resources

Under the no action alternative, although impacts to cultural resources are expected to be minimal, loss of historic resources due to SLR and erosion could occur.

Enough data does not currently exist to determine the extent of impacts to cultural resources from implementation of the TSP in the Harlem River, East River and Western Long Island Sound Planning Region. A limited number of surveys were completed by USACE in recent years in connection with the HRE study, the Bronx River Basin Ecosystem Restoration Project, and Flushing Creek and Bay Ecosystem Restoration Project:



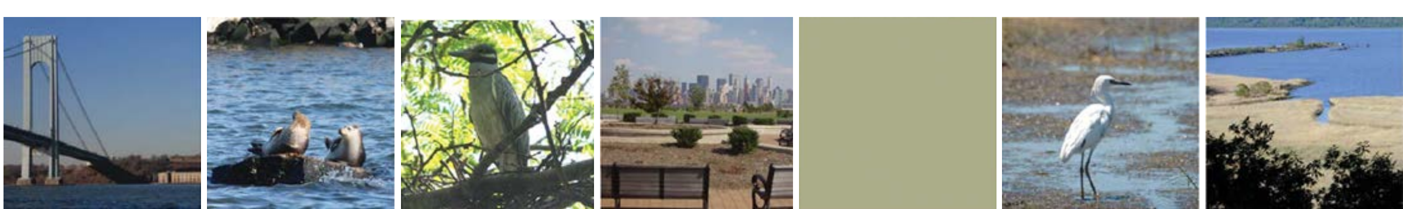
- *Cultural Resources Baseline Study: Flushing Bay Ecosystem Restoration Project, Queens County, New York (Panamerican Consultants, Inc., 2003);*
- *Cultural Resources Phase IA Report, Soundview Park Aquatic Ecosystem Restoration Project, Soundview Park, Bronx County, New York (Davis, 2005);*
- *Cultural Resources Baseline Study, Bronx River Ecosystem Restoration Study, Westchester and Bronx Counties, New York (Atwood et al., 2007); and*
- *Cultural Resources Overview for the Hudson-Raritan Estuary Comprehensive Restoration Plan (Harris et al., 2014).*

Essentially all of the surveys conducted to date were preliminary, consisting mostly of background research, and did not include archaeological testing or architectural survey. In the most recent survey, the Cultural Resources Overview, all existing cultural resources data relevant to the CRPcandidate restoration sites were inventoried (Harris et al., 2014). Approximately 150 historic properties and districts were identified within one (1) mile of the restoration sites in the planning region.

The majority of the restoration sites are located along the Bronx River. The Bronxville Lake, Crestwood Lake, Garth Woods, and Westchester County Center sites are located within the Bronx River Parkway Historic District. The Stone Mill Dam restoration site is located within the historic New York Botanical Gardens. The Westchester County Center, Crestwood Lake and Flushing Creek sites contain archaeological sites within their boundaries. Thirty-three (33) archeological sites were recorded within one (1) mile of the sites. Additionally, the Automated Wreck and Obstruction Information System (AWOIS) database identified four (4) sites within one (1) mile of the Soundview Park oyster restoration site.

Until additional surveys are conducted to determine the presence or absence of cultural resources at the sites, it is not known whether additional resources exist within the TSP project areas. At this time it is assumed that under the TSP, construction activities on the restoration sites have the potential to adversely affect cultural resources if those activities occur in close proximity to the resources. The effects may include disturbance to archaeological sites, alterations to historic properties, and impacts to historic viewsheds.

The USACE drafted two (2) PAs (see Appendix I) that cover the restoration sites within New York State and New Jersey and stipulate the actions the USACE will take with regard to cultural resources as the project proceeds. The draft PAs will ensure that the USACE satisfies its responsibilities under Section 106 of the National Historic Preservation Act and other applicable laws and regulations. The draft PAs were provided to the Advisory Council on Historic Preservation, the NPS Gateway National Recreation Area, the New York City Landmarks Preservation Commission, and Native American Tribes with an expressed interest in the area for their review and participation. In addition, a list of potentially interested parties is currently being developed. The draft PAs are available for public review and will serve as the USACE Section 106 public coordination. The final PAs will incorporate comments received on the draft documents, as appropriate.



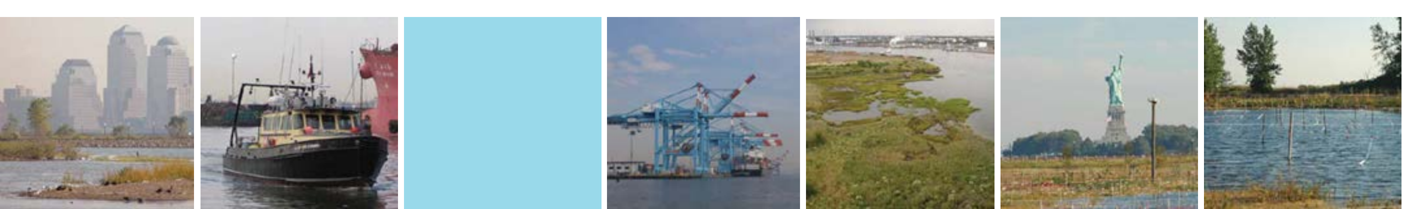
Restoration Sites	Potential Environmental Consequences*
All Sites	• Potential for archaeological sites exists in the study area. • Additional survey is required under the stipulations of the draft PAs to determine whether other resources are present within the project area. • Mitigation would be required for impacts to significant resources.
Flushing Creek	• Three (3) archaeological sites are listed within the site boundaries. • Twenty-two (22) historic properties are listed within one (1) mile of the site.
Bronxville Lake Crestwood Lake Westchester County Center Garth Woods/Harney Road	• Located within the Bronx River Parkway Historic District.
Stone Mill Dam	• Located within the historic New York Botanical Gardens.
Soundview Park	• Four (4) AWOIS sites are recorded within one (1) mile of the site. • Potential for submerged historic resources.

5.4.17 Aesthetics

Under the no action alternative, the degraded condition of the Harlem River, East River, and Western Long Island Sound ecosystem is anticipated to continue, decreasing aesthetic and scenic resource value in the planning region. The expansion of invasive plants at all restoration sites would decrease visual quality. Public access improvements would not occur at any freshwater riverine restoration sites, limiting scenic viewing opportunities.

During construction of the TSP temporary impacts to the aesthetic and scenic resources would occur on site due to the presence of construction equipment, vegetation clearing and the earthwork. However, the sites are overgrown with invasive species and the proposed restoration would replace invasive species with diverse vegetation including native low marsh, high marsh, scrub/shrub wetland, and maritime forest species at the estuarine habitat restoration sites, and native riparian forest vegetation within freshwater riverine habitat restoration sites, thus improving aesthetic and scenic resource value. Additionally, public access improvements would increase opportunities for wildlife and natural landscape observation.

Restoration Sites	Potential Environmental Consequences*
All Sites	• Minor, short-term negative impacts to aesthetic and scenic resources during construction. • Long-term improvement in scenic resource value with vegetation restoration and overall habitat improvement.



Restoration Sites	Potential Environmental Consequences*
Bronxville Lake Crestwood Lake Westchester County Center River Park/West Farm Rapids Park Bronx Zoo and Dam	• Long-term benefits from improved public access.

5.4.18 Coastal Zone Management

Under the no action alternative, no restoration would take place and no impacts to state or local coastal zone management plans would occur.

Restoration activities within the Harlem River, East River and Western Long Island Sound Planning Region were evaluated with respect to their consistency with New York State's *State Coast Policies* and New York City's *The New Waterfront Revitalization Program* and the goals are directly in line with the respective coastal zone policies. The restoration activities are consistent with state and local coastal zone management programs.

Restoration Sites	Potential Environmental Consequences*
All Sites	• Restoration activities are consistent with state and local coastal zone management programs.

5.5 Upper and Lower Bay Planning Regions

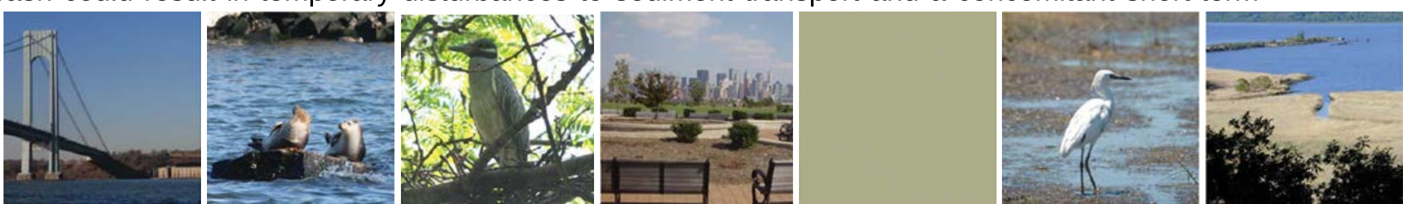
It is anticipated that without restoration there would be a further demise and degradation of existing estuarine habitats within the Upper Bay and Lower Bay, due to continuing natural erosive forces and rising sea levels, and anthropogenic stressors, like urbanization, dredging, compromised water quality, landfilling and landfill leachate intrusions, and illegal dumping.

Implementation of the TSP would restore oyster habitat at two (2) sites in the Upper Bay Planning Region and one (1) site in the Lower Bay Planning Region. Small-scale oyster restoration would be undertaken at Bush Terminal and Governors Island in Upper Bay, where approximately 48 acres of oyster reef habitat would be created, and at Naval Weapons Station Earle in Lower Bay, where approximately 7.6 acres of oyster reef habitat would be created with the placement of gabion blocks and reef balls.

5.5.1 Geomorphology and Sediment Transport

Under the no action alternative, conditions in the Upper Bay and Lower Bay planning regions, with respect to geomorphology and sediment transport, would remain unchanged. Substrates at the Bush Terminal and Governors Island oyster restoration sites would continue to be laden with sediments that reduce available habitat.

During restoration construction under the TSP, sediment resuspension from placing spat on shell, installing reef balls, oyster condos, super trays, and wire cages/gabions, and vessel movements and prop wash could result in temporary disturbances to sediment transport and a concomitant short-term



increase in turbidity in nearby waters in the bay. These activities and their effects would be localized and, generally, short-term. As appropriate, silt curtains may be used to minimize sediment transport, precluding resuspended sediments being transported by currents and forming new shoals.

Oyster restoration could naturally change the local bathymetry as the reefs mature and expand. With increased elevation, established reefs provide long-term, incremental improvements to shoreline stability, by attenuating waves and boat wakes, and retaining sediments, potentially reducing shoreline and bottom erosion, and reducing the sediment load. Shoreline retreat has been reduced by as much as 40 percent by constructed oyster reefs (Scypher et al., 2011). Oyster beds established under the TSP also would reduce turbidity, by mitigating shoreline erosion and filtering suspended solids and phytoplankton (Meyer et al., 1997; Coen et al., 2007; Scyphers et al., 2011). The resulting reduction in turbidity under the TSP would provide long-term habitat enhancement for shellfish, fish communities, and aquatic vegetation (Cahoon et al., 1999; Paul and Meyer, 2001; Steinberg et al., 2004).

Restoration Sites	Potential Environmental Consequences*
Bush Terminal Governors Island Naval Weapons Station Earle	• During construction, negligible, short-term local sediment disturbance and sedimentation and minor, short-term local increase in turbidity from offshore placing spat on shell, installing reef balls, oyster condos, super trays, and wire cages/gabions, and vessel and equipment movement. • BMPs employed to minimize erosion and sedimentation. • Long-term wave and turbidity attenuation, sediment accretion, erosion and sedimentation control, sediment load reduction, shoreline protection, and coastal resiliency improvements.

5.5.2 Water Resources

Under the no action alternative, the Bush Terminal and Governors Island oyster restoration sites in the Upper Bay Planning Region and the Naval Weapons Station Earle oyster restoration site in Lower Bay Planning Region would experience continuing or worsening degradation of hydrologic conditions, depending on the magnitude and effects of SLR and climate change.

The hard structure of oyster reefs, in both intertidal areas and further offshore in deeper subtidal waters, may function to moderate wave climate and potentially reduce shoreline erosion from storm events and vessel wakes. With increased reef elevation, up thrusting reefs can divert and modify surrounding currents (Hargis and Haven, 1999). Large reefs (or series of smaller reefs) can act as natural wave attenuators, protecting nearby shorelines and other aquatic, tidal, and terrestrial habitats. Oyster beds/reefs seaward of salt marshes may enhance/supplement the ability of marshes to stabilize shorelines and moderate wave energy. Within the immediate area of the sites, oyster restoration under the TSP would provide long-term regulation of water flow, storm surge and flood buffering, wave attenuation, and protection of shorelines, per the findings of Woodward and Wui (2001), Zelder and Kercher (2005), Koch et al. (2009), Barbier et al. (2011), Gedan et al. (2011), and Shepard et al. (2011).

Restoration Sites	Potential Environmental Consequences*
Bush Terminal Governors Island Naval Weapon Station Earle	• During construction, negligible, short-term disruption of local wave and current regimes, and hydrology from offshore placing spat on shell, and installing reef balls, oyster condos, super trays, and wire cages/gabions. • BMPs employed to minimize erosion and sedimentation. • Long-term improvements in regulation of water flow, storm surge and flood buffering, and wave attenuation.

5.5.3 Vegetation

It is anticipated that, under the no action alternative, no change would occur with respect to vegetation at the Bush Terminal, Governors Island or Naval Weapon Station Earle oyster restoration sites.

In the short term, construction associated with implementation of the TSP would not remove or disturb existing vegetation. However, placing spat on shell, installing oyster condos, super trays, and wire cages/gabions, and vessel movements and prop wash likely would cause short-term resuspension of sediments and a concomitant short-term increase in turbidity, in nearby waters in the Upper and Lower Bays. In turn, this increase in turbidity could have a short-term, negative impact on aquatic macrophytes (Erftemeijer and Lewis, 2006). BMPs would be employed to minimize suspended sediments in open water areas. There would also be a permanent elimination of any submerged aquatic macrophytes in bay bottom areas targeted for oyster restoration.

Conversely, establishment of oyster reefs would provide water filtration and an attendant reduction in turbidity (Coen et al., 2007), which would provide long-term benefits to aquatic macrophytes (Newell and Koch, 2004. Improved water clarity can increase light penetration, which can increase growth of benthic vegetation (Grabowski and Peterson, 2007).

Restoration Sites	Potential Environmental Consequences*
Bush Terminal Governors Island Naval Weapon Station Earle	• During construction, minor, short-term disturbance of existing aquatic vegetation from offshore placing spat on shell, and installing reef balls, oyster condos, super trays, and wire cages/gabions. • BMPs employed to limit vegetation disturbance, and minimize erosion and sedimentation. • Negligible, long-term removal of existing aquatic vegetation, and disruption of associated ecosystem services. • Long-term benefit to aquatic vegetation through water filtration and turbidity reduction.

5.5.4 Finfish

Under the no action alternative, sedimentation and poor water quality around the Bush Terminal, Governors Island, and Naval Weapons Station Earle oyster restoration sites as would continue to contribute to the decline and lack of diversity of finfish populations.

Under the TSP, construction associated with small-scale oyster restoration would result in short-term, negative impacts to fish. Fish may be displaced due to noise, changes in currents, and changes in

water quality, including increases in turbidity from placing spat on shell, installing reef balls, oyster condos, super trays, and wire cages/gabions, and vessel movements and prop wash. Suspension or resuspension of sediments or other materials may be injurious to fish, provide less suitable nursery habitats, or reduce hatching success and larvae development (Auld and Schubel, 1978; Wilber and Clarke, 2001; Bilkovic, 2011). Reduced water clarity can also affect fish by interfering with their ability to feed or by changing the composition of prey species (Newcombe and MacDonald, 1991). BMPs would be employed to minimize suspended sediments in open water areas. Short-term, negative impacts to fish and fish populations also would occur if construction activities deterred fish from using essential migratory pathways, breeding, foraging, or seeking shelter from predators. However, under the TSP, construction effects would have only short-term, localized influence and fish would return to the area shortly after the cessation of construction activities. These short-term, adverse effects would be outweighed by substantive, long-term benefits.

Oysters are described as a keystone species on the Atlantic coast of the United States (Stanley and Sellers, 1986; Rothschild et al., 1994; USFWS, 2010)—i.e., a species whose presence is vital to the structure of the rest of the associated estuarine community. In the long term, larval, juvenile, and adult oysters would provide a prey resource for many fish species. Establishment of oyster reefs would provide water filtration and an attendant reduction in turbidity (Coen et al., 2007), which would provide long-term benefits to fish. Additionally, oyster establishment and growth creates three-dimensional reefs, providing habitat for large numbers of species, including fish (Kellogg et al., 2013).

Restoration Sites	Potential Environmental Consequences*
Bush Terminal Governors Island Naval Weapons Station Earle	• During construction, negligible, short-term local displacement of fish from placing spat on shell and installing reef balls, oyster condos, super trays, and wire cages/gabions. • Negligible, short-term, local adverse effect to managed and associated species. • BMPs employed to limit vegetation disturbance, and minimize erosion and sedimentation. • Long-term positive impacts to fish from improved water quality, provision of a prey resource, and provision of forage, spawning, nursery, and refuge habitat. • On balance, long-term benefits to managed and associated species.

5.5.5 Essential Fish Habitat

Under the no action alternative, lack of essential fish habitat and nursery grounds would continue around the Bush Terminal, Governors Island, and Naval Weapons Station Earle oyster restoration sites as a result of sedimentation and poor water quality.

With respect to EFH (Appendix F), construction activities under the TSP would employ BMPs to reduce construction impacts. A short-term increase in turbidity and sedimentation would be generated by the proposed construction activities. If eggs and larvae are present during construction, they could be affected. BMPs would be employed to minimize suspended sediments in open water areas. During the construction period, adult and juvenile fish would leave the area of construction and move to nearby suitable locations outside the area of disturbance. Also, for a short period of time after construction, there would be a reduction in benthic organisms immediately adjacent to the in-water construction

footprint; however, this area would be recolonized quickly. All adverse impacts on managed species, associated species, and EFH are expected to be temporary and localized. Implementation of the TSP may result in short-term adverse effects on EFH, but the resulting changes to EFH and its ecological functions would be relatively small and insignificant. On balance, however, it is anticipated that ecosystem restoration would result in long-term, net benefits to managed species (all life stages), associated species, and EFH, as oyster establishment and growth creates three-dimensional reefs which can provide habitat for large numbers of fish (Kellogg et al., 2013). Agency consultation for federally listed threatened and endangered marine species is discussed in Section 5.5.8.

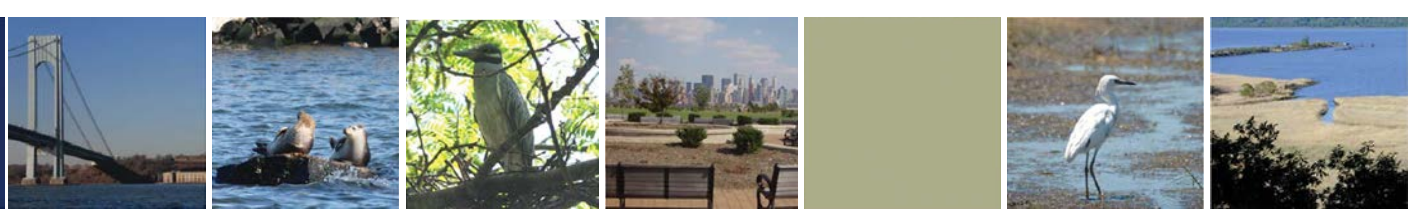
Restoration Sites	Potential Environmental Consequences*
Bush Terminal Governors Island Naval Weapons Station Earle	• During construction, negligible, short-term local displacement of fish from placing spat on shell and installing reef balls, oyster condos, super trays, and wire cages/gabions. • Negligible, short-term, local adverse effect to EFH. • BMPs employed to limit vegetation disturbance, and minimize erosion and sedimentation. • Long-term positive impacts to fish from improved water quality, provision of a prey resource, and provision of forage, spawning, nursery, and refuge habitat. • On balance, long-term benefits to EFH.

5.5.6 Shellfish and Benthic Resources

Under the no action alternative, benthic habitat around the Bush Terminal, Governors Island and Naval Weapon Station Earle oyster restoration sites would continue to degrade due to sedimentation and poor water quality. Oyster populations would remain limited to small, localized communities that are threatened by the continued degradation of the estuary.

Under the TSP, construction associated with small-scale oyster restoration would result in short-term, negative impacts on benthic invertebrates. Mortality of sessile and less motile species is expected on shellfish beds and habitats targeted for placing spat on shell and installing reef balls, oyster condos, super trays, and wire cages/gabions. Establishing these structures, and vessel movements and prop wash, would cause short-term resuspension of sediments in the bay and a concomitant short-term increase in turbidity. Although BMPs would be employed to minimize suspended sediments in open water areas, this increase in turbidity and resuspension of sediments could have a short-term, negative impact on shellfish (Wilber and Clarke, 2001; Knott et al., 2009) and benthic invertebrates. However, where benthic habitats suitable for shellfish are created or restored, and where existing shellfish habitat is not substantively changed or is restored, recovery of shellfish populations to levels that occurred prior to construction is expected to occur relatively rapidly.

In the long term, oyster restoration would provide suitable habitat for other shellfish species (Steimle and Zetlin, 2000; Peterson et al., 2003; Scyphers et al., 2011). Oyster restoration would provide hard-bottom habitat that support more productive and higher density invertebrate communities (Grizzle et al., 2013). Larval, juvenile, and adult oysters also provide a prey resource for invertebrates, including blue and mud crabs (Stanley and Sellers, 1986). Establishment of oyster reefs would provide water filtration and an attendant reduction in turbidity (Coen et al., 2007), which would provide long-term benefits to shellfish. Oyster establishment and growth creates three-dimensional reefs, providing habitat for large numbers of species (Kellogg et al., 2013).



Restoration Sites	Potential Environmental Consequences*
Bush Terminal Governors Island Naval Weapons Station Earle	• During construction, minor, short-term negative impacts from shellfish mortality due to placing spat on shell and installing reef balls, oyster condos, super trays, and wire cages/gabions. • Negligible, short-term, local negative impacts to shellfish from water quality deterioration, including increased turbidity. • BMPs employed to minimize erosion and sedimentation. • Long-term positive impacts to shellfish from improved water quality and establishment of shellfish habitat.

5.5.7 Wildlife

Under the no action alternative, wildlife habitat at the Bush Terminal, Governors Island or Naval Weapons Station Earle oyster restoration sites would remain unchanged.

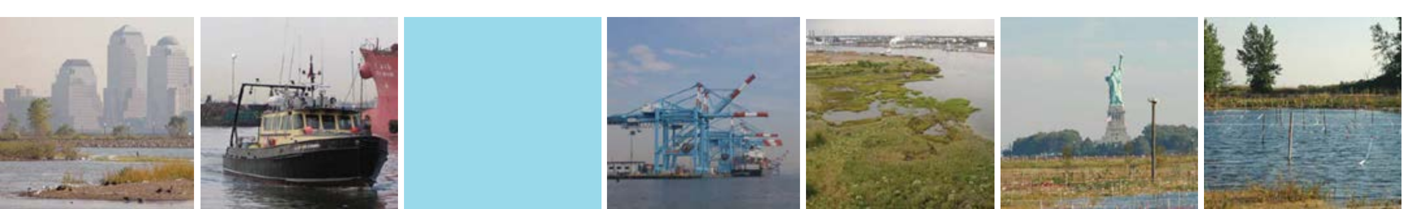
Under the TSP, construction associated with small-scale oyster restoration at Naval Weapons Station Earle, Bush Terminal and Governors Island would not impact terrestrial wildlife, as restoration would occur along the existing piers and bulkheads, or from the water. However, construction activities may result in mortality among sessile and less mobile aquatic fauna. Construction, and construction-related noise and human activity would cause short-term disruption to more mobile wildlife present at the restoration sites. Some aquatic wildlife may be displaced temporarily, but eventually would populate or return to using the restored habitats.

In the long term, oyster restoration would create conditions more favorable for certain aquatic wildlife groups and species, and uninhabitable or more challenging to others. Overall, however, the established oyster reef would be higher in quality and function than the existing habitat it replaces. The reef would provide refugia and, with the growth and maturation of the reef, aquatic wildlife communities of greater diversity and ecological value are anticipated.

Restoration Sites	Potential Environmental Consequences*
Bush Terminal Governors Island Naval Weapons Station Earle	• During construction, minor, short-term negative impacts from mortality of sessile aquatic wildlife due to placing spat on shell and installing reef balls, oyster condos, super trays, and wire cages/gabions. • Negligible, short-term, local negative impacts to mobile aquatic wildlife from construction-related noise and human activity, with rapid recovery expected. • BMPs employed to limit vegetation disturbance, and minimize erosion and sedimentation. • Long-term positive impacts to aquatic wildlife from improved water quality and establishment of oyster habitat.

5.5.8 Rare, Threatened, and Endangered Species

Under the no action alternative, impacts on rare, threatened, and endangered species at the Bush Terminal, Governors Island or Naval Weapons Station Earle restoration sites would remain unchanged.



In the short term, construction associated with implementation of the TSP potentially could displace or disturb rare, threatened, and endangered species on or in the vicinity of the restoration sites. Such effects would result from changes in water quality, including increases in turbidity, and construction-related noise and human activity.

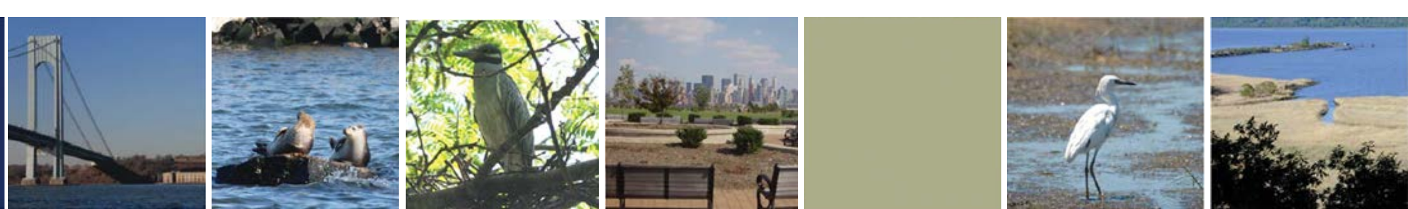
All appropriate federal and state agencies were consulted regarding the documentation of rare, threatened, and endangered species, and species of special concern within the Upper and Lower Bay planning region project sites and their vicinities. The NMFS was contacted regarding federally listed threatened and endangered species under the ESA, while the NYSDEC Division of Fish, Wildlife, and Marine Resources was contacted regarding state listed species in the NYNHP and the NJDEP Division of Parks and Forestry was contacted regarding state listed species in the NJNHP. Correspondences with the agencies are in Appendix G. Prior to restoration activities, onsite surveys will be conducted at each restoration site to fully assess any potential impacts on biological resources and confirm whether any documented species may be impacted by any restoration activities. If rare, threatened, and endangered species are confirmed at the sites that could be adversely impacted by restoration activities, precautions will be taken to avoid, minimize, or mitigate the impacts as determined by the appropriate agency.

According to NMFS correspondence, four (4) different species of protected marine turtles, the endangered Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) and endangered shortnose sturgeon (*Acipenser brevirostrum*) may be present at the Bush Terminal, Governors Island or Naval Weapons Station Earle restoration sites. Disruptions to marine wildlife are expected to be insignificant and short-term during construction, and BMPs would be employed to minimize impacts from suspended sediments. If construction activities are determined to make the water habitat unsuitable for wildlife, the use of timing restrictions or noise attenuating tools will be implemented.

The NYNHP identified the New York state-threatened Common Tern (*Sterna hirundo)* at the Governors Island oyster restoration site in Upper Bay Planning Region. NJNHP has also identified foraging habitat within the Naval Weapons Station Earle project area in Lower Bay for the Common Tern, which in New Jersey only holds special concern status. As construction on the oyster restoration sites would take place on and around piers, and the Common Tern nests on the beach, adverse impacts are unlikely to occur. This species is highly mobile and capable of avoiding construction activities so any disturbance would be short-term and localized.

As the restoration goals include creating, restoring, and protecting wildlife habitat, impacts to rare, threatened, and endangered species are expected to be short-term and insignificant. In the long term, implementation of the TSP would benefit rare, threatened, and endangered species by establishing oyster reefs that would be higher in quality and function than the existing habitats they replace, and providing water filtration, a reduction in turbidity, and a prey resource for wildlife.

Restoration Sites	Potential Environmental Consequences*
All Sites	• No long-term negative impacts to protected species. • Long-term positive impacts to rare, threatened, or endangered species from habitat and ecosystem restoration.
Governors Island	• Minor temporary impact to Common Tern foraging habitat. If temporary disturbance could impact active nest sites, buffers and timing restrictions will be employed as necessary.



Restoration Sites	Potential Environmental Consequences*
Naval Weapons Station Earle	• Insignificant, short-term impacts to sea turtles and sturgeon possible during construction. Sediment controls, noise attenuation, and/or timing restrictions may be utilized.

5.5.9 Land Use

Oyster restoration in the Upper Bay Planning Region will take place at the Bush Terminal and Governors Island sites. Oyster restoration in the Lower Bay Planning Region will take place at the Naval Weapons Station Earle pier owned by the United States Navy. Under the no action alternative, land use at these sites would remain unchanged.

Restoration activities at the oyster restoration sites will take place under or around existing piers and would not alter the current land use of the sites in the long term. In the short term, public access or boat use of the piers may be suspended during construction activities.

Restoration Sites	Potential Environmental Consequences*
Bush Terminal Governors Island Naval Weapons Station Earle	• Implementation of the TSP would not change the existing land use of the sites. • Short-term limitations to recreational boat traffic during construction activities.

5.5.10 Hazardous, Toxic, and Radioactive Waste

It is anticipated that, under the no action alternative, there would be continued or worsening degradation of water quality in the Upper and Lower bays, due to shoreline erosion, stormwater runoff, and anthropogenic inputs, such as landfill leachate and illegal dumping.

Under the TSP, construction activities, vessel movements, and prop wash likely would cause short-term resuspension of sediments and a concomitant short-term increase in turbidity, in nearby waters in the bay. BMPs would be employed to minimize turbidity and sedimentation.

In the long term, establishing oyster habitat would improve water quality and provide nutrient removal and denitrification services. As filter feeders, oysters filter large quantities of seston (organic particulates, including phytoplankton) from the water column. At high densities, oysters can filter large volumes of water, which can modify biogeochemical cycles and improve water quality in the surrounding environment. Filtered seston is digested and utilized for growth and maintenance of the organism, or is deposited by the organism on the sediment surface as feces (Dame and Patten, 1981; Bayne and Newell, 1983; Hadley et al., 2005; Kellogg et al., 2013). This removal and deposition of organic material can act as a buffer against eutrophication by removing nitrogen, carbon, and phosphorous from the water column, and depositing it in the sediment, where it becomes buried. Removal of seston reduces water turbidity, and reduces water concentrations of nitrogen, phosphorous, and organic carbon. Each of these factors is often elevated in waters adjacent to urban areas, such as the HRE. Removal of seston and nutrients from the water column eases the oxygen debt of the water. The organic molecules are digested and deposited, rather than settling to decay, which can cause oxygen debt and, in extreme conditions, anoxia.

Oyster habitat established under the TSP also would reduce turbidity, by mitigating shoreline erosion and filtering suspended solids and phytoplankton (Meyer et al., 1997; Coen et al., 2007; Scyphers et al., 2011). The resulting reduction in turbidity under the TSP would provide long-term habitat enhancement for shellfish and fish communities, and aquatic vegetation (Cahoon et al., 1999; Paul and Meyer, 2001; Steinberg et al., 2004).

Restoration Sites	Potential Environmental Consequences*
Bush Terminal Governors Island Naval Weapons Station Earle	• During construction, minor, short-term local increase in turbidity from offshore placing spat on shell, installing reef balls, oyster condos, super trays, and wire cages/gabions, and vessel movements and prop wash. • BMPs employed to minimize turbidity and sedimentation, and safeguards employed to prevent and respond to spills. • Long-term surface water quality improvements—i.e., increased turbidity reduction, nutrient removal, and denitrification.

5.5.11 Air Quality

No long-term impacts to air quality are expected from implementing the no action alternative. Population growth and increased use of boat traffic in the planning regions may cause minor reductions in future air quality, however these may also be offset by more stringent emissions standards and technological improvements moving forward.

Implementation of the TSP would contribute to emissions during construction from the combustion of fossil fuels from equipment used at each restoration site. To minimize the impact of increased greenhouse gas emissions, applicable BMPs, such as turning off machines when not working and using low sulfur fuels, would be utilized.

In the long term, oyster reefs established under the TSP would contribute to reducing air quality impacts through sequestering carbon, thereby reducing or offsetting the emission of carbon dioxide and other air pollutants. Though oysters are net producers of carbon dioxide through respiration, oysters remove carbon dioxide from the water column by sequestering it into the calcium carbonate shells they secrete as protection. The shells are insoluble and, thus, the aqueous carbon concentration is reduced (Grabowski and Peterson, 2007; Hall et al., 2009; Dehon, 2010; Smith, 2012; USFWS, 2012).

Restoration Sites	Potential Environmental Consequences*
Bush Terminal Governors Island Naval Weapons Station Earle	• During construction, negligible, short-term contribution to pollution, primarily from the operation of construction equipment and vehicles. • BMPs employed to minimize greenhouse gas emissions. • Long-term air quality mitigation through the removal of carbon dioxide from the atmosphere.

5.5.12 Noise

Under the no action alternative, restoration would not take place and short-term, temporary increases in ambient noise levels due to construction activities would not occur. Population growth and increased use of railways and roadways in the region may cause noise levels to rise in the future.

Heavy equipment used during construction may contribute to short-term increase in noise levels. However, noise levels would not exceed those cited in local ordinances and would occur only during normal daytime working hours. No long-term impacts to noise levels are anticipated.

Restoration Sites	Potential Environmental Consequences*
All Sites	• Short-term increases in noise levels from construction equipment will occur during normal daytime working hours. • Implementation of the TSP at each site would not cause any negative long-term noise impacts.

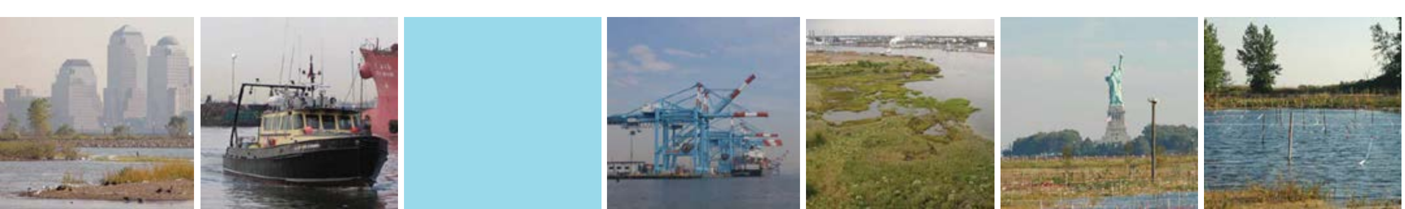
5.5.13 Social and Economic Resources

Under the no action alternative, no change to the social and economic resources would occur from short-term job or educational opportunities. The degraded condition of the Upper and Lower Bay ecosystem is anticipated to continue potentially adversely affecting social and economic resources.

Under the TSP, access to recreational resources may be negatively affected temporarily, during construction. Oyster restoration at Bush Terminal, Governors Island, and Naval Weapons Station Earle would result in both short- and long-term social and economic benefits for the regional economy. Construction activities would generate jobs, and it is assumed that the majority of the workforce would be from the local area. In the short term, this employment would contribute to local earnings, induced spending for goods and services, and tax revenues. Implementing the TSP would give local community groups and educational institutions opportunities to participate in the restoration efforts, providing valuable educational experiences that would bolster environmental education. No permanent or long-lasting economic effects are anticipated as a result of construction.

Improvements to the environment, notably cleaner water and greater abundance and diversity of desirable terrestrial wildlife, fish, and vegetation, potentially would stimulate the local economy by increasing activities such as fishing, hiking, boating, and bird watching, and tourism in general. Improved quality of life would strengthen the desirability of living in the region and maintain, if not increase, property values. Ongoing restoration and monitoring activities would give local community groups and educational institutions opportunities to participate, providing valuable educational experiences.

Restoration Sites	Potential Environmental Consequences*
Bush Terminal Governors Island	• Combined total first cost of approximately $37,830,000. • During construction, minor, short-term increases in local employment, earnings, induced spending, and tax revenues, and provision of educational opportunities. • Negligible, long-term stimulation of the local economy and provision of educational opportunities.
Naval Weapons Station Earle	• Total first cost of approximately $7,420,000. • During construction, minor, short-term increases in local employment, earnings, induced spending, and tax revenues..



5.5.14 Navigation

Under the no action alternative, no restoration will take place and no changes or impacts to navigation would occur.

Construction activities at the Bush Terminal and Governors Island oyster restoration sites may create short-term limitations to the local boat traffic to minimize the agitation of the water, to allow the suspended sediments to settle, and to avoid accidents. Impacts would be minimal, of short durations and likely not affect navigation channels where major boat traffic is likely to occur.

The proposed oyster restoration at the Naval Weapons Station Earle would have no temporary impact on navigation near the project site, as construction activities would be limited to a section of the pier that is closer to land and away from naval ship activities. The presence of naval security and exclusion areas already prevents commercial and recreational boat traffic from navigation near the project site.

Restoration Sites	Potential Environmental Consequences*
Bush Terminal Governors Island	• Short-term limitations to boat traffic during construction activities.
Naval Weapons Station Earle	• Implementation of the TSP would not affect navigation near the project site.

5.5.15 Recreation

Under the no action alternative, construction will not take place and impacts to recreational opportunities would not occur.

The TSP would have very minor temporary construction related impacts on existing recreational resources. At sites which currently offer recreational resources, there may be adverse temporary impacts due to the presence of heavy equipment, however boat activity would not be substantially impacted during construction.

Though no direct improvements to recreational opportunities are proposed, oyster restoration would provide educational and research opportunities and potentially provide opportunities for public awareness and involvement due to easy access from Bush Terminal Park and The Harbor School on Governors Island to the proposed Bush Terminal and Governors Island restoration sites, respectively. The TSP would complement other ongoing oyster restoration work and would benefit students through expanded scientific study opportunities.

Improvements to the environment, particularly cleaner water and greater abundance and diversity of desirable fish, potentially would increase some recreational activities such as fishing and boating. However, the proposed oyster restoration at the Naval Weapons Station Earle would have no impact on recreational resources. The presence of naval security and exclusion areas prevents recreational use near the project site.

Restoration Sites	Potential Environmental Consequences*
Bush Terminal/ Governors Island	• Minor, short-term negative impacts from limited access to recreational resources during construction. • Long-term improvement in educational and research opportunities.
Naval Weapons Station Earle	• Implementation of the TSP would not affect recreation near the project site.

5.5.16 Cultural Resources

Under the no action alternative, although impacts to cultural resources are expected to be minimal, loss of historic resources due to SLR and erosion could occur.

Enough existing data does not currently exist to determine the extent of impacts to cultural resources from implementation of the TSP in the Upper Bay and Lower Bay planning regions In the Cultural Resources Overview (Harris et al., 2014) all existing cultural resources data relevant to the CRP candidate restoration, including Bush Terminal and Governors Island sites in the Upper Bay Planning Region, and the Naval Weapons Station Earle site in the Lower Bay Planning Region, were inventoried.

Sixty-eight (68) historic properties and districts were identified within one (1) mile of the Governors Island oyster restoration site. Additionally, 30 AWOIS database records and 24 archaeological sites were recorded within one (1) mile of the site. No resources, with the exception of the Governors Island Historic District boundaries, fell within the restoration site boundaries. Other surveys within the Governors Island restoration site have not yet been reported.

Thirteen (13) historic properties or districts and five (5) AWOIS database records were documented within one (1) mile of the Bush Terminal oyster restoration site. A number of surveys have been conducted around the restoration area, but have not yet been reported.

One (1) historic property, the Alexander Hamilton Steamship, was identified at the location of the Naval Weapons Station Earle oyster restoration site. The eastern portion of the proposed oyster restoration site is within the Naval Weapons Station Earle Transshipment Historic District and one (1) of the adjoining piers is a contributing feature of the historic district. Additionally, six (6) AWOIS database records were found within one (1) mile of the study area.

Until additional surveys are conducted to determine the presence or absence of cultural resources at the restoration sites it is unknown whether additional resources exist. At this time it is assumed that under the TSP, construction activities at the Bush Terminal, Governors Island, and Naval Weapons Station Earle restoration sites have the potential to adversely affect cultural resources if those activities occur in close proximity to the resources. Adverse effects may include disturbance to archaeological sites, alterations to historic properties, and impacts to submerged resources.

The USACE drafted two (2) PAs covering sites in New York State and in New Jersey (see Appendix I) that stipulate the actions the USACE will take with regard to cultural resources as the project proceeds. The PAs will ensure that the USACE satisfies its responsibilities under Section 106 of the National Historic Preservation Act and other applicable laws and regulations. The draft PAs were provided to the Advisory Council on Historic Preservation, the New York City Landmarks Preservation Commission, the

National Parks Service and Native American Tribes with expressed interest in the area for their review and participation. In addition, a list of potentially interested parties is currently being developed. The draft PAs are available for public review and will serve as the USACE Section 106 public coordination. The final PAs will incorporate comments received on the draft document, as appropriate.

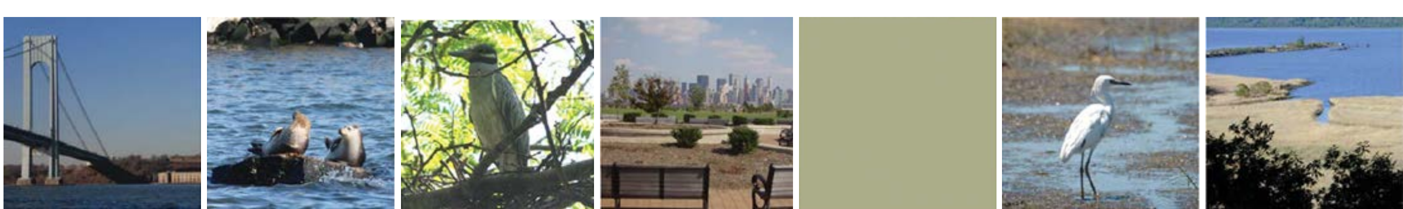
Restoration Sites	Potential Environmental Consequences*
All Sites	• Additional survey is required under the stipulations of the draft PAs to determine whether other resources are present within the project area. • Mitigation would be required for impacts to significant resources.
Bush Terminal Governors Island	• Potential for submerged cultural resources. • Thirteen (13) historic properties or districts and five (5) AWOIS database records were found within one (1) mile of the site.
Governors Island	• Governors Island Historic District is located within or adjacent to the site. • Thirty (30) AWOIS database records and 24 archaeological sites were recorded within one (1) mile of the site
Naval Weapons Station Earle	• Adjoining pier is contributing feature of the Naval Weapons Station Earle Transshipment Historic District. • Includes the Alexander Hamilton Steamship, a historic property. • Six (6) AWOIS records were identified within one (1) mile of the site.

5.5.17 Aesthetics

Under the no action alternative, construction will not take place and no changes to aesthetics would occur. The degraded condition of the Upper and Lower Bay ecosystem would continue to decrease aesthetic and scenic resource value in the planning regions.

Oyster restoration in the Upper Bay Planning Region would take place at Bush Terminal and Governors Island. The Upper Bay Planning Region provides many opportunities to view the waters of the area, mostly found along the waterfront of South Brooklyn, Bayonne, Jersey City, and a few on the waterfront of northern Staten Island. The entire shoreline of Governors Island is publicly accessible, providing additional views of the region. During construction of the TSP there would be temporary impacts to the aesthetic and scenic resources on site due to the presence of construction equipment. Post construction, limited visual and aesthetic impacts are anticipated if on-bottom techniques are used. However, potential visual effects may be detected if buoys and floats are used with off-bottom techniques.

Oyster restoration in the Lower Bay Planning Region will take place at the Naval Weapons Station Earle pier owned by the United States Navy. Negligible, short-term negative impacts to local aesthetics would occur as a result of minimal construction equipment on site. Once constructed, the proposed oyster restoration would have no impact on aesthetic resources. All structures will set under the existing pier. The presence of naval security and exclusion areas limits access and therefore scenic resource value in the vicinity of the TSP.



Restoration Sites	Potential Environmental Consequences*
Bush Terminal/ Governors Island	• Minor, short-term negative impacts from presence of construction equipment. • Minor, long-term impact to aesthetic resource value dependent upon technique.
Naval Weapons Station Earle	• Implementation of the TSP would not affect aesthetic resource value near the project site.

5.5.18 Coastal Zone Management

Under the no action alternative, no restoration will occur and no impacts to state or local coastal zone management plans would occur.

Restoration activities at the Bush Terminal and Governors Island oyster sites in the Upper Bay Planning Region were evaluated with respect to their consistency with New York State's *State Coast Policies* and New York City's *The New Waterfront Revitalization Program* and the goals are directly in line with the respective coastal zone policies. The restoration activities are consistent with state and local coastal zone management programs.

Restoration activities at the Naval Weapons Station Earle oyster restoration site in the Lower Bay Planning Region were evaluated with respect to their consistency with NJDEP Coastal Zone Management Program and the restoration activities were found to be consistent with the coastal zone management rules (Appendix J).

Restoration Sites	Potential Environmental Consequences*
All Sites	• Restoration activities are consistent with state and local coastal zone management programs.

5.6 Mitigation Measures*

NEPA regulations at 40 CFR 1500.2(f) state that federal agencies shall, to the fullest extent possible, use all practicable means consistent with the requirements of the Act and other essential considerations of national policy to restore and enhance the quality of the human environment, and avoid or minimize any possible adverse effects of their actions on the quality of the human environment. Furthermore, at 40 CFR 1508.20, NEPA defines mitigation to include avoiding impacts by not taking an action, minimizing the magnitude, rectifying the impact through restoring the resource, reducing the impact over the life of the action, or compensating for the impact. Agencies are required to identify and include in the action all relevant and reasonable mitigation measures that could reduce negative effects of the action.

Site restoration would involve construction in proximity to ecological resources. Each site would have short-term construction-related effects with varying spatial and temporal scales and degrees of intensity. Construction designs would include practices that avoid and minimize effects to significant resources.

5.6.1 Standard Practices to Mitigate Negative Effects of Construction

Specific measurable and enforceable mitigation measures will be developed for each site based on its specific impacts. Construction designs and timing would include standard measures:

- In-water work would occur during designated periods consistent with recommended periods established by NYSDEC, NJDEP, NMFS and USFWS.
- Work would be scheduled outside of bird nesting season except where unavoidable.
- Each construction site would have an approved environmental protection plan.
- Traffic alterations would be designed to minimize impediments, with the shortest and least disruptive detours possible, and in coordination with the relevant transportation agency(s).

5.6.2 Best Management Practices to Protect Water Quality

Restoration sites will require in-water work and significant areas of ground clearing. Protecting water quality from storm water runoff would require implementation of BMPs to avoid excessive runoff and elevated turbidity in the receiving waterbody. Every site would have a stormwater pollution prevention plan and a temporary erosion and sedimentation control plan approved by a USACE staff biologist. Standard construction stormwater BMPs can be incorporated into site designs, operational procedures, and physical measures on site. The following are some examples of frequently used BMPs:

- Minimize area of ground disturbance and vegetation clearing.
- Stabilize erodible surfaces with mulch, compost, seeding, or sod.
- Use features such as silt fences, gravel filter berms, silt dikes, check dams, and gravel bags for interception and dissipation of turbid runoff water.

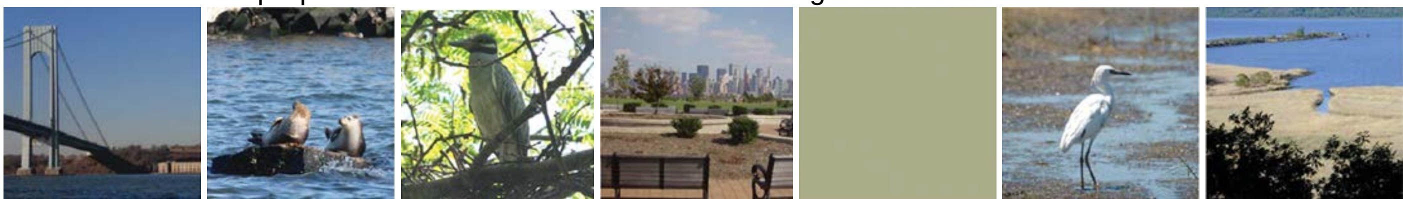
5.6.3 Mitigation Measures for Effects of Greenhouse Gas Emissions

Mitigation for GHG emissions is not legally required; however, BMPs are available for fuel and material conservation during construction. Such BMPs include the following:

- Maximizing use of construction materials that are reused or that have a high percentage of recycled material content, such as recycled asphalt pavement, concrete, and steel.
- Obtaining construction materials and equipment from local producers or vendors to minimize energy use for shipping.
- Turning off equipment when not in use to reduce idling.
- Maintaining equipment in good working order to maximize fuel efficiency.
- Routing truck traffic through areas where the number of stops and delays would be minimized, and using off-peak travel times to maximize fuel efficiency.
- Scheduling construction activities during daytime hours or during summer months when daylight hours are the longest to minimize the need for artificial light.
- Implementing emission-control technologies for construction equipment.
- Using ultra low sulfur (for air quality) and biodiesel fuels in construction equipment.

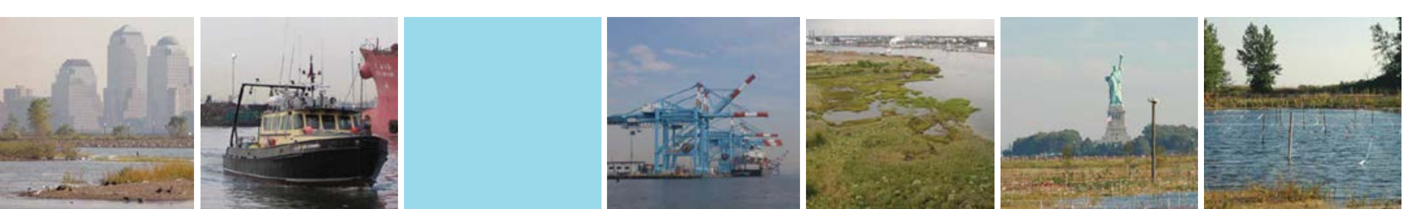
5.6.4 Best Management Practices and Mitigation Measures for Cultural Resources

USACE has consulted with the SHPO, ACHP, and federally recognized Native American Tribes on appropriate mitigation measures following the procedures laid out in the referenced PA. If any cultural resources identified within the APE are eligible for the National Register, the USACE will make effects assessments. Should the proposal have an adverse effect on an eligible cultural resource that cannot



be avoided, USACE would work toward a resolution of adverse effects with the SHPO/ACHP, tribes, and other consulting parties following the procedures defined in the PA. Examples of mitigation measures include but are not limited to the following:

- Recordation packages using digital photography and 35 mm black-and-white film photography;
- Treatment plans;
- Public interpretation;
- Historic property inventory; and
- Geo-referenced historical maps and aerial photographs.



Chapter 6: Cumulative Effects*

The approach taken in this analysis of cumulative effects follows the objectives of the National Environmental Policy Act (NEPA), Council on Environmental Quality (CEQ) regulations, and CEQ guidance. A cumulative effect is an “impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions” (40 Code of Federal Regulations §1508.7). In addition, it is defined as “two or more individual effects, which, when considered together, are considerable or which compound or increase other environmental impacts” (CEQ Guidelines §15355). Cumulative effects can result from individually minor but collectively significant actions taking place over time (40 Code of Federal Regulations §1508.7). CEQ guidance for considering cumulative effects states that NEPA documents “should compare the cumulative effects of multiple actions with appropriate national, regional, state, or community goals to determine whether the total effect is significant” (CEQ, 2010).

The analysis of cumulative effects may go beyond the scope of project-specific direct and indirect effects to include expanded geographic and time boundaries, and a focus on broad resource sustainability. The true geographic range of an action’s effect may not be limited to an arbitrary political or administrative boundary. Similarly, the effects of an action may continue beyond the time the action ceases. This “big picture” approach is becoming increasingly important as growing evidence suggests that the most significant effects to natural and socioeconomic resources result not from the direct effects of a particular action, but from the combination of individual, often minor, effects of multiple actions over time. The underlying issue is whether or not a resource can adequately recover from the effect of a human action before being exposed to subsequent action or actions.

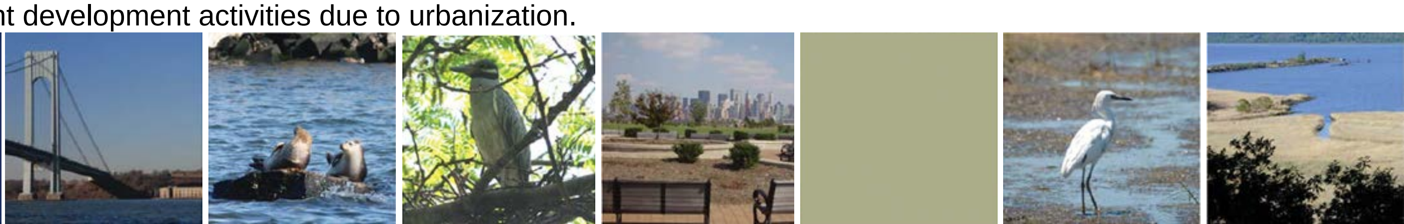
Consistent with CEQ guidance, this analysis focuses on potential cumulative effects that can be described as the reasonable and foreseeable estimate for implementation of cumulative projects, in addition to the proposed action (CEQ, 1997). The timeframe for this analysis and discussion of existing, ongoing, or planned projects extends from 2020 to 2070.

In this chapter, an effort has been made to identify past and present actions associated with the resources analyzed in Chapters 2 and 5, plus those actions that are in the planning phase—limited to future actions that are reasonably foreseeable. Only actions that have the potential to interact with or be impacted by the tentatively selected plan (TSP) are addressed in this cumulative effects analysis. The analysis evaluates only actions with potential effects on the environment that are fundamentally similar to the anticipated effects of the TSP, in terms of the nature of the effects, the geographical area affected, and the timing of the effects.

This cumulative effects analysis covers actions in the study area from the recent past through the 50-year planning period of analysis described in Section 2.2. Assuming the proposed project is expected to be operational in 2020, the planning period of analysis is 2020 to 2070. Additional ongoing ecosystem and coastal restoration efforts that are not highlighted and summarized below are included in Ongoing Efforts and Prior Reports Appendix B.

6.1 Recent Past, Present, and Foreseeable Future Actions

The no action alternative has no cumulative effects associated with restoring the mosaic of habitats within the HRE. The continued lack of functioning habitats that currently has a cumulative negative effect on ecological resources influences socioeconomic and recreational quality throughout the region. The existing negative impacts on ecological processes in the study area are a result of past and present development activities due to urbanization.



A number of actions unrelated to the TSP, occurring historically and up to the present time, or reasonably expected to occur in the future, have the potential to influence the resources affected by implementation of the TSP, as identified in Chapter 5. Multiple restoration and conservation programs and development projects were identified. A brief description of these relevant past, present, and reasonably foreseeable future actions follows, with an emphasis on components of the activity that are relevant to the effects previously identified. When determining whether a particular activity may contribute cumulatively and significantly to the effects identified in Chapter 5, the following attributes are considered: geographical distribution, intensity, duration, and the historical effects of similar activities.

Combined Sewer Overflow Abatement Program

Timeframe: Recent past, present, and foreseeable future
Sources: New York State Department of Environmental Conservation (NYSDEC), 2012
New York City Department of Environmental Protection (NYCDEP), 2016

In 2012, the NYSDEC and NYCDEP signed an agreement to reduce combined sewer overflows and improve water quality through the collection and treatment of sewerage prior to release into the HRE. Under this agreement, several long-term control plans for specific waterbodies and one for the City of New York were drafted to identify appropriate combined sewer overflow controls necessary to improve water quality. Overflow abatement measures include conducting environmental dredging of several tributaries within the City of New York to remove combined sewer overflow mounds that contribute to nuisance odors and dissolved oxygen deficits within affected waterbodies. These waterbodies include Paerdegat Basin, Flushing Bay, Flushing Creek, Gowanus Canal, Bergen Basin, Fresh Creek, Newtown Creek, and Thurston Basin. While construction activities may have short-term negative impacts on water quality resulting from disturbance of sediments and stormwater runoff during the program, the long-term impacts to water quality will be very positive.

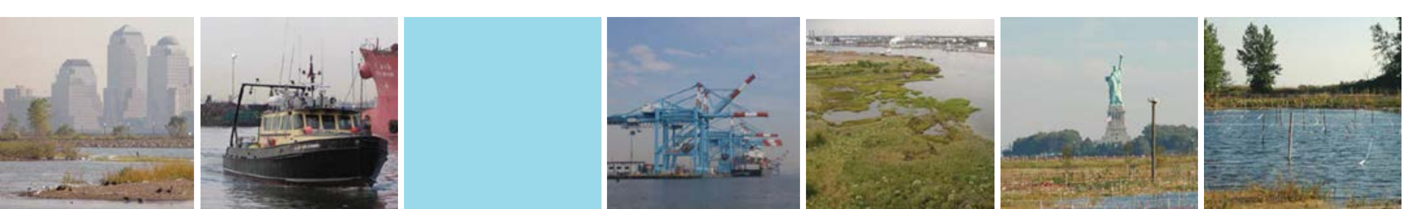
Superfund Program

Timeframe: Recent past, present, and foreseeable future
Source: United States Environmental Protection Agency (USEPA), 2016

The USEPA Superfund program is responsible for cleaning up some of the nation's most contaminated areas. A National Priorities List has been established to serve as a list of hazardous waste sites that are eligible for remedial action financed under the Superfund program. In recent years, the USEPA has made major progress on planning for the remediation of contaminated sediments on several sites within the HRE study area that are on the list. Remediation projects include measures such as contaminated sediment removal and capping. The Superfund program is especially relevant for the Lower Passaic River Tier 2 sites that are dependent on completion of remediation activities. Short-term impacts from suspension of sediment may occur during dredging activities, but would be minimized through the use of best management practices (BMPs). Long-term positive effects will result from sediment and water quality improvements, minimized exposure to contamination and overall risk reduction to human health and ecological communities.

Public Greenways

Timeframe: Recent past, present, and foreseeable future



Source: New York City Department of Parks and Recreation (NYC Parks), 2003
Byron and Greenfield, 2006
New York City Department of Transportation (NYCDOT), 2014
MillionTrees NYC, 2015
Bronx River Alliance, 2016
Brooklyn Greenway Initiative, 2016
NYCDOT, 2016
New York City Economic Development Corporation (NYCEDC), 2016

Greenway initiatives and the development of waterfront greenways are underway throughout the HRE:

- MillionTrees NYC, a PlaNYC initiative, is a public-private program. In 2015, two (2) years ahead of schedule, MillionTrees NYC achieved the program goal of planting 1,000,000 trees in New York City.
- The Manhattan Waterfront Greenway is a 32-mile multi-use trail that circumnavigates Manhattan Island, and includes over 23 miles of waterfront pathways and facilitates access to over 1,500 acres of parkland throughout the borough. The greenway builds on recent efforts to transform a long-neglected waterfront into a green attraction for recreational and commuting use.
- Construction on the South Bronx Greenway and the Bronx River Greenway is underway and most of the construction phases should be near completion by 2018. The South Bronx Greenway compasses 1.5 miles of waterfront greenway, 8.5 miles of inland green streets, and nearly 12 acres of new waterfront open space throughout the Hunts Point and Port Morris neighborhoods in the Bronx. The Bronx River Greenway extends for 23 miles along the Bronx River, from Westchester County to Soundview Park in the South Bronx. Approximately 19 miles of the greenway are currently in place with completion anticipated within the next decade.
- The Brooklyn Waterfront Greenway will comprise 14 miles of landscaped, designated off-street pathways, enhanced sidewalks, and on-street bike lanes that will connect neighborhood parks and open spaces from Greenpoint to Bay Ridge. Six (6) miles have already been completed with eight (8) miles remaining.
- The Jamaica Bay Greenway will be a 28-mile network of bicycle and pedestrian paths connecting more than 10,000 acres of parks and beaches. More than 10 miles are in place.

Construction of the greenway projects may have short-term negative impacts on water quality resulting from disturbance and runoff in areas adjacent to the waterfront. In the long term, these projects would improve public access and aesthetics in the region.

Rebuild by Design

Timeframe: Recent past, present, and foreseeable future
Source: Rebuild by Design, 2016

In 2013, following Hurricane Sandy, the United States Department of Housing and Urban Development (HUD) and the Hurricane Sandy Rebuilding Task Force initiated the Rebuild by Design (RBD) competition to create solutions for improving coastal resiliency in the region. From the 148 international applicants, 10 interdisciplinary teams were selected to compete in the year-long process. Several winning proposals within the HRE were chosen, including the Big U in Manhattan, New Meadowlands in the New Jersey Meadowlands, OMA in Hoboken, Hunts Point Lifelines in the Bronx, and Living Breakwaters on Staten Island. These projects include many resiliency measures, such as living shorelines, flood protection structures, tide gates, and reefs. The projects are largely located adjacent to or in close proximity to the waterfront, and are likely to have extensive short-term construction impacts to resources found along the shoreline, as well as long-term beneficial impacts from increases in habitat and flood protection when completed. The projects have been allocated over $1,100,000,000 in federal funding and the federal government has continued to invest in and recognize the innovations that these projects have brought to the region.

New York State Governor's Office of Storm Recovery

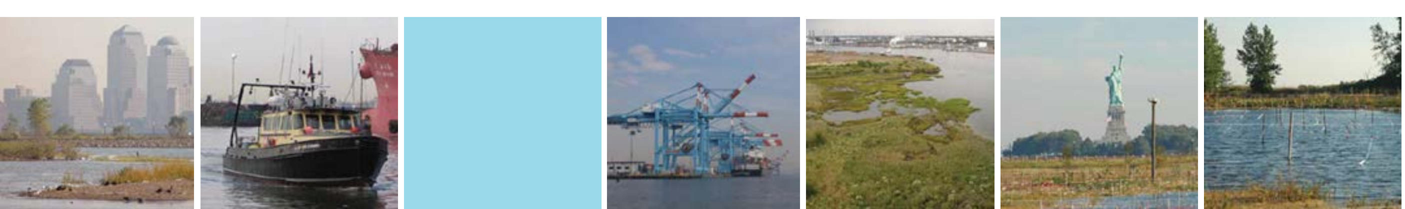
Timeframe: Recent past, present, and foreseeable future
Source: United States Department of Housing and Urban Development, 2014
New York State Governor's Office of Storm Recovery, 2016

New York State established the Governor's Office of Storm Recovery to address communities' most urgent needs, while also encouraging the identification of innovative and enduring solutions to strengthen the state's infrastructure and critical systems. Operating under the umbrella of New York Rising, the office utilizes approximately $4,400,000,000 in flexible funding made available by the HUD Community Development Block Grant Disaster Recovery Program to concentrate aid to four (4) main areas: housing recovery, small business, community reconstruction, and infrastructure. Paired with additional federal funding that has been awarded to other state agencies, the program enables homeowners, small businesses, and entire communities to build back even better than before. While the program will primarily result in short-term construction impacts from rebuilding on existing developed property, some long-term negative impacts could result from reconstruction or infrastructure projects that have a larger impervious footprint or that alter existing hydrology and habitat, long-term positive impacts could result from buyout and acquisition programs or shoreline stabilization projects that increase habitat and return developed land to a natural state.

Wetland Mitigation

Timeframe: Recent past, present, and foreseeable future
Source: NYCEDC, 2015
New Jersey Department of Environmental Protection (NJDEP), 2016b

Wetland mitigation banks are becoming increasingly important within the HRE study area, as on-site mitigation areas are scarce and development increases mitigation demands. Wetland mitigation banks currently servicing the HRE study area are all located in New Jersey and include the MRI-3 Mitigation Bank, Kane Wetland Mitigation Bank, Oradell Reservoir Mitigation Bank, Cranbury Wetland Mitigation Bank, and Pio Costa Wetland Mitigation Bank, among others. Additional mitigation banks that would service the HRE are proposed in New Jersey and New York, including the Saw Mill Creek Wetland Mitigation Bank on Staten Island. Creating wetland mitigation banks requires extensive construction activities, such as excavation, sediment removal, grading, hydrologic restoration, and planting. Many of these activities would occur below the high tide line and potentially within contaminated sediments. Wetland mitigation activities may have cumulative impacts with projects implemented under the TSP including short-term construction impacts to sediments and water quality or long-term alterations to local topography, hydrology, and habitat. While these impacts may be negative in the short-term, the long-term benefits from adding high-value habitats would be very positive.



Wetland restoration and creation projects not associated with wetland mitigation banks are also common throughout the HRE. Many smaller projects that provide compensatory mitigation for development can be found in all of the CRP planning regions. In general, on-site mitigation is preferred by the agencies, but off-site mitigation is also acceptable within the same watershed.

Coastal Storm Risk Management Projects

Within the HRE, the USACE and states of New York and New Jersey partner on multiple projects that manage coastal storm risk. Short-term construction impacts may occur during these projects, but will likely be minor and minimized through the use of BMPs. Although the long-term goals of these projects are to minimize negative impacts on the environment, they may cause permanent alterations to hydrology and natural habitats as an unavoidable consequence. These impacts may adversely affect implementation of the TSP or can potentially cause cumulative impacts. Projects that are considered in this analysis are:

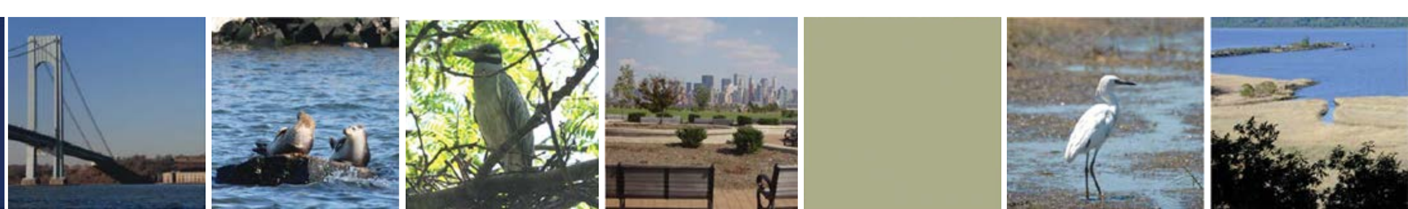
Atlantic Coast of New York, East Rockaway Inlet to Rockaway Inlet, and Jamaica Bay Reformulation Study
Timeframe: Present and foreseeable future
Source: USACE (http://www.nan.usace.army.mil/Missions/Civil-Works/Projects-in-New-York/East-Rockaway-Inlet-to-Rockaway-Inlet-Rockaway-Be/)

In August of 2016, the USACE released its Draft Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement for the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay. USACE examined coastal storm risk management problems and opportunities for the project area, and identified and screened alternatives based on the following principal planning objectives: reduce vulnerability; do so sustainably and economically; improve community resiliency; and enhance natural storm surge buffers. Since the problems and opportunities varied within the project area, the USACE tentatively selected a plan that addresses two (2) planning reaches: the Atlantic Ocean Shoreline Reach and the Jamaica Bay Reach. The TSP includes a composite seawall in combination with beachfill and groin features along the Atlantic Ocean Shoreline and a Coastal Storm Surge Barrier across Rockaway Inlet in Jamaica Bay.

Presently, reviews (including the public review of the Draft Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement) and higher-level coordination within USACE are ongoing. The study's non-federal sponsor is the NYSDEC, with the New York City Mayor's Office of Recovery and Resiliency as the local sponsor to New York State. Other project partners include NYCDPR, NYCDEP, and the National Park Service (NPS). USACE may consider a phased decision process that would move forward the implementation of discreet components while finalizing the details associated with more technically complex features. Construction start of the first phase is targeted for 2018, but will depend on the length of reviews and approvals, and the relative complexity of design.

NY/NJ Harbor and Tributaries Coastal Storm Risk Management Study
Timeframe: Present and foreseeable future
Source: USACE

The New York-New Jersey Harbor and Tributaries is one of nine (9) focus areas identified in the North Atlantic Coast Comprehensive Study report (USACE, 2015). The purpose of this coastal



storm risk management (CSRM) study is to investigate comprehensive approaches to improve community resilience and to manage risk of damages from future coastal storms and impacts of sea level rise (SLR). The objective of the New York-New Jersey Harbor and Tributaries CSRM Study is to identify and explore areas of coastal storm risk and develop the most feasible comprehensive combination of structural, non-structural, and/or natural and nature-based measures into alternatives that best manage risks from current and projected future coastal flooding in both the short and long term.

USACE Restoration Projects

The USACE has implemented the following restoration projects that may have had short-term negative cumulative impacts from construction activities, but has created significant positive, long-term benefits from the restoration and connection of fragmented habitats:

Elders East Mitigation for NY/NJ Harbor Deepening
Timeframe: Recent past (2006)
Source: USACE and Port Authority of New York and New Jersey (PANYNJ)
Approximately 40 acres of marsh islands restored

Gerritsen Creek, Marine Park, NY Ecosystem Restoration Project (Continuing Authorities Program [CAP] 1135)
Timeframe: Recent past (2010)
Source: USACE and NYC Parks
Approximately 20 acres of tidal marsh and 20 acres of coastal grassland restored

Elders West Marsh Restoration
Beneficial use of dredged material (CAP Sections 204/207)
Timeframe: Recent past (2010)
Source: USACE, PANYNJ, NPS, NYSDEC, and NYCDEP
Approximately 43 acres of marsh islands restored

Soundview Park, Bronx, New York (CAP Section 206)
Timeframe: Recent past (2012)
Source: USACE and NYCDPR
Approximately 3.7 acres of tidal marsh restored

Yellow Bar Hassock Marsh Restoration
Beneficial use of dredged material (CAP Sections 204/207)
Timeframe: Recent past (2012)
Source: USACE, PANYNJ, NPS, NYSDEC, and NYCDEP
Approximately 47 acres of marsh islands restored

Rulers Bar and Black Wall
Beneficial use of dredged material
Timeframe: Recent past (2012)
Source: USACE, PANYNJ, NYCDEP, and NYSDEC
Rulers Bar: approximately 10 acres of sand placed
Black Wall: approximately 20 acres of sand placed

The USACE is expected to conduct the following restoration projects within the next two (2) years. These projects may have short-term negative cumulative impacts from construction activities, but will provide significant positive, long-term benefits from the restoration and connection of fragmented habitats:

<u>Spring Creek North, Brooklyn, New York (CAP Section 1135)</u>
Timeframe: Foreseeable future (2020)
Source: USACE and NYCDPR

Restoration of approximately 35 acres of habitat, including approximately 13 acres of intertidal salt marsh and approximately 22 acres of maritime upland habitat. This recommendation complements the additional 2.4 acres of maritime forest that NYCDPR will construct in the north eastern portion of the site.

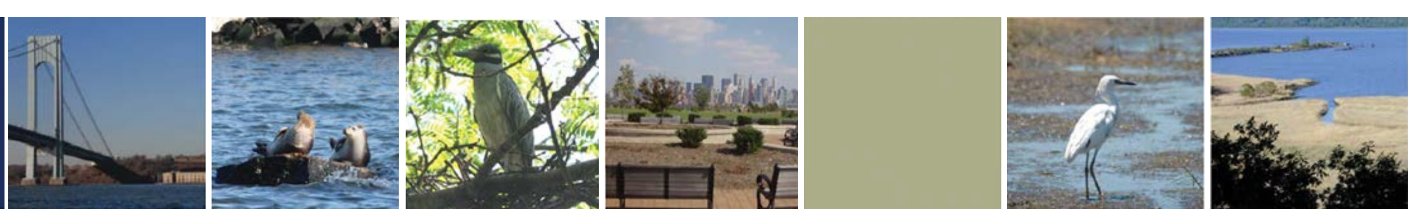
<u>Spring Creek South, Queens, New York</u>
Hazard Mitigation Grant Program - Coastal Storm Risk Management Project
Timeframe: Foreseeable future (2020)
Source: Federal Emergency Management Agency (FEMA) and NYSDEC

This project will manage the risk of storm damage and flooding caused by coastal storms such as nor'easters, tropical storms, and hurricanes Spring Creek South and the surrounding Howard Beach neighborhood. The area is currently prone to erosion and shoreline destabilization, as well as wildfires due to widespread presence of the invasive plant, common reed (*Phragmites australis*) reducing the wetlands' ability to mitigate floodwaters. The project could potentially restore between 22 to 51 acres of wetlands, 147 to 178 acres of maritime upland, and freshwater wetlands. The project would also create a protective berm, flap gates, and nuisance stormwater control.

Smaller Development Projects
Timeframe: Recent past, present, and foreseeable future
Many other, smaller development projects have been, are, or will be constructed within the HRE. These projects, although too numerous to enumerate and too early in their planning to ensure their ultimate implementation, could also lead to cumulative impacts.

6.2 Summary of Cumulative Effects Relative to the Tentatively Selected Plan

Environmental effects associated with the TSP were analyzed in Chapter 5. The proposed alternative at each restoration site will increase the amount of high-quality habitat through restoration measures. Some alternatives address restoration of ecosystem function, and thus increasing levels of sustainability. All of the alternatives, except the no action alternative, are presumed to improve the habitat and ecological integrity at the planning region level with varying degrees of effectiveness. In addition to the long-term ecological and societal benefits of improving habitats and providing access to natural resources, construction activities associated with the TSP could cause temporary adverse impacts. These effects were determined individually to be negligible or minor, or to have no impact. Implementation of the TSP may have cumulative effects when combined with other similar actions occurring in the region of influence, on the resources discussed below.



6.2.1 Cumulative Effects on Biological Resources

Short-term, negative impacts to species diversity and abundance, including rare, threatened, and endangered species, are anticipated as a result of construction activities at restoration sites. These impacts are unlikely to be cumulative as a result of implementing the TSP alone, but may become cumulative if larger construction projects that are unrelated to the TSP occur in the vicinity. As previously discussed, impacts related to construction would be short term and would be minimized using applicable BMPs. Ongoing consultation with United States Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), NYSDEC, and NJDEP will take place over the duration of the project to prevent adverse impacts to federal- or state-listed species from implementation of the TSP.

Long lasting, cumulative impacts may result from TSP implementation in the vicinity of wetland mitigation banks, land acquisition and protection areas, and coastal resiliency and green infrastructure projects. The cumulative effects would be beneficial to species because the actions would improve existing habitats, provide additional new habitat, and enhance the connectivity between new and existing habitats. Ongoing improvements to habitat and connectivity throughout the HRE would increase biodiversity, as species that are more sensitive to environmental degradation or have specific habitat needs would colonize the restored habitats.

Widespread habitat improvements and enhanced connectivity resulting from TSP implementation also would work in concert with state and federal programs that manage and protect species listed under the Endangered Species Act, the NYSDEC Endangered Species Program, and the NJDEP Endangered and Nongame Species Program. The USFWS and NMFS implement the Endangered Species Act using recovery programs that aim to stop the decline of a species or population and remove or reduce the threats to ensure long-term survival in the wild. Tools used in a recovery program include restoring and acquiring habitat, removing introduced animal predators or invasive plant species, conducting surveys, monitoring individual populations, and breeding species in captivity before releasing them into their historic range. Recovery plans exist for several species that are in the HRE study area.

The Mid-Atlantic Fisheries Management Council, NMFS, and Atlantic States Marine Fisheries Commission implement fisheries management programs in the HRE study area. These programs focus on species that may not be listed as threatened or endangered, but otherwise may be important for commercial or other reasons. The programs provide management objectives and strategies, such as harvest limits and habitat protection. Fisheries management coupled with habitat improvements and creation of new habitats resulting from implementing the TSP would cumulatively enhance sustainable fish population within the HRE and throughout the Mid-Atlantic Bight. Healthier fish stocks would benefit the fishing industry within the HRE and bolster the regional economy.

Species that are not of commercial value would also benefit from the cumulative effects of implementing the TSP and existing, ongoing species protection programs. The TSP combined with existing programs would increase the rate of habitat improvement, protection, and creation, thereby increasing biodiversity within the HRE at a faster pace than would happen if the TSP were not implemented.

6.2.2 Cumulative Effects on Water Quality

Cumulative adverse impacts to surface waters, and in particular to water quality, may result from implementation of the TSP concurrently or in close proximity to other development projects in the area. Examples include recommended alternatives requiring in-water construction or sediment removal

activities that may be constructed at the same time as a site remediation, wetland mitigation bank, or development project that requires dredging. These projects result in a cumulative increase of turbidity in the region, leading to short-term cumulative impacts to water quality for the duration of construction and dredging activities. The cumulative impacts to water resources resulting from implementation of the TSP and other construction projects in the HRE are unlikely to be significant as these activities are generally short term and require the use of BMPs that minimize erosion and sedimentation.

Long lasting, beneficial cumulative impacts to water quality may result from implementing the TSP alongside other, ongoing and future restoration projects, such as combined sewer overflow abatement. Many of the past, present, and foreseeable future actions involve projects that improve water quality in the long term by treating wastewater, reducing contaminants, and constructing softer shorelines, wetlands, reefs, and other structures that reduce wave action and water velocity. Because most recommended alternatives include the same restoration measures, substantial beneficial cumulative impacts would be anticipated over time throughout the HRE. Improvements to water quality and reductions in turbidity would also increase primary productivity and available oxygen in the water by increasing light penetration in the water column.

6.2.3 Cumulative Effects on Climate Change and Sea Level Rise

Individual activities in the HRE study area make incremental contributions to greenhouse gas emissions, together representing a very small percentage of total United States and global emissions. The potential effects of greenhouse gas emissions are by nature global and cumulative, as individual sources of greenhouse gas emissions are not large enough to have an appreciable effect on climate change. An appreciable impact on global climate change would only occur when proposed greenhouse gas emissions combine with emissions from other man-made activities on a global scale. Implementation of the TSP would contribute a negligible amount of greenhouse gases. When combined with other past, present, and reasonably foreseeable future actions, implementing the TSP would have the potential for negligible, long-term negative impacts on climate change.

Estuarine salt marshes and other wetlands potentially affected by SLR face new risks related to climate change. Increasing rates of SLR may lead to substantial loss of salt marsh habitat, especially in areas that are subsiding and/or where sediment supply is reduced, or where upland migration of marshes is prevented by shoreline armoring, coastal development, or natural bluffs. Projected changes in water temperature, water salinity, and soil salinity could change the mix of plant species in salt marshes and the viability of invertebrates that play a key role in the health of salt marshes. Furthermore, many freshwater marshes adjacent to marine waters are likely to convert to salt marshes or to transitional marshes that experience frequent saltwater inundation. If coastal development occurs or if shoreline armoring continues to be used as a countermeasure for SLR, the new salt marshes will also, in turn, disappear due to subsidence or lack of sediment supply.

6.2.4 Cumulative Effects on Social and Economic Resources

Construction activities of the TSP over the implementation period would have beneficial socioeconomic impacts to the region. When evaluated with other projects and programs, cumulative beneficial impacts to the local recreation economy are anticipated. Implementation of the TSP would have no adverse human health or environmental effects on environmental justice, minority or low-income populations within HRE. In fact, many of the ongoing restoration and conservation programs will improve aesthetics in the area and others, such as the Combined Sewer Overflow Abatement Program and the Superfund program, will also improve sediment and water quality. Programs such as the New York City Comprehensive Waterfront Plan and local waterfront revitalization programs would also improve access

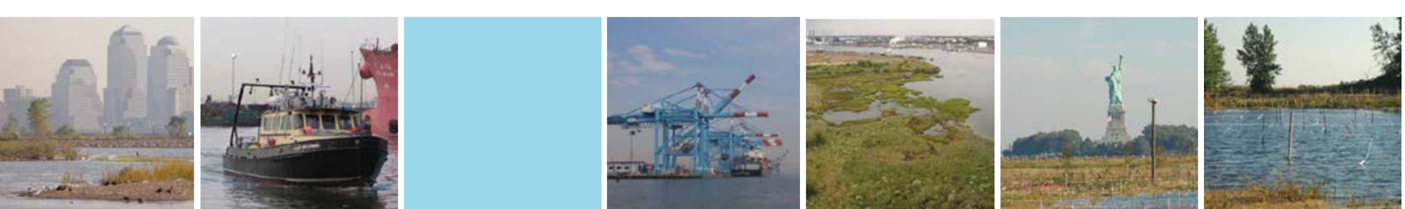
to the waterfront and waterways. Cumulatively, these improvements would attract tourists and create recreation and ecotourism jobs, bringing capital into the area. In addition, local community groups and educational institutions would have opportunities to participate in restoration and monitoring efforts associated with implementation of the TSP and the projects constructed under other programs. If such projects are funded by grants and other outside sources, these investments would further help to bolster the local economy. Cumulatively, creating new jobs and increasing the amount of income entering the local economy and the additional educational benefits from implementing the TSP and other programs would be a long-term beneficial impact to the region.

Over the long term, recommended alternatives that restore roosting, nesting, and foraging habitat for waterbirds near airports, in concert with wetland mitigation projects that increase habitat for birds, are likely to have cumulative impacts on airport activities and aviation as there would be increased risk of bird-aircraft strikes. To manage this risk, restoration projects targeting bird habitat would be completed outside of Federal Aviation Administration (FAA) prescribed buffer areas, or in close coordination with the FAA. Other activities that may indirectly attract birds near airports, if needed, would utilize bird deterrent measures, such as reflective flagging, fencing, and string.

Implementing the TSP alongside other restoration and development programs, especially the greenways initiatives that are currently underway and existing waterfront programs, would have beneficial impacts to recreation and public access. The greenways and waterfront programs work to improve and increase the number of public access areas. When combined with recommended alternatives that restore degraded habitats, improve public access and provide the added benefits of improved water quality and educational opportunities, the cumulative effects are beneficial to the people in the region. The New York City Department of City Planning has developed the New York City Waterfront Revitalization Program for shoreline areas around the city, and in Rockland and Westchester Counties, in the HRE study area. The communities of Piermont, Dobbs Ferry, Mamaroneck, Port Chester, and Rye also have approved local waterfront revitalization programs. Projects developed under these programs potentially may interact with TSP activities, cumulatively contributing to beneficial impacts to public access to the waterfront and waterways. Implementation of the TSP would also be subject to local waterfront development plans and programs leading to an organized approach to development, with isolated projects—both TSP and non-TSP projects—linked to each other under an overarching plan or program that has specific goals.

6.2.5 Irreversible or Irretrievable Commitments of Resources Involved in the Implementation of the Tentatively Selected Plan

No irreversible or irretrievable commitment would foreclose the formulation or implementation of any reasonable and prudent alternative. No commitment of resources would prejudice the selection of any alternative before making a final decision.



Chapter 7: Environmental Compliance with Environmental Statutes*

This chapter provides documentation of how the Tentatively Selected Plan (TSP) complies with all applicable federal environmental laws, statutes, and executive orders.

7.1 National Environmental Policy Act of 1969

The National Environmental Policy Act (NEPA) (42 United States Code 4321 et seq.) commits federal agencies to considering, documenting, and publicly disclosing the environmental effects of their actions. This Integrated Feasibility Report/Environmental Assessment (FR/EA) is intended to achieve NEPA compliance for the proposed recommended alternative. Before preparing this document, the United States Army Corps of Engineers (USACE) held a series of public information meetings in each of the eight study areas during the development of the Comprehensive Restoration Plan (CRP). Comments received to date were considered in determining which opportunities and which resources must be considered in a detailed analysis. The draft FR/EA will be published for a 45-day public comment period to ensure satisfactory public review. A final FR/EA, which takes into account all comments received, as well as additional feasibility-level activities (e.g., more detailed designs and accurate cost estimates), will be published prior to project implementation.

7.2 USACE Procedures for Implementing NEPA (33 Code of Federal Regulations [CFR], part 230, ER 200-2-2)

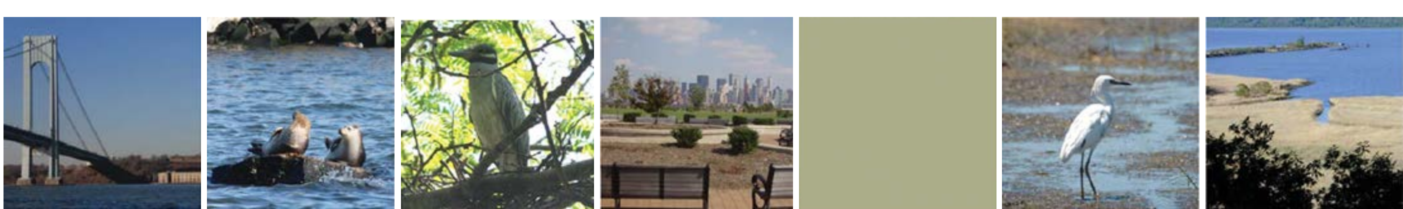
This regulation provides guidance for implementation of the procedural provisions of the NEPA for the Civil Works Program of the USACE. It supplements Council on Environmental Quality (CEQ) regulations 40 CFR 1500-1508, in accordance with 40 CFR 1507.3. This FR/EA has been prepared in compliance with Engineering Regulation (ER) 200-2-2.

7.3 Bald and Golden Eagle Protection Act of 1940

The Bald and Golden Eagle Protection Act (16 United States Code 668-668c) applies to USACE Civil Works projects through the protection of bald and golden eagles from disturbance. Review of the state databases of critical habitats showed no recorded eagle nesting site within two miles of any of the proposed projects. No aspects of the proposed project are anticipated to have any effect on eagles.

7.4 Clean Air Act of 1963

The Clean Air Act (CAA) as amended (42 United States Code 7401, et seq.) prohibits federal agencies from approving any action that does not conform to an approved state, tribal, or federal implementation plan. Under the CAA General Conformity Rule (Section 176(c)(4)), federal agencies are prohibited from approving any action that causes or contributes to a violation of a national ambient air quality standard in a nonattainment area. Construction activities associated with the proposal would create air emissions, but these would not affect implementation of New York's and New Jersey's CAA implementation plans. The proposed actions would occur in a nonattainment or maintenance area. The individual estimated emissions will be prepared to meet the standards set forth by the United States Environmental Protection Agency (USEPA) and implemented by the states. Air emission estimates will be prepared based on the detailed feasibility-level designs and will be included in the Final FR/EA. USACE will ensure that the projects are in compliance with the CAA as part of project implementation.



7.5 Coastal Zone Management Act of 1972

Section 307 of the federal Coastal Zone Management Act (CZMA) of 1972, as amended (16 United States Code 1451 et seq.) requires federal agency actions to be consistent to the maximum extent practical with the enforceable policies of the approved state's coastal zone management program as well as New York City's Local Waterfront Revitalization Program. Please refer to Appendix J for the CZMA consistency determination for the projects according to the relevant enforceable policies.

7.6 Endangered Species Act of 1973

The Endangered Species Act (ESA) (16 United States Code 1531-1544), Section 7(a) requires that federal agencies consult with the National Marine Fisheries Service (NMFS) and United States Fish and Wildlife Service (USFWS), as appropriate, to ensure that proposed actions are not likely to jeopardize the continued existence of endangered or threatened species or to adversely modify or destroy their critical habitats. Refer to Chapters 2 and 5 regarding ongoing agency coordination.

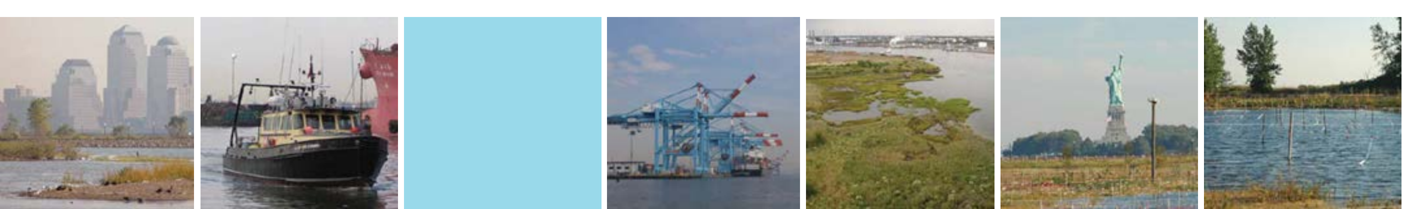
7.7 Federal Water Pollution Control Act of 1972 (Clean Water Act)

The Clean Water Act (CWA) (33 United States Code 1251 et seq.) requires federal agencies to protect waters of the United States. The regulation implementing the CWA disallows the placement of dredge or fill material into water unless it can be demonstrated there are no practical alternatives that are less environmentally damaging. Under Section 401 of the CWA, any project that involves placing dredged or fill material in waters of the United States or wetlands, or mechanized clearing of wetlands requires a water quality certification from the state agency as delegated by USEPA. For the TSP, the New York State Department of Environmental Conservation (NYSDEC) and the New Jersey Department of Environmental Protection (NJDEP) are the delegated authorities within their respective states. The USACE has had initial coordination with agencies to certify that the proposed federal action will not violate established water quality standards. The USACE will produce and submit documentation necessary for the respective Departments individual 401 review based on the feasibility-level design. A Section 404(b)(1) Evaluation and Compliance Review are incorporated into the FR/EA in Appendix Q. An application shall be filed for State Water Quality Certification pursuant to Section 401 of the CWA.

7.8 Fish and Wildlife Service Coordination Act of 1934

The Fish and Wildlife Coordination Act (FWCA) of 1934 as amended (16 United States Code 661-667e) ensures that fish and wildlife conservation is given equal consideration as is given to other features of water resource development programs. This law provides that whenever any water body is proposed to be impounded, diverted, deepened or otherwise controlled or modified, the USACE shall consult with the USFWS and NMFS as appropriate, and the agency administering the wildlife resources of the state. Any reports and recommendations of the wildlife agencies shall be included in authorization documents for construction or modification of projects. Recommendations provided by the USFWS in FWCA Reports must be specifically addressed in USACE feasibility reports.

The USACE initiated coordination for consideration of fish and wildlife species in spring 2016. Further coordination has occurred through informal emails and via phone and will continue throughout feasibility level design phase. The USACE received a Planning Aid Report from USFWS (see Appendix G) and a final FWCA Report is expected prior to finalizing this FR/EA. Results of the coordination and USFWS recommendations will be discussed in the final FR/EA.



7.9 Magnuson-Stevens Fishery Conservation and Management Act of 1976

The Magnuson-Stevens Fishery Conservation and Management Act (MFCMA) (16 United States Code 1801 et. seq.), requires federal agencies to consult with NMFS on activities that may adversely affect Essential Fish Habitat (EFH). The objective of an EFH assessment is to determine whether the proposed action(s) “may adversely affect” designated EFH for relevant commercial, federally managed fisheries species within the proposed action area. The assessment also describes conservation measures proposed to avoid, minimize, or otherwise offset potential adverse effects to designated EFH resulting from the proposed action.

The HRE is designated as EFH for various groundfish and coastal pelagic species, and two species of sturgeon. The USACE has prepared an EFH determination (refer to Appendix F) for this draft FR/EA. Results of the consultation will be reported in the final FR/EA. Refer to Chapter 2, for additional discussion regarding EFH within the proposed action area.

7.10 Marine Mammal Protection Act of 1972

The Marine Mammal Protection Act (MMPA) of 1972 (16 United States Code 1361-1407) restricts harassment of marine mammals and requires interagency consultation in conjunction with the ESA consultation for federal activities. All marine mammals are protected under the MMPA regardless of whether they are endangered, threatened, or depleted. The primary concern for protection of marine mammals is underwater noise from construction. The USACE will consult with NMFS on effects to marine mammals in conjunction with the ESA Section 7 consultation. The USACE anticipates implementing all practicable conservation measures and will use BMPs as appropriate to avoid and minimize impacts of noise to marine mammals.

7.11 Migratory Bird Treaty Act of 1918 and Executive Order 13186 Migratory Bird Habitat Protection

The Migratory Bird Treaty Act (16 United States Code 703-712) as amended protects over 800 bird species and their habitat, and commits that the United States will take measures to protect identified ecosystems of special importance to migratory birds against pollution, detrimental alterations, and other environmental degradations. Executive Order (EO) 13186 directs federal agencies to evaluate the effects of their actions on migratory birds, with emphasis on species of concern, and inform the USFWS of potential negative effects to migratory birds. Implementation of restoration would not have any negative effects to migratory bird habitat and would provide positive impacts on feeding habitat.

7.12 National Historic Preservation Act of 1966

In accordance with Section 106 of the National Historic Preservation Act of 1966, the USACE carried out consultation with the New Jersey State Historic Preservation Office (NJSHPO), the New York State Historic Preservation Office (NYSHPO), the New York City Landmarks Preservation Commission (NYCLPC), upon completion of the Cultural Resources Overview for the HRE in 2014 (Harris, 2014). The USACE met with the NJSHPO in May of 2016 to discuss the National Economic Development plan and the need for development of a Programmatic Agreement (PA) that would outline the steps that the USACE shall take when the project is authorized and additional funds become available to ensure the project is in compliance with Section 106 of the National Register of Historic Places.

Two PAs were prepared that detail the steps that will be taken to identify resources and determine and address adverse effects to significant historic resources. Separate agreements were prepared for the

TSP sites in New Jersey and New York to allow for independent coordination as these project elements move forward toward construction (Appendix I).

The PAs are to be entered into minimally by the USACE and the state historic preservation offices. The Advisory Council on Historic Preservation, the Delaware Nation, Delaware Tribe of Indians, the Shawnee and Eastern Shawnee Tribes of Oklahoma, the Stockbridge Munsee, and the Shinnecock Tribe were invited to review and participate in the PAs as well. Additional public involvement will be conducted as part of the public review of the environmental assessment and the PA under NEPA and will serve as the USACE's Section 106 public coordination. The final PA will incorporate comments on the draft document, as appropriate.

7.13 Executive Order 11988 Floodplain Management

This EO directs federal agencies to evaluate the potential effects of proposed actions on floodplains. Such actions should not be undertaken that directly or indirectly induce growth in the floodplain unless there is no practicable alternative. The Water Resources Council Floodplain Management Guidelines for implementation of EO 11988, as referenced in USACE ER 1165-2-26, require an eight-step process that agencies should carry out as part of their decision making on projects that have potential impacts on or within the floodplain. The eight step assessment is as follows:

1. **Determine if the proposed action is in the base floodplain.** The proposed actions are located within the base floodplain for the Bronx, Hackensack and Passaic Rivers.

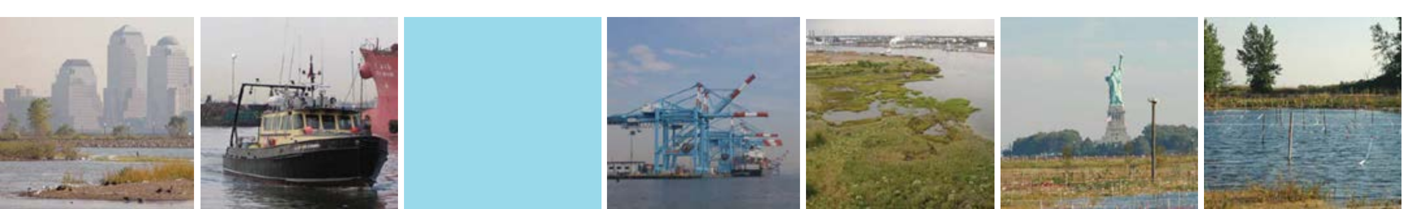
2. **If the action is in the floodplain, identify and evaluate practicable alternatives to locating in the base floodplain.** As the primary objective of the project is aquatic ecosystem restoration, no practicable alternatives are completely outside of the base floodplain for the sites that would achieve this objective.

3. **Provide public review.** The proposed projects in the TSP were coordinated with the public, government agencies, and interested stakeholders.

4. **Identify the impacts of the proposed action and any expected losses of natural and beneficial floodplain values.** Practicable measures and alternatives were formulated and potential impacts and benefits were evaluated in Chapter 5 of this document. The anticipated impacts associated with the TSP are summarized. While construction of project features would result in mostly minor and temporary adverse impacts to the natural environment, the proposed restoration would result in a substantial and long-term increase in habitat values including an increase in the quantity and quality of riparian and aquatic habitat. For each resource analyzed in Chapter 5, wherever there is a potential for adverse impacts, appropriate best management practices or other environmental considerations were identified. As there is a net benefit to biological resources, no mitigation is required for the TSP.

5. **Minimize threats to life and property and to natural and beneficial floodplain values. Restore and preserve natural and beneficial floodplain values.** Implementing the TSP would have no significant flooding impacts on human health, safety, and welfare.

6. **Reevaluate alternatives.** Chapters 3 and 4 of this document present an analysis of alternatives. As the primary objective of the project is aquatic ecosystem restoration, no practicable alternatives are completely outside of the base floodplain for the sites that would achieve this objective.



7. **Issue findings and a public explanation.** The public will be advised that no practicable alternative to locating the proposed action in the floodplain exists, as indicated in Item 2 above.

8. **Implement the action.** The proposed project does not contribute to increased development in the floodplain and does not increase flood risk, but rather it restores "natural and beneficial values." The TSP is consistent with the requirements of this Executive Order.

This assessment concludes that all practicable alternatives have been considered in developing the TSP, and that the main federal objective of reducing coastal flood risk cannot be achieved by alternatives outside the floodplain. Additionally, USACE has determined that the TSP does not induce direct or indirect floodplain development within the base floodplain.

7.14 Executive Order 11990 Protection of Wetlands

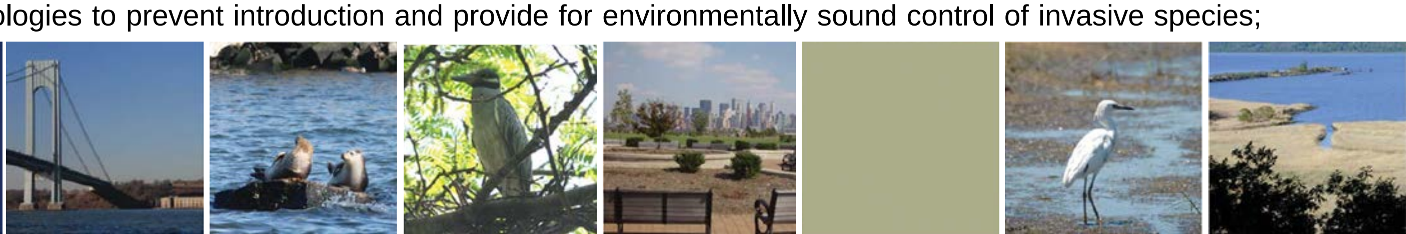
EO 11990, Protection of Wetlands, dated May 24, 1977, requires federal agencies to take action to avoid adversely impacting wetlands wherever possible, to minimize wetlands destruction, preserve the values of wetlands, and prescribe procedures to implement the policies and procedures of the executive order. In addition, federal agencies shall incorporate floodplain management goals and wetlands protection considerations into its planning, regulatory, and decision-making processes. One of the primary goals of the TSP is to restore wetlands that have been lost or degraded due to the presence of dikes, fill, armoring, and urban development. The proposed actions would be beneficial to wetlands, as a functional increase in habitat and water quality would occur.

7.15 Executive Order 12898 Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations

EO 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations" provides that each federal agency shall make achieving environmental justice part of its mission by identifying and addressing disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations. Environmental justice concerns may arise from impacts on the natural and physical environment, such as human health or ecological impacts on minority populations, low-income populations, and Indian tribes or from related social or economic impacts. The USACE evaluated the location and design of each restoration site to determine whether they would affect minority populations, low-income populations, and Indian tribes. The USEPA Environmental Justice Viewer was used to determine whether protected groups are present in the proposed restoration areas. Based on a demographic analysis of the study area and based on findings of an environmental justice review, the TSP would not have a disproportionately high and adverse impact on any low-income or minority population. USACE has determined that the TSP will provide short- and long-term benefits to the disappropriated populations adjacent to the areas where restoration activities would occur.

7.16 Executive Order 13112 Invasive Species

This EO states that each federal agency whose actions may affect the status of invasive species shall, to the extent practicable and permitted by law, use relevant programs and authorities to: (i) prevent the introduction of invasive species; (ii) detect and respond rapidly to and control populations of such species in a cost-effective and environmentally sound manner; (iii) monitor invasive species populations accurately and reliably; (iv) provide for restoration of native species and habitat conditions in ecosystems that have been invaded; (v) conduct research on invasive species and develop technologies to prevent introduction and provide for environmentally sound control of invasive species;



and (vi) promote public education on invasive species and the means to address them. This TSP includes removal of invasive species and establishment of native habitat, and is in compliance with this EO.

7.17 State Laws & Regulations

Habitat restoration projects in the HRE also are subject to regulation by individual New York and New Jersey state statutes and permitting authorities. The NYSDEC regulates activities in tidal wetlands under Environmental Conservation Law Article 25, freshwater wetlands under Environmental Conservation Law Article 24, and both resources under the State Environmental Quality Review Act (6 New York Codes, Rule, and Regulations Part 617). The TSP implementation projects will involve federal funds, triggering review under the provisions of the NEPA of 1969, as amended (42 United States Code 4321 et seq.). Further, some of the projects also may be subject to the provisions of the State Environmental Quality Review Act in New York. Projects within New York City may be subject to the provisions of the City Environmental Quality Review program, which specifies that city actions must be evaluated for the potential to affect freshwater wetlands, tidal wetlands, and associated buffer zones.

NYSDEC regulates activities in tidal wetlands according to the Tidal Wetlands Land Use Regulations, administered by the state's Freshwater and Tidal Wetlands Program. Tidal wetlands have a 300-foot regulated adjacent area landward of the wetland boundary. The adjacent area width for tidal wetlands within the five boroughs of New York City is 150 feet. Freshwater wetlands regulated by NYSDEC are generally over 12.4 acres (5.0 hectares) in size and have an additional 100-foot-wide regulated buffer zone or adjacent area emplaced around them. While New York State's wetland regulations generally apply to freshwater wetlands more than 12.4 acres (5.0 hectares) in size, a municipality can petition NYSDEC to designate individual, smaller wetlands as wetland of "unusual local importance," hence affording them regulatory protection under state law. New York's Significant Coastal Fish and Wildlife Habitats Program, administered by the New York State Department of State, designates coastal fish and wildlife habitats to be protected, preserved, and, where practical, restored so as to maintain their viability.

The NJDEP Bureau of Tidelands Management regulates activities in tidal waters under the Waterfront and Harbor Facilities Act of 1914 (New Jersey Statutes Annotated 12:5-3), Coastal Areas Facility Review Act of 1973 (New Jersey Statutes Annotated 13:9-1 et seq.), and Wetlands Act of 1970 (New Jersey Statutes Annotated 13:9A-1 et seq.). Under these authorities, the state requires that construction activities, such as dredging, filling, bulkhead construction, and pier construction, in tidal waters of the state first secure a waterfront development permit from the NJDEP, as well as a tidelands license from the NJDEP Bureau of Tidelands Management. New Jersey also requires an Acceptable Use Determination, issued by NJDEP, for any proposed use or disposal of dredged material in state waters.

NJDEP's Division of Land Use Regulation oversees activities within or near freshwater wetlands under the Freshwater Wetlands Protection Act. NJDEP emplaces regulated freshwater wetland adjacent areas based on the resource value: 150 feet for exceptional value wetlands, 50 feet for intermediate value wetlands, and no adjacent area for ordinary value wetlands. Exceptional value wetlands are typically those that drain to trout production waters or provide habitat for endangered or threatened species.

Chapter 8: Summary of Coordination, Public Views, and Comments

Throughout any planning effort, the U.S. Army Corps of Engineers (USACE) strives to inform, educate, and involve the many groups who may have an interest in proposed action. This coordination is paramount to assuring that all interested parties have the opportunity to be part of the planning process. USACE has been working together with federal, state, and local agencies, non-governmental organizations, academic institutions and stakeholders throughout the implementation of the Hudson Raritan Estuary (HRE) Ecosystem Feasibility Study, the development of the HRE Comprehensive Restoration Plan (CRP) since 2003 and the “source” studies that have been integrated into this Draft Integrated Feasibility Report and Environmental Assessment (FR/EA). Substantial coordination throughout the program has resulted in a consensus restoration plan for the region, a strategy for advancing restoration priorities within the region and unprecedented support garnered for HRE restoration. The collaborative approach taken for the study, in accordance with Engineering Circular 1105-2-409 (Planning in a Collaborative Environment), has been touted as an excellent national example of extensive public outreach and collaboration.

8.1 Public Coordination

Key coordination with partners throughout the HRE Restoration Feasibility Study Program (including “source studies”) is summarized below and includes:

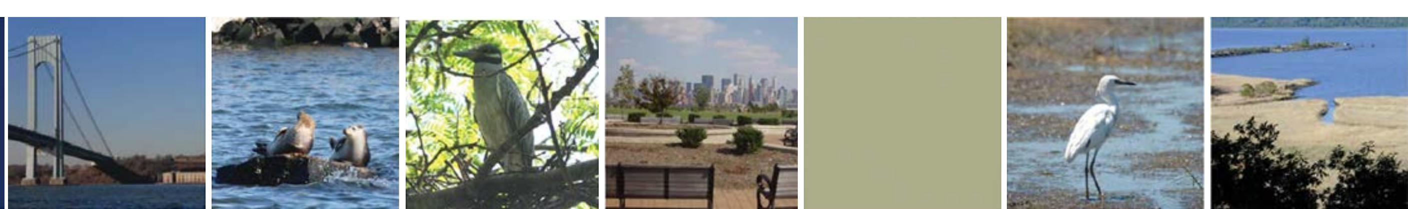
8.1.1 Jamaica Bay, Marine Park, and Plumb Beach Ecosystem Restoration Feasibility Study: 1998-2005

This study had included an extensive collaborative effort to reach out and include the needs/concerns of the general public as well as a myriad of government agencies from the City to the federal level. Site selection in Jamaica Bay was focused through numerous meetings with various agencies and local community boards in late 1998. In May 1999, a newsletter was published and mailed to interested parties as a way to introduce the project before the formal public meetings. Also in May 1999, interviews were conducted with stakeholders including community board members, local environmental interest groups, and city officials to gather an understanding of local issues and a general level of interest in the restoration of Jamaica Bay. Two (2) public meetings were held in June 1999 to discuss Jamaica Bay Feasibility Study and gather further public feedback on the initial stages of the project.

Numerous informal presentations had been given at public and professional forums regarding the ongoing studies and plans for Jamaica Bay. Special attention was paid to providing ongoing updates at regularly scheduled meetings of the Jamaica Bay Taskforce, an outreach group attended by government agencies, community groups and individuals with interest and/or responsibility for the bay. These meetings occurred on a roughly quarterly basis and provided an active and ongoing forum to continually engage the communities and agencies.

An interagency team conducted the background existing conditions inventories and research for this project. The Jamaica Bay Ecosystem Research and Restoration Team included individuals from many local universities and colleges, as well as the National Park Service (NPS), USACE, the Wildlife Conservation Society, the American Museum of Natural History, local engineering firms, and the New York City Butterfly Club. The Jamaica Bay Ecosystem Research and Restoration Team report was completed in 2002.

All steps of the process allowed for input from various agencies and local constituents, in addition to the non-federal sponsor New York City Department of Environmental Protection (NYCDEP). Meetings were

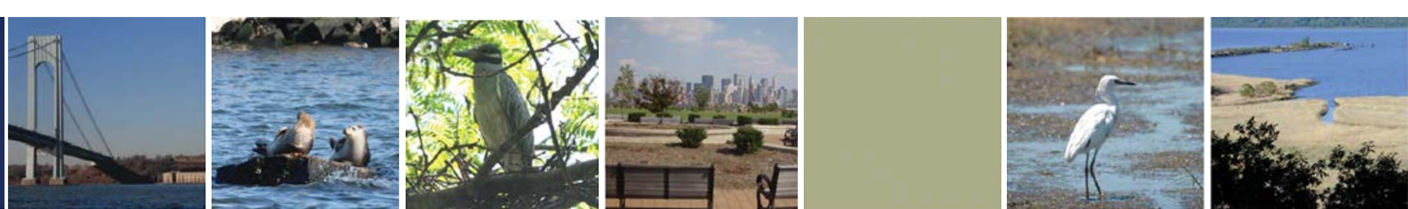


held to discuss site selection, concept plan creation, background research, project direction, and project progress to create an open forum with partner agencies and stakeholders. Table 8.1 is a summary of some of the meetings that occurred to discuss the Jamaica Bay, Marine Park and Plumb Beach Feasibility Study. Additional meetings

Table 8-1: Summary of interagency meetings held regarding the Jamaica Bay Feasibility Study

Date	Jamaica Bay Study Meetings
07-Dec-98	Site selection meetings with United States Fish and Wildlife Service (USFWS), National Oceanographic and Atmospheric Administration (NOAA), New York State Department of Environmental Conservation (NYSDEC), NPS, and United States Environmental Protection Agency (USEPA)
15-Dec-98	Presentation of sites and continued site selection process with NOAA, NPS, USEPA, NYCDEP, New York City Department of Parks and Recreation (NYC Parks), and local citizens.
May-99	Jamaica Bay Ecosystem Restoration Project Update Newsletter
07-May-99	Interviews with stakeholders from Queens CB 10
13-May-99	Interviews with stakeholders from Queens CB 14
13-May-99	Interviews with stakeholders from the Friends of Rockaway
20-May-99	Interviews with stakeholders from Brooklyn CB 15
25-May-99	Interviews with stakeholders from the Jamaica Bay Task Force and New York City Soil & Water Conservation District
22-Jun-99	Site visit with USEPA, USFWS, NOAA, NPS, NYSDEC, New York State Department of State and others
29-Jun-99	Public meeting in Howard Beach
30-Jun-99	Public meeting in Rockaway Park
8-Feb-00	Jamaica Bay Task Force Meeting, study update
20-Mar-00	Research meeting on marsh change in Jamaica Bay with NPS, United States Geological Survey, NYSDEC, and Columbia University.
09-Aug-00	Jamaica Bay Ecosystem Research and Restoration Team progress and direction meeting with all the constituents (colleges, NPS, environmental groups, etc)
22-Sep-00	Jamaica Bay site visit with Representatives from Congress, local community boards, NYCDEP, NYSDEC, NPS, USEPA, NOAA, Port Authority of New York and New Jersey (PANYNJ), Baykeeper, New York City Economic Development Corporation (NYCEDC), and USFWS
28-Nov-00	Meeting with NYCDEP and the Queen Borough President
25-Apr-01	Jamaica Bay EcoWatchers meeting and site visit discussing marsh loss in Jamaica Bay
01-May-01	Blue Ribbon Panel of Scientists discussion on investigating sea level rise and marsh loss and contributing factors in Jamaica Bay

Date	Jamaica Bay Study Meetings
22-May-01	A large interagency meeting held with NYSDEC, USEPA, NYCDEP, NPS, United States Department of Agriculture National Resources Conservation Service, PANYNJ, contractors, and several local colleges and universities
26-Jul-01	Jamaica Bay EcoWatchers meeting, included Jamaica Bay project updates
10-Dec-01	Jamaica Bay Task Force Meeting, included a Blue Ribbon Panel update and discussion on the Jamaica Bay estuary reserve legislation
11-Apr-02	Mosquito Task Force meeting with NYSDEC, Community Board members, New York City Department of Health, NYC Parks, New York State Department of State, New York State Office of Parks, Recreation and Historic Preservation, NPS, New York State Senate, New York State Department of Health, and NYCDEP
24-Jun-02	Jamaica Bay Task Force Meeting, including a study update
01-Nov-02	Site evaluation with NPS and other agencies
13-Jan-03	USFWS program review of Jamaica Bay and other USACE projects
27-May-03	Site visits with property owners including NPS, NYC Parks, New York State Office of Parks, Recreation and Historic Preservation for concept plan selection
28-May-03	Site visits with property owners including NPS, NYC Parks, New York State Office of Parks, Recreation and Historic Preservation for concept plan selection
04-Jun-03	Site visits and finalization of draft conceptual plans with NPS, NYCDEP
23-Sep-03	Site visits with agencies including NPS, NYC Parks, USEPA, NYCDEP, and USFWS to discuss site plans
16-Feb-05	Jamaica Bay Task Force Meeting to discuss Jamaica Bay draft concept plans
7-Dec-10	Alternative Formulation Briefing with HQUSACE and obtained approval on Tentatively Selected Plan
11-Mar-13	Meeting with NYSDEC to discuss contamination at the 8 restoration sites
16-Sept-13	Jamaica Bay Stakeholder Outreach Meeting to discuss study progress as a Coastal Restoration project following inclusion in the Second Interim Report to Congress (May 2013). Meeting discuss restoration proposed at 8 sites with representatives from NPS, USEPA, USFWS, NYSDEC, PANYNJ, NYC Parks, NYCDEP, NMWA, Rockaways Waterfront Alliance, Jamaica Bay Ecowatchers, American Littoral Society, Environmental Defense Fund, NY/NJ Baykeeper, The Nature Conservancy, Hudson River Foundation, Eastern Queens Alliance, NYC Audubon, Rockaway Chamber of Commerce, Belle Harbor Yacht Club, StonyBrook University, Harbor Coalition, National Parks Conservation Association
5-Dec-13	Jamaica Bay Restoration and Hurricane Sandy Jamaica Bay/Rockaway Reformulation Study Coordination Partner meeting with NYSDEC, NYCDEP, NPS, NYC Mayor’s Office
16-Dec-13	Jamaica Bay Resilience Institute meeting to coordinate USACE coastal restoration and other ongoing partner efforts with NPS, NYSDEC, NYCDEP NYC Parks, NYC Mayor’s Office, Hunter College, CUNY



Date	Jamaica Bay Study Meetings
16-Jan-14	Agency coordination meeting on Jamaica Bay restoration following submittal of USACE Initial Assessment (January 2014)
2014-current	Many Jamaica Bay Science and Resilience Institute and agency coordination meetings on coastal restoration with Jamaica Bay/East Rockaway Reformulation Study and the HRE Feasibility Study (Section 8.1.5)

8.1.2 Bronx River Ecosystem Restoration Feasibility Study

Bronx River Basin Ecosystem Restoration Study Scoping Meeting: 2004

A scoping meeting was held to coordinate with local, county, state, and federal agencies and identify issues and concerns that may be associated within the Bronx River Basin and associated scoping document (USACE, 2004). The scoping document provided a description of potential opportunities for ecosystem restoration; a discussion of the existing water, biological, and cultural resources within the study area known to date; and a preliminary assessment of potential impacts and benefits of any action that may be recommended.

8.1.3 HRE- Lower Passaic River Ecosystem Feasibility Study: 1999- present

A governmental partnership between the USACE, USEPA, New Jersey Department of Transportation (NJDOT), NJDEP, NOAA and USFWS was initiated in 1999 to develop comprehensive solutions for remediation and restoration within the 17 miles of the Lower Passaic River and major tributaries within the watershed. The agencies planned to bring together the authorities of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA; Superfund) Program, Water Resource Development Act (WRDA), the Clean Water Act and other laws to improve the health of the river. In 2002, the Urban Rivers Restoration Initiative was launched and USEPA and the USACE signed a National Memorandum of Understanding (MOU) for the purpose of coordinating and planning the execution of urban river cleanup and restoration.

Dozens of meetings occurred between the USACE, NJDOT [non-federal sponsor] and USEPA to develop a joint/integrated WRDA and Superfund Project Management Plan; as well as dozens of meetings with all six (6) partners to develop a local Memorandum of Agreement and confidentiality agreement. The study officially was initiated in 2003 upon the execution of the Feasibility Cost Share Agreement (FCSA) between USACE and NJDOT.

In 2004, USEPA entered into an Administrative Order on Consent (AOC) with 31 Potential Responsible Parties (PRPs) to fund the Superfund portion of the Lower Passaic River Study. In 2005, 12 additional PRPs were added to the AOC for the Superfund portion of the study and all PRPs formed a group known as the “Cooperating Parties Group” which the agencies coordinated with throughout the study.

The partner agencies prepared a coordinated Community Involvement Plan for the “Lower Passaic River Restoration Project” and the USEPA Newark Bay Study (Malcolm Pirnie [MPI], USEPA and USACE, 2006) which considered community concerns and suggestions from interviews conducted by the agencies in 2004 and 2005 outlined in a Community Interview Report (MPI, 2005). The study also utilized the USEPA Technical Assistance Grant awarded to the Passaic River Coalition (PRC) to assist the community in the interpretation of technical documents generated by the project.

The Passaic River Community Advisory Group (CAG) that had been established for the Diamond Alkali Site was utilized throughout the study. The Passaic River CAG provides advice and recommendations to the USEPA and its partner agencies to help ensure a more effective and timely cleanup and restoration of the Lower Passaic River. USACE is a participating agency in monthly meetings in order to coordinate the HRE restoration goals as it pertains to the Lower Passaic River. Study information and reports were accessible and posted in a timely fashion on www.ourpassaic.org.

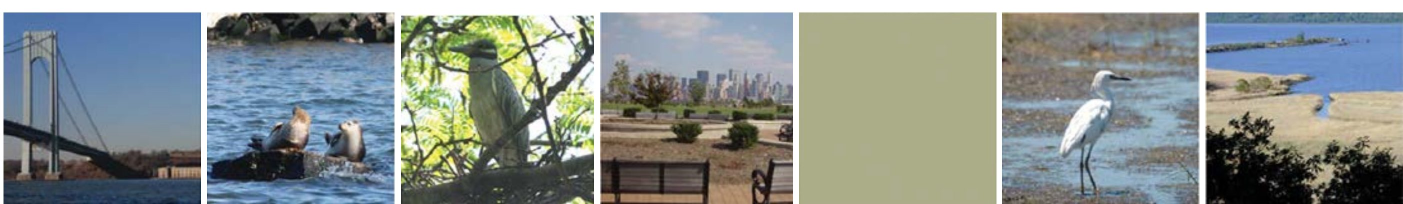
This study's unique governmental partnership held monthly meetings among all six (6) partner agencies in order to execute tasks to conduct the remedial investigation, restoration planning, environmental dredging pilot, decontamination technology pilots, the USEPA Focused Feasibility Study (river miles 0 to 8.3) and remaining investigation of the overall 17 miles. Work Groups were established for various parts of the study including:

- Lower Passaic River Restoration Work Group (2004-2006): Partner agencies, CPG, and environmental constituent groups (including NY/NJ Baykeeper, PRC, Ironbound Community Corporation, etc), City of Newark and others met periodically to discuss restoration opportunities and organizational priorities.
- Lower Passaic River Dredging and Decontamination Technology Pilot Work Group (2004-2005): Agencies and stakeholders held periodic meetings to plan and execute the environmental dredging pilot and decontamination technology pilots (including BioGenesis Soil Washing and Cement Lock).
- Remedial Options Work Group (2006-2012): Agencies, CPG, environmental constituent groups periodically met to discuss baseline remedial investigation data (contamination, hydrodynamics, sediment transport, pilot results) and feasibility options to determine clean up alternatives including dredging, capping, and disposal options (e.g., off-site, local decontamination or contained aquatic disposal).

Municipality Outreach Meetings (August 2007): Two (2) municipality outreach meetings, one for river miles 0 to 8 and one for river miles 8 to 17) were held to discuss the results of municipality surveys submitted by local officials from Bayonne, Elizabeth, Kearny, Harrison, Newark, East Newark, Belleville, Bloomfield, Nutley, East Rutherford, Rutherford, Clifton, Passaic County, Essex County. The surveys and outreach meetings were held to document and coordinate ongoing and future projects outlined in local master plans for the river shoreline (Figures 8-1 and 8-2).

Commercial Navigation Meeting (August 2009): USACE and USEPA hosted a meeting with Commercial Navigational Users of the Lower Passaic River to determine the navigational depths needed for their future use.

Lower Passaic River Symposium (2004, 2006, 2008, 2010, 2012, 2014 and 2016): The Passaic River Institute/Montclair University hosts biannual symposia featuring the Lower Passaic River Remedial Investigation and Feasibility Study to coordinate remediation, restoration and flood risk management within the Passaic River basin.



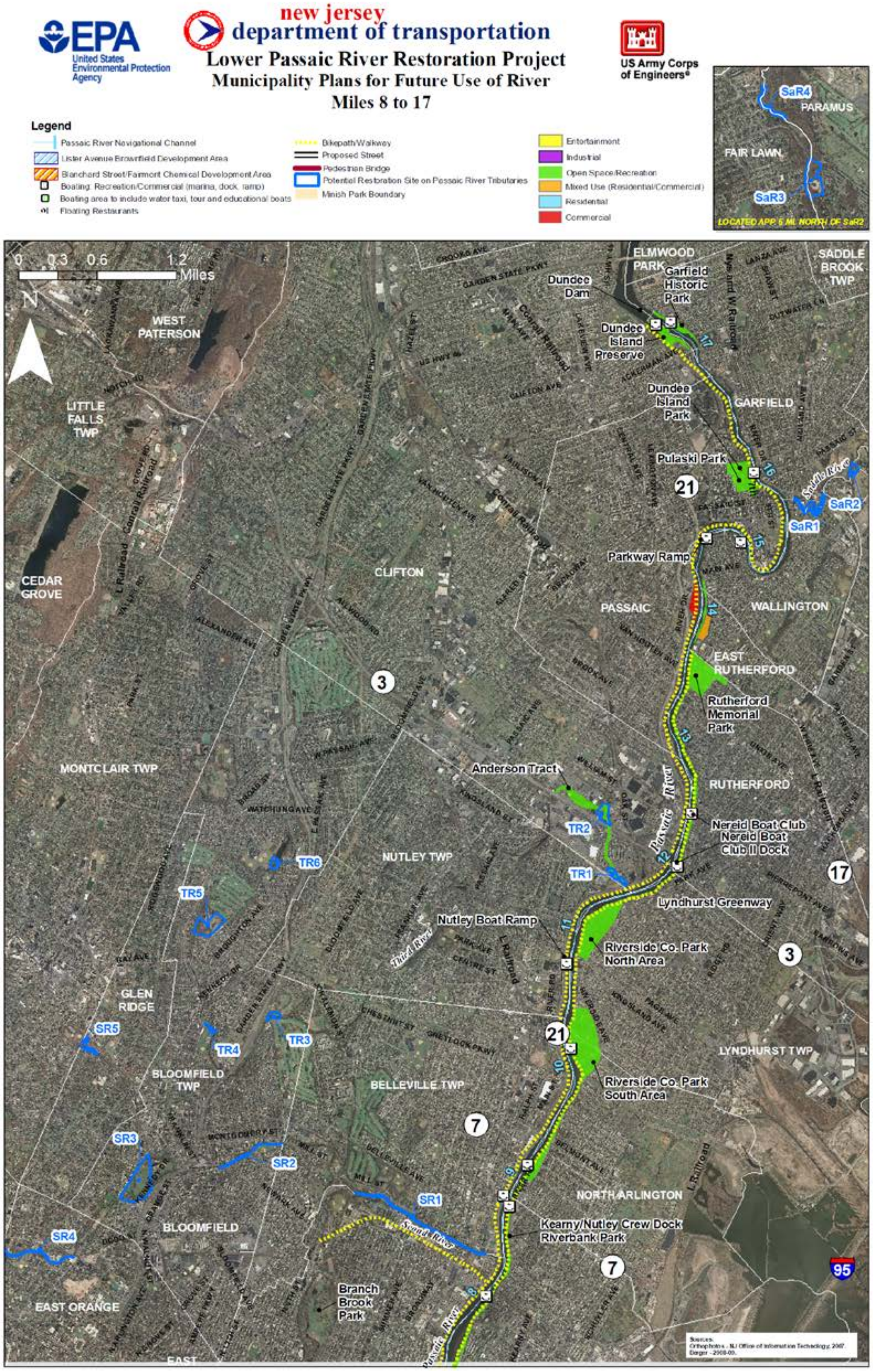


Figure 8-1: Lower Passaic River Restoration Project Miles 8 to 17

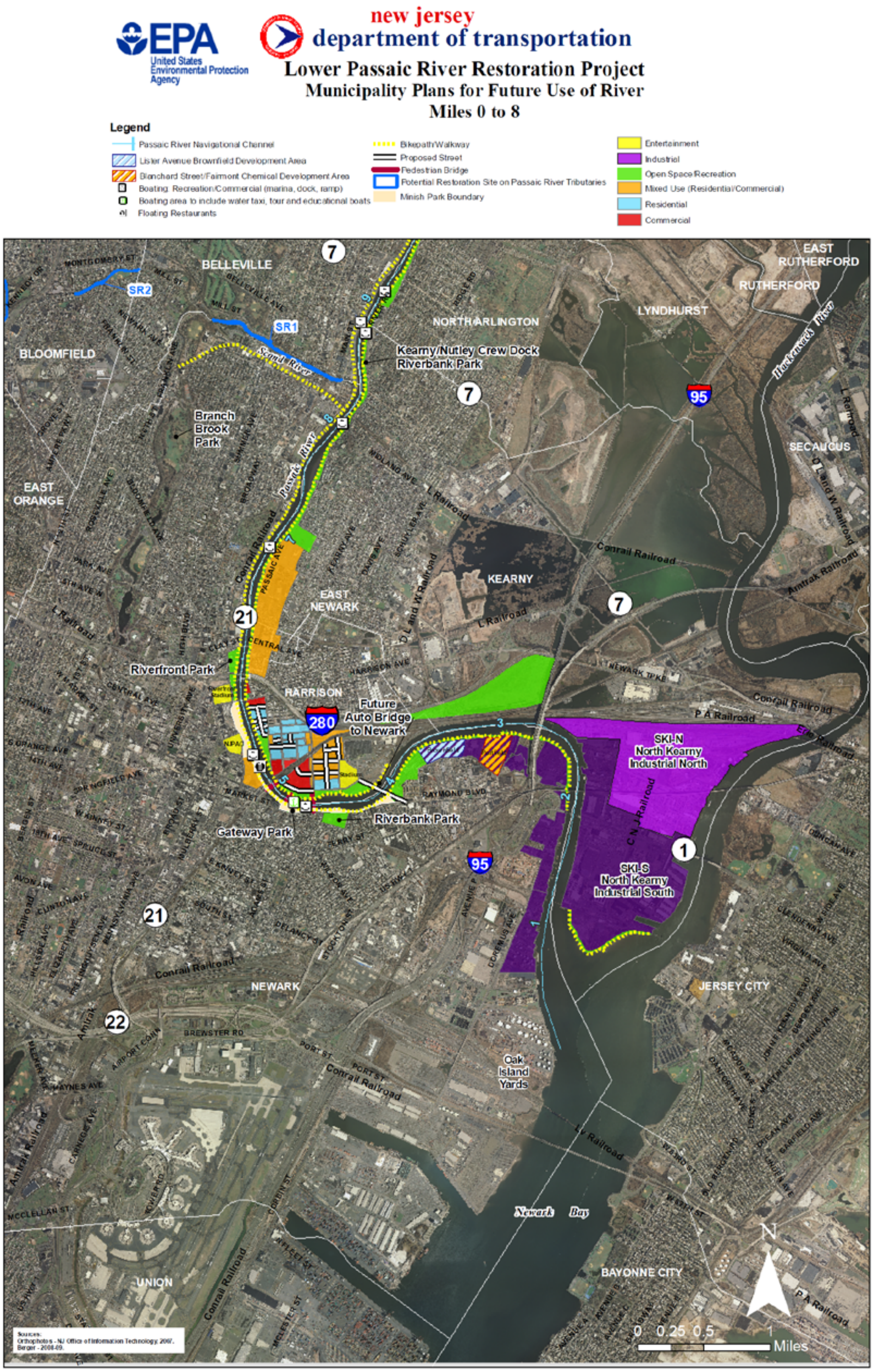


Figure 8-2: Lower Passaic River Restoration Project Miles 0 to 8

8.1.4 HRE- Hackensack Meadowlands Ecosystem Restoration Feasibility Study

Notice of Intents: 2004

Two (2) Notice of Intents for the preparation of an Environmental Impact Statement (EIS) were published in the Federal Register (Volume 69, No. 248) on December 28, 2004 for the HRE-Lower Passaic River Ecosystem Restoration Feasibility and HRE-Hackensack Meadowlands Ecosystem Restoration Feasibility Studies. Since that time, resource agency involvement through meetings, changes in plan formulation, and re-evaluation of the project, it was decided that an EIS was no longer necessary.

HRE-Hackensack Meadowlands Public Scoping and Stakeholder Meetings: 2005-2006

One (1) public scoping meeting and one (1) stakeholder meeting were held with Meadowlands stakeholders and partners to identify the needs (water resource problems) and potential restoration opportunities within the Meadowlands (USACE, 2003).

8.1.5 Hudson Raritan Estuary Ecosystem Restoration Feasibility Study

Needs and Opportunities Workshops: 2003

Multiple public outreach and workshops were held with the region's stakeholders and partners to identify the needs (water resource problems) and potential restoration opportunities throughout the HRE (USACE, 2003).

HRE Target Ecosystem Characteristics (TEC) Development: 2004-2005

Regional scientists and representatives from federal, state, local, non-governmental organizations and academic institutions participated in more than 14 workshops to identify the problems of the region, the habitats needing to be restored, regional restoration goals and near-term (2020) and long-term (2050) targets. These workshops enabled consensus on developing scientifically based regional goals and targets that formed the foundation of the planning objectives for this FR/EA and formed the vision for a restored estuary for all partners to work towards.

HRE CRP Development: **2006-2009**

The USACE New York District Team worked closely with the NY/NJ Harbor Estuary Program (HEP) and participated in quarterly meetings to identify restoration opportunity locations that had been nominated since 1994. Moreover, additional sites were identified using geographic information system (GIS) evaluation for each TEC and evaluated sites that provided opportunities to meet the overall CRP goal of "creating a mosaic of habitats.." throughout the HRE Study Area. These sites, representing known restoration opportunities, were subsequently evaluated for the FR/EA.

CRP Release and Coordination: 2009-2011

Following the release of the HRE CRP in March 2009 (USACE and PANYNJ, 2009a and b), the NY/NJ HEP Policy Committee agreed to adopt the HRE CRP as the consensus master plan for restoration for the region. Between that time and mid-summer 2012, the USACE, HEP, and their partners held public meetings in each of the HRE planning regions and participated in numerous local and National watershed conferences. The planning region outreach meetings were attended by the public and representatives from more than 100 different stakeholder organizations. Workshop participants contributed numerous comments and recommendations concerning the revision and future implementation of the CRP as a regional restoration strategy. Despite vastly diverse participant backgrounds and comments that reflected the broad geographic scope of the HRE, strong support for the CRP was evident at all meetings.

HRE CRP – TEC Workshop: May 2012

Many comments were obtained on the draft HRE CRP resulting from the significant public outreach that occurred over the subsequent two (2) years. The USACE and other participants from the original 14 TEC workshops were brought back together to discuss any changes to the restoration goals, TECs and the changes to the near-term and long-term targets.

NY/NJ HEP Restoration Work Group (RWG): 2009-current

The HEP RWG, chaired by the USACE, was formed for the sole purpose of managing the HRE CRP and coordinating restoration within the region to achieve the restoration goals outlined for the study. Representatives from partner agencies who participate on the RWG, were continuously consulted during plan formulation and site selection to identify regional priorities among the 296 sites identified in the HRE CRP. Given sponsor readiness is mandatory to recommend restoration sites in the HRE FR/EA, coordination with the RWG was helpful as sites advanced with FS-level design in the Feasibility Study. In addition, HEP RWG Partners reviewed Version 1.0 of the HRE CRP (USACE, 2016) solidifying the consensus nature of the HRE CRP.

As part of the charter of the HEP RWG, the group hosts a biannual restoration conference with the public highlighting partner progress for restoration, acquisition and public access efforts and advancements throughout the Harbor Estuary. To date, two (2) major symposia “Restoring the New York-New Jersey Harbor & Estuary” were held in June 2014 and June 2016. The symposia were attended by over 200 scientists, engineers, academics, and restoration professionals to discuss the progress of restoring the HRE and initiatives to continue improving the region’s ecological health and resiliency. Progress reports prepared by the RWG highlight the restoration efforts in the harbor estuary by partners, as well as the progress of the study (HEP, 2015)

Urban Waters Federal Partnership: 2011-current

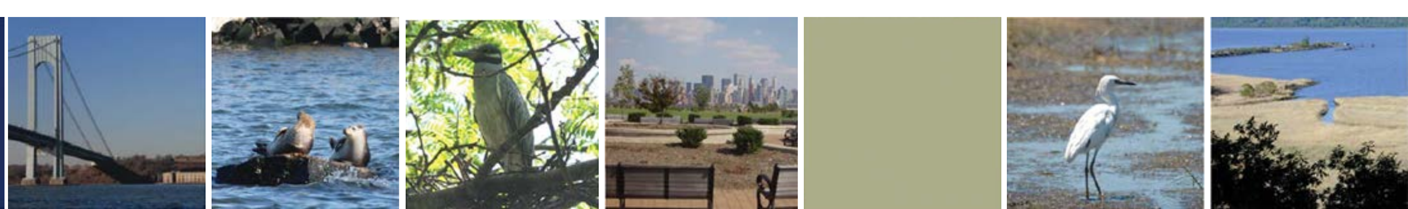
The Urban Waters Federal Partnership’s (UWFP) goal is to work closely with local partners to restore urban waterways and offers an opportunity to realize urban waterway and watershed revitalization goals that are larger than, and beyond the resources of any individual community, agency, or mission. Portions of two (2) planning regions (Newark Bay, Hackensack River and Passaic River and Harlem River, East River, and Western Long Island Sound) are represented within the Partnership’s program. Both the Lower Passaic River and the Bronx River/Harlem River are two project locations within the UWFP program. The USACE and USEPA are co-leads for the Lower Passaic River UWFP and have coordinated the restoration opportunities with other federal, state and local organizations within this program.

Science & Resilience Institute at Jamaica Bay (SRIJB): 2013-current

As a member of the Institute Public Agency Council, USACE representatives coordinate and better assess the resiliency investments that are needed and ongoing within Jamaica Bay. USACE used this forum to receive stakeholder input on the alternative formulation for the study.

Non-federal Sponsor Coordination during Plan Formulation (alternatives development) of the TSP (33 Restoration Sites): 2014-2016

- USACE coordinated with NYCDEP, NYC Parks and Bronx River Alliance during the alternatives development for the nine (9) Bronx River sites. Design Charrettes were held with NYCDEP, NYC Parks, and Bronx River Alliance (December 2015) and Westchester County Department of Planning (February 2016).
- USACE coordinated with NYCDEP to optimize the restoration designs for the Flushing Creek site from 2013 through 2016.



- In addition to ongoing partner coordination since 2003 with USEPA, NJDEP, NOAA and USFWS for the Superfund investigation on the Lower Passaic River, the USACE coordinated with NJDEP, Natural Resource Damage group to advance the Lower Passaic River restoration sites. A design charrette was held in July 2015 and field visits in August 2015 were held with NJDEP in order develop alternatives and determine sponsor readiness.
- USACE coordinated with NYSDEC, NYCDEP, NYC Parks and key stakeholders (including Jamaica Bay Guardian, Ecowatchers, American Littoral Society, Science and Resilience Institute at Jamaica Bay, among others) on the concept designs that were approved as the Tentatively Selected Plan at the Jamaica Bay Alternatives Formulation Briefing (held in 2010).
- USACE coordinated with non-federal sponsor New Jersey Meadowlands Commission (currently New Jersey Sports and Exposition Authority [NJSEA]) since 2003 on the site selection and design of Hackensack River restoration sites.
- USACE initially participated with more than 30 organizations on the Oyster Restoration Research Project in 2010 implementing oyster restoration pilots at five (5) locations in the HRE study area. Continued coordination occurred with NY/NJ Baykeeper, NY Harbor School, Hudson River Foundation and NYCDEP to advance small-scale oyster restoration designed and recommended in the FR/EA.

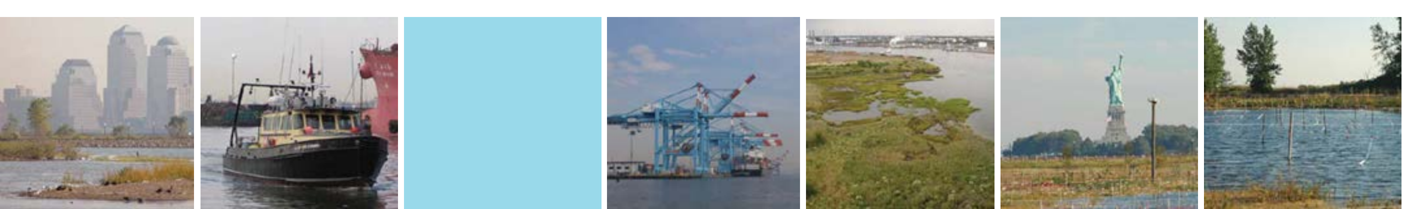
Collaborative planning will continue with the HEP RWG, which is composed of all of the study's non-federal sponsors, to advance the HRE CRP and advance the TSP that is recommended in this FR/EA. In addition, the HEP RWG will continue to coordinate, leverage programs and resources among the partners to influence federal and local investment for ongoing regional restoration. The USACE will also continue to coordinate with the RWG as the TSP is refined with more detailed designs and more accurate cost estimates are prepared for each site.

A summary of public comments received during the public review and comment period will be included in the final integrated feasibility report and environmental assessment.

Websites:
The public has also been made aware of study activities via two (2) study websites (http://www.nan.usace.army.mil/Missions/Navigation/New-York-New-Jersey-Harbor/HudsonRaritanEstuary/ and http://www.harborestuary.org/watersweshare/).

8.2 Views of the Non-federal Sponsors and Stakeholders

Significant support has been garnered as a result of all the partner and stakeholder coordination throughout the study. All non-federal sponsors during the feasibility studies and additional non-federal construction sponsors (identified in Section 8.1 and Table 1-X) are committed to advance restoration of the HRE. The TSP represents the highest priorities of the USACE and the non-federal sponsors. Appendix A includes letters of non-federal sponsor support to construct the sites recommended in the TSP.



Chapter 9: Recommendations

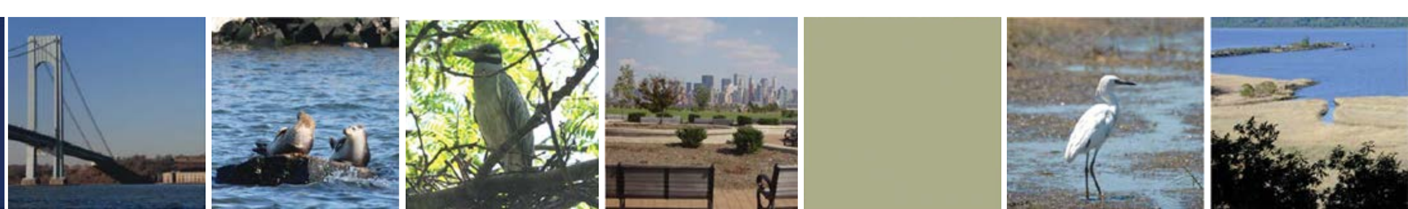
I recommend that the Tentatively Selected Plan (TSP) for ecosystem restoration in the Hudson-Raritan Estuary (HRE), New York and New Jersey as described in this report be authorized as a federal project, with such modifications thereof at the discretion of the Commander, U.S. Army Corps of Engineers (USACE) Headquarters, may be advisable. This TSP satisfies the recommendation for the HRE Ecosystem Restoration Feasibility Study as well as the following feasibility studies:

- Jamaica Bay, Marine Park, Plumb Beach Ecosystem Restoration Feasibility Study.
- Flushing Creek and Bay Ecosystem Restoration Feasibility Study.
- Bronx River Basin Ecosystem Restoration Feasibility Study.
- HRE-Lower Passaic River Ecosystem Restoration Feasibility Study.
- HRE-Hackensack Meadowlands Ecosystem Restoration Feasibility Study.

I have given full consideration to all significant aspects of this recommendation in the overall public interest including environmental, social, and economic effects; and engineering feasibility. The TSP includes the restoration of up to 33 sites throughout the estuary that will provide for an increase in the quality and extent of estuarine, freshwater riverine, marsh island and oyster habitat. The sites that are recommended for construction authorization are presented in Table 9-1 per cost allocation with non-federal sponsors specified in Table 4-21.

Table 9-1: Restoration Sites Recommended for Construction.

Location	Recommended Restoration	Site
Jamaica Bay Planning Region		
Jamaica Bay	Estuarine Habitat Restoration	• Dead Horse Bay • Fresh Creek • Hawtree Point • Bayswater Point State Park • Dubos Point • Brant Point
	Jamaica Bay Marsh Island Restoration	• Stony Creek • Duck Point • Elders Point Center • Pumpkin Patch East • Pumpkin Patch West
	Small-Scale Oyster Restoration	• Jamaica Bay, Head of Bay
Harlem River, East River, and Western Long Island Sound Planning Region		
Flushing Creek	Estuarine Habitat Restoration	• Flushing Creek

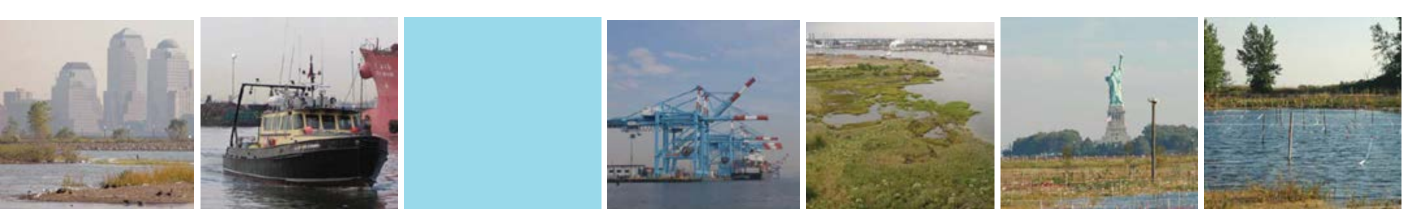


Location	Recommended Restoration	Site
Bronx River	Freshwater Riverine Habitat Restoration	• River Park/West Farm Rapids Park • Bronx Zoo and Dam • Stone Mill Dam • Shoelace Park • Muskrat Cove • Bronxville Lake • Crestwood Lake • Garth Woods/Harney Road • Westchester County Center
	Small-Scale Oyster Restoration	• Soundview Park
Newark Bay, Hackensack River, and Passaic River Planning Region		
Hackensack River	Estuarine Habitat Restoration	• Metromedia Tract • Meadowlark Marsh
Lower Passaic River	Tier 2 Estuarine Habitat Restoration	• Oak Island Yards • Kearny Point
	Freshwater Riverine Habitat Restoration	• Essex County Branch Brook Park • Dundee Island Park • Clifton Dundee Canal Green Acres
Upper Bay Planning Region		
Upper New York Bay	Small-Scale Oyster Restoration	• Bush Terminal • Governors Island
Lower Bay Planning Region		
Sandy Hook Bay	Small-Scale Oyster Restoration	• Naval Weapons Station Earle

The TSP is the National Ecosystem Restoration (NER) Plan that provides positive ecosystem and social benefits that support the USACE's restoration mission. Restoration measures were developed to restore ecosystem function while recognizing the urban nature of the existing environment. Each site is incrementally justified and a cost-effective approach. Each site meets the study planning objectives for ecosystem restoration of National and regionally significant resources. All recommended sites are considered best buy plans. Finally, all optimize the restoration measures for different levels of output.

As documented in this report, no significant environmental impacts would occur as a result of implementation of the TSP. Pending completion of public and State and Agency Review, a Finding of No Significant Impact (FONSI) will be prepared as part of the final recommendation (Appendix R). The plan includes monitoring until ecological success criteria are met, for no more than 10 years, and adaptive management as described in this document. A Final Operations, Maintenance, Repair, Replacement, and Rehabilitation plan will be established upon completion of each project.

The TSP will provide for the restoration of up to 360 acres of estuarine wetland habitat, 12 acres of freshwater riverine wetland habitat (providing an estimated 1970 net increase in average annual functional capacity units [AAFCUs]), 81 acres of coastal and maritime forest habitat, 5.5 acres of riparian forest habitat, and 57 acres of oyster habitat. Two (2) fish ladders would be installed and three (3) weirs would be modified to re-introduce or expand fish passage along the Bronx River along with 3.83 miles of bank stabilization and 2.35 miles of stream channel restoration for the freshwater sites.



The TSP is estimated with a first cost of $644,170,000 (2016 price level). The fully funded costs will be the basis for the Project Partnership Agreements.

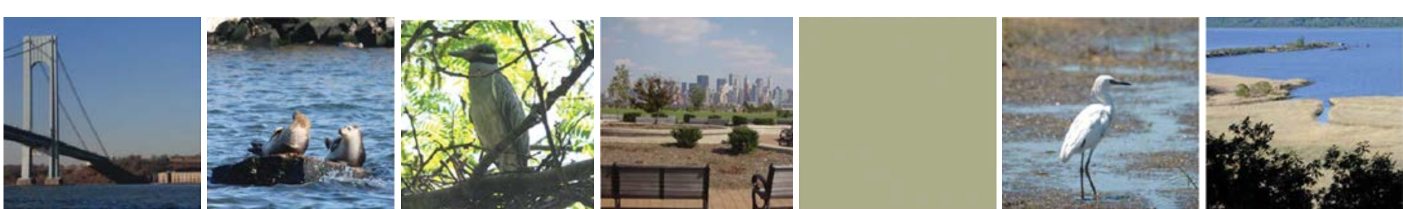
The TSP supports HRE program objectives and restoration goals in the HRE (Tables 4-17 through 4-20). It compliments past, ongoing, and planned restoration work by the USACE and other parties as described in the HRE Comprehensive Restoration Plan (CRP). In order to fully address the restoration needs of the HRE, I also recommend that the USACE participate in additional future restoration feasibility studies identified in the HRE Comprehensive Restoration Plan via the study authorization.

My recommendation is made with the provisions that the non-federal sponsors will:

a. Provide to the United States all necessary lands, easements, rights-of-way, relocations, and suitable borrow and/or disposal areas deemed necessary by the United States for initial construction and subsequent maintenance of the project.
b. Hold and save the United States free from claims for damages that may result from construction and subsequent maintenance, operation, and public use of the project, except damages due to the fault or negligence of the United States or its contractors.
c. Maintain continued public ownership and public use of the shorefront areas upon which the amount of Federal participation is based during the economic life of the project.
d. Provide and maintain necessary access roads, parking areas, and other public use facilities open and available to all on equal terms.
e. Contribute the local share of non-Federal costs for initial construction and operation and maintenance over the economic life of the project, as required to serve the intended purposes.
f. Acquire, rehabilitate, repair, replace, operate and maintain easements for public access to areas created or enhanced by the project upon completion of each project feature, as applicable. The cost of the operation and maintenance of these easements will be the responsibility of the non-Federal sponsors.

The recommendations contained herein reflect the information available at this time and current Department of the Army policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to the United States Congress as proposals for authorization and implementation funding. However, prior to transmittal to the Congress, the sponsor, the states, interested federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

David A. Caldwell
Colonel, U.S. Army
Commander and District Engineer



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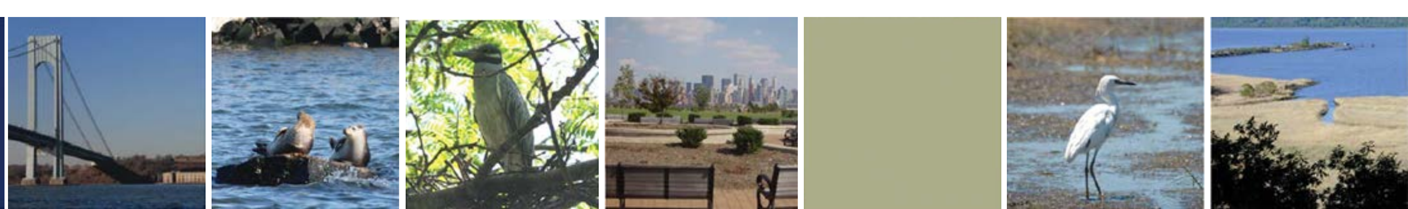

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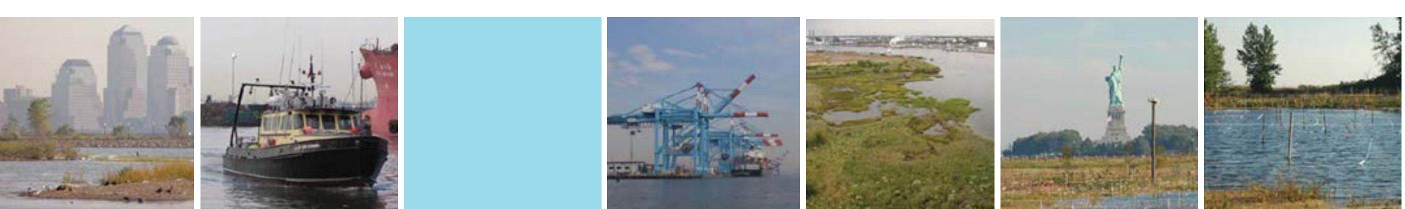

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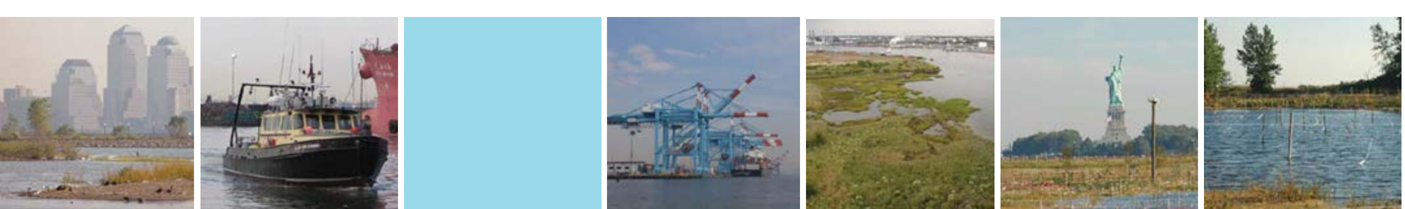

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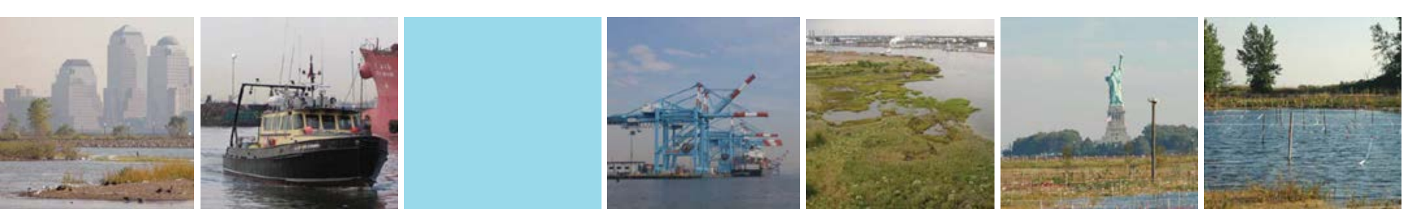

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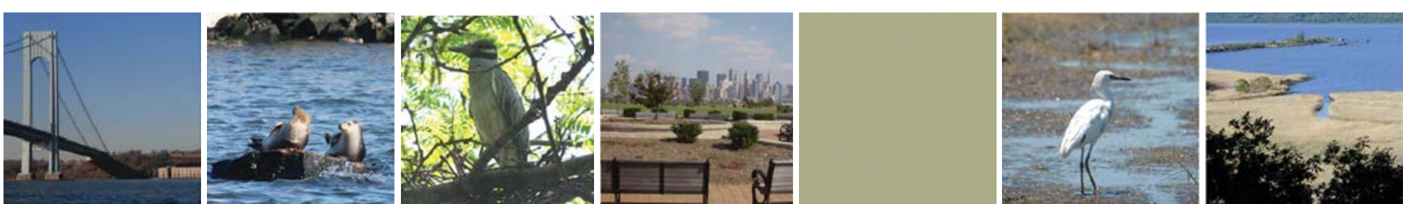

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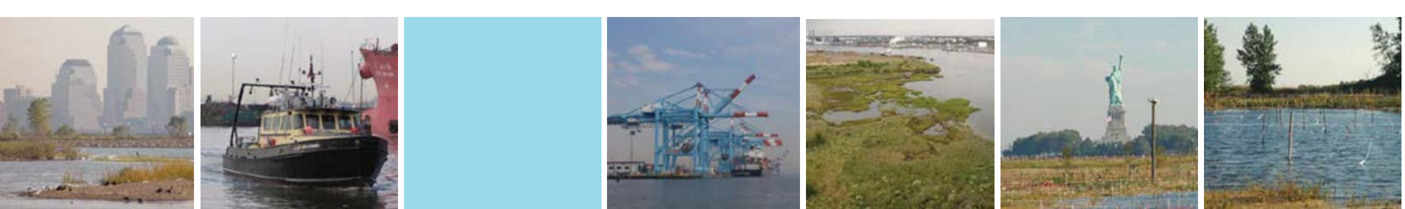

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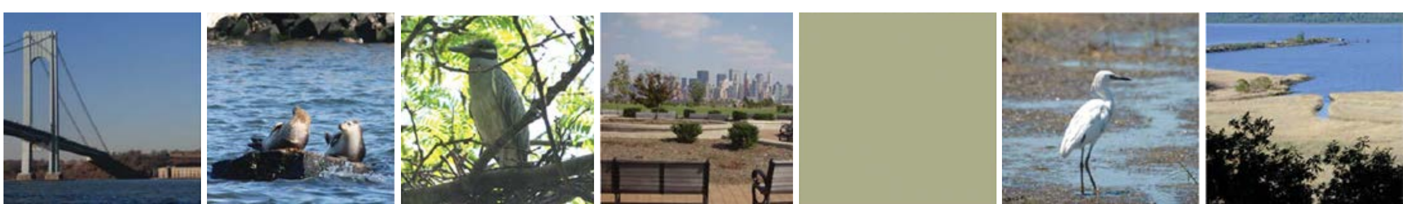

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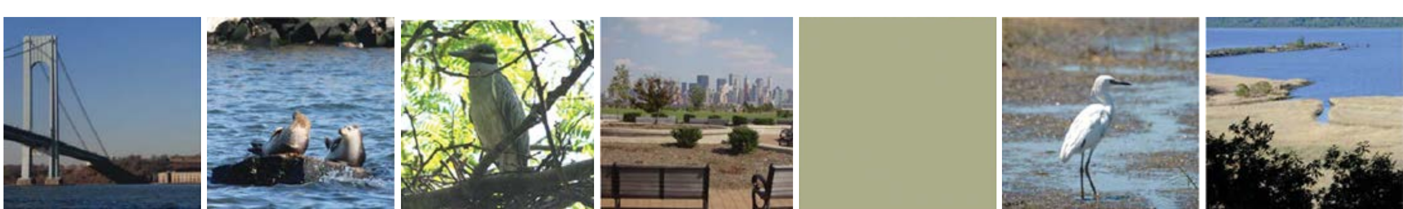

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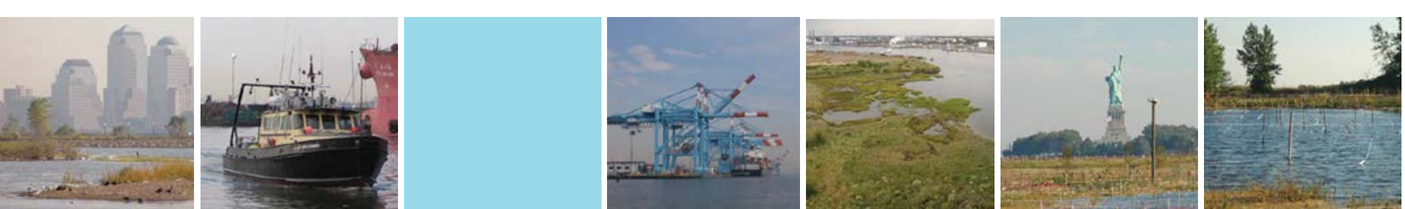

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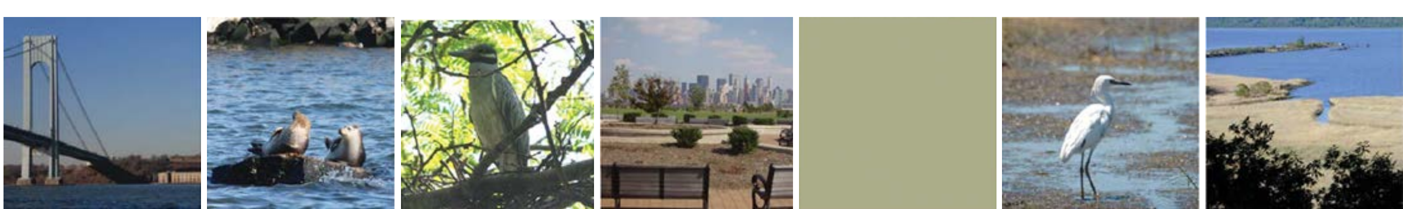

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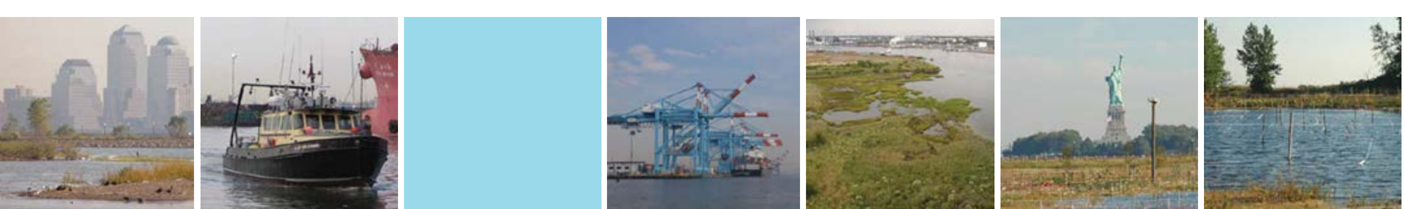

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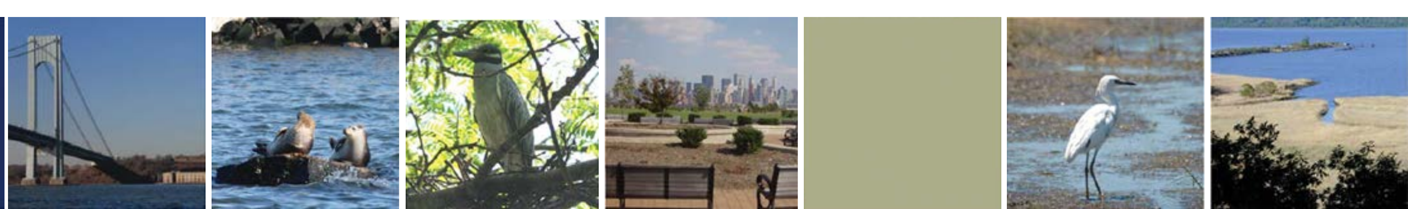

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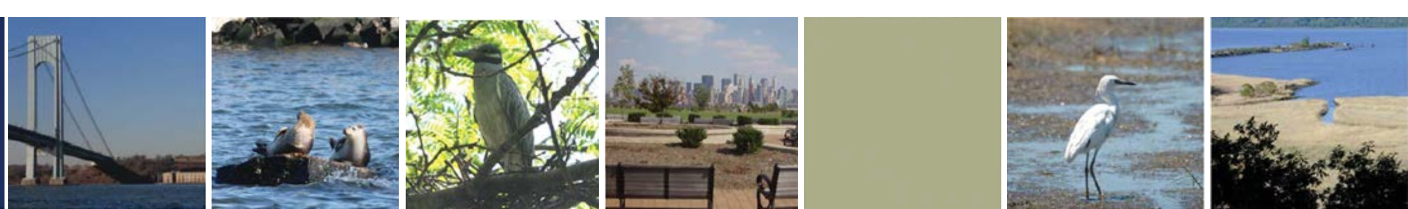

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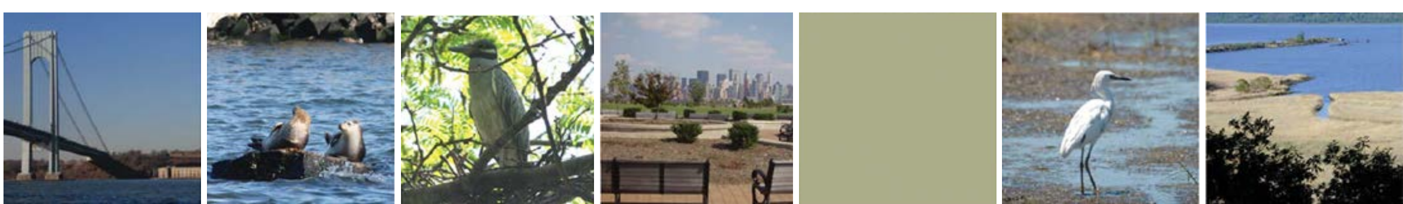

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Rei-Hua Wang	B.S. Environmental Science / 9 Years	Scientist - Preparer
Karen Appell	B.S. Agricultural and Biological Engineering / 17 Years	Ecological Engineer – Preparer
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List of Preparers

Name	Education/Experience	Responsibility
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James Trotta	B.A., Geology/ 6 Years	Geologist- Preparer
Alice Chapman	B.A., Chemistry, Geology/ 2 Years	Geochemist- Preparer

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